praveen kumar

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Praveen Kumar

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INSIGHT GENERAL STUDIES

TOPIC

1

WAVETHEORY

Categories of Waves
Waves come in many shapes and forms. While all waves share some basic characteristic properties and behaviours, some waves canbe distinguished from others based onsome observable (and some non-observable) characteristics. It is common to categorize waves based on these distinguishing characteristics.
Longitudinal versus Transverse Waves versus Surface Waves
One way to categorize waves is on the basis of the direction of movement of the individual particles of the medium relative to the direction that the waves travel. Categorizing waves on this basis leads to three notable categories: transverse waves, longitudinal waves, and surface waves.
Transverse Wave
• A transverse wave is a wave in which particles of the medium move in a direction perpendicular to the direction

that the wave moves. Suppose that a slinky is stretched out in a horizontal direction across the classroom and that a pulse is introduced into the slinky on the left end by vibrating the first coil up and down. Energy will begin to be transported through the slinky from left to right.

• As the energy is transported from left to right, the individual coils of the medium will be displaced upwards and downwards. In this case, the particles of the medium move perpendicular to the direction that the pulse moves. This type of wave is a transverse wave. Transverse waves are always characterized by particle motion being perpendicular to wave motion.

Longitudinal Wave
• A longitudinal wave is a wave in which particles of the medium move in a direction parallel to the direction that the wave moves. Suppose that a slinky is stretched out in a horizontal direction across the classroom and that a pulse

is introduced into the slinky on the left end by vibrating the first coil left and right. Energy will begin to be transported through the slinky from left to right.

• As the energy is transported from left to right, the individual coils of the medium will be displaced leftwards and rightwards. In this case, the particles of the medium move parallel to the direction that the pulse moves. This type of wave is a longitudinal wave. Longitudinal waves are always characterized by particle motion being parallel to wave motion.

• A sound wave travelling through air is a classic example of a longitudinal wave. As a sound wave moves from the lips of a speaker to the ear of a listener, particles of air vibrate back and forth in the same direction and the opposite direction of energy transport. Each individual particle pushes on its neighbouring particle so as to push it forward.

• This back and forth motion of particles in the direction of energy transport creates regions within the medium where the particles are pressed together and other regions where the particles are spread apart. Longitudinal waves can always be quickly identified by the presence of such regions. This process continues along the chain of particles until the sound wave reaches the ear of the listener.

Surface Wave

• While waves that travel within the depths of the ocean are longitudinal waves, the waves that travel along the surface of the oceans are referred to as surface waves. A surface wave is a wave in which particles of the medium undergo a circular motion. Surface waves are neither longitudinal nor transverse. In longitudinal and transverse waves, all the particles in the entire bulk of the medium move in a parallel and a perpendicular

direction (respectively) relative to the direction of energy transport. In a surface wave, it is only the particles
at the surface of the medium that undergo the circular motion. The motion of particles tends to decrease as one proceeds further from the surface.

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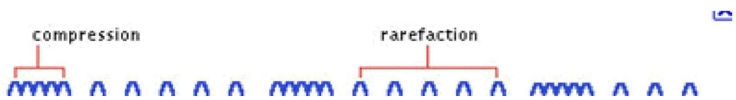

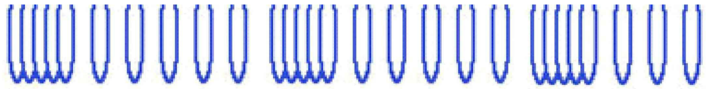

Figure 1: Longitudinal Wave

Conclusion

Figure 2: Transverse Wave

Conclusion

- Waves travelling through a solid medium can be either transverse waves or longitudinal waves. Yet waves travelling through the bulk of a fluid (such as a liquid or a gas) are always longitudinal waves. Transverse waves require a relatively rigid medium in order to transmit their energy. As one particle begins to move it must be able to exert a pull on its nearest neighbour. If the medium is not rigid as is the case with fluids, the particles will slide past each other. This sliding action that is characteristic of liquids and gases prevents one particle

• Waves travelling through a solid medium can be either transverse waves or longitudinal waves. Yet waves travelling through the bulk of a fluid (such as a liquid or a gas) are always longitudinal waves. Transverse waves require a relatively rigid medium in order to transmit their energy. As one particle begins to move it must be able to exert a pull on its nearest neighbour. If the medium is not rigid as is the case with fluids, the particles will slide past each other. This sliding action that is characteristic of liquids and gases prevents one particle from displacing its neighbour in a direction perpendicular to the energy transport. It is for this reason that only longitudinal waves are observed moving through the bulk of liquids such as our oceans. Earthquakes are capable of producing both transverse and longitudinal waves that travel through the solid structures of the Earth. When seismologists began to study earthquake waves they noticed that only longitudinal waves were capable of travelling through the core of the Earth. For this reason, geologists believe that the Earth's core consists of a liquid - most likely molten iron.

• Any wave moving through a medium has a source. Somewhere along the medium, there was an initial displacement of one of the particles. For a slinky wave, it is usually the first coil that becomes displaced by the from displacing its neighbour in a direction perpendicular to the energy transport. It is for this reason that only longitudinal waves are observed moving through the bulk of liquids such as our oceans. Earthquakes are capable of producing both transverse and longitudinal waves that travel through the solid structures of the Earth. When seismologists began to study earthquake waves they noticed that only longitudinal waves were capable of travelling through the core of the Earth. For this reason, geologists believe that the Earth's core consists of a liquid - most likely molten iron.

- Any wave moving through a medium has a source. Somewhere along the medium, there was an initial displacement of one of the particles. For a slinky wave, it is usually the first coil that becomes displaced by the hand of a person. For a sound wave, it is usually the vibration of the vocal chords or a guitar string that sets the

hand of a person. For a sound wave, it is usually the vibration of the vocal chords or a guitar string that sets the first particle of air in vibrational motion.

• At the location where the wave is introduced into the medium, the particles that are displaced from their equilibrium position always moves in the same direction as the source of the vibration. So if you wish to create a transverse wave in a slinky, then the first coil of the slinky must be displaced in a direction perpendicular to the entire slinky. Similarly, if you wish to create a longitudinal wave in a slinky, then the first coil of the slinky must be displaced in a direction parallel to the entire slinky.

Electromagnetic versus Mechanical Waves

• Another way to categorize waves is on the basis of their ability or inability to transmit energy through a vacuum (i.e., empty space).

• Categorizing waves on this basis leads to two notable categories: electromagnetic waves and mechanical waves.

Electromagnetic Wave

• An electromagnetic wave is a wave that is capable of transmitting its energy through a vacuum (i.e., empty space). Electromagnetic waves are produced by the vibration of charged particles.

• Electromagnetic waves that are produced on the sun subsequently travel to Earth through the vacuum of outer space.

• Were it not for the ability of electromagnetic waves to travel to through a vacuum, there would undoubtedly be no life on Earth. All light waves are examples of electromagnetic waves.

Mechanical Wave

• A mechanical wave is a wave that is not capable of transmitting its energy through a vacuum. Mechanical waves require a medium in order to transport their energy from one location to another. A sound wave is an example of a mechanical wave.

• Sound wavesare incapable oftravelling throughavacuum. Slinkywaves,waterwaves, stadiumwaves,and jump rope waves are other examples of mechanical waves; each requires some medium in order to exist.

• Slinky wave requires the coils of the slinky; a water wave requires water; a stadium wave requires fans in a stadium; and a jump rope wave requires a jump rope.

Important concepts related to waves

Amplitude

• Amplitude is the magnitude of change in the oscillating variable with each oscillation within an oscillating system.

• For example, sound waves in air are oscillations in atmospheric pressure and their amplitudes are proportional to the change in pressure during one oscillation.

Frequency

• Frequency refers to the number of cycles per second.

• Unit of frequency – Hz

• Frequency has an inverse relationship to the concept of wavelength; simply, frequency is inversely proportional to wavelength ë (lambda).

• The frequency f is equal to the phase velocity vof the wave divided by the wavelength ë of the wave:

^{v}f Ť

≑

Wave Length

• The wavelength of a sinusoidal wave is the spatial period of the wave – the distance over which the wave's shape repeats.
• It is usually determined by considering the distance between consecutive corresponding points of the same phase, such as crests, troughs, or zero crossings, and is a characteristic of travelling waves and standing waves, as well as other spatial wave patterns.
• Wavelength is commonly designated by the Greek letter lambda (≑).
Time Period
• The period T is the time taken by the wave to complete one cycle of an oscillation.

• Relation between the time period and frequency – T =1
f

Pitch
• Pitch is one of the major auditory attributes of musical tones along withduration, loudness, timbre, and sound source location. And while it is a crucial and immediate aspect of perceived sound, it is not one that is easily defined.
• It is the perceived fundamental frequency of a sound. The American National Standards Institute (1994) defines it as "that auditory attribute of sound according to which sounds can be ordered on a scale from low to high."
• Pitches are compared as "higher" and "lower" in the sense that allows the construction of melodies.Pitch may be quantified as a frequency in cycles per second (hertz), however pitch is not a purely objective physical property, but a subjective psycho acoustical attribute of sound.
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INSIGHT GENERAL STUDIES

TOPIC

2

SOUND

Sound Waves

• Sound wave is a longitudinal mechanical wave which is generated or produced by the transmission of the disturbances in the form of compressions or rarefactions.
• Sound is produced by vibrating objects.
• This train of packets of compressions and rarefactions on reaching the listeners ears produce variations of pressure on his or her ear-membranes. These pressure variations set up impulses on the auditory nerves which carry the message to the hearing centre of the brain.
• In fact sound is produced by the rapid vibration of the material bodies and its sensation is produced by a vibrating body provided its frequency of vibration lies within 20 Hz to 20,000 Hz called audibility limit (or range).
• The frequencies of less than 20 Hz (lower limit of audible frequencies) are called infrasonic and those above the upper limit of audible frequencies 20,000 Hz are called ultrasonic (supersonics) waves.
• The wave length of infrared electromagnetic wave is the highest.
• The roaring sound of cloud is due to the vibration of various echoes.
• The velocity of sound increases with the increase of temperature but there is no effect of pressure on it.
• A human can not hear the sound of more than 120 decibel.
• Because of moisture the density of the medium is reduced, so the velocity of sound is increased.
• If there is more humidity, the velocity of sound is increased.
• Resonance occurs if frequency of the two sources becomes equal.
• The velocity of sound is less on height because of less temperature.
Frequencies range of sound waves :
Infrasonic waves :
• The sound waves whose frequencies are less than 20 Hz (20 Hz down to 0.001 Hz) is called Infrasonic waves and such waves cannot be listened by

the human ears.
• Such waves are produced inside the earth during occurrence of earthquake. The heart beats of the human body are also infrasonic.
• This frequency range is utilized for monitoring earthquakes, charting rock and petroleum formations below the earth and also in ballistocardiography and seismocardiography to study the mechanics of the heart.
• Infrasound is characterized by an ability to cover long distances and get around obstacles with little dissipation.
• Infrasound has been known to cause feelings of awe or fear in humans. Since it is not consciously perceived, it can make people feel vaguely that supernatural events are taking place.
• An infrasonic signal of 19 Hz is considered to be responsible for some ghost sightings because it is very close to the resonant frequency of the eye given as 18 Hz by NASA.
• Whales, elephants, hippopotamuses, rhinoceros, giraffes, okapi, and alligators are known to use infrasound to communicate over distances—up to hundreds of miles in the case of whales. It has also been suggested that migrating birds use naturally generated infrasound, from sources such as turbulent airflow over mountain ranges, as a navigational aid. Elephants, in particular, produce infrasound waves that travel through solid ground and are sensed by other herds using their feet, although they may be separated by

hundreds of kilometres.These calls may be used to coordinate the movement of herds and allow male elephants

to find mates.
Audible waves :
• The sound waves whose frequencies lie between 20 Hz to 20, 000 (or 20 KHz) is called audible waves which can

be heard by the human ears.
Ultrasonic (Supersonic) waves :
• The sound waves whose frequencies are more than 20,000 Hz is called ultrasonic wave and such waves can not

be listened by the human ears.
• Ultrasonics were produced firstly by Galton and later these were produced in certain crystals of tourmaline,
quartz, zinc oxide, etc. by Piezo electric method. Thus Piezo electric crystals of quartz, rochelle salt, tourmaline
etc. are generator of ultrasonics.
• As the frequencies of ultrasonics are too large so these waves are very energetic and have shorter wavelengths.
• Children under the age of five and some animals, such as dogs can hear up to 25 kHz (1 kHz = 1000 Hz).
• Some animals like birds, bats, dogs, cats, dolphins, etc. not only hear or listen ultrasonics but also but also
produce them for communication, sighting and navigation.
• Moths of certain families have very sensitive hearing equipment. These moths can hear the high frequency
squeaks of the bat and know when a bat is flying nearby, and are able to escape capture.
• Rats also play games by producing ultrasound.
• In the dark, the bats can fly freely without dashing against any obstacle (or barrier) because during flight they

constantly send forward ultrasonics signals and if any obstacle is there, they hear the echoes (reflected sound
wave) of the ultrasonics and at once they change their course of flight. Bats can easily hear the ultrasonics of
the frequencies of 10, 000 Hz.

Use of Ultrasonics

(a) Ultrasounds are able to travel along welldefined paths even in the presence of obstacles. Ultrasounds are used
extensively in industries and for medical purposes.

(b) In medical science ultrasonics are used in bloodless surgical operations, in tumour and cavity detection of
teeth etc. By ultrasonic radiation various neurological disease and arthritis are being cured. (c) In western and developed countries milk is purified by passing contaminatedmilk throughultrasonics. Generally
contaminated (impure) milk has bacteria which are destroyed on passing ultrasonics.

(d)
Ultrasonicscoagulatesthedustparticlesinwinterseasonthusthemistsandfogsfrom
and this facilitates the aircrafts (aeroplane) in landing.

(e) Ultrasonics is also utilized in measuring the sea depth, some commodities spread inside the sea like large
rocks, icebergs, bigger fishes etc. SONAR (Sound Navigation And Ranging) is a technique by which inside
located objects of the sea are detected.It is a device that uses ultrasonic waves to measure the distance,
direction and speed of underwater objects. Sonar consists of a transmitter and a detector and is installed in a
boat or a ship, as shown in Sound is produced due to vibration of different objects.Naval forces use the SONAR
on large scale to detect submarines and drowned ships etc.

(f) The police use high frequency whistles which dogs can hear but humans cannotto guide the dogs during
investigations.

(g) Ultrasound is generally used to clean parts located in hard-to-reach places, for example, spiral tube, odd
shaped parts, electronic components etc. Objects to be cleaned are placed in a cleaning solution and ultrasonic

waves are sent into the solution. Due to the high frequency, the particles of dust, grease and dirt get detached
and drop out. The objects thus get thoroughly cleaned.
(h) Ultrasounds can be used to detect cracks and flaws in metal blocks. Metallic components are generally used in
construction of big structures like buildings, bridges, machines and also scientific equipment. The cracks or
holes inside the metal blocks, which are invisible from outside reduces the strength of the structure. Ultrasonic
waves are allowed to pass through the metal block and detectors are used to detect the transmitted waves. If
there is even a small defect, the ultrasound gets reflected back indicating the presence of the flaw or defect.

Ordinary sound of longer wavelengths cannot be used for such purpose as it will bend around the corners of
the defective location and enter the detector.

(i) Ultrasonic waves are made to reflect from various parts of the heart and form the image of the heart. This technique is called ‘echocardiography’.
(j) Ultrasound scanner is an instrument which uses ultrasonic waves for getting images of internal organs ofthe human body. A doctor may image the patient’s organs such as the liver, gall bladder, uterus, kidney, etc. Ithelps the doctor to detect abnormalities, such as stones in the gall bladder and kidney or tumours in different organs. In this technique the ultrasonic waves travel through the tissues of the body and get reflected from a region where there is a change of tissue density. These waves are then converted into electrical signals that are used to generate images of the organ. These images are then displayed on a monitor or printed on a film. This technique is called ‘Ultrasonography’. Ultrasonography is also used for examination of the foetus during pregnancy to detect congenial defects and growth abnormalities.
(k) Ultrasound may be employed to break small ‘stones’ formed in the kidneys into fine grains.
Doppler’s effect
⁂ The Doppler effect (or Doppler shift), named after Austrian physicist Christian Doppler who proposed it in 1842 in Prague, is the change in frequency of a wave for an observer moving relative to the source of the wave.
⁂ It iscommonlyheardwhen avehicle sounding a siren orhorn approaches,passes, and recedes from anobserver.
⁂ The received frequency is higher (compared to the emitted frequency) during the approach, it is identical at the instant of passing by, and it is lower during the recession.
Sonic booms andshock waves
• When the speed of any object exceeds the speed of sound it is said to be travelling at supersonic speed. Bullets, jet aircrafts etc. often travel at

supersonic speeds.

• When a sound, producing source moves with a speed higher than that of sound, it produces shock waves in air. These shock waves carry a large amount of energy. The air pressure variation associated with this type of shock waves produces a very sharp and loud sound called the “sonic boom”.

• The shock waves produced by a supersonic aircraft have enough energy to shatter glass and even damage buildings.

ECHO

• If we shout or clap near a suitable reflecting object such as a tall building or a mountain, we will hear the same sound again a little later. This sound which we hear is called an echo. The sensation of sound persists in our brain for about 0.1 second.

• To hear a distinct echo, the time interval between the original sound and the reflected one must be at least 0.1 second. If we take the speed of sound to be 344 m/s at a given temperature, say at 22^0C in air, the sound must go to the obstacle and reach back the ear of the listener on reflection after 0.1s. Hence, the total distance covered by the sound from the point of generation to the reflecting surface and back should be at least (344 m/ s)×0.1s=34.4 m.

• Thus, for hearing distinct echoes, the minimum distance of the obstacle from the source of sound must be half of this distance, that is, 17.2 m. This distance will change with the temperature of air. Echoes may be heard more than once due to successive or multiple reflections.

Mach number :

• Mach number (M) of an aircraft is an indicator which tells the speed of the aircraft relative to the speed of sound.

• The Mach number is named after Austrian physicist and philosopher Ernst Mach, a designation proposed by aeronautical engineer Jakob Ackeret.

• Because the Mach number is often viewed as a dimensionless quantity rather than a unit of measure, with Mach, the number comes after the unit; the second Mach number is “Mach 2” instead of “2 Mach” (or Machs).

• In French, the Mach number is sometimes called the “Sarrau number” after Émile Sarrau, who carried out researches on explosions in the 1870s and 1880s.

• Flight can be roughly classified in six categories:
Region Subsonic Transonic Sonic Mach <1.0 0.8–1.2 1.0

Sound of human beings
Supersonic Hypersonic 1.2–5.0 5.0–10.0

⁂ In humans, the sound is produced by the voice box or the larynx. The vibration of the vocal cords produces sound in human beings.If you put your fingers on the throat then you will find a hard bump that seems to move when you swallow. This part of the body is known as the voice box. It is at the upper end of the windpipe.

⁂ Two vocal cords are stretched across the voice box or larynx in such a way that it leaves a narrow slit between them for the passage of air.
⁂ The shape of the outer part of the ear is like a funnel. When sound enters in it, it travels down a canal at the end of which a thin membrane is stretched tightly. It is called the eardrum. Itperforms an important function. The eardrum senses the vibrations of sound, It sends the signals to the brain. This process is called hearing.
Features of sound waves
⁂ To and fro motion of an object is known as vibration. This motion is also called oscillatory motion.
⁂ The number of oscillations per second is called the frequency of oscillation. Frequency is expressed in hertz. Its symbol is Hz. A frequency of 1 Hz is one oscillation per second.
⁂ Amplitude and frequency are two important properties of any sound.
⁂ The frequency determines the shrillness or pitch of a sound. If the frequency of vibration is higher we say that the sound is shrill and has a higher pitch. If the frequency of vibration is lower, we say that the sound has a lower pitch.
⁂ Loudness of sound is proportional to the square of the amplitude of the vibration producing the sound. For example, if the amplitude becomes twice, the loudness increases by a factor of 4.

⁂ The loudness is expressed in a unit called decibel (dB).
⁂ When the amplitude of vibration is large, the sound produced is loud. When the amplitude is small, the sound produced is feeble.
⁂ Unpleasant sounds are called noise.
⁂ Excessive or unwanted sounds lead to noise pollution. Noise pollution may pose health problems for human beings.
⁂ Plantation on the roadside and elsewhere can reduce noise pollution.
⁂ When the level of a sound is increased by 10dB, the subjective loudness roughly doubles, whereas the sound power actually increases by a factor of 10.
⁂ The smallest detectable change in level is about 1dB.
⁂ The system was named after Alexander Graham Bell [1847-1922], who is given credit for being the inventor of the telephone.
⁂ Numerous studies have shown prolonged exposure to 85 decibels or more can cause permanent hearing loss. Other physiological damage can occur at lower levels.
⁂ A single, explosive noise is capable of damaging hair cells, but hearing loss is usually the result of continual exposure to volumes over 80-85 decibels.

Strength of sound produced by different sources

S. Source of sound
No.
1. Threshold of hearing
2. Broadcast studio interior or rustling of leaves 3. Normal breathing
4. Quiet house interior or rural nighttime
5. Quiet office interior or watch ticking,
6. Normal talk, quiet conversation, soft whisper,

quiet suburb, speech in a broadcasting studio 7. Quiet rural area, equivalent to quiet office,
living room, bedroom away from traffic,
residential area [no traffic]; computer hard
drives, soft whisper [five feet]
8. Quiet suburban area, dishwasher in next room,
quiet radio, average home, light traffic at a distance
of 100 feet, refrigerator, gentle breeze, average
office, non-electric typewriter, ordinary spoken voice. 9. Office interior, air conditioner at twenty feet,
conversation [at one meter], sewing machine, large
transformer, ordinary or average street traffic 10. Vacuum cleaner at 10 ft.
11. Busy traffic, equivalent to typewriter, average
factory noise, busy traffic [at one meter], office
tabulator, noisy restaurant [constant exposure],
quiet vacuum cleaner, TV.
12. Passing car at 10 ft. or garbage disposal at 3 ft 13. Factory noise, heavy city traffic [25-50 feet], alarm
clock at two feet, vacuum cleaner, heavy truck,
loud-radio music, garbage disposal.
14. Passing bus or truck at 10 ft. or food blender at
3 ft., police whistle, heavy traffic, truck traffic,
noisy home appliances subway-rail train,

pneumatic drill [or hammer] at one meter,
walk-man ear phone [average volume], rock
drill at 100 feet, some motorcycles at 25 feet,
shouted conversation.
15. Passing subway train at 10 ft. or gas lawn mower at
3 ft. Or noise produced by machine shop, chain saw,
pneumatic drill, printing plant, jackhammer,
speeding express train, some car horns at five
meters, farm tractor, riveting machine, some noisy
subways [about 20 feet]
Strength of sound 0 dB
10dB 10dB 20dB 30dB 30dB Comparison with
ordinary conversation
Don't hear anything
1/32ndasloudasconversation 1/32ndasloudasconversation 1/16th as loud
1/8th as loud
1/8th as loud

40dB 1/4th as loud
50dB 1/2 as loud
60dB Ordinary Conversation

70dB
70dB Twice as loud Twice as loud

80dB 80dB 4 times as loud 4 times as loud

90dB 8 times as loud
100dB 16 times as loud

16. Night club with band playing, loud factory noise
17. Supersonic jet sound/threshold of pain/Sound of an amplified rock concert in front of speakers, sandblasting, thunderclap [immediate danger], a nearby airplane engine, some rock or hard-metal cacophony groups, pneumatic hammer at one meter, thunderclap over head [the sensation of hearing is replaced by that of pain]
18. Sound of a diesel engine room
19. Sound of a gunshot blast, jet plane take-off at close range [approximately 200 feet], air raid siren [any length of exposure time is dangerous and is at the threshold of pain]
20. Rocket launching pad [hearing loss inevitable]

Effect of various factors on the speed of sound
Effect of Pressure:
110dB 32 times as loud
120dB 64 times as loud as

conversation (twice as loud as night club)
125dB 140dB
180dB

At the same temperature the speed of sound in the gas doesn't vary with pressure.
Effect of temperature:
The speed of sound is directly proportional to the square root of its absolute temperature. In any medium as we increase the temperature the speed of sound increases. For example, the speed of sound in air is 331 m s^{-1}at 0 ºC and344 m s^{-1}at22 ºC.
Effect of humidity:
The density of dry air is more than that of moist air. Thus in moist air the speed of sound is more than dry air. This is the reason why in rainy season the siren of the train are listened up to a far distances sharply then summer season. Effect of the speed of the medium:

If the medium has also the speed then the speed of sound increases in the same direction and decreases in opposite direction.
Speed of sound in different mediums

• Sound is a mechanical wave and needs a material medium like air, water, steel etc. for its propagation. Sound

propagates through a medium at a finite speed.

• It cannot travel through vacuum.

• The sound of a thunder is heard a little later than the flash of light is seen. So, we can make out that sound

travels with a speed which is much less than the speed of light. The speed of sound depends on the properties of the medium through which it travels.
The speed of sound in a medium depends also on temperature and pressure of the medium. The speed of sound decreases when we go from solid to gaseous state.

Gases Liquids at 25°C Solids
Material Speed (m/s) Material Speed (m/s) Material Speed (m/s) Hydrogen (0°C) 1286
Helium (0°C) 972
Air (20°C) 343
Air (0°C) 331
Glycerol 1904
Sea water 1533
Water 1493
Mercury 1450
Kerosene 1324
Methyl alcohol 1143
Carbon 926
tetrachloride
Diamond 12000 Pyrex glass 5640 Iron 5130 Aluminium 5100 Brass 4700 Copper 3560 Gold 3240

Lucite 2680
Lead 1322
Rubber 1600

QUICK REVIEW OF SOUND WAVES

1. The number of oscillations or vibrations per second is called the frequency of oscillation. The frequency is expressed in hertz (Hz).
2. Sound travels from one point to another in the form of waves.
3. In sound propagation, it is the energy of the sound that travels, not the particles of the medium.
4. The change in density from one maximum value to the minimum value and again to the maximum value makes one complete oscillation.
5. The distance between two consecutive compressions or two consecutive rarefactions is called the wavelength.
6. The time taken by the wave for one complete oscillation of the density or

pressure of the medium is called the time period, T.
7. The number of complete oscillations per unit time is called the frequency.
8. The speed (v), frequency (n) and wavelength of sound (ë)are related by the equation, v = në.
9. The speed of sound depends primarily on the nature and the temperature of the transmitting medium.
10. The law of reflection of sound states that the directions in which the sound is incident and reflected make equal angles with the normal to the reflecting surface and the three lie in the same plane.
11. For hearing a distinct sound, the time interval between the original sound and the reflected one must be at least 0.1 s.
12. The persistence of sound in an auditorium is the result of repeated reflections of sound and is called reverberation.
13. Sound properties such as pitch, loudness and quality are determined by the corresponding wave properties.
14. Loudness is a physiological response of the ear to the intensity of sound.
15. The amount of sound energy passing each second through unit area is called the intensity of sound.
16. The audible range of hearing for average human beings is in the frequency range of 20 Hz – 20 kHz.
17. Sound waves with frequencies below the audible range are termed "infrasonic" and those above the audible range are termed "ultrasonic".
18. Ultrasound has many medical and industrial applications.
19. The SONAR technique is used to determine the depth of the sea and to locate under water hills, valleys, submarines, icebergs, sunken ships etc.

20. Sound waves are longitudinal in nature.

21. Sound waves cannot be polarised.
22. Sound waves require a material medium to travel.The matter or substance through which sound is transmitted is called a medium. It can be solid, liquid or gas. Sound moves through a medium from the point of generation to the listener.
23. A microphone converts sound energy into electrical energy.
24. Loudspeaker converts electrical energy into sound energy.
25. Decibel is the unit of measuring the intensity of a sound.
26. In water, sound is recorded by the help of a hydrophone.
27. Bells are made of metals because of the elasticity of metals.
28. There is no effect of pressure on the velocity of the sound if the temperature is kept constant.
29. Speed of sound increases with an increase in temperature and the humidity of air.
30. The speed of sound in a gas is proportional to the square of its absolute temperature.
31. The speed of sound in air increases by 0.61 m/s by the increase of 1°C temperature.
32. The speed of sound is higher in rainy season than in summers.
33. The unit of frequency is hertz.
34. Sound waves exhibit interference.
35. Interference is a phenomenon in which two waves superimpose to form a resultant wave of greater or lower amplitude. Interference usually refers to the interaction of waves that are correlated or coherent with each other, either because they come from the same source or because they have the same or nearly the same frequency. Interference effects can be observed with all types of waves, for example, light, radio, acoustic and surface water waves.
36. One characteristic of every standing wave pattern is that there are points along the medium that appear to be standing still. These points, sometimes described as points of no displacement, are referred to as nodes. There are other points along the medium that undergo vibrations between a large

positive and large negative displacement. These are the points that undergo the maximum displacement during each vibrational cycle of the standing wave. In a sense, these points are the opposite of nodes, and so they are called antinodes. A standing wave pattern always consists of an alternating pattern of nodes and antinodes.

37. Nodes and antinodes are formed in stationary waves.

38. The difference between a node and an antinode is ë/4.

39. The difference between two consecutive nodes (or antinodes) is ë/2.

40. A sound of single frequency is called a tone whereas a sound of multiple frequencies is called a note. Of the several frequencies present in a note, the sound of the lowest frequency is called the fundamental tone. Besides the fundamental, other tones present in a note are known as overtones. Of the overtones, those which have their frequencies simple multiple of fundamental frequency, are known as harmonics. All harmonics are overtone but all overtones are not harmonics.

41. Whenever there is relative motion between the source of sound and the listener, the actual frequency (or pitch) of the source of sound appears to be changed to the listener. This apparent change in frequency is called the Doppler’s effect.

42. Doppler’s effect is related with the change in frequency of sound and not its intensity.

43. Doppler’s effect is also applicable on light waves.

44. If a light source is receeding away from the observer on earth, then the frequency of light will appear to be decreased (or wave- length increased) to the observer. Due to this, the spectral lines appear to displace towards the red end of the spectrum. This is called the ‘recessional red shift.’

45. If a light source is coming towards the observer on earth, the frequency of light will appear to be increased (i.e. wavelength decreased) to the observer due to which the spectral lines will appear to displace towards the violet end of the spectrum.

46. In supersonic motions, the speed of an object is expressed relative to the speed of sound. Their ratio is called the Mach number.

47. Mach number =speedofobject
speedofsound

1. Mach number is greater than 1 for supersonic motions.
2. Mach number is used to express the motion of jet planes or rockets.
3. Echo is produced by the reflection of sound.
4. When two sound sources of approximately same frequencies produce sound then beats are heard.
5. The number of beats per second is equal to the difference in frequencies per second of the sound sources.
6. The frequency of the sound produced by the supersonic planes is beyond the audible region.
7. The quality of the same note produced from two different musical instruments is different.
8. Hydrophone records sound inside water.
9. Megaphone spreads sound to far off places.
10. Sound waves cannot travel in vacuum.
11. Tape of a tape recorder is coated with a thin layer of iron oxide. It is a magnetic substance.
12. If the original frequency of an open pipe is n, then the frequency of the pipe closed at one end remains n/2.
13. If the light emitted from a star is found to be redder than the sun light then it means that the star is receding away from the earth.
14. The sound from a piano or a guitar can be distinguished on the basis of its quality.
15. Sonar is used for communication and ranging beneath the surface of the ocean.
16. The speed of sound in air at room temperature is 330 m/s.
17. Pitch of sound is determined by its frequency.
18. On reflection of a wave from a surface there is no change in its velocity,

wavelength and frequency.
19. All particles between the two successive nodes vibrate in the same phase.
20. The phase of vibration of the particles on one side of a node is opposite from the phase of vibration of the particles on the other side.
21. Sonar works on the reflection of sound waves.
22. Audible frequency range of sound is from 20 to 20,000 hertz.
23. Whensoundtravelsfromonemediumtoanotherthenitsfrequencyremainsunchang and intensity change.
24. The amplitude of a wave does not depend upon its velocity, wave length or frequency.
25. The intensity of sound increases with the increase in density of the medium.
26. In a telephone receiver electrical energy converts into sound energy.
27. In a microphone sound energy converts into electrical energy.
28. The phase difference between the particles on either side of a note at the same distance is ð.
29. The sound of supersonic planes is not heard on earth because the velocity of supersonic plane is either equal to or more than the velocity of sound. Hence its frequency is outside and audibility range.

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INSIGHT GENERAL STUDIES

TOPIC

3

TOPIC
3

OPTICS

OPTICS

Light

• Light or visible light is the portion of electromagnetic radiation that is visible to the human eye, responsible for the sense of sight. Visible light has a wavelength in a range from about 380 or 400 nanometres to about 760 or 780 nm, with a frequency range of about 405 THz to 790 THz. In physics, the term light often comprises the adjacent radiation regions of infrared (at lower frequencies) and ultraviolet (at higher), not visible to the human eye.

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• Primary properties of light are intensity, propagation direction,frequencyorwavelengthspectrum and polarization, while its speed, about 300,000,000 meters per second (300,000 kilometres per second) in a vacuum, is one of the fundamental constants of nature.

• Light, which is emitted and absorbed in tiny “packets” called photons, exhibits properties of both waves and particles. This property is referred to as the wave–particle duality. The study of light, known as optics, is an important research area in modern physics.

• Light seems to travel along straight-line paths in a transparent medium.

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• There is no need of medium for passing the light.
• Holography is a process by which 3D - images are formed without using a lens or photographic film.
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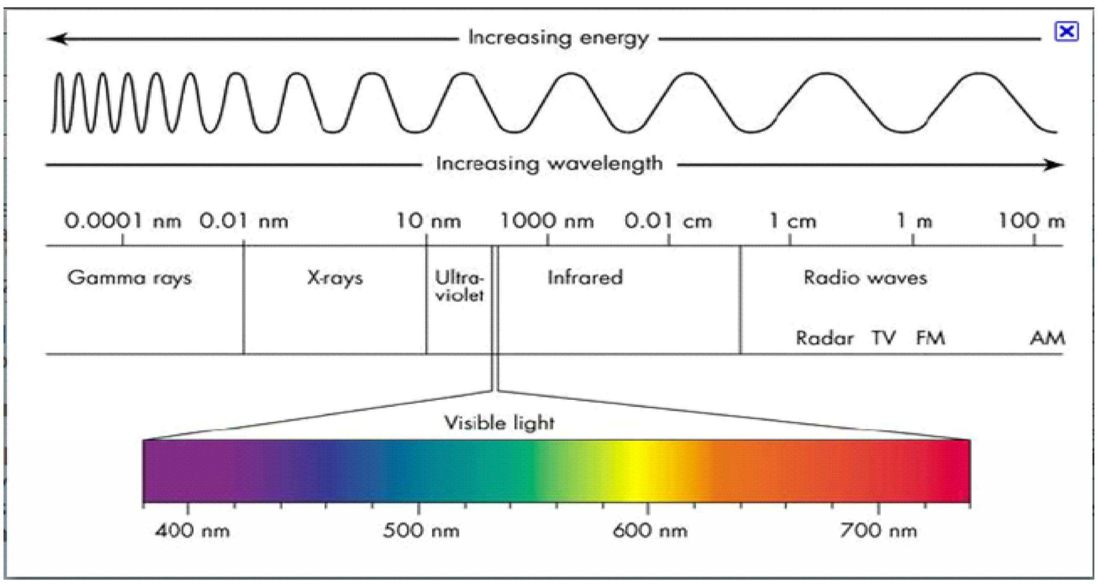

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Laws of Reflection
• After striking the mirror, the ray of light is reflected in another direction. The light ray, which strikes any surface, is called the incident ray. The ray that comes back from the surface after reflection is known as the reflected ray.
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(b) The incident ray, the normal at the point of incidence and the reflected ray all lie in the same plane.

Refraction of Light

• Refraction is the bending of a wave when it enters a medium where it’s speed is different. The refraction of light when it passes from a fast medium (thinner/rarer medium) to a slow medium (denser medium) bends the light ray toward the normal to the boundary between the two media.

• The amount of bending depends on the indices of refraction of the two media and is described quantitatively by Snell’s Law.

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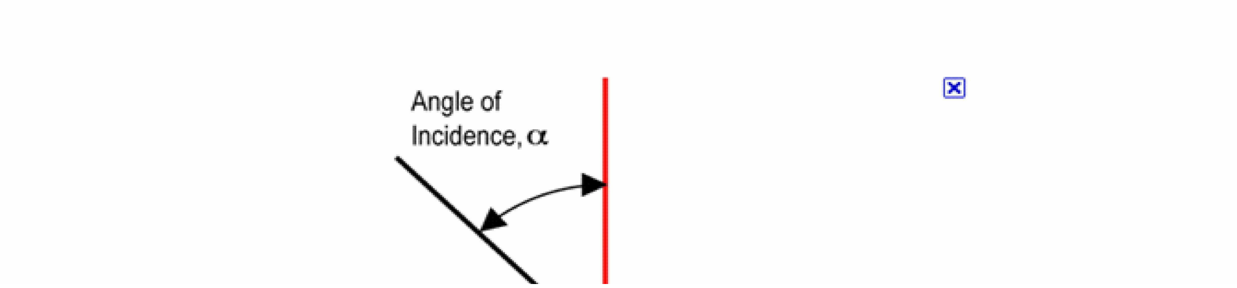
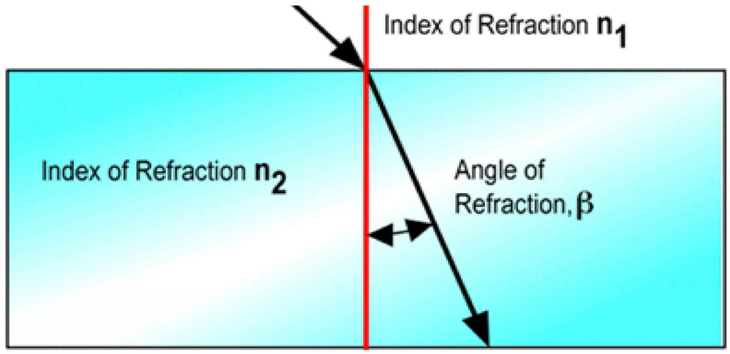

Angle of
Incidence, α



$$n_1 \text{ sine } \alpha = n_2 \text{ sine } \beta$$

Examples of refraction of Light

• The bottom of a tank or a pond containing water appears to be raised due to the refraction of light.
• When a thick glass slab is placed over some printed matter, the letters appear raised when viewed through the glass slab.
• A pencil partly immersed in water in a glass tumblerappears to be displaced at the interface of air and water.
• A lemon kept in water in a glass tumbler appears to be bigger than its actual size, when viewed from the sides.
• The coin placed in a bowl of water appears slightly raised above its actual position due to refraction of light.
• Because of refraction of light, the sun appears a few minutes before the sun rise of horizon.
• Because of Atmospheric Refraction, the sun remains visible after the sunset for sometimes.
• Because of Refraction the sun and the moon look elliptical.
• Both Reflection and Refraction take place in Periscope.
• Light rays come from the stars pass through different layer of air whose density is different because of the variation of temperature. It results the refraction of light and stars look twinkling.

Scattering of light
• When the light waves fall on the extremely small bodies (particles) such as dust particles, very small suspended water droplet, suspended particles as in colloidal solution etc then the light rays are thrown out in all directions. The phenomenon of light is known as scattering.
• Here bodies are small in the sense of their sizes and are smaller than the sizes (wavelengths) of the incident waves. Thus the strength of scattering depends on the wavelength of the light beside the size of the bodies (particles) which cause scattering.
• Shorter wavelength and higher frequency colours scatter the most. The tendency to scatter increases as we move from the Red to the violet end. The

Red scatters the least and the violet the most.

- If these particles are smaller than the wavelength of the incident light, then scattering is proportional to 1/ë^{4}. This is called Rayleigh's law of scattering.
- The red light is scattered the least and the violet is scattered the most. That's why red signals are used to indicate dangers. Such a signal appears to be visible to the large distances without an appreciable loss due to scattering.
- The power of a colour to travel distance increases as we move from the violet end to the red end.

Examples of scattering of light in our daily life

- The blue appearance of the sky is due to the scattering of light. When we look at the sky it is scattered light (sunlight) from the atmosphere that enters the eyes. Among the shorter wavelength the colour blue is present in larger proportion in sunlight. Light of short wavelengths are strongly scattered by the air molecules and the suspended water droplets and it explains the blue colour appearance of sky.
- The red appearance of sun at the sunset and at the sunrise is also due to the scattering of light. At these times, the sunlight has to travel a large distance through the atmosphere. The blue and neighbouring colours are scattered away in the path and the light reaching the observer is predominantly red. Thus at sunset and sunrise the red appearance of the sun is due to the scattering of light.
- If the earth had no atmosphere, the sky will appear black and stars would be seen during the day as well.
- On a humid day before rains, the sky appears light blue, while as on a clear day it appears deep blue. The change in the quality of colour of the sky results from the fact that the water droplets and the dust particles may have size greater than the wavelength of light. Rayleigh's law of scattering doesn't apply in this case and colours other than blue may be scattered in larger proportion.
- The seas also appear blue due to the scattering of light.

Diffraction of light

- If an opaque obstacle (or aperture) be placed between a source of light and a screen, a sufficiently distinct shadow (or an illuminated region) is obtained on the screen. This shows that light travels the obstacle or aperture is small (comparable to the wavelength of light), there is a departure from straight line propagation,

and the light bends round the corners of the obstacle or aperture, and enters in the geometrical shadow. This bending of light is called diffraction. Consequently the edges of the shadow (or illuminated region) are not sharp, but the intensity is distributed in a certain way depending upon the nature of the obstacle or aperture.

• If the size of the obstacle is in the order of the wavelength of light then diffraction would be clear and distinctive.
• The phenomenon of diffraction confirms the wave character of the light. Sound wave has longer wavelength, that’s why acoustical diffraction takes place clearly in which sound wave bends from obstacle and we listen. While light wave is shorter than commonbarrier or obstacle we use in our daily life, that’s why the phenomenon of optical diffraction is observed frequently.
• There are two types of optical diffractions :
(a) Fresnel’s diffraction : In the Fresnel’s class of diffraction, the source of light or screen on which diffraction pattern is observed, or usually both are at finite distances from the diffraction obstacle or aperture. In this case no lenses are used and the wave front (wave shape) is either spherical or cylindrical.
(b) Fraunhofer diffraction : In the Fraunhofer class of diffraction, the source of light and the screen are effectively at infinite distances from the diffracting obstacle or aperture. This is achieved by placing the source and the screen in the focal planes of two lenses. Here the incident wave front (wave shape) is plane.
Dispersion of light
• When a light ray incidents upon the prism then it gets refracted through it and bends towards the base of the prism and this ray splits into various colours, thus this group of splited colours is called spectrum. Also the activity of splitting of a white light is called dispersion of light.
• In all the colours of white light, violet ray (colour) deviates the most and red

ray (colour) deviates the least.
• The white light has seven colours i.e. VIBGYOR (Violet, Indigo, Blue, Green, Yellow; Orange and Red).
• Newton observed that different colours of white light deviates on different angles. The optical dispersion takes place due to different velocities of different colours for any transparent material. As well as the refractive indices of the various colours of the light increase correspondingly their velocities decrease.
• The violet ray (colour) has largest refractive index and least velocity or speed in the glass and red ray (colour) has least refractive index and the largest velocity or speed. Other colours have their speeds between these two i.e. violet and red.

Rainbow

• When the phenomenon of refraction, reflection and total internal reflection occur coincidentally and a comprehensive optical dispersion takes place then a rainbow is appeared.
• The rainbow is of two types—
(a) Primary rainbow : Whenever rainfall occurs then after its complete end some rain drop remains suspended in the sky and in the meantime if any light ray (from the sun) incidents on a particular drop in such a way that it reflects one time and refracts two times then primary rainbow is formed. In it red colour is located outwardly and violet colour is located inwardly. Inwardly located violet ray makes angle of 40°8' and outwardly located red ray makes angle of 42°8' at the eye.
(b) Secondary rainbow : As above if the light ray (from the sun) incidents on a particular drop in such a way that reflects two times and refracts two times then secondary rainbow is formed. In it violet colour is located outwardly and red colour is located inwardly. Outwardly located violet ray makes angle of 54° 52' and inwardly located red ray makes angle of 50° 8' at the eye.
• The secondary rainbow is less distinctive and clear than the primary rainbow,

Prism

Nicol’s Prism : It is an optical device made from a calcite crystal for producing and analyzing plane-polarised light.
Dichroism : Some doubly-refracting crystals have the property of absorbing strongly one of the two refracting rays,
while allowing the other to emerge with little loss. This selected absorption

by the crystal is known as dichroism.
The best example of such a crystal is tourmaline.

When a ray of unpolarised light is sent through a tourmaline plate about 1 mm thick, it splits up into planepolarised light in which the O-ray and E-ray vibrate in mutually perpendicular planes. The O-ray is completely absorbed while the E-ray is transmitted. Thus the light emerging from the plate is plane-polarised. This is the basic principle of the commercial polarizing devices called Polaroids.

Prism Effect

• A beam of light, when it passes through a prism is split up into the constituent colours and this a called

dispersion of light . The image thus formed on the screen is called a spectrum.

• The spectrum consists of visible and invisible regions. In the visible region the order of the colours is from
violet to red

• The principal colours are given by the word VIBGYOR (Violet, Indigo, Blue, Green, yellow, Orange, Red).

• The deviation produced for the violet rays of light is maximum and that for red ray of light is minimum.

• Theregionofthespectrumofwavelengthsshorterthanvioletiscalledultra-violetandtheregionofwavelengths
longer than red is called Infra-red.

• The refractive index for the material of a prism (or lens) is different for different wavelengths (or colours).

• The deviation and hence the refractive index is more for the blue rays of light than the corresponding values
for red rays of light.

• The deviation and the refractive index of the yellow constituent are taken as the mean values. Polaroid

• It is a large sized polarising film mounted between two glass plates, and is used to obtain plane—polarized
light for the commercial purposes. The film consists of a thin sheet of nitro-cellulose packed with ultra

microscopic crystals of the organic compound iodosulphate quinine (also called herapathite) with their optic
axes all parallel. These crystals are highly dichroic, absorbing one of doubly refracted beams completely.
Hence when a beam of unpolarised light passes through the Polaroid film, the emerging light is plane polarized.
• Recently large sized Polaroids have been made by stretching a film of polyvinyl alcohol. The stretching orients
the complex molecules with their long axes in the direction of stress and makes them doubly-refracting. Then
the film is impregnated with iodine which makes it dichroic. Such Polaroids are called as H—Polaroids. If
instead of iodine impregnation, the stretched film is heated with a dehydrating agent, then it slightly darkens
and becomes strongly dichroic. It is called as K Polaroid.
Uses of Polaroids:
• Polaroids are used in the laboratory to produce and analyse plane polarised light. These are cheaper than the
Nicols.
• K-Polaroids are used in head-lights and wind-screens of cars to cut off the dazzling light of a car approaching
from the opposite direction. They are fitted in the head-light and wind-screen of each car with their vibration—
planes parallel to each other but inclined at $45^0$to the vertical.
• When two cars approach each other from opposite directions then through the vibration-plane of Polaroids
light are sent out to each other and hence light coming from the head light of one car is completely cut off by
the wind—screen of the another car and thus the driver is able to see the other car by light sent out from his or
her own car.
• Polaroids are used to control the intensity of light entering trains and planes. A Polaroid is fixed outside the
window, while the other is fitted inside which can be rotated and the intensity of light can be adjusted by
rotating the inner Polaroid.
• Polaroid glasses are used for viewing three dimensional pictures.

• The Polaroids are used in sun-glasses to cut off the glare of light reflecting from horizontal surfaces such as wet
roads, cover glasses of paintings, polished table, pavements etc.

Plane, circularly and Elliptically polarised light :

• According to Maxwell's electromagnetic theory; a light wave consists of electric and magnetic fields (vectors)
vibrating in mutually perpendicular planes, both being perpendicular to the direction of propagation of light.

The electricvector isresponsible for the optical effectsofthe waveandalso calledthelightvector. Inunpolarised

light, the light vector takes on all possible directions of vibration in a plane perpendicular to the directions of propagation. lf however, the light vector vibrates along a fixed straight line in the plane, the light is said to be plane-polarised or linearly-polarised.

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• When two plane—polarised waves are superimposed, then under certain conditions, the resultant light vector rotates with a constant magnitude in a plane perpendicular to the direction of propagation. The tip of the

rotates with a constant magnitude in a plane perpendicular to the direction of propagation. The tip of the vector traces a circle and the light is said to be circularly—polarised.

• If although the magnitude of the resultant light vector varies periodically during its rotation, the tip of the vector traces an ellipse, and the light is said to be elliptically polarised. Thus there are only three types of polarised light exist in nature.

Kaleidoscope

• Three rectangular plane mirrors of equal length and equal breadth are attached to eachother in such a way that angle between two mirrors be of 60°. The reflecting surfaces of all these mirrors are towards inward and in the space confined by the mirrors, the pieces of colour glasses are kept. These three mirrors are kept inside a thick long pipe.

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• The spherical piece of glass is attached to the first end of the pipe and at another end the piece of rubbed glass is attached. When we look inside the pipe through transparent glass end and on rotating the pipe new colour images are seen. These images are of pieces of the colour glasses, which have been formed due to the multiple reflections of plane mirrors. On moving the pipe the location of the pieces of the colour glass and the colour of the images also change.

Periscope

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• That's why during war time military (army) uses periscope to detect the enemies who are hidden in bunker. Also in submarine, periscopes are frequently used today.

Total Internal Reflection

• Total internal reflection is an optical phenomenon that happens when a ray of light strikes a medium boundary at an angle larger than a particular critical angle with respect to the normal to the surface. If the refractive index is lower on the other side of the boundary, no light can pass through and all of the light is reflected.

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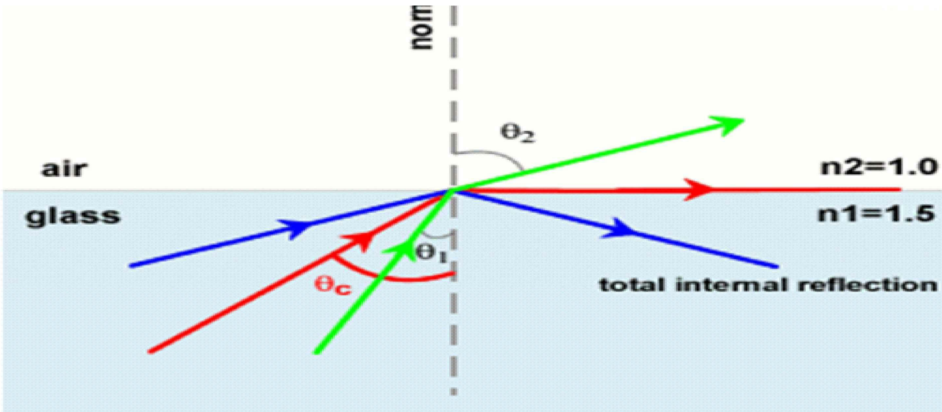
nom
θ_2
air
n2=1.0
glass
n1=1.5
θ_1
θ_c
total internal reflection

• The critical angle is the angle of incidence above which the total internal reflection occurs.

• When light crosses a boundary between materials with different refractive indices, the light beam will be partially refracted at the boundary surface, and partially reflected. However, if the angle of incidence is greater (i.e. the ray is closer to being parallel to the boundary) than the critical angle – the angle of incidence at which light is refracted such that it travels along the boundary – then the light will stop crossing the boundary altogether and instead be totally reflected back internally.

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• This can only occur where light travels from a medium with a higher [n_1=higher refractive index] to one with a lower refractive index [n_2=lower refractive index]. For example, it will occur when passing from glass to air, but not when passing from air to glass.

Applications of total internal reflection
⁂ Optical fibers, which are used in endoscopes and telecommunications.
⁂ Rain sensors to control automatic windscreen/windshield wipers.
⁂ Another interesting application of total internal reflection is the spatial filtering of light. ⁂ Prismatic binoculars use the principle of total internal reflections to get a very clear image

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camera to capture and analyze footprints of laboratory rodents.
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- ❖ Endoscope technique works on the principle of Total Internal Reflection.

Example in everyday life

❖ Endoscope technique works on the principle of Total Internal Reflection.
Example in everyday life

- Total internal reflection of the green turtlecan be seen at the air-water boundary.
- Total internal reflection can be observed while swimming, if one opens one's eyes just under the water's surface. If the water is calm, its surface appears mirror-like.
- During hot summer noon, we feel as if there is water on the road due to total internal reflection.

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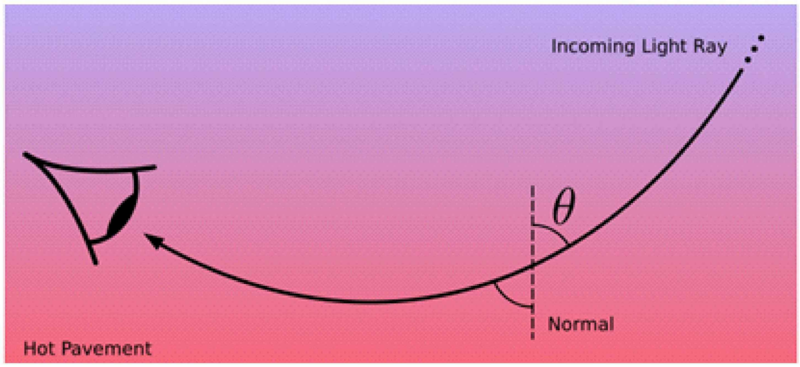

• One can demonstrate total internal reflection by filling a sink or bath with water, taking a glass tumbler, and placing it upside-down over the plug hole (with the tumbler completely filled with water). While water remains both in the upturned tumbler and in the sink surrounding it, the plug hole and plug are visible since the angle of refraction between glass and water is not greater than the critical angle. If the drain is opened and the tumbler is kept in position over the hole, the water in the tumbler drains out leaving the glass filled with air, and this then acts as the plug. Viewing this from above, the tumbler now appears mirrored because light reflects off the air/glass interface.

•

Extreme shining in diamond : The critical angle is very low (approximately 24°) for the light ray coming from

diamond into air. When external light rays enter inside the diamond then from the various layer these reflect repeatedly and if the angle of incidence of any ray becomes less than 24° then light ray comes out from diamond. Thus light rays entering from every side into the diamond, only appear to come from certain side and that’s why diamond appears extremely shining.

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• Test tube filled of water appears to be shining due to the similar reason.
• Formation of Mirage:

⁂ A mirage is a naturally occurring optical phenomenon in which light rays are bent to produce a displaced image of distant objects or the sky. A mirage is a real optical phenomenon which can be captured on camera, since light rays actually are refracted to form the false image at the observer’s location. What the image appears to represent, however, is determined by the interpretive faculties of the human mind.

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❖ In desert, one may see images of distant trees during high temperature. Since in nature, images of trees are formed only in water, therefore one is tricked into believing that a tree is situated near some water body and its reflection is being seen. Similar thing happens on hot roads as well which may be very easily mistaken for the reflections from a small body of water.

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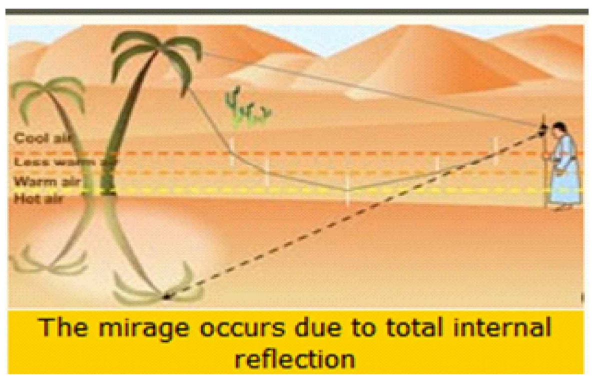


The mirage occurs due to total internal reflection

- The phenomenon of Looming is caused by Total internal reflection. Due to this a *ship* located below the horizon can be seen along the line of sight from a far away place due to the bending of light rays caused by a layer of

• The phenomenon of Looming is caused by Total internal reflection. Due to this a ship located below the horizon can be seen along the line of sight from a far away place due to the bending of light rays caused by a layer of warmer area above a colder sea surface.

Optical fibers

• Rectilinear propagation of light is a well known optical phenomena and by the use of total internal reflection light can also be passed through the curved path.

• Optical fiber is an optical system based on the basic principle of total internal reflection and through which light signal is transferred from one place to another without any loss (decay) of amplitude or intensity.

• The optical fiber is basically composed from long, large and compact quartz fibers and each fiber is 10^{-4}cm thick. Around the optical fiber is a substance which index of refraction is about 1.6 is wrapped out, When light ray incidents on one side of this fiber by making a very small angle then it is refracted inside it. This incident ray talker being totally internally reflected collides with other end of the fiber. On this limiting surface upto which optical fiber is confined again angle of incidence becomes greater than the critical angle and total interval reflection takes place again.

• Thus phenomenon of total internal reflection repeatedly takes place and light ray is reached from one end to another end.

Use of optical fiber:

a. To send electric signal by transforming into light signal and vice versa.
b. To send Laser light rays inside the human body.
c. The great use of optical fibers is today frequently taken in telecommunication. Today old copper cables are

being replaced by optical fibers whose capacity is large and are noise free.
Photoelectric Effect
•
TheemissionofelectronsfromametallicLightsurfaceIlluminatedwithlight(photo

or frequency is called photoelectric effect.
• In other words photoelectric effect is a phenomenon in which, when the light(photon) of appropriate
wavelength or frequency incidents on the metallic surface called photo cathode, photo electrons are emitted
and then due to the production of photo electrons, photocurrent is generated.
• By the use of visible light, only certain alkali metals like sodium, potassium etc can exhibit the phenomenon of
photoelectric effect but using high frequency electromagnetic radiations (X-rays or Y- rays) almost all metals
can show the photoelectric effect. The photoelectric effect can also be exhibited by the liquids and gases. But
in the liquid it is electrolysis, while in the gas it is ionization.
• It is also observed that the number of photo electrons emitted per second (photo current) varies directly as per
the intensity of the incident light, but the energy (maximum) of the photo electrons is independent of the
intensity of the incident light. The maximum energy of the liberated photoelectrons only depends on the
frequency of the incident light or its wavelength. Also this energy varies linearly with the frequency or inverse

linearly with the wavelength of the incident light (photon).

X-rays

• X-rays are short electromagnetic waves which are produced when rapidly moving electrons are stopped by heavy metallic target like tungsten, molybdenum, platinum etc. The metallic targets are made up of those, which have high melting point, high atomic number, high thermal conductivity.

• X-rays were firstly observed and produced by Prof. W.C. Roentgen in 1895, thus X—rays were also referred as Roentgen rays. Within three months after Roentgen's discovery, X-rays were being put to use in a hospital in Vienna in connection with major surgical operations.

Fluorescence

• There are various type of substances occur in our nature and on a few of them if ultraviolet light directed, whose wavelength is small (frequency large), then it is absorbed by them and emit a light of longer wavelength (shorter frequency) this incident or phenomenon is called fluorescence and corresponding substances are called fluorescent substances.

• The examples of fluorescent substances are fluorspar, petrol, quinine, sulphate, uranium oxide etc. To detect X rays we use barium platino cyanide which is a sensitive fluorescent substance, through which when X-rays pass then it absorbs X-ray and emit green light. Today in domestic tube-light, inner coating of fluorescent substances are laminated to get a fascinating and decorative flavour of the light.

Phosphorescence

• As from the basic characteristic of the fluorescence, only substances emit light until these being in absorbing position of the suitable light of lower wavelength. But there are also some substances which not only emit the light incidents at glance but is also remains emitting for some longer time, even while its incidence be stopped.

This is called phosphorescence and the corresponding substances are called

phosphorescent substances. On
heating, the ability and quality of the phosphorescent substance is completely destroyed.

• The examples of phosphorescent substances are zinc sulphide, calcium sulphide, barium sulphide etc. Today
in the needle of watches and in the various hoarding boards employed for the advertising and marketing
purposes the lamination of phosphorescent substances are used. These needles and hoarding boards absorb
sunlight in the day and shine in very glazy and fascinating way in the night.

Primary, secondary and complementary colours

• Red, Green and Blue colours are called primary colours while Yellow, Magenta and Peacock blue (cyan) colours are called secondary colours. These Red colours are prepared by two primary colours.
• Red + Blue$^{23}_{11}$Magenta.
• Green + Blue$^{23}_{11}$Peacock blue (cyan)
• Red + Green$^{23}_{11}$Yellow
• If two colours mutually meet to form a white light then the colour is complementary.

Example :
• Red + peacock blue (cyan)$^{23}_{11}$white. Green + Magenta$^{23}_{11}$White.
• Yellow + Blue$^{23}_{11}$white, Red + green + yellow$^{23}_{11}$white.
• Such type of colours can not be achieved in our daily life because colours which we use practically are impure.
• Colour TV utilises primary colour red, green and blue.
Speed of Light
• Ole ChristensenRomerwas the first to calculate the speed of light. His calculation was based on the motion of

satellites of the planet Jupiter.
• In different medium speed of light is different and it depends upon the refractive index of the medium. The
medium which has larger refractive index has lesser speed of light.
• The light reaches from the sun to the surface of earth's in 8 minutes 19 seconds and the reflected light from the
moon takes 1.28 seconds to reach on the earth's surface.
• In vacuum, the speed of all the seven component colours are same but through glass, the violet travels the
slowest and the red the fastest.
• We see lightning before we hear thunder because light travels much faster than sound. Light travels at 299,729,

485 miles per second and sound only travels at 340 miles per second. The speed of light is approximately
881,500 times faster than the speed of sound, and thus lightning is visible to our eyes before we hear claps of
thunder during a storm.
Speeds of light in various media:

Medium	Speed of light (m/s)
Vacuum	3×10^8
Water	2.25×10^8
Oil of tarpin	2.04×10^8
Glass	2×10^8
Rock Salt	2×10^8
Nylon	1.96×10^8

MIRRORS AND IMAGES

Mirror

- Any polished or a shining surface acts as a mirror.
- An image which can be obtained on a screen is called a real image. An image formed on a screen is called a real

image.
- An image which cannot be obtained on a screen is called a virtual image.
- Regular reflection takes place when light is incident on smooth, polished and regular surfaces.
- Diffused/irregular reflection takes place from rough surfaces.

Plane Mirror

- In an image formed by a mirror the left of the object appears on the right and the right appears on the left. This

is known as lateral inversion.

• The image formed by a plane mirror is erect. It is virtual and is of the same size as the object.

• The image is at the same distance behind the mirror as the object is in front of it.
• Two mirrors inclined to each other give multiple images.
• Beautiful patterns are formed in a kaleidoscope because of multiple reflections.
• It is of the same distance from the mirror as the object and of same size also.
• It is virtual. (Cannot be displayed on screen).
• If an object is placed between two mirrors inclined at 90^o, there will be a total of three images.
• In the case of parallel mirrors, there will be an infinite number of images.
• The minimum size of plane mirror, required to see the full size image of a person by himself, is half of the height of that person.
• The formula to find the number of images formed by plane mirrors is –

No. of images (n) =(360/theta) -1
wheretheta is the angle between the mirrors.
If the theta is 90 degree you will have n=3, if the thetais 60 degree you will have n=5 ,if theta is 30 degree n= 11, i.e. 11 images.

Concave mirrors

• Concave mirrors are used for many purposes. Doctors use concave mirrors for examining eyes, ears, nose and throat.
• Concave mirrors are also used by dentists to see an enlarged image of the teeth.
• A concave mirror can form a real and inverted image.
• Inner surface is reflecting - is a magnifier.
• A parallel beam of light after reflection actually converges to a point called the focus of the mirror.

• It forms a virtual or real image depending on the position of the object.
• When an object is placed close to the mirror, i.e., at a distance less than the focal length of the mirror the image formed is virtual, erect and larger than the object.
• Barbers use concave mirror as the shaving mirror to see a larger image of the face.
• Concave mirrors are commonly used in torches, search-lights and vehicles headlights to get powerful parallel beams of light.
• Large concave mirrors are used to concentrate sunlight to produce heat in solar furnaces.

Convex mirrors

• Convex mirrors are commonly used as rear-view (wing) mirrors in vehicles. These mirrors are fitted on the sides of the vehicle, enabling the driver to see traffic behind him/her to facilitate safe driving. Convex mirrors are preferred because they always give an erect, though diminished, image. Also, they have a wider field of view as they are curved outwards. Thus, convex mirrors enable the driver to view much larger area than would be possible with a plane mirror.So, these help the drivers to see the traffic behind them travels along straight lines.
• Image formed by a convex mirror is erect, virtual and smaller in size than the object.
• Convex mirror is used in super markets to deter shoplifters.
• Outer surface of convex mirror is reflecting.
• When a parallel beam of light is incident on a mirror, the reflected rays appear to diverge from a pint called focus of the mirror.
• It always produces virtual images.
• These images are behind the mirror erect and smaller than the objects.

Convex lens

• A convex lens can forms real and inverted image. When the object is placed very close to the lens, the image formed is virtual, erect and magnified.

• All the incident rays after passing through the convex lens, converge to a point called the principal focus.

• The image is erect, magnified and virtual, if the lens is held near an object so that the object lies within the principal focus.
• When the object is outside the principal focus of a converging lens, it forms a real image.
• When used to see objects magnified, the convex lens is called a magnifying glass.

Concave lens

• A concave lens always forms erect, virtual and smaller image than the object.
• The incident rays passing through it diverge is different direction.
• Air bubble in water acts like a concave lens.

HUMAN EYE

Various parts of eye and their functions

• Human eye is like a camera by the help of which we see the objects. Important parts of the eye are cornea, iris, pupil, lens, retina and optic nerve. A normal eye can see nearby and distant objects clearly
• Human eye is externally very hard and it is covered with Cornea opaque white membrane which is called sclerotic.
• The front part of sclerotic is concave which is called cornea. During eye donation this part is donated. The light ray enters into the eye through cornea.
• Behind the cornea a colour opaque membrane is located which is called Iris.
• At the middle of the Iris there is a sharp hole, which is called pupil. Iris controls the amount of light enters into the eye. If more light comes into it, then automatically it compresses itself. Also in dark or insufficient light it automatically expands. Behind the pupil eye lens is located.
• Cornea acts as lens (convex). It converges the rays on the retina where image is formed. The eye lens is made from many layers whose index of refraction increases from outside to inside and its mean index of refraction is

approximately 1.44. The eye lens is confined within the muscular region and it is capable to adjust its focal length that’s why human eye has a variable nature of focal length.

• Between cornea and eye lens a saline transparent liquid is filled up which is called aqueous humour, and its index of refraction is 1.336. Behind the eye lens an another transparent liquid which is called vitreous humour and whose index of refraction is also 1.336.

• Behind sclerotic there is a black coloured membrane which is called choroid. It absorbs the light and stop the process of internal reflection.

• Inside this membrane and in the innermost part of the eye there is a transparent membrane which is called retina. The retina is basically a film of optical nerves and these nerves produce the sensation of the image formed in the mind (brain). Thus shape, size and colour of the objects image is observed by the human eye.

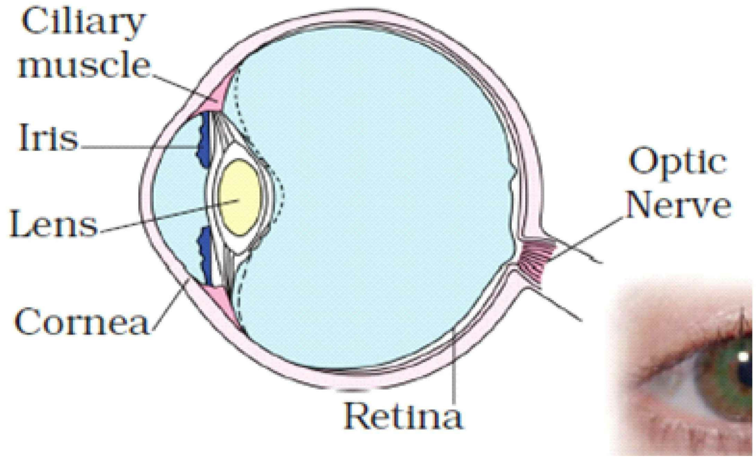
• Any light ray when incidents on the object then by reflecting passes through the cornea and aqueous humour reaches to retina.

• At retina (uses as screen for glass lens) the image of the object is formed diminished, real and inverted and this massage is brought to the human brain by the visionary (optic) nerves and the brain realises the real erected image.

• The place (point) where optic nerves by making the hole in the retina goes upto brain, there is no effect of light. This place is called blind spot.

• There is amid-pointin the retina whichisyellowcoloured.Here the obtainedimage isverysharpanddistinctive. It is called yellow spot.

• The iris is the part of that eye which gives it its distinctive colour. When we say that a person has green eyes, we refer actually to the colour of the iris. The iris controls the amount of light entering into the eye.



- The impression of an image does not vanish immediately from the retina. It persists there for about 1/16th of a second. So, if still images of a moving object are flashed on the eye at a rate faster than 16 per second, then the eye perceives this object as moving.
- Optic nerves carry the impressions on the retina brain.
- It is difficult to see when the eye is placed inside water because in contact with water the focal length of eye lens increases and the image formed on the Retina is not sharp.
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- Visually challenged persons develop their other senses more sharply to improve their interaction with their environment.

Accommodation power of eye

- To look any object distinctly, it is necessary that the light ray reflected from object must be totally confined on the retina. In usual condition the coming light rays from far flung object is assumed to be confined on the retina by which the muscles of the eye is not stretched and object becomes visible. At this position eye lens has maximum focal length. But if eye looks any nearer object, then eye muscles start to shrink and reduces the radii of curvature of the lens surfaces. Here the focal length of the eye lens is reduced and again image starts to form at the retina.

- This adjustment of the focal length of the eye is called accommodation power of eye. As well as we try to look

• This adjustment of the focal length of the eye is called accommodation power of eye. As well as we try to look the nearest object more and more accommodation power of eye is required and it has also a limit.

• If any object be kept very near to eye it doesn’t look distinct. Thus the nearest point of the object where maximum accommodation power of eye is applied and object looks sharp and distinct is called least distance of distinct vision and for a normal human eye it is 25 cm.

• But inversely any object located at far point and eye without applying the power of accommodation can look the object distinctly and for a normal human eye it is infinity.

Colour vision

• There are two types of cells in the retina of the eye which are optically sensitive. These are cones and rods. Cones shaped cell react according to the consistency of the colours by which we see the colours.

• Cones are sensitive to bright light. Besides, cones sense colour.

• Rods are sensitive to dim light.

• Rods shaped cells react according to the consistency of the intensity of light. That’s why we also speculate or guess about the object in the dark.

• When light is shining or dazzling then rods cells stop to act and cones cells become active. A normal human eye's retina has three types of cones cells :
(a) First type - Sensitive to light of shorter wavelength (blue colour)
(b) Second type - Sensitive to light of middle range wavelength (green colour)
(c) Third type - Sensitive to light of longer wavelength (red colour)
Chromatic Induction or simultaneous contrast
• The district vision of any colour depends on all around colours. If we look a particular colour in the various layers of the surfaces where various colours are to be confined it looks different.
• If any colour be seen in the background of sharp colour this colour seems to be light, but in the domain (background) of light colour seems to be sharp. This relative distinction in the colour is called chromatic induction or stimulation contrasts.
Phantom colour
• Sometimes we look colours in the region of black and white. These colours are called phantom colour.
• It can be observed on black and white TV sometimes when pictures pass very rapidly.
Eye's Defect or Defects of Vision
There are mainly three common refractive defects of vision. These are (i) Myopia or Near-sightedness, (ii)
Hypermetropia or Far-sightedness, and (iii) Presbyopia. These defects can be corrected by the use of suitable
spherical lenses.
Myopia
• Myopia is also known as near-sightedness. A person with myopia can see nearby objects clearly butcannot see distant objects distinctly.
• In Myopia the image of the object is formed in front of Retina. For Normal vision, the image of the object should be formed on the Retina.
• A person with this defect has the far point nearer than infinity. Such a person may see clearly upto a distance of a few meters. In a myopic eye, the image of a distant object is formed in front of the retina and not at the retina

itself. This defect may arise due to (i) excessive curvature of the eyelens, or (ii) elongation of the eyeball.
• This defect can be corrected by using a concave lens of suitable power. A concave lens of suitable power will bring the image back on to the retina and thus the defect is corrected.
Hypermetropia
• Hypermetropia is also known as far-sightedness. A person with Hypermetropia can see distant objectsclearly but cannot see nearby objects distinctly.
• In Hypermetropia, the image is formed far from the retina.
• The near point, for the person, is farther away from thenormal near point (25 cm). Such a person has to keep a reading material much beyond 25 cm from the eyefor comfortable reading.
• This is because the light rays from a closeby object are focussed at a point behindthe retina. This defect arises either because (i) the focal length of the eye lens is toolong, or (ii) the eyeball has become too small.
• This defect can be corrected by using a convex lens of appropriate power. Eye-glasses with converging lenses provide the additional focusing power required for forming the image on the retina.
Presbyopia
• The power of accommodation of the eye usually decreases with ageing. For most people, the near pointgradually recedes away. They find it difficult to see nearby objects comfortably and distinctly withoutcorrective eye-glasses. This defect is called Presbyopia.
• It arises due to the gradual weakening of the ciliary muscles and diminishing flexibility of the eye lens.
Astigmatism
• Sometimes, a person may suffer from both myopia and Hypermetropia. This defect is known as Astigmatism.
• Such people often require bifocal lenses. A common type of bi-focal lenses consists of bothconcave and convex lenses.

• The upper portion consists of a concave lens. It facilitates distant vision. The lower part is a convex lens. It facilitates near vision.
• These days, it is possible to correct the refractive defects with contact lenses or through surgical interventions.

Colour of bodies

• The colour of a luminous body is determined by the radiated light.
• The colour of a non-luminous body is determined by the reflected light. It is transparent if the body do not reflects and opaque if all the light is reflected.
• A body absorbs all colours except its own colour.
• A body has no permanent colour of its own. To see a body in its true colour it should be illuminated by Natural light.
• A body is said to be white if it does not absorb any colour.
• A body is said to be black if it absorbs all colour.

Use of Various Types of Mirrors & Lenses

• Shaving Glass -
• Astigmatism -
• Short Sightedness (Myopia) -
• Long sightedness (Hypermetropia) -
• Presbyopia -
• Magnifying glass -
• Burning Glass -
• Telescope -
• Solar Cooker -
• Dressing table -
• Reflector of Road lights -
• Search Light -
• Ophthalmoscope -
• Rear view mirror of motor Vehicle -
• Compound Microscope -
• Simple Microscope -

Phenomenon and Cause

• Glittering of Diamond -
• Mirage -

• Rainbow -
• Sky looks blue -
• Star twinkles -
• Looming -
• It appears that water has been sprinkled on a - metalled road on a hot summer day
• Heavenly bodies appear higher in the sky than they are -
• Sun becomes visible before actual sunrise -
• Sun appears oval- shaped during morning & evening -
• A stick partially immersed in water appears to be bent - Concave Mirror

Cylindrical Glass
Concave lens
Convex lens
Bifocal lens
Concave Mirror
Concave lens
Two convex lenses
Concave Mirror
Plane Mirror
Concave Mirror
Parabolic Concave Mirror Concave Mirror
Convex Mirror
Two Convex Lenses
One convex Lens

Total Internal Reflection Total Internal Reflection Dispersion
Scattering
Refraction
Total Internal Reflection Total Internal Reflection.

Refraction Refraction. Refraction Refraction.

Misc. points about optical instruments
1.Camera
2.Magnifying glass or Simple Microscope
3.Compound Microscope
4.Telescope
5.Kaleidoscope
6.Periscope

7. Sextant Forms real, inverted and diminished image.
Uses short focal length double convex lens and a concave mirror. It forms virtual, erect and magnified image. Uses short focal length convex lenses and a concave mirror. Forms a virtual and magnified image.
Uses two convex lenses. The object lens - is of large focal length and eye-lens is of short focal length.
Two plane mirrors are placed at an angle of 60^oinside a tube. At the bottom of the tube there is a ground glass plate. When coloured glass pieces are scattered on the ground plate, five images are formed which together with the object form symmetrical pattern in six sectors. Two plane mirror are fixed at an angle of 45^o. Periscope, used in submarines, have prism instead of plane mirror. Is an optical instrument used for finding out the altitude of celestial bodies and their angular distance. It consists of two plane mirrors mounted on a circular sector, a telescope and a Vernier scale.

QUICK REVIEW OF OPTICS
1. Light waves are electromagnetic in nature.
2. Material medium is not necessary for the transmission of light waves.
3. Light waves are transverse.
4. Light waves exhibit polarization.
5. The blue colour of sky is due to scattering of light.
6. Velocity of light, amplitude and wavelength changes in refraction of light but frequency remains unchanged.
7. A rod kept in the bucket of water appears to be bent because of refraction.
8. A pond appears to be lesser in depth due to refraction.

9. The refractive index of water w. r. t. air is$_a m_w$= and refractive index of glass w.r.t. air is$_a m_g$=
10. Refractive index of glass w.r.t. water is$_w m_g$=

11. Formation of a mirage is an optical illusion which takes place due to total internal refraction of light.
12. Myopia is short sightedness and Hypermetropia is long sightedness.
13. In myopia a person can see the near objects clearly but he can’t clearly see the far objects.
14. In hypermetropia a person can see the distant objects clearly but he can’t clearly see the near objects.
15. In myopia the rays get focused in front of retina and in hypermetropia they are focussed behind the retina.
16. Myopia is corrected by the use of concave lens and hypermetropia is corrected by using convex lens.
17. In a reading lens a convex lens of short focal length is used.
18. A driver uses convex mirror for seeing the traffic at the back.
19. If a lens is dipped in such a medium whose refractive index is greater than the refractive index of the material of lens then along with the change in focal length of the lens its nature also changes that is convex lens behaves as concave and concave lens behaves as convex.
20. In astigmatism a person cannot distinctly see the horizontal and vertical lines simultaneously at a normal distance.

21. Black colour is actually the absence of all colours.

22. Refractive index of red light is lesser than the refractive index for violet light.
23. Light travels faster in vacuum than in air.
24. A polished diamond due to its high refractive index shines by total internal reflection.
25. Colour of stars exhibits their temperature.
26. There is redistribution of energy in the interference pattern. Total energy in it remains conserved.
27. The unit of luminous intensity is candela.
28. Faut is the unit of illuminance 1 faut = 10^4lux.

29. The formula for critical angle (C) is: sin C =
30. The power of a lens is measured in diopters.
31. Resolving power of a telescope is . In it D is the diameter of the objective lens.

32. Polarisation of light proves its transverse wave nature.
33. Longitudinal waves cannot be polarised.
34. Gamma rays, X-rays, ultraviolet rays, infra-red rays and radio waves are all electro magnetic radiations.
35. Sextant measures the angle formed by an object with the eye.
36. Infinite images of an object are formed that is placed between two parallel mirrors.

☆360–1

37. The number of images formed if the angle between the two mirrors is Ö is★ ·★ ï

☆360–1

38. If the angle between two plane mirrors is 75° then five images★ of an object placed between them★ 75

will be formed.
39. Periscope is used to see the objects outside a submarine.
40. The colours in thin films of soap and the bubbles are seen due to scattering of light.
41. Various types of coloured designs may be seen by a kaleidoscope.
42. We cannot determine whether an a.c. (alternating current) or d.c. (direct current) is flowing by just by observing a glowing electric bulb.

43. When a glass lens (
μ = 3/2) is dipped in water (= 4/3) its focal length becomes four times of its focal length in air..

44. The speed of light is 3×10^8m/s which is equivalent to 18.6×10^4miles/sec.
45. Lux is the unit of illuminance.
46. 1 lux = 1 lumen/m^2.
47. Lumen is the unit of luminous flux.
48. Sunlight consists of seven colours. The rays whose frequency is less than the frequency of red colour of sunlight are called ultraviolet rays and the rays whose frequency is greater than the frequency of violet colour are called ultraviolet rays. Both types of rays are invisible. Infrared rays are not only emitted from sun but also from every hot object.
49. Some objects absorb light of a definite colour and emit rays of some other colour. For example, calcium fluoride absorbs violet rays and emits blue rays. This phenomenon is called fluorescence.
50. Some objects emit light even on being removed from the presence of a light source (Sun). This phenomenon is called phosphorescence. Calcium sulphide exhibits this property.
51. Electromagnetic radiations whose wavelength lies in the range of 400 nm to 700 nm are visible. This is the wavelength range of the visible region in spectrum.

52. Homer (1876) first explained the colour blindness.

53. A coin inside a bucket of water appears to be nearer than its actual depth in water due to refraction.
54. If a person standing in water sees a coin above the water surface the coin appears to be higher than its actual position.
55. The focal length of a lens is maximum for red light and minimum for violet light.
56. Three dimensional imagesare called hologram.
57. Light radiation is both of wave and particle nature.
58. Sun always rises in the east because earth rotates from west to east.
59. If a transparent object becomes invisible on immersing in water, it implies that the refractive index of both water and the material of the object is same.
60. When a light ray enters from air into glass, its wavelength decreases.
61. Objective lens is a convex lens of lesser focal length.
62. Optical fiber was invented by T. H. Maiah.
63. In India optical fiber is mainly used in telecommunication.
64. Optical fiber is also used in endoscopy.
65. Diamond sparkle is due to its high refractive index.
66. The unit of power of a lens is Dioptre.
67. If a green colour tie is seen in the red light it appears black.
68. Sky appears black to a space tourist.
69. Only cornea is donated in eye donation.
70. Polarising angle for a glass plate of 1.54 refractive index is 57°.
71. When a plane mirror is rotated by an angle Ö then the reflected ray rotates by an angle 2 Ö.
72. The red colour of the setting sun is due to scattering of light.
73. Astigmatism can be corrected by the use of a cylindrical lens.
74. The sea water appears blue in colour due to sky’s reflection and light scattering by water particles.
75. Mirage formation takes place due to total internal reflection.
76. The speed of light is 1,86,000 miles/sec.

77. Human eye contains convex lens.
78. An erect image of the same size as the object may be seen only by a plane mirror.
79. The critical angle of diamond is 24.4°.
80. Light rays in the human eye convert into neural impulses.
81. Raman effect is related with the scattering of light.
82. Erect and virtual images are always formed by plane and convex mirror.
83. Optical fibre is based on the principle of total internal reflection.
84. For a normally incident ray the angle of incidence is zero hence the angles of reflection and refraction for it are also zero.

85. If $_a\mu w$ = than $_w\mu_a$=
86. $_w\mu_g$=

87. Endoscopy, a technique used for the testing of the internal organs of the body and stomach, is based on the phenomenon of total internal reflection.
88. Erect and diminished image is seen by a convex mirror.
89. A convex mirror is fitted at the side of a driver to see the images of the vehicles at the back.
90. Since the red colour is less scattered hance a red signal may be seen from a long distance.

91. National Science Day is celebrated on 28 February (In the memory of the discovery of Raman effect by Sir C. V.

Raman).
92. A rare solar eclipse in 1999 was observed on 16 February.
93. When light falls on an object at polarising angle then reflected and refracted rays are mutually perpendicular.
94. An air bubble in water acts as a concave lens.
95. Hypo i.e. sodium thio-sulphate solution is used for fixing in photography.
96. The colour of an opaque object is due to the colour of light reflected by it.
97. The image of the object formed on retina is small and inverted.
98. The power of sun glasses is zero.
99. Infinite images of an object are formed that is placed between two parallel mirrors.
100. If the atmosphere is absent sky would appear to be black.
101. The order of the colours of the rainbow is Violet, Indigo Blue, Green, Yellow, Orange and Red.

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INSIGHT GENERAL STUDIES

TOPIC

4

HEAT/THERMODYNAMICS

Introduction

• The heat flows from a body at a higher temperature to a body at a lower temperature. There are three ways in which heat can flow from one object to another. These are conduction, convection and radiation.
• In solids, generally, the heat is transferred by conduction. In liquids and gases the heat is transferred by convection. No medium is required for transfer of heat by radiation.
• The materials which allow heat to pass through them easily are conductors of heat. For examples, aluminium, iron and copper. The materials which do not allow heat to pass through them easily are poor conductors of heat such as plastic and wood. Poor conductors are known as insulators.
• Dark-coloured objects absorb radiation better than the light-coloured objects. That is the reason we feel more comfortable in light-coloured clothes in the summer.
• In the winter, we use woollen clothes. Wool is a poor conductor of heat. Moreover, there is air trapped in between the wool fibres. This air prevents the flow of heat from our body to the cold surroundings. So, we feel warm.
• The matter around us exists in three states— solid, liquid and gas.
• The forces of attraction between the particles are maximum in solids, intermediate in liquids and minimum in gases.
• The spaces in between the constituent particles and kinetic energy of the particles are minimum in the case of solids, intermediate in liquids and maximum in gases.
• The arrangement of particles is most ordered in the case of solids, in the case of liquids layers of particles can slip and slide over each other while for gases, there is no order, particles just move about randomly.
• The states of matter are inter-convertible. The state of matter can be changed by changing temperature or pressure.

Utilities and Applications of transmission of heat in our daily life

Utilities and Applications of conduction
⁂ When we touch a piece of iron and wood placed in the same room, we feel iron to be colder than the wood the reason behind it is good conduction of heat by the iron.Our body temperature (normally 37°C) is generally greater than that of the room, When we touch an iron piece, heat is rapidly conducted from the hand (hotter body) to the iron and wood being a bad conductor conducts very little heat. So we lose more heat by touching iron than wood. That’s why iron appears colder. But when both have been lying long in the sun then they are touched, the iron piece appears hotter than the wooden piece.
⁂ Eskimo’s people dwell in the houses of double walls of ice.Such houses keep people warmer and comfortable because air molecules are being trapped between the ice walls of the house which is bad conductor of heat.
⁂ To drink tea in a metallic cup is painful then the cup of ceramics or fibers. The simple reasons behind it is the heat from the tea goes into the metallic cup which becomes hot and the lips of the man or woman have painful and bitter experience due to good conduction. But due to bad conduction of heat, in ceramic or fibers cup heat doesn‘t undergo from tea into these cups and do not warm.
Utilities and Applications of convection
Ventilation:
⁂ The ventilation of a room is the process of expulsion of warm and impure air and the introduction of cold and fresh air into the room. For proper ventilation an outlet is necessary near the top of the room and an inlet near the bottom of the room.
⁂

The hot and impure air being light escapes through the top outlet and fresh air enters into the room through the inlet at the bottom of the room.

Chimney :

⁂ Smoke coming out from all chimneys is a common phenomenon and in chimney the process of convection

occurs. Hot air and smoke being lighter move up by the chimney while the cold and heavier air is continually drawn in at the bottom. Thus a convection current is set up.

⁂ In the tall chimney the difference in the density of air between the top and the bottom is being large. Narrow chimneys are preferable to the wide ones because they can prevent downward currents of air more effectively

Winds and breezes :

⁂ Trade winds, land breeze and sea breeze are the natural consequences of convection. The equatorial belt of the earth is hotter than other regions. Air of this belt thus becomes lighter and rises up. Cold air from North and South rushes to take up the place of the hot air.Due to the rotation of the earth from west to east, this natural air current actually flows from the north—east direction in the northern hemisphere and from south-west direction in the southern hemisphere. These are called trade winds.

⁂ Land is a better absorber of heat and has a higher thermometric conductivity than water. Consequently land attains a higher temperature during the day time than water. Air over land, so becomes lighter and rises up. Cold air from seas, oceans or lakes, whatever they be near the land, rushes to the land. This is called sea— breeze.

⁂ As a body which is a good absorber of heat is a good radiator of heat, now at night the temperature over land goes down much earlier than over the water. Air over water being hotter rises up and cold air from land flows to the sea. This is called land-breeze.

To insert or fill up inert gases in the electric bulbs :

⁂ To avoid the burning of the filaments of the electric bulbs which are made of tungsten (high atomic wt. and high m.p.) the bulb is evacuated (creation of

vacuum).
⁂ Also to avoid the melting of the filaments in the bulb some inert gases like argon or krypton are filled up and thusthermalradiationsgeneratedbythefilamentsformaconvectionalcurrentinside quantity of thermal energy produced doesn't melt the filament.

Utilities and applications of radiation

⁂ Cloudy night of winter is warmer than that of night of free and clear sky: In the night of free and clear sky the thermal energy (thermal radiation) produced from the earth's surface goes upwards uninterruptly into the space through the sky. But during cloudy night these radiation do not go to the space as the cloud is the bad conductor of heat and thus these radiations would be reflected back and our surrounding becomes warmer.

⁂ In desert area day is too hot and night is too cold: Since sand (silica) is a good absorber of the thermal radiations and by kirchhoff's law good absorber of heat is also a good emitter (radiator). During day the sand absorbs the thermal radiations from the sun and so day becomes too hot but in night all such radiations are emitted thus night becomes too cold.

⁂ Tea container (jar)'s outer layers are made shiny : The shiny layer neither permits inner thermal energy to go out nor absorb or accept outer thermal energy (radiation), it simply reflects back and thus the container remains hot a longer time.

Prevost's theory of heat exchange

• The most basic and fundamental concept was propounded by Prevost at Geneva in 1792 about the radiation process. Before this theory it was assumed that there are two types of radiations — hot and cold. Cold bodies emit cold radiations and hot bodies emit hot radiations. A block of ice was supposed to emit cold radiations, because it produces a sensation of coldness and a red hot iron ball was supposed to emit hot radiation, as it produces the sensation of warmness. If this is a fact then there must be a basis to define hot and cold bodies. But we have no any such basis of thinking and no any scientific background. The correct explanation was given by Prevost.

• Prevost asserted that all bodies irrespective of their temperature emit only one type of radiation and the temperature being the only decisive factor regarding its rate of emission. At low temperature, the total emission (radiation of all wavelengths) is poor and at high temperature, the emission of radiation is very high. The rise or fall of temperature, which is observed in a body, is due to its exchange of radiant energy with surrounding bodies, which goes on uninterrupted in equal amount even after the attainment of thermal equilibrium. This is called Prevost's theory of heat exchange.
• By the devices Pyrometers and Bolometers the thermal radiations were detected earlier but at present thermopiles are the appropriate devices opted on the basis of variation of temperature with resistance of platinum wires. Thus the temperature of the sun can be measured by pyrometers or Bolometers or thermophiles.

Vaporisation

• Vaporisation of an element or compound is a phase transition from the liquid or solid phase to gas phase. There are three types of vaporization: evaporation, boiling and sublimation.
• Evaporation is a phase transition from the liquid phase to gas phase that occurs at temperatures below the boiling temperature at a given pressure. Evaporation usually occurs on the surface.
• Boiling is a phase transition from the liquid phase to gas phase that occurs at or above the boiling temperature. Boiling, as opposed to evaporation, occurs below the surface.
• Sublimation is a direct phase transition from the solid phase to the gas phase, skipping the intermediate liquid phase.
• The heat of vaporization is the amount of energy required to convert or vaporize a saturated liquid (i.e., a liquid at its boiling point) into a vapor.
Evaporation
• The phenomenon of change of a liquid into vapours at any temperature below its boiling point is called evaporation.
• Evaporation is a type of vaporization of a liquid that occurs only on the

surface of a liquid. The other type of vaporization is boiling, which, instead, occurs on the entire mass of the liquid. Evaporation is also part of the water cycle.

• From the outer surface of any liquid at any temperature slowly and steadily the conversion of liquid into the vapour is called evaporation. In the process of evaporation the heat energy is supplied by the inner molecules of the liquid and when a sufficient heat energy is acquired by the molecules of outer surface then these molecules detached from the liquid and thus vapour is formed and along with themselves molecules have also heat energy and ultimately temperature falls. Thus evaporation is a process of obtain cooling from the liquid.

• Evaporation is a surface phenomenon in which molecules located near the liquid’s edge, not contained by enough liquid pressure on that side, escape into the surroundings as vapor.

• Evaporation causes cooling.

• The rate of evaporation increases with–

↘ An increase of surface area: We know that evaporation is a surface phenomenon. If the surface area is increased, the rate of evaporation increases. For example, while putting clothes for drying up we spread them out.

↘ An increase of temperature: With the increase of temperature, more number of particles get enough kinetic energy to go into the vapour state.

↘ A decrease in humidity: Humidity is the amount of water vapour present in air. The air around us cannot hold more than a definite amount of water vapour at a given temperature. If the amount of water in air is already high, the rate of evaporation decreases. If the water vapour present in the atmosphere is larger then the rate of evaporation is less and vice-versa. That’s why in summer wet cloths are dehydrated soon and becomes dry in short time while in rainy season it (cloth) take longer time.

↘ An increase in wind speed: It is a common observation that clothes dry faster on a windy day. With the increase in wind speed, the particles of water vapour move away with the wind, decreasing the amount of water vapour in the surrounding.

• In summer, Surahi (water container made of ceramic) by evaporation process lowers the temperature and water becomes cool. When anybody suffering through fever and if the temperature of the body becomes too large then wet cloth is placed on the forehead of the man or woman and then by the process of evaporation his or her body temperature falls and the body becomes relaxed.
• On average, the molecules in a glass of water do not have enough heat energy to escape from the liquid. With

- In summer, Surahi (water container made of ceramic) by evaporation process lowers the temperature and water becomes cool. When anybody suffering through fever and if the temperature of the body becomes too large then wet cloth is placed on the forehead of the man or woman and then by the process of evaporation his or her body temperature falls and the body becomes relaxed.
- On average, the molecules in a glass of water do not have enough heat energy to escape from the liquid. With sufficient heat, the liquid would turn into vapor quickly (see boiling point). When the molecules collide, they

sufficient heat, the liquid would turn into vapor quickly (see boiling point). When the molecules collide, they transfer energy to each other in varying degrees, based on how they collide. Sometimes the transfer is so onesided for a molecule near the surface that it ends up with enough energy to escape.
• Liquidsthatdonotevaporatevisiblyatagiventemperature inagivengas(e.g.,cookingoilatroomtemperature) have molecules that do not tend to transfer energy to each other in a pattern sufficient to frequently give a molecule the heat energy necessary to turn into vapor. However, these liquids are evaporating. It is just that the process is much slower and thus significantly less visible.

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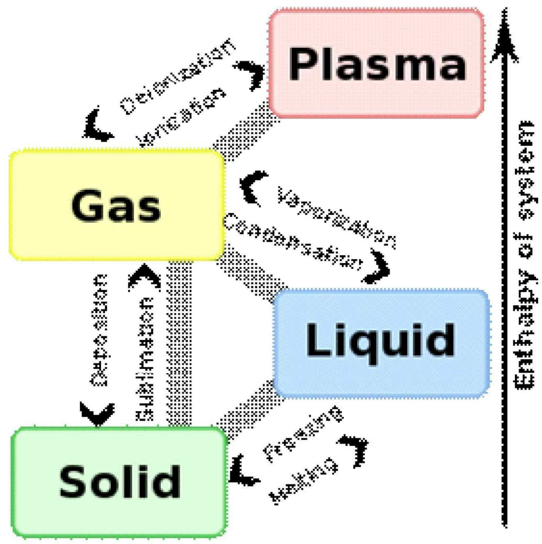
- Liquids that do not evaporate visibly at a given temperature in a given gas (e.g., cooking oil at room temperature) have molecules that do not tend to transfer energy to each other in a pattern sufficient to frequently give a molecule the heat energy necessary to turn into vapor. However, these liquids *are* evaporating. It is just that the process is much slower and thus significantly less visible.



- Evaporation is an essential part of the water cycle. Solar energy drives evaporation of water from oceans, lakes, moisture in the soil, and other sources of water. In hydrology, evaporation and transpiration (which involves evaporation within plant stomata) are collectively termedevapotranspiration. Evaporation is caused when water is exposed to air and the liquid molecules turn into water vapor, which rises

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Evaporation is caused when water is exposed to air and the liquid molecules turn into water vapor, which rises up and forms clouds.

Boiling of liquid

- Boiling is the rapid vaporization of a liquid, which occurs when a liquid is heated to its boiling point. It refers to a constant temperature at which liquid is transformed into gas (vapour) by the heat energy of latent heat of vapourization.
- The temperature at which the vapour pressure of the liquid is equal to the pressure exerted on the liquid by the surrounding environmental pressure is known as the boiling point.

• While below the boiling point a liquid evaporates from its surface, at the boiling point vapor bubbles come from the bulk of the liquid. For this to be possible, the vapor pressure must be sufficiently high to win the atmospheric pressure, so that the bubbles can be “inflated”. Thus, the difference between evaporation and boiling is “mechanical”, rather than thermodynamical.
• The boiling point is lowered when the pressure of the surrounding atmosphere is reduced, for example by the use of a vacuum pump or at high altitudes.

• The boiling point is lowered when the pressure of the surrounding atmosphere is reduced, for example by the use of a vacuum pump or at high altitudes. Because of this cooking becomes difficult at high altitudes.
• The boiling point becomes higher when the pressure of the surrounding atmosphere is increased. This is a common phenomenon in pressure cookers. The use of pressure cooker increases the boiling point of water and because of this cooking of vegetables becomes faster.
• Evaporation is a surface phenomenon in which molecules located near the liquid's edge, not contained by enough liquid pressure on that side, escape into the surroundings as vapor. On the other hand, boiling is a process in which molecules anywhere in the liquid escape, resulting in the formation of vapour bubbles within the liquid.

Effect of pressure on B.P.

When a liquid boils i.e. charges from liquid to gas there is an increase in its volume. Thus the boiling point of a liquid rises with increase in pressure and vice-versa. Thus a liquid would boil at temperature under reduced pressure. Hence water would boil at a temperature less than 100°C when the pressure applied is less than normal pressure (76 cm of Hg).

Effect of Impurity on B.P.

On mixing impurity the boiling point of the liquid increases.

Sublimation

• Sublimation refers to the process of transition of a substance from the solid phase to the gas phase without passing through an intermediate liquid phase. Sublimation is an endothermic phase transition that occurs at temperatures and pressures below a substance's triple point.
• At normal pressures, most chemical compounds and elements possess three different states at different temperatures. In these cases the transition from the solid to the gaseous state requires an intermediate liquid state. So, all solids which possess an appreciable vapor pressure at a certain temperature usually can sublime in air (e.g. ice just below 0°C).
• For some substances, such as carbon and arsenic, sublimation is much

easier than evaporation from the melt, because the pressure of their triple point is very high, and it is difficult to obtain them as liquids.

- Sublimation requires additional energy and is an endothermic change.
- The reverse process of sublimation is deposition. The formation of frost is an example of meteorological deposition.
- Solid carbon dioxide (dry ice) sublimes readily at atmospheric pressure.
- Snow and ice sublime, although more slowly, below the melting point temperature. This allows wet cloth to be hung outdoors in freezing weather and retrieved later in a dry state. In freeze-drying the material to be dehydrated is frozen and its water is allowed to sublime under reduced pressure or vacuum. The loss of snow from a snowfield during a cold spell is often caused by sunshine acting directly on the upper layers of the snow.
- Ablation is a process which includes sublimation and erosive wear of glacier ice.
- Camphor sublimes.
- Iodine produces fumes on gentle heating. It is possible to obtain liquid iodine at atmospheric pressure by controlling the temperature at just above the melting point of iodine.
- Naphthalene, a common ingredient in mothballs, also sublimes easily. Arsenic can also sublime at high temperatures.
- Various substances appear to sublime because of undergoing chemical reactions or decomposition; for example, ammonium chloride when heated decomposes into hydrogen chloride and ammonia.
- Sublimation is a technique used by chemists to purify compounds. Typically a solid is placed in a sublimation apparatus and heated undervacuum. Under this reduced pressure the solid volatilizesand condenses as a purified compound on a cooled surface (cold finger), leaving a non-volatile residue of impurities behind. Once heating ceases and the vacuum is removed, the purified compound may be collected from the cooling surface.

Melting Point

• The melting point of a solid is the temperature at which it changes state from solid to liquid. At the melting point the solid and liquid phase exist in equilibrium. It refers to a constant temperature at which solid is transformed into the liquid by the heat energy of latent heat of fusion is called melting point (m.p).
• The melting point of a substance depends (usually slightly) on pressure and is usually specified at standard atmospheric pressure. When considered as the temperature of the reverse change from liquid to solid, it is referred to as the freezing point or crystallization point.
• Because of the ability of some substances to supercool, the freezing point is not considered as a characteristic property of a substance. When the “characteristic freezing point” of a substance is determined, in fact the actual methodology is almost always “the principle of observing the disappearance rather than the formation of ice”, that is, the melting point.
• The melting point of a solid is an indication of the strength of the force of attraction between its particles.

Effect of pressure on M.P.
When a solid melts, there may be an increase or decrease of volume with the application of pressure. The melting point of certain solids like wax and Sulphur increase with increase in pressure while the melting point of certain solids like ice, gallium and bismuth decreases with increase in pressure. Thus ice would melt at a temperature lower than 0°C when the pressure is higher than the normal pressure (76 cm of Hg).
Effect of Impurity on M.P.
Normally the m.p. of the solid more sharply decreases on mixing impurity. Example – if some salts or perfumes be added in the melting ice of 0°C then its melting point decreases upto -22°C from 0°C.
Freezing Point
• For any given liquid, the temperature at which the liquid changes state from a liquid to a solid. At a fixed

temperature the transformation of the liquid into solid by lowering the temperature or withdrawing the thermal energy (latent heat of fusion) is called freezing point. The freezing point coincides with the melting point of solid.

• Freezing-point depression describes the phenomenon in which the freezing point of a liquid (a solvent) is depressed when another compound is added, meaning that a solution has a lower freezing point than a pure solvent. This happens whenever a non-volatile solute is added to a pure solvent, such as water. The phenomenon may be observed in sea water, which due to its salt content remains liquid at temperatures below 0°C (32°F), the freezing point of pure water.
• The phenomenon of freezing point depression is used in technical applications to avoid freezing. In the case of water,ethylene glycol or other forms of antifreeze is added to cooling water in internal combustion engines, making the mixture stay a liquid at temperatures below its normal freezing point.
• This phenomenon is effective in quickly lowering the temperatureof a beverage placed in an ice bath containing salt;itiscommonlyusedtomakeicecreamorcoolbeersrapidly.Roadsaltingisthemo helping to melt ice and snow on the highway.
• It is especially useful in removing black ice, which is a hidden but lethal danger to drivers. The maximum depression of the freezing point is about 0°F (-18°C), so if the ambient temperature is lower, salt or sodium chloride will be ineffective.

Latent heat

• Latent heat of vaporisation is the heat energy required to change 1 kg of a liquid to gas at atmospheric pressure at its boiling point.
• Latent heat of fusion is the amount of heat energy required to change 1 kg of solid into liquid at its melting point.
Humidity
The amount of water vapour in the atmosphere is called humidity. The amount of water vapour in air is different at
different places. Generally, amount of water vapour near sea level is larger thus humidity is also larger. Also in

rainy season, humidity is found to be more.

Relative Humidity

The relative humidity is the ratio of amount of water vapour in the air of a given volume at a particular temperature to the required water vapour in air to saturated the same volume at the same temperature. Relative humidity is measured by a device called Hygrometer. On increasing temperature relative humidity is increased.

Saturated Vapour

If at a given temperature air absorbs a definite amount of water vapour then at this state air is saidto be in the state of saturated water vapour.

Air-Conditioning

The climate of any place at the earth's surface is determined by various parameters like temperature, relative humidity, the wind flowing direction etc. Usually for a hygienic and comfortable climate following conditions should be fulfilled:

↘ The temperature should lie between 23°C to 25°C.
↘ The relative humidity lies between 60% to 64%.
↘ The speed of wind should lie between 0.0125 m/sec to 0.01417m/sec.

BlackBody

• A perfectly black body is one, which absorbs completely all the radiations of whatever wavelength incident on it. Since it neither reflects nor transmits any radiation, it appears black whatever the colour of the incident radiation may be. If a black body be placed inside a uniform temperature enclosure, it will absorb the full radiation of the enclosure.

• The quantity and quality of the radiation inside a uniform temperature enclosure is not affected bythe presence of anybody inside it, the black body will emit the full radiation of the enclosure on attaining equilibrium temperature with it. Thus the radiation emitted by a black body is also the full radiation consisting of all possible wavelength.

• But there is no surface available in practice which will absorb all the radiation falling on it. Even the lampblacked surface, which is assumed to be perfect black body and absorbs practically all the visible and infrared radiations, reflects the far infra-red radiation.

Condensation point

At a constant temperature, the transformation of vapour into the liquid is called condensation point and usually the
condensation point and the boiling point of the liquid coincide.

Anomalous expansion in water

⁂ Ordinarily the volume of the almost liquids increase with supply of heat or thermal energy while its density decreases. But the behaviour of the water is just opposite. If the water be heated which is already at 0°C, up to 4°C then its volume decreases and density increases. At 4°C the volume of the water is minimum and its density is maximum but on onwards heating water behaves like ordinary liquids. Thus, when water of 4°C is heated further its volume increases and density decreases. It is called anomalous expansion of water. There are so many incidents of anomalous expansion of water in our aquatic life.

⁂ In the winter season or in cold regions when atmospheric temperature falls the upper layer of the water of the lakes and ponds are frozen and consequently density increases while lower layer of the water is comparatively warmer and this process continues until the complete water achieve the temperature of 4°C. If the atmospheric temperature falls more sharply than the density of the outer layer of water start to diminish due to anomalous expansion of water consequently outer layer is remained in frozen ice at 0°C and lower layer of the water is in liquid state of 4°C. That’s why in the lower layer of the water of the lakes and ponds fishes and others aquatic organisms live. Due to anomalous expansion of the water, the water pipes in the cold regions burst or crack. Since at 0°C water freezes and on transforming water into ice its volume increases that’s why water tanks or pipes burst or crack.

Misc. Points

• During summer, we perspire more because of the mechanism of our body which keeps us cool. We know that during evaporation, the particles at the surface of the liquid gain energy from the surroundings or body surface and change into vapour. The heat energy equal to the latent heat of vaporisation is absorbed from the body leaving the body cool. Cotton, being a good absorber of water helps in absorbing the sweat and exposing it to the atmosphere for easy evaporation. This is why we should wear cotton clothes in summer.
• Let us take some ice-cold water in a tumbler. Soon we will see water droplets on the outer surface of the tumbler. The water vapour present in air, on coming in contact with the cold glass of water, loses energy and gets converted to liquid state, which we see as water droplets. Matter is made up of small particles. This is why we see water droplets on the outer surface of a glass containing ice-cold water.
• Expansion due to heat is also used by ironsmiths to put iron ring over wooden wheel and wooden handle into the iron blades. The iron blade of these tools has a ring in which the wooden handle is fixed. Normally, the ring is slightly smaller in size than the wooden handle. To fix the handle, the ring is heated and it becomes slightly larger in size (expands). Now, the handle easily fits into the ring. When the ring cools down it contracts and fits tightly on to the handle. Such a change is also used for fixing the metal rim on a wooden wheel of a cart.
• Air, water and ice are to some extent bad conductor of heat.
• The boiling point of water increases with the increase of pressure.
• A black surface is bad radiator and good absorber of heat.
• Polished surface is good reflector but bad absorber of heat.
• At hilly stations, because of low atmospheric pressure, the boiling point of water becomes below $100^{o}C$.
• Because of the polish with silver in thermos flask, the radiation prevents the flow of heat.
• Food is cooked fast in pressure cooker, because it enhances the boiling point of water.

• At -40^{o}C, the Centigrade and the Fareinheight scale becomes similar. (C/5 = F -32/9).
• Burning with steam is more dangerous than that of boiling water because the latent heat of steam is greater than that of water.
• Night in deserts is colder because heat is radiated by sand very fast.
• Glass is a good insulator.
• In Dead Sea the boiling point is maximum.
• There is a minimum radiation of heat through polished surface.
• The specific heat of ice is less than that of water.
• Dew is never formed in clouded atmosphere.
• When the relative humidity of air increases, dew is formed.
• Mercury is a good conductor of heat.
• Because of the evaporation of sweat from the body, we feel comfortable is summer when we sit under fan.
• There is a gap between two rails because temperature leads to expansion in it.
• Alcohol is used in thermometer in place of mercury in cold regions because the freezing point of it is very low.
• Velocity of sound increases with the increase of temperature.
• Heat transferred in liquid through convection.
• If the pressure of water is 760 mm, the boiling point will be 100^{o}C.
• If the door of a running fridge in closed room opens, the temperature of the room will be increased after sometimes.
• $CO_2$is responsible to increase the global warming because it absorbs all the solar radiation.
• In high temperature and low humidity, transpiration becomes high.
• Mica is good conductor of heat but insulator of electricity.
• Woollen clothes prevent the heat to go out form our body, which keeps the body warm in winter.

• Heat Science is known as Pyrology, whereas the science which measures the shape and size of the earth is known as Geodesy.
• The cloudless night is colder than the clouded night because of the radiation of heat.
• The amount of heat which is required to increase the temperature by $1^{o}C$ in 1 kg mass of a matter is known as specific heat.
• The heat of sun rays is due to the infrared radiation.
• If many small droplets become a large drop, then its temperature is increased.
• Ice is having heat as well, (80 cal/gram at $0^{o}C$).
• With the increase of impurities, the melting point and freezing point decrease but the boiling point increases.
• New quilt is warmer than old quilt because there are more air gaps in new quilts.
• The voice of a female is more melodious than that of a male, because of its high frequency.
• The production of short wave is heard more clearly than that of long wave because it is more energetic.
• Work done on an object by a force would be zero if the displacement of the object is zero.
• An object having capability to do work is said to possess energy. Energy has the same unit as that of work.
• An object in motion possesses what is known as the kinetic energy of the object. An object of mass, m moving

with velocity v has a kinetic energy of .

• The energy possessed by a body due to its change in position or shape is called the potential energy. The gravitational potential energy of an object of mass, m raised through a height, h from the earth's surface is given by mgh.
• According to the law of conservation of energy, energy can only be transformed from one form to another; it can neither be created nor destroyed. The total energy before and after the transformation always

remains constant.
• Energy exists in nature in several forms such as kinetic energy, potential energy, heat energy, chemical energy etc. The sum of the kinetic and potential energies of an object is called its mechanical energy.
• Power is defined as the rate of doing work. The SI unit of power is watt. 1 W = 1 J/s.
• The energy used in one hour at the rate of 1kW is called 1 kWh.

THERMOMETRY
Introduction

• The branch of thermal physics in which the temperature is measured by the various devices like thermometers, thermocouple, total radiation pyrometer etc.
• A reliable measure of the hotness of an object is its temperature. Temperature is measured by a device called thermometer.
• All thermometers operate on the single principle by the use of the substance dependent on the temperature. The thermometersare of various typeswhichare fabricatedanddesignedfor the differentmeans andpurposes. The various thermometers are liquid thermometer (based on the expansion of volume of the liquid by increase in temperature.) Gas thermometer (expansion in volume of the gas with increase in temperature), platinum resistance thermometer etc.
• The range of a laboratory thermometer is generally from –10°C to 110°C.
Types of Thermometers
Liquid thermometer
• In liquid thermometer mercury or alcohol are mainly used.
• Alcohol is used in those liquid thermometers which measures the temperature below – 40°C. The freezing point of alcohol is – 115°C so below to it alcohol thermometer doesn’t work.
• Thefreezingpointandboilingpointofthemercuryare– 39°Cand357°C.Thusmercurythermometerisfabricated and designed to remain operationalized from –30°C to 350°C.

Clinical thermometer
• To measure the temperature of the human body a suitable thermometer is fabricated which is designed is

Fahrenheit scale called clinical thermometer.
• Since the temperature of the human body varies in very short span, thus in the clinical thermometer lower fixed point is kept at 95°F (35°C) and upper fixed point at 110°F (43°C).
Gas thermometer
• Constant volume hydrogen gas thermometer is the standard gas thermometer from which every other gaseous thermometeris fabricated.
• The temperature upto 500°C can be measured and if hydrogen is replaced by nitrogen then temperature up to 1500°C can be measured.
Platinum resistance thermometer
• This thermometer is constructed on the basis that the resistance of a metal increases quite uniformly with the temperature. The great advantage of this thermometer is that it measures very high temperature range from —200°Cto1200°C.
• The value measured by platinum thermometer is so consistent, precise and accurate that this thermometer can be used to standardize the other thermometers.
• The platinum resistance thermometer has a large thermal capacity and the protecting tube has low thermal conductivity andso the thermometer doesn’tquickly attainthe temperature of the bath inwhichit isimmersed. Thermo-couple
• This is a special type of temperature measuring device in which two junctions are constructed by different metals, one junction is hot and another is cold and due to thermoelectric effect temperature is measured and this effect is called Seebek’s effect.

Total radiation pyrometer
• This is also a temperature measuring device by which the temperature of the bodies like stars, sun etc. (which
have very high temperatures) are measured which are far away from us. Thus radiation pyrometer is a device
through which by the estimation of radiation without touching the bodies, temperatures are measured.
• Total radiation pyrometer operates on the principle of Stefan’s law and according to which heat radiation
emitted per second per unit area is proportional to the fourth power of the absolute temperature.
• The body having temperature less than 800°Cdoesn’t emit a suitable (detective) radiation and that’s why
throughthetotalradiationpyrometerthetemperatureofthosebodiesaremeasuredwl
of more than 800°C.
Various scales of temperature measurement
• For the fabrication of the thermometers two fixed points are selected in various scales—one is a maximum
point called Upper Fixed Point (U.F.R) and another is minimum point called Lower Fixed Point (L.F.R). There
are various scales like Celsius (or centigrade), Fahrenheit, Reaumur,Kelvin and Rankin.
• Generally; the freezing point of ice is taken as L.F.R and the boiling point of pure water at 76 cm of is taken as
UFR The difference between the U.F.P and LHR is called Fundamental difference or Interval (F.I.)

= = = =
Absolute zero

• Theoretically there is no limit of maximum temperature but there is a limit or restriction on the lower temperature. The lowermost temperature is —273.15°C and it is called absolute temperature.

• On Kelvin scale absolute temperature is expressed as 0 K and it is the required temperature at which molecular motion of the body is ceased.
• Thus0K=—273.15°C=>273.15K=0°Cor; 0°C=273.15K

• It is a convention in physics that the temperature of the kelvin scale is never represented in degree.

Some temperature on various scales

Temperature Celsius (°C) Fahrenheit (° F) Kelvin (K) Freezing of water 0°C 32°F 273K Normal Temperature 27°C 80.6°F 300K of the room
Normal temperature 37°C 98.6°F 310K of human body
Boiling point of water 100°C 212°F 373K

Quick review
1. The maximum portion of solar energy obtained by earth is in the form of infrared and thermal energy.
2. 100°C is equivalent to212° F and 373K.
3. Bolometer, an instrument used to measure infrared, or heat, radiation. The bolometer is essentially a very sensitivethermometer.Itcanbe usedwithaspectroscope tomeasure the ability of certainchemicalcompounds to absorb various wavelengths of infrared radiation. These measurements provide valuable information about the structures of these compounds. The bolometer has also been used to measure the temperature of the moon’s surface through a telescope.A bolometer contains a thin, blackened strip of platinum metal. Heat radiation falling on the strip changes its resistance to an electric current. This change is recorded by a sensitive electric meter. The instrument was invented in 1878 by Samuel P. Langley.
4. The boiling point of a liquid increases with an increase in pressure.
5. Skating on ice is possible due to regelation. Regelation is the phenomenon of melting under pressure and freezing again when the pressure is reduced.
6. There is no exchange of heat energy in an adiabatic process.
7. Temperature remains constant in an isothermal process.
8. 1 calorie heat is equivalent to 4.2 Joule of work.
9. A process taking place at constant volume is called isochoric process.
10. The specific heat in an isothermal process is infinite.
11. C_p-C_v= R is called Mayer’s formula.
12. -40°C and -40°F exhibit the same temperature.
13. $T_k=t^{O}C+273$.

14. Total Radiation Pyrometer is based on Stefan's law.
15. There is the following relation between the various scales of temperature.

16. = =

17. In a platinum thermometer $R_1 = R_o(1 + á\ t)$ in which a is the temperature resistance coefficient of platinum.
18. The isothermal modulus of elasticity of an ideal gas is equal to its pressure.
19. The ratio of the elasticity of an ideal gas is equal to the ratio of its specific heats.
20. The adiabatic modulus of elasticity of an ideal gas is y times its pressure.
21. The transmission of heat by radiation does not require any material medium.
22. Hydrometer is used to measure the relative humidity.
23. Absolute humidity increases with an increase in temperature and relative humidity decreases.
24. The temperature of a glowing bulb is between 2000°C to 2500°C.
25. The study of very low temperatures is called Cryogenics.
26. Cryogenics is used in spacecraft, surgery and magnetic levitation.
27. Alcohol is opted as a thermo- metric liquid in cold countries instead of mercury because its freezing point is quite less.

28. Radiations from the earth heat the atmosphere.

29. In the absence of atmosphere there had been large variation between the temperatures of day and night.
30. A thermostat keeps the temperature of a body constant.
31. The volume of a fixed amount of a gas at constant pressure is directly proportional to its absolute temperature.
32. Change of state is an isothermal process. Its specific heat is infinite.
33. Specific heat in adiabatic change is zero.
34. $C_p$is greater than $C_v$for gases.
35. There is no negative temperature on Kelvin scale.
36. At -40° the readings on the Celsius and Fahrenheit scale are the same.
37. Pyrometer is used to measure high temperatures.
38. Sir C. V. Raman was honoured with the Nobel Prize in 1930 for the discovery of Raman effect.
39. The density of water is maximum at 4°C.
40. Absolute zero temperature (- 273.15°C) is considered to be the lowest possible temperature.
41. Relative humidity is the ratio of the amount of water vapour present in air at a given temperature to the maximum amount of water vapour required to saturate the air at that temperature.
42. Density of solids generally decreases on melting.
43. The size of a metal ring increases on being heated.
44. The boiling point of water increases when salt is mixed in it.
45. Carbon dioxide gas produces green house effect.
46. If the surface of a hot body is black and rough then it radiates heat rapidly.
47. If water is heated from 0°C to 10°C then its volume first decreases, becomes minimum at 4°C and then starts increasing.
48. If water is heated from 0°C to 10°C then its density first increases, becomes maximum at 4°C and then starts decreasing.

49. The efficiency of an ideal heat engine is determined by the relation : n = 1

$\frac{T2}{T1}$ (T 1 > T 2).

50. Critical temperature is the temperature below which a gas can be liquefied on increasing the pressure.
51. Air conditioner controls temperature and relative humidity.
52. Heat engine converts heat into mechanical energy.
53. If an opened refrigerator is kept in a closed room then the temperature of the room increases.
54. Heat is transmitted by conduction, convection and radiation.
55. Temperature of sun is measured by pyrometer.
56. The specific heat of water is 1.0 cal/gm^{o}C.
57. A thermos flask prevents the heat loss by conduction, convection and radiation.
58. In a refrigerator the thermostat regulates the temperature.
59. Volcano is called the ‘safety valve’ of nature.
60. When two metal strips are heated on rivetting the metal with greater expansion bends such that it remains outside while the metal which expands less remains inside.
61. In cold countries, glycerol is mixed with water in car radiators due to which freezing point of water is lowered.
62. While skating on ice the melting point of ice lowers due to pressure.
63. When iron and wood are kept in sun then iron becomes more hot because it is a good conductor of heat.
64. Hand pump water is warm in winters because in winters the underground temperature is more than the atmospheric temperature.
65. Two thin blankets give more warmth in winters in comparison to one thick blanket because there is a layer of

air between the two thin blankets which is a bad conductor of heat and hence prevents the loss of heat from

within.
66. Dark clothes are heat absorbers whereas white clothes are heat reflectors.
67. Thermal energy is more largely produced in India in comparison to other forms of energy.
68. The ice on hills melts very slowly because of its high latent heat.
69. Ice-cream has a more cooling effect on teeth than chilled water because while melting the ice cream takes sufficient heat (equal to its latent heat) from the teeth.
70. The work done in rubbing hands converts into heat which makes our hands warm.
71. Ammonia gas is used as a coolant in refrigerators.
72. Calorie is the unit of measuring heat.
73. The atmospheric temperature increases due to the increase in the amount of carbon dioxide because it absorbs the infrared radiations from space.
74. The bulb of a thermometer is made long and cylindrical instead of making it spherical because area of the cylindrical surface is greater than that of a spherical surface hence more surface area of the bulb comes in contact with the temperature to be measured which results in fast response to the change in temperature.
75. Snow is a better insulator than ice because snow has air filled in its pores which is a bad conductor of heat.
76. The thermal conductivity of an ideal insulator is zero and that of an ideal conductor is infinite.
77. The blanket which keeps us warm in winter, prevents the ice from melting because air fills up the space between the fibres of the blanket which is an insulator.
78. Inert gases such as argon, neon etc. are filled in electric bulbs instead of vacuum because if there is vacuum then the heat produced on burning the filament may increase the temperature of filament to the extent that it melts but if inert gases are filled the heat of the filament spreads by the convection

currents preventing the filament temperature to rise up.
79. Energy can neither be created nor destroyed. It just changes form one to another e.g. mechanical to electrical or other forms.
80. If a mass attains the speed of light then the mass gets converted into energy ($E=mc^2$).
81. It takes 8½ minutes to reach the light/ray/energy to the earth from the sun, which comes through radiation.
82. The energy of Sun is produced by nuclear fusion, in which hydrogen keeps on changing in Helium.
83. Liquid sodium is used as coolant in fast breeder reactor.
84. Uranium (238) changes into Plutonium (239) in fast breeder reactor.
85. Nuclear reactor and atom bomb are based on nuclear fission whereas solar explosion (source of solar energy) and hydrogen bomb are based on nuclear fusion.
86. The explosion of atom bomb is due to uncontrolled fission process (U^{235}).
87. Cadmium rod is used for the absorption of neutron in atomic reactor.
88. The cheapest energy is solar energy.
89. Nuclear fusion is known as thermo-nuclear reaction because it can take place at very high temperature and under very high-pressure conditions.
90. The most of the part of the energy received by the earth from the Sun is in the form of infrared and heat energy.
91. Electrical energy is converted into mechanical energy in refrigerator. Simultaneously, it converts the high temperature of heat into low temperature as well.
92. The lead-acid storage battery used in motor vehicles is reversible, rechargeable and is like galvanic cell.
93. Chemical energy is converted into heat and light in the burning of candle.
94. The mechanical energy is conserved in a falling object under gravity.
95. Light energy is converted into electrical energy by optical cell.
96. Solar energy can be directly converted into electric energy by photovoltaic cell.

INSIGHT GENERAL STUDIES

TOPIC

5

ELECTRICITY

What is electricity

The word is from the New Latin çlectricus, “amber-like”, coined in the year 1600 from the Greek electron meaning amber (hardened plant resin), because static electricity effects were produced classically by rubbing amber.

Electricity is a general term encompassing a variety of phenomena resulting from the presence and flow of electric charge. These include many easily recognizable phenomena, such as lightning, static electricity, and the flow of electrical current in an electrical wire. In addition, electricity encompasses less familiar concepts such as the electromagnetic field and electromagnetic induction.

Concepts related to electricity

Electric charge

• The electric charge is a fundamental conserved property of some subatomic particles, which determines

their electromagnetic interaction. Electrically charged matter is influenced by, and produces, electromagnetic fields. The interaction between a moving charge and an electromagnetic field is the source of the electromagnetic force, which is one of the four fundamental forces.

• Electriccharge isa physicalproperty of matter whichcausesittoexperiencea force whennearotherelectrically charged matter.

• Itis a conservedquantity,that is, the net charge withinan isolated system will alwaysremain constantregardless of any changes taking place within that system.

• The presence of charge gives rise to the electromagnetic force: charges exert a force on each other, an effect that was known, though not understood, in antiquity.

• Electric charge comes in two types, called positive and negative. Two positively charged substances, or objects, experience a mutual repulsive force, as do two negatively charged objects. Positively charged objects and negatively charged objects experience an attractive force.

• The SI unit of electric charge is the coulomb (C), although in electrical engineering it is also common to use the ampere-hour (Ah). The study of how charged substances interact is classical electrodynamics.

• Twentieth-century experiments demonstrated that electric charge is quantized; that is, it comes in multiples of individual small units called the elementary charge, e, approximately equal to $1.602 \times 10^{"19}$coulombs (except for particles called quarks which have charges that are multiples of S!e). The proton has a charge of e, and the electron has a charge of “e.

• By convention, the charge carried by electrons is deemed negative, and that by protons positive, a custom that originated with the work of Benjamin Franklin.

• The study of charged particles, and how their interactions are mediated by photons, is quantum electrodynamics.

Electric current

• The movement of electric charge is known as an electric current, the intensity of which is usually measured in amperes. Current can consist of any moving charged particles; most commonly these are electrons, but any charge in motion constitutes a current.

• By historical convention, a positive current is defined as having the same direction of flow as any positive charge it contains, or to flow from the most positive part of a circuit to the most negative part. Current defined in this manner is called conventional current.

• The motion of negatively charged electrons around an electric circuit, one of the most familiar forms of current, is thus deemed positive in the opposite direction to that of the electrons. However, depending on the conditions, an electric current can consist of a flow of charged particles in either direction, or even in both directions at once. The positive-to-negative convention is widely used to simplify this situation.
• The process by which electric current passes through a material is termed electrical conduction, and its nature varies with that of the charged particles and the material through which they are travelling. Examples of electric currents include metallic conduction, where electrons flow through a conductor such as metal, and electrolysis, where ions (charged atoms) flow through liquids. While the particles themselves can move quite slowly, sometimes with an average drift velocity only fractions of a millimetre per second, the electric field that drives them itself propagates at close to the speed of light, enabling electrical signals to pass rapidly along wires.
• Current causes several observable effects, which historically were the means of recognising its presence. That water could be decomposed by the current from a voltaic pile was discovered by Nicholson and Carlisle in 1800, a process now known as electrolysis. Their work was greatly expanded upon by Michael Faraday in 1833. Current through a resistance causes localised heating, an effect James Prescott Joule studied mathematically in 1840. One of the most important discoveries relating to current was made accidentally by Hans Christian Ørsted in 1820, when, while preparing a lecture, he witnessed the current in a wire disturbing the needle of a magnetic compass. He had discovered electromagnetism, a fundamental interaction between electricity and magnetics.
• In engineering or household applications, current is often described as being either direct current (DC) or alternating current (AC). These terms refer to how the current varies in time. Direct current, as produced by example from a battery and required by most electronic devices, is a unidirectional flow from the positive part of a circuit to the negative. If, as is most common, this flow is carried by electrons, they will be travelling in the opposite direction. Alternating current is any current that reverses direction repeatedly; almost

always this takes the form of a sinusoidal wave. Alternating current thus pulses back and forth within a conductor without the charge moving any net distance over time. The time-averaged value of an alternating current is zero, but it delivers energy in first one direction, and then the reverse. Alternating current is affected by electrical properties that are not observed under steady state direct current, such as inductance and capacitance. These properties however can become important when circuitry is subjected to transients, such as when first energised.

Electric field

• The concept of the electric field was introduced by Michael Faraday. An electric field is created by a charged body in the space that surrounds it, and results in a force exerted on any other charges placed within the field. The electric field acts between two charges in a similar manner to the way that the gravitational field acts between two masses, and like it, extends towards infinity and shows an inverse square relationship with distance. However, there is an important difference. Gravity always acts in attraction, drawing two masses together, while the electric field can result in either attraction or repulsion. Since large bodies such as planets generally carry no net charge, the electric field at a distance is usually zero.

• The study of electric fields created by stationary charges is called electrostatics. The field may be visualised by a setof imaginarylines whose directionat any point is the same as thatof the field.This conceptwas introduced by Faraday, whose term ‘lines of force’ still sometimes sees use.

Electric potential

• The electric potential at any point is defined as the energy required to bring a unit test charge from an infinite distance slowly to that point.

• It is usually measured in volts, and one volt is the potential for which one joule of work must be expended to bring a charge of one coulomb from infinity.

• The capacity of an electric field to do work on an electric charge.

• Electric potential is a scalar quantity, that is, it has only magnitude and not direction.

Electromagnetism

• A fundamental interaction between the magnetic field and the presence and motion of an electric charge.
• Ørsted's discovery in 1821 that a magnetic field existed around all sides of a wire carrying an electric current indicated that there was a direct relationship between electricity and magnetism.
• This relationship between magnetic fields and currents is extremely important, for it led to Michael Faraday's invention of the electric motor in 1821.
• Electromagnetic waves were analysed theoretically by James Clerk Maxwell in 1864. Maxwell developed a set of equations that could unambiguously describe the interrelationship between electric field, magnetic field, electric charge, and electric current.

Conductor
• The bodies in which electric charge carriers (free electrons) urn mobile then electric current is generated and these bodies are called good conductor or conductor. All metallic bodies, acids, human body etc. are good conductor of electricity.
• Silver is the best conductor. Other good conductors are metallic bodies, like copper, iron etc.
• In all metallic bodies only free electrons are charge carriers due- to which electric current generates.
Bad conductor and Insulator
• Those bodies which do not have mobile charge carriers are called bad conductor. Sometimes in bad conductor also immobile charge carriers are provoked to become free in zig-zag way but not regularly like in wetted rod of wood, thus it acts like good conductor. But if in any condition or circumstances the charge carriers do not be activate or provoked then bad conductor is called insulator.
• Wood, rubber, mica etc. are example of bad conductors but asbastoss, ebonite are examples of insulators.

Semi conductor

• Those bodies whose electrical conductivity or resistivity lies between the conductor and insulator are called semi conductors. At 0 K all semi conductors are insulators. In semi conductors the charge carriers are electrons and holes (+ve ions) both.

• Germanium, silicon, selenium etc. are example of semi conductors. On adding impurity in pure semiconductor its electrical conductivity increases too. If the temperature of good conductor be increased then its electrical resistance increases, consequently its electrical conductance decreases.

• But in semi-conductor with rise in temperature its resistance decreases and consequently its conductivity increases. That’s why it is said that semiconductor has negative temperature coefficient of resistance while metallic conductor has positive temperature coefficient of resistance.

Superconductivity

• The phenomenon of superconductivity was firstly invented in 1911 by a Dutch physicist K. Onnes. He experimentally observed that electrical resistance of some metals, alloys and compounds drops suddenly to zero whenthe specimeniscooledbelowa certaintemperature calledtransitiontemperature. Thisphenomenon is called superconductivity and the specimen is called Superconductor.

• Superconductivity and the specimen cooled is called Superconductor. He also observed that the resistance of the mercury vanishes completely at 4.2K. The critical or transition temperature below which a material undergoes a transition from a state of normal conductivity to a superconductivity is different for different materials.

• The normal good conductors like Cu, Ag, Au, Li, Na, K etc. do not exhibit the phenomenon of superconductivity even at more and more lower temperature. Thus these are called normal metals. This implies that in general not all materials are superconducting. Since the superconducting state of a material is characterised by zero electrical resistance even in the absence of an applied voltage and the current can persist for years without any detectable decay.

• A bulk superconductor in a weak magnetic field acts like a perfect diamagnet with zero magnetic field into the interior. If a super conducting material is placed in a magnetic field and then cooled below its critical or transition temperature (Tc), it expels all the originally present magnetic flux from its interior and it is called

Meissner effect. ln fact this phenomenon was observed by W. Meissner and R. Ochsenfeld in 1933.
• Also scientists of all over the world have been trying to develop the new materials that are superconducting at
high temperatures. A break through in this regard or hot superconductor was obtained in 1986 when Karl Alex
Muller of IBM’S Zurich Lab made a substance metallic oxide of lanthanum—barium-copper called ceramics
that lost its electrical resistance at 30 K. In 1987 the transition temperature (Tc) jumped to about 90 K when Paul
Chu and his team discovered a ceramic copper—oxide superconductor, called cuprate consisting of Yttrium,
barium and copper oxide.
Applications :
• A large scale application of superconductor is in transmission of power. The cables made from superconductors
can save 30 to 40 percent power which is lost in conventional system of transmission. The solenoid of super
conductor can trap a larger amount of electrical energy endlessly.
• Extremely Sophisticated electronic devices such as Magnetic Resonance imagining (MRI), scanners,
superconducting Quantum Interference Devices (SQUIDS) etc.
Domestic power supply
• The power is supplied for the domestic use of 220 volt (ac) which has the frequency of 50 Hz. This implies that
its polarity in each second changes 100 times. Thus in a complete cycle the alternating current (a.c.) changes its
direction two times.
• Domestically supplied this current is called main line, and the wire through which this current is passed is

called mains.
• Domestically supplied power has two types of current one is of 5 ampere and other is of 15 ampere. The
current of 5 ampere is called domestic and the current of 15 ampere is called power line.
• The current of 5 ampere is used in electrical appliances like electric bulbs, T.V., tube light, radio etc. But the
current of 15 ampere is used in electrical appliances like electric heater, electric iron, refrigerator etc. Domestic wiring
• In domestically supplied current three types of wires are utilised which are live, neutral and connected to the
earth (earthing). Ordinarily live wire is of red colour, neutral wire of black colour and earthing wire of green
colour.
• Through the live wire electric current is passed, while through the neutral wire current goes back. In home
usually two types of circuit are installed one circuit is for 5 ampere appliances and another for 15 ampere
appliances. Earthing wire is directly goes to earth and it is a means or way of safety. In every circuit the
electrical appliances are attached between the live wire and neutral wire. For the regulation of every appliance
or equipment there is a switch which is attached in every circuit from live wire.
• In home the distribution of power is made through electric meter. The electric meter measures the power in
kilo watt hour (kwh). The power distribution through the meter is done by two pairs of wires grouped in
parallel combination. In every pair of wires a fuse is attached. The fuses of all wires are attached at one place
on the switch board. In home electrical appliances like fan, bulb, heater etc. are attached with parallel
combination of wires, while switches of these appliances are attached in series combination of the wires. Electric fuse
• For the safety point of view electric fuses are utilised in the various electrical circuits and thus electrical
appliances are safeguarded. For the electric fuse those materials are used

which have less melting point and
easily melt o passing high electric current in the circuit.
• Whenever there are the occurrences of overloading or short circuiting any where in the circuit, the current of
very large magnitude starts to flow in the wire and the wire of the electric fuse melts and concerned appliances
are prevented to damage. Always electric fuse is attached through the live or hot wire.
• Normally electric fuse is made of tin but good quality of fuse is made from the alloy of copper, tin and lead.
Usually the electrical circuit from where the current of 15 ampere be permissible to flow then thick wire is
used for the fuse and from it maximum current passing capacity is of 15 ampere.

• Similarly for the electrical circuit from where the current of 5 ampere be permitted to pass thin wire fuse is used and its maximum current passing capacity is of 5 ampere.

Socket

• The socket is three cylindrical holes fiber structure from where three wires pass.

• In the socket, the uppermost hole is large from where earthing's wire passes and from the lowermost right small hole live wire passes, while from the lowermost left small hole neutral wire passes.

Plug

• In plug there are three cylindrical needles which can be completely enclosed in the socket.

• When any plug fits directly with socket then corresponding; appliance is connected to mains (circuit) directly.

Regulator

• Te regulator acts or works like a current controller in the electrical circuits. This is used normally to increase or decrease the speed of electric fan.

• Whenever the knob of the regulator is rotated then the electric resistance of the wire increases or decreases by which the quantity of electric current decreases or increases.

Electric switch

• By the electric switch the current in the circuit is either stopped or surpassed. With the electric appliances like bulb, fan etc. switches are connected in series.

• While switch is always connected between the phase wire and the appliance, but the neutral wire is directly connected to the appliance. Since the voltage of the phase wire is about 220 volt and during the off time or when appliances be not in action, phase wire must be detached with appliances. If this is not to be done then appliance even in the absence of action can provide a sharp electric shock to anybody who will touch the appliance.

• This detachment of the phase wire with the appliances are completed by installing electric switches at suitable places in the electric circuits.

Lightning Conductors

• Lightning Conductor is a device used to protect buildings from the effect of lightning. A metallic rod, taller than the building, is installed in the walls of the building during its construction.

• A lightning conductor is a metal rod or conductor mounted on top of a building and electrically connected to the ground through a wire, to protect the building in the event of lightning. If lightning strikes the building it will preferentially strike the rod, and be conducted harmlessly to ground through the wire, instead of passing through the building, where it could start a fire or cause electrocution.

• A lightning rod is a single component in a lightning protection system. In addition to rods placed at regular intervals on the highest portions of a structure, a lightning protection system typically includes a rooftop network of conductors, multiple conductive paths from the roof to the ground, bonding connections to metallic objects within the structure and a grounding network.

• The rooftop lightning rod is a metal strip or rod, usually of copper or aluminium. Lightning protection systems are installed on structures, trees, monuments, bridges or water vessels to protect from lightning damage. Individual lightning rods are sometimes called finials, air terminals or strike termination devices.

• The lightning rod was invented by Benjamin Franklin in the Americas in 1749 and, perhaps independently, by Prokop Diviš in Europe in 1754

Transformer

• A transformer is a static device that transfers electrical energy from one circuit to another through inductively coupled conductors—the transformer's coils. A varying current in the first or primary winding creates a varying magnetic flux in the transformer's core and thus a varying magnetic field through the secondary winding. This varying magnetic field induces a varying electromotive force (EMF) or "voltage" in the secondary winding. This effect is called mutual induction.

• The transformers are used to step up or to step down the voltage.

• The transformers work only on alternating current (AC).
• The transformers function on the principle of electro-magnetic induction.
Rectifier
• A rectifier is an electrical device that converts alternating current (AC), which periodically reverses direction,

to direct current (DC), which is in only one direction, a process known as rectification. Rectifiers have many uses including as components of power supplies and as detectors of radio signals. Rectifiers may be made of solid state diodes, vacuum tube diodes, mercury, and other components.

• A device which performs the opposite function (converting DC to AC) is known as an inverter. Electric power plant
• At electric power plant, the power or electricity is generated by the rotation of turbine in which blades are

attached. In hydro electric power plant to rotate the turbine water is continuously dropped on the blades of the turbine through storing water by constructing barrage. In thermal power plant and in nuclear or atomic power plant the turbines are rotated by the vapour.

• In wind power plant turbine is rotated by the atmospheric pressure. In thermal power plant vapour is prepared by burning the coal or natural gas. But in atomic power plant the vapour is prepared by the nuclear energy. Through the axis of turbine a coil or a core is attached which on the rotation of turbine (in a permanent magnetic field) starts to rotate and electricity begin to be generated,
• At primary electric power plant the alternating current (a.c.) is generated and it has alternating voltage of 22kv or of beyond. This alternating current (ac.) is sent to the consumers by the transmission line. At the grid substation step-up transformers are installed which can increase the alternating voltage

up to 132kv. At this order of alternating voltage during the transmission less amount of electrical energy is lost. Ultimately at various sub-station this alternating voltage is decreased by step-down transformer and normally 220 volt (a.c.) is supplied to the domestic consumers.

Electric cell

• The electric cell is a device which maintains a potential difference between any two points of the conducting wire so that the flow of electric current be continued sustainably. In electric cells the chemical energy which is produced by various chemical reaction transforms into electrical energy. There are two metallic rods in every electric cell which are called electrodes and have opposite nature. The metallic rod which is +vely charged is called anode and collected ions are called anions. But the metallic rod which is -vely charged is called cathode, and collected ions are called cations. These metallic rods (electrodes) are kept inside the solvent of the container called electrolyte.

• Usually electric cells are of two types :

(i) Primary cell (ii) Secondary cell

(i) Primary cell :

In primary cells the chemical energy is directly converted into electrical energy and when all the chemical energy is exhausted and it is used up the cells become dead. The volta cells, Leclanche’s cell, dry cell, denial cell etc. are examples of primary cell.

(ii) Secondary cell :

In secondary cells firstly electrical energy is converted into chemical energy then this chemical energy is converted into electrical energy. The entire process is completed by charging and during use it is discharged then again it is charged and it is the way of functioning. That’s why all secondary cells are rechargeable. The process of recharging is done by the external source of electrical energy. The battery or cell attached in motor vehicle, motor bike, emergency light etc. are examples of secondary cells.

Voltaic cell :

The voltaic cell was invented by Professor Alsendro Volta in 1799. In this cell a zinc rod and copper rod kept inside the glass container of sulphuric acid.

In this cell copper rod acts as anode and zinc rod acts as cathode. The value of emf in this cell is 1.08 volt.

Leclanche cell :

In this cell in the glass container a saturated solution of NH_4Cl is taken in which zinc rod acts as cathode and for anode, the carbon rod is kept in the mixture of manganese dioxide (MnO_2) and carbon. The value of emf is 1.5 volt. This type of cells are utilised where electric current is not regularly available. Such cells are mainly used in electric alarm or siren, telephone etc.
Solar cell :
A solar cell is a semiconductor device (on junction) which converts solar energy directly into electrical energy and it is based upon the phenomenon of photo voltaic effect. The commercial solar cells are made from single silicon crystal and it is used in space vehicles where small mass of solar batteries is needed or inaccessible places on the earth where automatic equipments/ devices are kept non-stopped operating.
Measuring Instruments
Galvanometer :
Galvanometers are electrical devices used for the detection or measurement of the electric currents. The action of these Galvanometers is facilitated by the torque experienced by a magnetic needle due to the magnetic field of a current loop.
One of this class galvanometer is tangent galvanometer consisting of a circular consisting a compass needle at its centre. The frame containing the coil can revolve about the vertical axis. The compass box consisting of a small magnetic needle pivoted at the centre of the coil. A long aluminum pointer is attached at right angles to the needle, which moves over the graduated circular scale. The scale is divided into four quadrants reading from 0° to 90°. The needle and scale are enclosed in a flat casing provided with a glass top so that the scale needle and pointer may be visible from outside.
Ammeter :
Ammeter is a current measuring device and can measure high current. Basically it is a low resistance moving coil galvanometer. It In always

connected in series in the electrical circuit in which the current to be measured. An ideal ammeter should have zero resistance. Infact ammeter of low resistance is more accurate although it is less sensitive. Voltmeter: Voltmeter is a potential difference (pd) measuring device and basically it is high resistance moving coil galvanometer. It is always connected in parallel to the resistance across which p.d. is to be measured. lts reading is not accurate because it draws current so the p.d. across the resistance decreases (since the current through it decreases). Hence a voltmeter of high resistance is more accurate. In fact an ideal voltmeter In one which has infinite resistance so it measures accurately and no any current be passed through it.

Potentiometer:

A potentiometer is a device .In measure the emf of a cell or p.d. between the ends of current-carrying conductor without drawing any current from the circuit. It operates on the principle that an emf or p.d. can be balanced against another emf or p.d. and produce zero current.

Thermal effect of Electric Current

• As the electrons through a medium, such as a wire, they experience friction, which produces heat. The fast the

electrons are moving, the more friction they experience and the more heat is generated. Typically, this heat energy dissipates and is not useful.

•

Electricalheatingappliancesthecurrentismadetopassthroughhighlyresistantmate of heat through friction. This is the basic premise of an electric stove range.

• According to the Joule’s Law: “The heat produced per unit time, on passing electric current through aconductor at a given temperature, is directly proportional to the square of theelectric current”.

Applications of thermal effect:

The thermal effect of the electric current are vigorously utilised in electric heater, electric press, electric bulb, tubelights etc.

Electric Heater :

• In an electric heater an aliment (thick of coil) nichrome (alloy of nickel and chromium) is kept inside the frame like plate which are made of plaster of Paris.
• When an electric current is passed through the thick coil of nichrome then due to large electrical resistance the current remains confined for a longer time within the aliment and due to Joule's heat it becomes red heated and supply a tremendous amount of thermal energy.
• In the position of red heated condition the temperature of the thick coil goes upto 800°C to 1000°C. Thus for a good electric heater the aliment must have large electrical resistance and at high temperature oxidation should not be occurred.
Electric Iron :
• In domestic electric iron the nichrome wire or coil is wounded on the mica sheet. As the mica has good electrical resistance and doesn't melt at high temperature and this sheet or plate enclosing nichrome coil is kept on the upper surface of steel slab.
• On the whole mica sheet-steel slab system, a hand keeper is attached which is made of wood or good quality of fiber or of any others which are bad conductors. Whenever the electric current is passed through the nichrome coil, the base of the steel slab is heated and cloths and garments are pressed.
Electric Bulb :
• The electric bulb was firstly invented by Thomas Alva Edison. The bulb is evacuated (vacuum created) and a filament of tungsten metal is attached to it. As an electric current is passed inside the bulb then to avoid from the burning of filament or to avoid the oxidation of the filament the bulb is made evacuated. Sometimes along with evacuation a small quantities of inert gases argon or krypton is kept inside the bulb, so that tungsten couldn't be burnt and vaporised.
• The ordinary electric bulbs are incandescent in nature.
• At high temperature tungsten vaporises and sometimes blackens the inside walls of the bulb, which is called blackening. Those metals are utilised in

making the filaments of the bulb which has high melting point and high atomic weight.

• Since tungsten has high melting point about 3500°C. That's why the filament of the bulb is made of it. On passing electric current normally bulb's filament acquires the temperature from 1500°C to 2500°C. In ordinary bulb 5% to 10% electrical energy only converts into light energy while rest is destroyed in the form of thermal energy.

Tube light :

• Basically it is a long tube of glass and inside wall of the tube is coated by the thin layer of fluorescent material. The tube glass has mercury along with some inert gas like argon inside it. The two ends of the tube has two terminals on which a thin layer of barium oxide is coated.

• A fluorescent lamp tube is filled with a gas containing low pressure mercury vapor and argon, xenon, neon, or krypton. The pressure inside the lamp is around 0.3% of atmospheric pressure. The inner surface of the bulb is coated with a fluorescent (and often slightly phosphorescent) coating made of varying blends of metallic and rare-earth phosphor salts. The bulb's electrodes are typically made of coiled tungsten and usually referred to as cathodes because of their prime function of emitting electrons. For this, they are coated with a mixture of barium, strontium and calcium oxides chosen to have a low thermionic emission temperature.

• Whenever these two terminals of the tube are provoked to pass an electric current then electrons are emitted which are directly respondent to ionize the gas present inside the tube. Consequently through ionization of the gas, ions generate a flow of current inside the tube. The mercury confined inside the tube gets sufficient thermal energy and it (mercury) starts to vaporise and finally due to electron emission ultraviolet UV-rays are emitted. When these UV-rays incident on the inside wall of the tube on which fluorescent material is coated then UV—rays are observed by the wall and a visible rays or light of lower frequency seems to be appeared.

• The utilised fluorescent material is coated in such a way that light produced from the tube light appears similar to the white visible sunlight. In tube light thermal energy is produced in lesser amount so 60% to 70% electrical energy transforms into light energy. That's why the power of tube light is more sharp then an ordinary bulb. A

40 watt tube light provides 6 to 8 times light than an ordinary bulb of 40 watt.
Compact Florescent Lamp (CFL)
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• Compared to general service incandescent lamps giving the same amount of visible light, CFLs use less power and have a longer rated life. In the United States, a CFL has a higher purchase price than an incandescent lamp. Like all fluorescent lamps, CFLs contain mercury, which complicates their disposal.
• CFLs radiate a different light spectrum from that of incandescent lamps.
• Improved phosphor formulations have improved the perceived colour of the light emitted by CFLs such that some sources rate the best "soft white" CFLs as subjectively similar in colour to standard incandescent lamps.

Electrolysis

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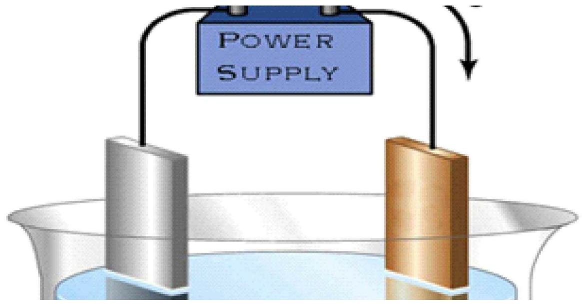
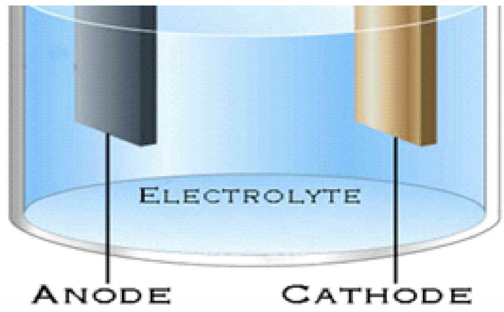
Electrolysis


POWER
SUPPLY



• A process in which a chemical change, especially decomposition, is brought about by passing the electric current through a solution of electrolyte so that the electrolyte's ions move towards the negative and positive electrodes and react with them.
• The electrolysis is a chemical decomposition produced by passing an electric current through a liquid or solution containing ions.
• In 1800, a British chemist, William Nicholson (1753–1815), had shown that if electrodes were immersed in water, and a current was passed, bubbles of oxygen and hydrogen were produced. Oxygen bubbles formed on the electrode connected to the positive terminal of the battery and hydrogen bubbles formed on the other electrode.
• The passage of an electric current through a conducting solution causes chemical reactions. As a result, bubbles of a gas may be formed on the electrodes. Deposits of metal may be seen on electrodes. Changes of colour of solutions may occur. The reaction would depend on what solution and electrodes are used. These are some of the chemical effects of the electric current. The process of depositing a layer of any desired metal on another

material by means of electricity is called electroplating. It is one of the most common applications of chemical

effects of electric current. Electroplating is a very useful process. It is widely used in industry for coating metal objects with a thin layer of a different metal.

Applications of electrolysis :

(i) Extraction of metals :

The metals like aluminium, sodium, calcium, magnesium are extracted from their respective salts by the process of electrolysis. The electrodes are made of these metals and when electric current is passed through the salts of these metals then pure metals are deposited on the cathode.

(ii) Analysis by electrolysis :

Bythebasicprincipleofelectrolysissomechemicalcompoundsareanalysed.Thestr of the compounds like HCl, HCN, HBr etc are investigated.

(iii) Electroplating :

On the basis of the principle of electrolysis electroplating (the thin layer of any metal is coated on another metallic body) is done. The metallic body which is to be coated acts like anode and the metal whose layer be coated acts like cathode. Thus an electrolyte cell is formed and process of electrolysis occurs. When electric current flows through the electrolyte then the metal from anode starts to dissolve in the solution and deposits on the cathode. Thereby after sometime a thin layer becomes coated on cathode and ultimately metal is coated. For electroplating (coating) usually metals like Gold, Silver, Platinum, Nickel, Zinc, Chromium etc are used.

(iv) Electro-typing :

Today in large printing press by the use of copper voltmeter on the behalf of cathode printing papers are kept and after a short time a thin layer of copper is coated. Thus excellent prints appear

on these copper coated papers.
(v) Electrolytic capacitor or condenser:
In such capacitor or condenser both electrodes are made from aluminium. The mixture of boric acid, glycerine and
aqueous ammonia act like electrolyte and when an electric current is passed through it then the layer of aluminium
hydroxide deposits on anode. This layer acts like dielectric for both electrodes.
(vi) Purification of metals :
For the purification of metals anode is made of impure metal and cathode is made of pure metal. The electrolyte is
made from the liquified impure metal. When an electric current is passed through it then pure metal starts to
deposit on the cathode of pure metal and thus purified metals are obtained. By this process copper can be purified
upto99.99%
Electrical appliances
Television:
• Television was firstly invented in 1923 by John L. Baired through which sound wave and light wave (audio and video both) is transmitted by an electromagnetic wave by the means of resonance from any suitable place. In other words pictures, scenes and photographs of moving objects, vehicles etc are transmitted in the form electromagnetic. Wave through the picture tube and by the means of amplified modulation these are pictures on the television screen. Broadly there are two parts in the television :
•
Iconoscope:Iconoscopetransformsthescatteredlightwaveofthepictureofanyobje
wave which is transmitted to the far flung distances and places by amplified modulation mechanism,
• Kineoscope :It is a type of cathode ray oscilloscope (CRO) through which cathode ray emancipates and accommodates the tuning like iconoscope and produce a resonance with the amplified, modulated electromagnetic wave. Consequently a fascinating, fluorescent pictures and scenes due to persistence of vision appear,
Microphone :
• Microphone is an acoustical device which transforms sound energy into electrical energy and consequently voice or soundis reached from one to

another place. The microphone works on the principle of electromagnetic induction.

• In its basic composition and fabrication carbon granules are attached in the middle of two metallic plates. In two metallic plates one is fixed and another is flexible and it is called diaphram. Whenever any vocalist speaks then diaphram starts to vibrate and along with diaphram an attached coil with itself which is kept in magnetic field also vibrates.
• Consequently an electromotive force (emf) produces and the value of this feeble emf is strengthened by a step-up transformer. Now this electrical energy (due to strengthen emf) is converted into sound energy by the help of loudspeaker or telephone receiver at the suitable places wherever required.

Loudspeaker :
• Loudspeaker is also an acoustical device through which the electrical energy is compressed and induced by the microphone is converted into the sound energy in amplified and loud form. Simply in loudspeaker there is a coil which is kept in powerful magnetic field, and this field is generated by an electromagnet.
• The coil of the loudspeaker is attached with a cylindrical thick paper or with a metallic cylinder and it is called diaphram. YA/hen the induced current from the microphone is passed through the coil then diaphram whose shape and size is large starts to vibrate or oscillate with a larger amplitude. That’s why we listen or hear sharp sound.
Electric Motor :
• An electric motor is a device which converts electrical energy into mechanical energy. The magnetic field is produced by electric current passing through only conductor and by this magnetic field a motion can be generated in the conductor. On this principle electric motor works. Firstly this concept was propounded by Michael Faraday.
• In an electric motor a rectangular coil of wire which is wounded on an armature and this armature is free to rotate on the axis of the poles of the magnet. Whenever an electric current is passed through the coil then the magnetic field forcibly pushes the coil of opposite sides up and down.
• Consequently coil rotates towards right hand but due to directional polarity coil changes the direction of rotation after completing half rotation, and now

forces operative on the sides of the coil are reversed. Thus a couple (or moment of force) is generated and electric motor is remained operationalized. Thus here we observed that electric motor doesn't work on the principle of electromagnetic induction.

MISC. POINTSABOUT ELECTRICITY

• There are two kinds of charges — positive charge and negative charge.
• Like charges repel and unlike charges attract each other.
• The electrical charges produced by rubbing are called static charges.
• When charges move, they constitute an electric current.
• The process of transfer of charge from a charged object to the earth is called earthing.
• The process of electric discharge between clouds and the earth or between different clouds causes lightning.
• Lightning strike could destroy life and property.
• Lightning conductors can protect buildings from the effects of lightning.
• Some liquids are good conductors of electricity and some are poor conductors.
• Most liquids that conduct electricity are solutions of acids, bases and salts.
• The passage of an electric current through a conducting liquid causes chemical reactions. The resulting effects are called chemical effects of currents.
• The process of depositing a layer of any desired metal on another material, by means of electricity, is called electroplating.
• The metal to be platted is put as anode, while the object to be platted is put as cathode.
• Miniature circuit breakers (MCBs) are increasingly being used in place of fuses.
• It is convenient to represent electric components by symbols. Using these, an electric circuit can be represented by a circuit diagram.

• When an electric current flows through a wire, the wire gets heated. It is the heating effect of current. This effect has many applications.
• Wires made from some special materials melt quickly and break when large electric currents are passed through them. These materials are used for making electric fuses which prevent fires and damage to electric appliances.
• When an electric current flows through a wire, it behaves like a magnet.
• A current carrying coil of an insulated wire wrapped around a piece of iron is called an electromagnet.
• It is a convention to call the charge acquired by a glass rod when it is rubbed with silk as positive.
• The plastic straw would carry a negative charge.
• The electrical charges generated by rubbing are static. They do not move by themselves. When charges move, they constitute an electric current.
• A device can be used to test whether an object is carrying charge or not. This device is known as electroscope.
• During a thunderstorm carrying umbrella is not a good idea at all.
• During thunderstorms if in a forest, take shelter under shorter trees. If no shelter is available and you are in an open field, stay far away from all trees. Stay away from poles or other metal objects. Do not lie on the ground. Instead, squat low on the ground. Place your hands on your knees with your head between the hands. This position will make you the smallest target to be struck.
• It is safer to use mobile phones and cordless phones. However, it is not wise to call up a person who is receiving your phone through a wired phone. Bathing should be avoided during thunderstorms to avoid contact with running water. Electrical appliances like computers, TVs, etc., should be unplugged. Electrical lights can remain on. They do not cause any harm.
• Fuse wire is used in a electric circuit to prevent the excess flow of electric current. Its melting point is very low.
• Domestic electric circuits have parallel connection because in parallel circuits potential difference or voltage remains uniform.
• Dynamo works on the principle of Electro-MagneticInduction.
• The core of the transformer is made up of soft steel.

• Flowing of electric current in a metal means flow of electrons.
• Sometimes a peculiar sound is heard while combing because electric charge is produced because of friction.
• Fuse is joined in series with live wire.
• Electric energy is converted into heat energy or magnetic energy in Electroplating.
• Capacitoror condenser is used in electric circuit to store ElectricCharge.
• Electric energy is converted into mechanical energy by electricmotor.
• In loudspeaker; energy is converted into mechanical from sound and finally in electrical energy.
• 220 volt AC in used in domestic use, where 220 denotes the effective voltage.
• Electric bulb is evacuated from air completely so that the Tungsten should not get oxidised.
• When a electric bulb is lit up, the resistance of Tungsten filament is increased because the resistance of pure metal is increased on being hot.
• On low pressure, mercury vapour is filled in a common florescent tube.
• SomeamountofnitrogenandArgonisusedonlowpressureinelectricbulb,sothatfila
• There is a coiled filament in a electric bulb and because of its shape it cover minimum space.
• Chemical energy is converted into electrical energy in drycell.
• Electrical energy is converted into chemical energy by electrical charger.
• In washing machine electrical energy is converted into mechanical energy.
• The resistance of a pure metal increases with the increase of temperature.
• Chemicalenergyisconvertedintoelectricalenergybyaelectriccell.Whencurrentis
all around the conductor, magnetic field is formed.

• If electric current is passed through the vein of a human, it will be excited.

• Hydro-electricity is the primary source of electricity in India.
• Generally rubber is used as insulator in electric wire.
• According to Kirchauf'slaw a good absorber is a good radiator as well.
• The metal which is used in storage battery is lead.
• In an electric cell the chemical energy is converted into electrical energy.
• There are true types of electric cells i.e. the primary cell and the secondary cell.
• Dry cells used in torches, radius etc. are primary cells.
• Secondary cells are used in cars, bus and other vehicles.
• Primary cells are not chargeable but secondary cells are rechargeable.
• Lead cell accumulators are called secondary cells.
• Solar cell – solar cell is basically made of p-n junction. It is used to convert solar energy into electrical energy. At present solar cells are used extensively in satellites and space vehicles as most important ling duration power supply.
• Generator – the mechanical energy is converted into electrical energy. In a generator the armature (a coil which can be rotated) is rotated in the magnetic field and an e.m.f is induced in it due to electromagnetic induction.
• Electric power is generally conveyed by AC, as it can be transformed to very high voltage and transmitted over long distance with minimum power loss. Electricity is generated at 11kv at power stations and then stepped up to132kv. At main substation, it is stepped down to 33kv. At main substation, it is stepped down at transformer and supplied to consumer at 220V. 220 is the effective value while the peak value of voltage is 311V.
• Electricity is supplied to homes through two cables. One is neutral wire and other is live wire. Neutral wire is earthed at substation. In domestic supplies a third wire, earth is introduced as a safeguard against shock.
• To prevent short circuit, a fuse wire of tin and load having low milting points is inserted in positive live-wire.

QUICK REVIEW
1. The unit of charge is coulomb.

2. The number of electrons in 1coulomb charge is 6.25×10^{18}.
3. One unit ampere-second is equivalent to one coulomb.
4. The magnetic effect of electric current was discovered by Oersted.
5. Only d.c. current can be measured by a Weston Ammeter.
6. The resistance of an ammeter is very low and that of voltmeter is very high.
7. The potential difference in volts between two points in an electrical circuit is measured by a voltmeter.
8. Voltmeter is a vessel in which electrolysis takes place.
9. By connecting a wire of low resistance (shunt) in parallel with a galvanometer, it is converted into an ammeter.
10. When a wire of high resistance is connected in series with a galvanometer, it gets converted into voltmeter.
11. Ammeter is always connected in series with the electrical circuit.
12. The resistance of an ideal ammeter is zero.
13. A voltmeter is always connected in series in an electrical circuit.
14. The resistance of an ideal voltmeter is infinite.
15. Electron volt (eV) is the unit of energy.
16. 1 eV= 1.6×10^{-19}joule.
17. Watt is the unit of Power.

18. Watt = volt x ampere= Ampere^{2}X ohm =
19. Kilowatt hour (kWh) is the unit of electrical energy.

20. 1 kWh = 3.6 x 10 joule

21. The resistance of the filament of a low power (watt) bulb is higher than the resistance of the filament of a high power (watt) bulb.
22. The filament of an electric bulb is made of tungsten.
23. The wire of an electric heater is made of nichrome.
24. Fuse wire is made of lead and tin.
25. A transformer works on the principle of electromagnetic induction. It brings about a change in the potential of an alternating current.
26. A step-up transformer changes a strong a. c. of low potential into a weak a. c. of high potential.
27. A step down transformer converts a high potential, weak alternating current into a weak potential, strong alternating current.
28. Transformers work only with an a.c. and cannot work with d.c.
29. The transformer ratio of a step up transformer is always greater than 1.
30. The unit of specific resistance is ohm-metre.
31. Lead is used in a storage battery.
32. A magnetic field does not interact with a static charge.
33. Silver is the best conductor of electricity.
34. Heating effect of current does not depend upon the direction of the current.
35. An a.c. cannot be used for electro plating.
36. Soft iron is used for making electromagnets.
37. Steel is used for making permanent magnets.
38. A dynamo converts mechanical energy into electrical energy.
39. An electric motor converts electrical energy into mechanical energy.
40. The potential inside a charged hollow spherical conductor is constant.
41. A dynamometer measures the power produced by an engine.
42. A cell converts chemical energy into electrical energy.
43. The core of a transformer is laminated to prevent the formation of eddy currents.
44. Electrons in motion form electric current.
45. The unit of capacitance is Faraday.

46. Lenz’s law is based on the principle of energy conservation.
47. Lenz’s law states that the direction of the induced current produced in an electric circuit is such that it opposes the cause due to which it is produced.
48. The unit of mutual induction is Henry.
49. The value of alternating current for a complete cycle is zero.

50. I = = 0.707 I_0' where I_0 is the peak value of the current.$_{rns}$
51. In a complete cycle, the square root of average value of square of alternating current is called the root mean square (rms) value of alternating current.
52. V_{rms}= = 0.707 V_o, where V_o is the peak value of voltage.

53. If ohmic resistance in an a. c. circuit is zero then during the passage of electric current through the circuit, the average power is zero that is, energy is not consumed. This current is called wattless current. Practically, it is impossible to make the ohmic resistance zero.

54. The inductance (L) of a choke coil is very high and its resistance (R) is very less. Choke coil is used in an a.c. circuit. The energy loss in it is negligible.

55. Thermistor is a non-ohmic circuit.
56. The resonant frequency in a parallel resonant circuit is f =

57. If Q coulomb charge is taken from one point to the other at V volt then W = V × Q work has to be done.
58. The relative permittivity of a substance is always greater than 1. The relative permittivity of a material under given conditions reflects the extent to which it concentrates electrostatic lines of flux.
59. In electric bulbs a filament of high resistance and high melting point, like tungsten wire is used.
60. Nitrogen or an inert gas is filled in electric bulbs.
61. The potential of a motor car battery is 12 volt.
62. Chemical energy is stored in a storage cell.
63. The specific resistance of a conductor depends upon its substance and temperature.
64. The electrolyte used in car batteries is dilute sulphuric acid.
65. German silver is an alloy of copper, zinc and nickel.
66. AC is not suitable for charging a storage battery.
67. If a metal experiences a feeble repulsion by a magnet then it is called diamagnetic.
68. If on observing a coil from its surface the current is flowing towards south in it then that end of the coil is called the South Pole.
69. The resistance of carbon, silicon and germanium decreases with an increase in temperature.
70. Oxygen, aluminium and platinum are paramagnetic substances.
71. Lenz's law is based on energy conservation.
72. Transformer is used for stepping up or stepping' down the a. c. voltage.
73. The thermal coefficient of resistance of Constantan and Manganin is almost negligible.
74. Dry cell is a primary cell. It converts chemical energy into electrical energy.
75. Cadmium cell is called the standard cell.
76. The frequency of household a.c. mains in India is 50 c/s.

77. The resistance of mercury at 4K is zero.
78. The function of a fuse in an electrical circuit is the prevention of the damage of electrical instruments.
79. The amount of electricity that deposits 108 gm of silver at the cathode is called 1 Faraday.
80. 1 faraday = 96500 coulomb/gm -equivalent = 9.65×10^7coulomb/kg equiv.
81. Copper is used in making electrical wires because it contains large number of free electrons.
82. Even on having the same power an illumination tube gives more light than an electric bulb because the illuminating substance in the tube converts the u. v. radiations into visible light.
83. 1 kilo watt = 1.34 horse power
84. Electrical energy is transferred from one place to another at high a. c. voltage because there is minimum energy loss in it.
85. The distilled water is supposed to be abad conductor of electricity.
86. In the presence of impurities the electrical resistance of semi-conductors decreases.
87. The solution of salt in water is conductor of electricity.
88. Copper rod is supposed to be more suitable for lightening conductor than iron rod because copper is good conductor of electricity.
89. First known super-conductor is mercury.
90. With the increase of temperature, the resistance of a semi-conductor decreases.
91. Generally gases are insulator of electricity.

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INSIGHT GENERAL STUDIES

TOPIC

6

MAGNETISM

What is Magnetism

• Magnetism is the phenomena exhibited by a magnetic field. It involves the study of magnets and their effects.
• Magnetism is a property of materials that respond at an atomic or subatomic level to an applied magnetic field.For example, the most well known form of magnetism is ferromagnetism such that some ferromagnetic materials produce their own persistent magnetic field.
• However, all materials are influenced to a greater or lesser degree by the presence of a magnetic field. Some are attracted to a magnetic field (paramagnetism); others are repulsed by a magnetic field (diamagnetism); others have a much more complex relationship with an applied magnetic field.
• Substances that are negligibly affected by magnetic fields are known as non-magnetic substances. They include copper, aluminium, gases, and plastic.
• The magnetic state (or phase) of a material depends on temperature (and other variables such as pressure and applied magnetic field) so that a material may exhibit more than one form of magnetism depending on its temperature, etc.

Types of magnetic substances :

• Normally every substance in a strong magnetic field has some magnetic effect or influence more or less, thus broadly on the basis of magnetizing behaviours it is categorized into three classes :

Diamagnetic substance :

• Diamagnetism is the property of an object which causes it to create a magnetic field in opposition to an externally applied magnetic field, thus causing a repulsive effect. Specifically. an external magnetic field alters the orbital velocity of electrons around their nuclei. thus changing the magnetic dipole moment. According to Lenz’s law,this opposes the external field.

• Diamagnets are materials with a magnetic permeability less than μ_0(a relative permeability less than 1).
• Diamagnetism is a form of magnetism that is only exhibited by a substance in the presence of an externally applied magnetic field. It is generally quite a weak effect in most materials, although superconductors exhibit a strong effect.
• Materials that are said to be diamagnetic are those that are usually considered by non-physicists to be “non— magnetic”, and include water, wood, most organic compounds such as petroleum and some plastics and many metals including copper, particularly the heavy ones with many core electrons, such as mercury, gold and bismuth.
Ferromagnetic substance:
• Ferromagnetism is the basic mechanism by which certain materials (such as iron) form permanent magnets, or are attracted to magnets. In physics, several different types of magnetism are distinguished.
• Ferromagnetism is the strongest type, it is the only type that can produce forces strong enough to be felt, and is responsible for the common phenomena of magnetism encountered in everyday life. One example is refrigerator magnets.
• The attraction between a magnet and ferromagnetic material is “the quality of magnetism first apparent to the ancient world, and to us today.” according to a classic text on ferromagnetism.
• All Permanent magnets (materials that can be magnetized by an external magnetic field and which remain magnetized after the external field is removed) are either ferromagnetic or ferrimagnetic, as are other materials that are noticeably attracted to them.

• Cobalt, Iron and Nickel etc. are some of the common ferromagnetic materials.

Paramagnetic substance:

• The Paramagnetic substances are substances which, when placed in a strong magnetic held, get weakly magnetized.
• Platinum, Chromium, Manganese, Copper Sulphate, liquid Oxygen and solutions of salts of iron and Nickel are examples of Paramagnetic substances.
• When a bar of Paramagnetic substances is placed in an external magnetic field, the flux density (field intensity) in it is slightly greater than the flux density in free space. Thus the relative permeability becomes slightly greater than 1.

Characteristics of a Magnet

• If a bar of paramagnetic substance is suspended between the poles of a magnet. it shows poles at its ends which are opposite to those of the magnet and turns until it lies along the field.
• In a non—uniform field paramagnetic substances tend to move from weaker to stronger parts of the magnetic field. If a paramagnetic liquid is placed in a watch glass resting on two pole-pieces very near to each other, the liquid accumulates in the middle where the field is strongest.
• If on the other hand the pole-pieces are far apart, the field is strongest near the poles and the liquid moves away from the centre producing a depression in the middle,
• A paramagnetic gas when allowed to ascend between the pole pieces of a magnet, spread along the field.
• The magnetic susceptibility decreases with rise in temperature.

Types of magnet :

• Normally the magnet is of two types :

(l)Temporary Magnet:

• Temporary magnets are those in which magnetic substance magnetizes easily and also demagnetizes quickly. That’s why these magnets are also called electromagnets.

• Usually for making temporary magnet soft irons are utilized.
• Electromagnets (temporary magnets) are used frequently in the electric alarm, in the core of transformer, in the dynamo in which soft irons are magnetised.
(II) Permanent Magnet :
• Permanent magnets are those in which magnetic substance magnetises by slowly and steadily in the long span of time and do not demagnetises easily. Stainless steel is utilised to obtain good quality of permanent magnet.
• In loudspeaker, needle indicator, Galvanometer etc. permanent magnet of steel isused.
Misc. points about Magnetism
• Aristotle attributes the first of what could be called a scientific discussion on magnetism to Thales, who lived from about 625 BCE to about 545 BCE.
• In ancient India, the Indian surgeon, Sushruta, was the first to make use of the magnet for surgical purposes.
• In ancient China, the earliest literary reference to magnetism lies in a 4th century BCE book called “Book of the Devil Valley Master “the lodestone makes iron come or it attracts it.”
• The ancient Chinese scientist Shen Kuo (1031-1095) was the first person to write of the magnetic needle compass and that it improved the accuracy of navigation by employing the astronomical concept of true north (Dream Pool Essays, AD 1088), and by the 12th century the Chinese were known to use the lodestone compass for navigation.
• Alexander Neckham, by 1187, was the first in Europe to describe the compass and its use for navigation.
• In 1269, Peter Peregrinus de Maricourt wrote the Epistola de msgnete, the first extant treatise describing the properties of magnets.
• In 1282, the properties of magnets and the dry compass were discussed by Al-Ashraf, a Yemeniphysicist, astronomer and geographer,

• In 1600, William Gilbert described many of his experiments with his model earth called the terrella. From his experiments, he concluded that the Earth was itself magnetic and that this was the reason compasses pointed north (previously, some believed that it was the pole star (Polaris) or a large magnetic island on the north pole that attracted the compass).
• An electric magnet is used in electric bell.
• The magnetism of earth is due to its metallic core (Nife).
• There is a magnetism in cobalt, Nickel and Iron.
• The core of electric magnet is made up of soft iron.
• The matter which is reflected by the magnet is known as diamagnetic.
• In the centre of bar magnet the magnetism is zero.
• Zeeman Effect is the splitting of a spectral line into several components in the presence of a static magnetic field.

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INSIGHT GENERAL STUDIES

TOPIC

7

FORCE,WORK,POWERANDENERGY

FORCE

• A push or a pull on an object is called a force.
• Forces applied on an object in the same direction add to one another.
• If the two forces act in the opposite directions on an object, the net force acting on it is the difference

between the two forces.
• The strength of a force is usually expressed by its magnitude.
• A change in either the speed of an object, or its direction of motion or both, is described as a change in its state

of motion. Thus, a force may bring a change in the state of motion of an object.
• The force resulting due to the action of muscles is known as the muscular force, Since muscular force can be
applied only when it is in contact with an object, it is also called a contact force friction.
• It is the force of friction between the surface of the ball and the ground that brings the moving ball to rest.
Similarly, friction between water and the boat brings it to a stop once you stop rowing.
• The force exerted by a charged body on another charged or uncharged body is known as electrostatic force.
This force comes into play even when the bodies are not in contact. The electrostatic force, therefore, is
another example of a non—contact force ·
• The force acting on a unit area of a surface is called pressure. Pressure = Force/Area on which it acts.
• Gases, too, exert pressure on the walls of their container.
• There is air all around us, this envelop of air is known as the atmosphere.

The atmospheric air extends up to
many kilometres above the surface of the earth. The pressure exerted by this air is known as atmospheric
pressure.

- A force arises due to the interaction between two objects.
- Force has magnitude as well as direction.
- Force acting on an object may cause a change in its state of motion or a change in its shape.
- A force can act on an object with or without being in contact with it.
- Liquids and gases exert pressure on the walls of their containers.
- If an object to be taken at the centre of the earth, its weight would be zero because the gravitation force would be zero.
- Taking out butter from milk is possible because of centrifugal force which is known as centrifugation.
- Various satellites move around the sun because of centripetal force.
- The weight of an object is equal of the gravitational force exerted on it.
- A moving object comes into stationary state because friction force exerts on it.
- The mass of an object tells the presence of matter in the object, whereas the weight of the object is the force by which the earth pulls that object towards itself.
- The cohesive force of mercury is greater than the adhesive force between the glass and the mercury so a drop of mercury does not spread when it put on clean glass but a drop of water spreads.
- In hilly regions the roads are curved so that minimum force could be exerted to get the gravitational centre.
- If a bucket filled with water moves around with high velocity, the water in it does not fall out because centrifugal force becomes greater than centripetal force and it pulls water inwards.

Gravitation

• Gravitation, or the force of gravity, is a natural phenomenon by which physical bodies attract with a force proportional to their mass. In everyday life, gravitation is most familiar as the agent that gives weight to objects with mass and causes them to fall to the ground when dropped. Gravitation causes dispersed matter to coalesce, and coalesced matter to remain intact, thus accounting for the existence of the Earth, the Sun, and most of the macroscopic objects in the universe.
• Gravitation is responsible for keeping the Earth and the other planets in their orbits around the Sun; for keeping the Moon in its orbit around the Earth; for the formation of tides; for natural convection, by which fluid flow occurs under the influence of a density gradient and gravity; for heating the interiors of forming stars and planets to very high temperatures; and for various other phenomena observed on Earth.
• Gravitation is one of the four fundamental interactions of nature, along with electromagnetism, and the nuclear strong force and weak force. Modern physics describes gravitation using the general theory of relativity by Einstein, in which it is a consequence of the curvature of spacetime governing the motion of inertial objects. The simpler Newton’s law of universal gravitation provides an accurate approximation for most calculations.
• Modern work on gravitational theory began with the work of Galileo Galilei in the late 16th and early 17th centuries. In his famous experiment dropping balls from the Tower of Pisa, and later with careful measurements of balls rolling down inclines, Galileo showed that gravitation accelerates all objects at the same rate. This was a major departure from Aristotle’s belief that heavier objects accelerate faster. Galileo correctly postulated air resistance as the reason that lighter objects may fall more slowly in an atmosphere. Galileo’s work set the stage for the formulation of Newton’s theory of gravity.

Gravitational force of earth

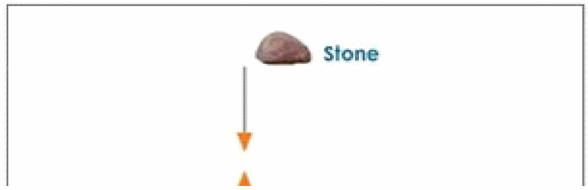
• The gravityofEarth,denoted g,referstothe acceleration thatthe Earth impartstoobjectsonornearits surface.
• The SI unit of acceleration is metres per second^2(in symbols, m/s^{2}or m·s^{-2}) or in Newton per kilogram (N/

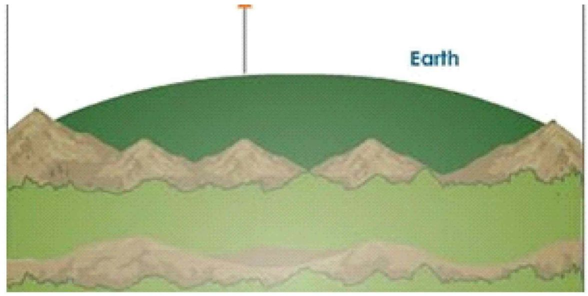
kg or N·kg^{-1}).
• It has an approximate value of 9.81 m/s^2, which means that, ignoring air resistance, the speed of an
object falling freely near the Earth's surface increases by about 9.81 metres per second every second.
• The velocity, by which a object runs away from its gravitational field is known as escape velocity.
• The formula of acceleration due to gravity at a place on the earth is

2
1
=
g gr+h

Where
g= standard acceleration due to gravity i.e. 9.8 m/s^2
r = radius of the earth
h = height or depth of the place

• The acceleration due to gravity becomes less as we go up or go deep into the earth.
• The acceleration due to gravity is maximum at the polesbecause radius of the earth is least at the poles (6356.7km).
• The acceleration due to gravity is minimum at the equatorbecause radius of the earth is maximum at the equator (6378.1 km) .


Stone



• If the motion of the earth increases, the weight of the object will decrease. The path of a bullet coming out form a gun will be parabolic.
• The escape velocity of a object for coming out form the gravitational field of the earth is 11.2km per second.
• The velocity of all the objects falling freely in vacuum will be same.
• The value of gravitational acceleration keeps on increasing from equator to pole.

DENSITY

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• The maximum density of water is 4°C.
• A ship made up of iron does not sink in sea ware because the density of sea water is greater than river water.
• When floating ice in a glass melts the level of water does not change.

• To extinguish the fire of petrol, one should not use water because water is heavier than petrol and petrol keeps on floating and burning over water.
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• The specific gravity of ice is less than that of water but more than that of alcohol.

• The purity of milk can not be measured completely by lactometer because butter is lighter than water and if it is removed from milk, the density of milk is increased. If water mixes in it, the density of it can be increased at the level of pure milk.

• The density of sea water increases with the decrease of depth and increase of salinity.

Buoyancy

• All objects experience a force of buoyancy when they are immersed in a fluid.

• Objects having density less than that of the liquid in which they are immersed, float on the surface of the liquid. If the density of the object is more than the density of the liquid in which it is immersed then it sinks in the liquid.

• Buoyancy is an extremely important aspect of diving, without it, one would just become another rock at the bottom of the ocean. Archimedes, an ancient Greek mathematician and inventor, had discovered how buoyancy works.

•

Archimedes Principle states: ”that a body completely or partially submerged in a fluid (gas or liquid) at rest is

acted upon by an upward, or buoyant force, the magnitude of which is equal to the weight of the fluid displaced by the body”.
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(a) The body will float
(b) The body will sink –
(c) The body will be stuck –
– if the buoyancy is positive if the buoyancy is negative
if the buoyancy is neutral

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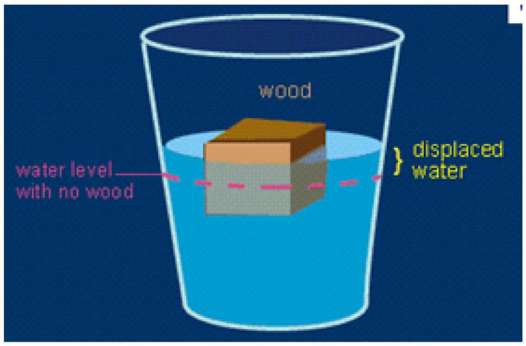

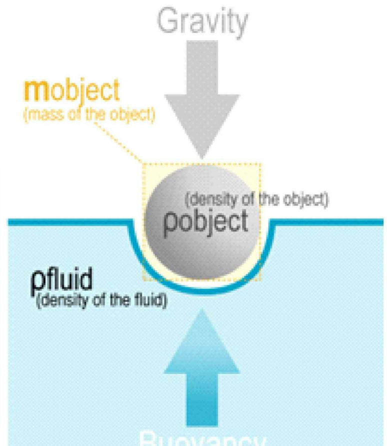

Surface Tension

• The shape of rain drop is spherical due to surface tension.
• The surface tension of liquid deceases with the increase of temperature.
• The surface tension of hot soup is less than the cold soup because of this hot soup spreads over a larger area

over the tongue and it feels tasty.
• The capillary action takes place due to surface tension.
• Bloating paper soaks ink, this is based on the theory of capillary action.

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• Oil spreads over water because the surface tension of oil is lower than that of water.
• The surface tension of soap water becomes low so, the dirt of the clothes oozes out when it is washed with

sop.
Work
• Work done on an object is defined as the magnitude of the force multiplied by the distance moved by the

object in the direction of the applied force. The unit of work is joule.
• It refers to an activity involving a force and movement in the direction of the force. A force of 20 Newton pushing an object 5 meters in the direction of the force does 100 joules of work
Energy
• Energy is the capacity for doing work. To do 100 joules of work, you must expend 100 joules of energy.
• The law of conservation of energy states that energy may neither be created nor destroyed. Therefore the sum of all the energies in the system is a constant. The Energy in a system may take on various forms (e.g. kinetic, potential, heat, light).

Kinetic Energy

Kinetic energy is the energy of motion. An object that has motion - whether it is vertical or horizontal motion - has kinetic energy. There are many forms of kinetic energy - vibrational (the energy due to vibrational motion), rotational (the energy due to rotational motion), and translational (the energy due to motion from one location to another).

The Kinetic energy –KE = mv^2

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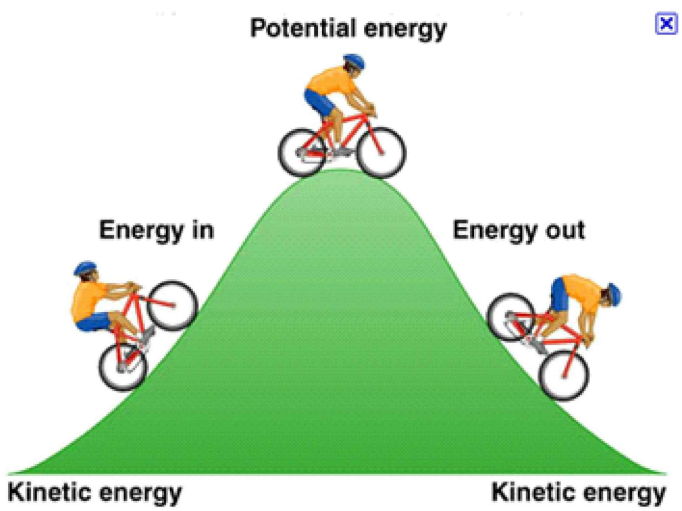

Potential Energy

- The potential energy is the energy stored in a body or in a system due to its position in a force field or due to

Potential Energy

• The potential energy is the energy stored in a body or in a system due to its position in a force field or due to its configuration.
• The SI unit of measure for energy and work is the Joule (symbol J).
• The term “potential energy” was coined by the 19th century Scottish engineer and physicist William Rankine.
• The potential energy – PE = m.g.h where m= mass of the object, h= height of the object
Power
• Power is the rate of doing work or the rate of using energy, which are numerically the same.
• If you do 100 joules of work in one second (using 100 joules of energy), the power is 100 watts.

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INSIGHT GENERAL STUDIES

TOPIC

8

FRICTION

What is Friction

• Friction is the force resisting the relative motion of solid surfaces, fluid layers, and/or material elements slidingagainst each other. Friction opposes the relative motion between two surfaces in contact. It acts on both the surfaces.

• When surfaces in contact move relative to each other, the friction between the two surfaces converts kinetic energy into heat. This property can have dramatic consequences, as illustrated by the use of friction created by rubbing pieces of stone together to start a fire.

• Kinetic energy is converted to heat whenever motion with friction occurs, for example when a viscous fluid is stirred. Another important consequence of many types of friction can be wear and tear, which may lead to performance degradation and/or damage to components. Friction is a component of the science of tribology.

• Friction isnot a fundamental force but occurs because of the electromagneticforces between charged particles which constitute the surfaces in contact. Because of the complexity of these interactions friction cannot be calculated from first principles, but instead must be found empirically.

• TheclassicrulesofslidingfrictionwerediscoveredbyLeonardodaVinci(1452-1519),butremainedunpublished in his notebooks. They were rediscovered by Guillaume Amontons (1699) and were further developed by Charles-Augustin de Coulomb (1785). V

• Leonhard Euler (1707-1783) derived the angle of repose of a weight on an inclined plane and first distinguished between static and kinetic friction. Arthur Morrin (1833) developed the concept of static friction.

• Osborne Reynolds (1866) derived the equation of viscous flow. This completed the classic model of friction (static, kinetic, and fluid) commonly used today in engineering.

• The focus of research during the last century has been to find the physical mechanisms behind friction. F. PhillipBowden and David Tabor (1950) showed that the actual area of contact between surfaces is a very small fraction of the apparent area.

• This actual area of contact, caused by “asperities” increases with pressure, explaining the proportionality between normal force and frictional force. The development of the atomic force microscope (1986) has recently enabled scientists to study friction at the atomic scale.

• In mechanics, friction plays a major role both in the laboratory and industrial worlds. Friction is the resistance to the sliding, rolling, or flowing motion of an object due to its contact with another object.

• Friction depends on the nature of surfaces in contact.

• For a given pair of surfaces friction depends upon the state of smoothness of those surfaces.

• Friction depends on how hard the two surfaces press together.

• Friction can be reduced by using lubricants.

• In many machines, friction is reduced by using ball bearings.

• Fluid friction can be minimised by giving suitable shapes to bodies moving in fluids.

Types of Friction

Static friction

• Static friction is friction between two solid objects that are not moving relative to each other. For example, static friction can prevent an object from sliding down a sloped surface. The coefficient of static friction, typically denoted as ì$_{s}$, is usually higher than the coefficient of kinetic friction.

• The maximum value of static friction, when motion is impending, is sometimes referred to as limiting friction, although this term is not used universally. It is also known as traction.

• Static friction comes into play when we try to move an object at rest.

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Kinetic friction

- Kinetic (or dynamic) friction occurs when two objects are moving relative to each other and rub together (like a sled on the ground). The coefficient of kinetic friction is typically denoted as μ_k,and is usually less than the

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• New models are beginning to show how kinetic friction can be greater than static friction. Kinetic friction is now understood, in many cases, to be primarily caused by chemical bonding between the surfaces, rather than interlocking asperities; however, in many other cases roughness effects are dominant, for example in rubber to road friction. Surface roughness and contact area, however, do affect kinetic friction for micro and nano-scale objects where surface area forces dominate inertial forces.

• Kinetic friction is of two types i.e. the Rolling Friction and the Sliding Friction.

Rolling friction

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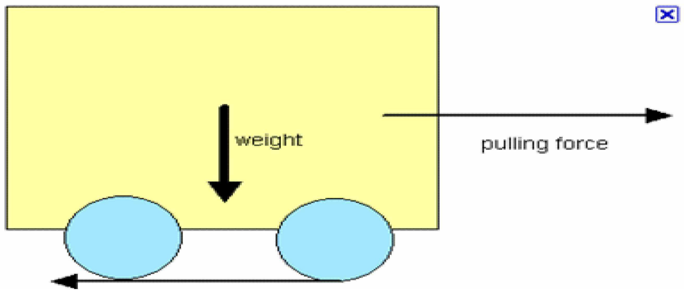
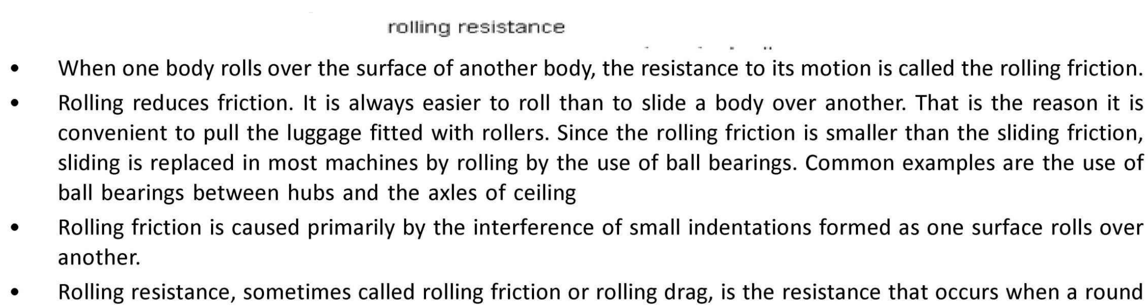
Rolling friction



• When one body rolls over the surface of another body, the resistance to its motion is called the rolling friction.
• Rolling reduces friction. It is always easier to roll than to slide a body over another. That is the reason it is convenient to pull the luggage fitted with rollers. Since the rolling friction is smaller than the sliding friction, sliding is replaced in most machines by rolling by the use of ball bearings. Common examples are the use of ball bearings between hubs and the axles of ceiling
• Rolling friction is caused primarily by the interference of small indentations formed as one surface rolls over another.



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• Rolling resistance, sometimes called rolling friction or rolling drag, is the resistance that occurs when a round object such as a ball or tire rolls on a flat surface, in steady velocity straight line motion. It is caused mainly by the deformation of the object, the deformation of the surface, or both.
• Additional contributing factors include wheel radius, forward speed, surface adhesion, and relative micro— sliding between the surfaces of contact. It depends very much on the material of the wheel or tire and the sort of ground.
• For example, rubber will give a bigger rolling resistance than steel. Also, sand on the ground will give more rolling resistance than concrete. Any moving wheeled vehicle will gradually slow down due to rolling resistance including that of the bearings, but a train car with steel wheels running on steel rails will roll farther than a bus of the same mass with rubber tires

running on tarmac.
• In pure rolling motion, friction causes the wheel to catch and stops the sliding and slipping motion; for example when a car spins its tires, slipping is taking place, thus the frictional force works to stop the spinning out and causes the tires to catch and begin pure rolling motion.
• Rolling friction is always less than the sliding friction because of this is it easy to roll a box than slide over a distance.

INSIGHT GENERAL STUDIES

Sliding/dragging friction

• Sliding friction is the friction that occurs when an object slides over a surface. Sliding friction is friction caused by moving two flat surfaces against each other. An example is sliding a book across a desk. It is also known as Kinetic friction.
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• The reason why friction exists is that the surfaces are not really flat. But if you zoom in on the surfaces you would be able to see bumps and ridges on the surface. And those bumps slide against one another.
• Rubbing your hands together causes heat due to friction. Friction causes heat. Unlike rolling friction sliding friction’s main purpose is to stop an object.
• It’s easier to roll a rubber ball than to slide a rubber box.

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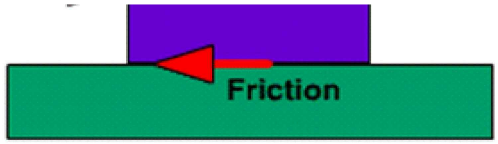
Dryfriction



Dry friction

- It resists relative lateral motion of two solid surfaces in contact. Dry friction is subdivided into static *friction* between non—moving surfaces, and *kinetic friction* between moving surfaces.

Fluid friction

• It resists relative lateral motion of two solid surfaces in contact. Dry friction is subdivided into static friction between non—moving surfaces, and kinetic friction between moving surfaces.
Fluid friction

• It describes the friction between layers within a viscous fluid that are moving relative to each other.

Lubricated friction

• It is a case of fluid friction where a fluid separates two solid surfaces.

Skin friction

• It is a component of drag, the force resisting the motion of a solid body through a fluid.

Internal friction

• It is the force resisting motion between the elements making up a solid material while it undergoes deformation.

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Reducing the Friction

Reducing the Friction

• Devices such as wheels, ball bearings, roller bearings, and air cushion or other types of fluid bearings can change sliding friction into a much smaller type of rolling friction.

• A common way to reduce friction is by using a lubricant, such as oil, water, or grease, which is placed between the two surfaces, often dramatically lessening the coefficient of friction. The science of friction and lubrication is called tribology. Lubricant technology is when lubricants are mixed with the application of science, especially to industrial or commercial objectives.

• Superlubricity, a recently—discovered effect, has been observed in graphite: it is the substantial decrease of friction between two sliding objects, approaching zero levels. A very small amount of frictional energy would still be dissipated.

• Lubricants to overcome friction need not always be thin, turbulent fluids or powdery solids such as graphite and talc; acoustic lubrication actually uses sound as a lubricant.

• Another way to reduce friction between two parts is to superimpose micro—scale vibration to one of the parts. This can be sinusoidal vibration as used in ultrasound—assisted cutting or vibration noise, known as dither.

Negative effects of friction

• Excessive erosion or wear of mating surfaces occur when work due frictional forces rise to unacceptable levels. Harder corrosion particles caught between mating surfaces (fretting) exacerbates wear of frictional forces. Bearing seizure or failure may result from excessive wear due to work of friction. As surfaces are worn by work due to friction, fit and surface finish of an object may degrade until it no longer functions properly.
• In the reference frame of the interface between two surfaces, static friction does no work, because there is never displacement between the surfaces. In the same reference frame. Kinetic friction is always in the direction opposite the motion, and does negative work.
• Split friction is a particularly dangerous condition arising due to varying friction on either side of a car.

Positive contributions of friction
• Friction can do positive work in certain frames of reference. One can see this by placing a heavy box on a rug, then pulling on the rug quickly. In this case, the box slides backwards relative to the rug, but moves forward relative to the frame of reference in which the floor is stationary. Thus, the kinetic friction between the box and rug accelerates the box in the same direction that the box moves, doing positive work.
• The work done by friction can translate into deformation, wear, and heat that can affect the contact surface properties (even the coefficient of friction between the surfaces). This can be beneficial as in polishing.
• The work of friction is used to mix and join materials such as in the process of friction welding.
• Friction plays an important role in the transportation system. Rail adhesion (the grip wheels of a train have on the rails) enables the movement of train.Road slipperiness is an important design and safety factor for automobiles. Road texture affects the interaction of tires and the driving surface.
• Friction is also used in the friction belt or belt drive used in machines, such

as a car engine’s fan belt. The friction between the rubber belt and pulley wheels is used to enable a pulley wheel connected to the engine to drive a pulley wheel connected to the fan.

• Friction makes walking and running possible. If there were no friction, we would be unable to move our legs on the ground without slipping and falling, just like you would experience when you try to move on a slippery surface, such as ice, which offers very little friction underfoot.

• Friction enables vehicles to move controllably on the road without sliding or skidding, as it would have if it were on a wet slippery road with little friction.

• The Grindstone works due the friction. This is a very rough surface used to wear away metal surfaces to sharpen chisels and knives.

• We can run or walk of the surface of the earth because it produces friction on us.

• It is difficult to much on ice in comparison to move on concrete because ice produces less friction force.

• Friction is important for many of our activities. Friction can be increased by making a surface rough. The sole of the shoes and the tyres of the vehicle are treaded to increase friction.

• The friction is also useful in –

(a) Striking a Match

(b) Walking: boot/sneaker to pavement

(c) Car Brakes

(d) Using a Pencil/Pen

(e) Chewing food

(f) Maintaining balance, etc

Measurement of friction

• A Tribometer is an instrument that measures friction on a surface.

• A Profilograph is a device used to measure pavement surface roughness.

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INSIGHT GENERAL STUDIES

TOPIC

9

MOTION

What is Motion

• Motion is a change of position.
• It can be described in terms of the distance moved or the displacement i.e. if an object has undergone

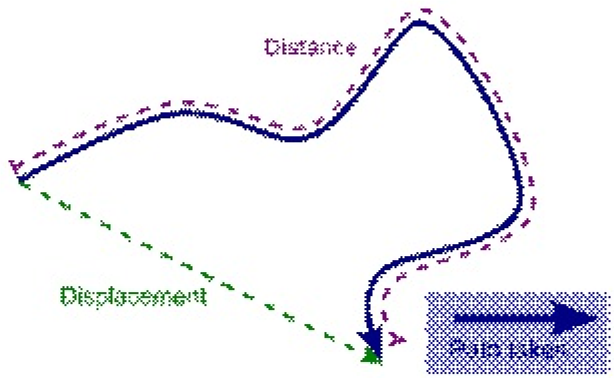
displacement or has covered some distance then it can be said that motion has taken place.
• Motion of objects can be presented in pictorial form by their distance-time graphs.
• The motion of an object could be uniform or non-uniform depending on whether its velocity is constant or

changing.
• Uniform and non-uniform motions of objects can be shown through graphs.

Displacement and Distance

• The shortest distance measured from the initial to the final position of an object is known as the

displacement.
• It is the length of an imaginary straight path, typically distinct from the path actually travelled by the object.
• A displacement vector represents the length and direction of that imaginary straight path.
• Automobiles are fitted with a device that shows the distance travelled. Such a device is known as an odometer.



Speed

• The speed of an object is the distance travelled divided by the time taken to cover that distance. Its SI unit is meter per second (m/s).
• Speed of objects help us to decide which one is moving faster than the other.
• It is a scalar quantity i.e. speed has only amplitude.
• The average speed of an object is obtained by dividing the total distance travelled by the total time taken.
• Vehicles have an instrument called a speedometer. It records the speed directly in km/h.
• There is also another meter that measures the distance moved by the vehicle. This meter is known as an odometer.

Velocity

• Velocity refers to the displacement per unit time.
• It is a vector quantity i.e. velocity has both direction and amplitude.
· Velocity is the speed of an object moving in a definite direction. The velocity of an object can be uniform or variable. It can be changed by changing the object’s speed, direction of motion or both.

• In case the velocity of the object is changing at a uniform rate, then average velocity is given by the arithmetic mean of initial velocity and final velocity for a given period of time. That is,

Average Velocity =

Acceleration

- In case the velocity of the object is changing at a uniform rate, then average velocity is given by the arithmetic mean of initial velocity and final velocity for a given period of time. That is,

$$\text{Average Velocity} = \frac{\text{Initial Velocity} + \text{Final Velocity}}{2}$$

Acceleration

- The acceleration of an object is the change in velocity per unit time.

• The acceleration of an object is the change in velocity per unit time.
• The acceleration is taken to be positive if it is in the direction of velocity and negative when it is opposite to

the direction of velocity. The SI unit of acceleration is m s^{-2}.
• If the velocity of an object changes from an initial value u to the final value v in time t, then acceleration a is given by –

Acceleration (a) =
Uniform Circular Motion

- The acceleration is taken to be positive if it is in the direction of velocity and negative when it is opposite to the direction of velocity. The SI unit of acceleration is m s^{-2}.
- If the velocity of an object changes from an initial value *u* to the final value *v* in time *t*, then acceleration *a* is given by –

$$\text{Acceleration (a)} = \frac{v-u}{t}$$

Uniform Circular Motion

- When an object moves in a circular path with uniform speed, its motion is called uniform circular motion.
- We know that the circumference of a circle of radius *r* is given by $2\pi r$. If the athlete takes *t* seconds to go

• When an object moves in a circular path with uniform speed, its motion is called uniform circular motion.
• We know that the circumference of a circle of radius r is given by 2 r . If the athlete takes t seconds to goo

once around the circular path of radius r, the velocity v is given by
Velocity (v) =
Simple harmonic motion/Pendulum

• One of the most well-known periodic motions is that of a simple pendulum. The time taken by the pendulum to complete one oscillation is called its time period.
• A simple pendulum is one which can be considered to be a point mass suspended from a string or rod of negligible mass. It is a resonant system with a single resonant frequency. For small amplitudes, the period of such a pendulum can be approximated by:

once around the circular path of radius *r,* the velocity *v* is given by

$$\text{Velocity (v)} = \frac{2\pi r^2}{t}$$

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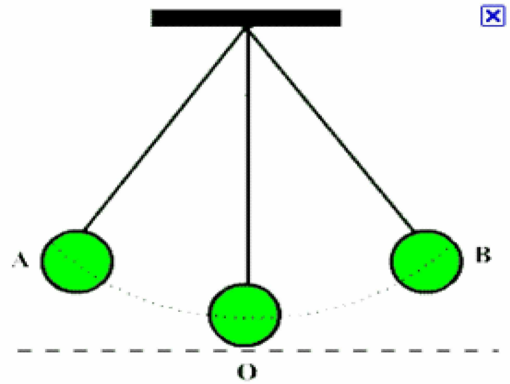
$$T = 2\pi\sqrt{\frac{L}{g}}$$



Here T = time period of Pendulum
L = length of Pendulum
g = gravitational force of earth

Important Points

• Periodic motion of a pendulum has been used to make clocks and watches.
• There is no effect of variation in the mass of the bob of the Pendulum on its time period.
• From its discovery around 1602 by Galileo Galilei the regular motion of pendulums was used for timekeeping,

and was the world’s most accurate timekeeping technology until the 1930s.
• Pendulums are used to regulate pendulum clocks, and are used in scientific instruments such

as accelerometers and seismometers. Historically they were used as gravimeters to measure the acceleration

of gravity in geophysical surveys, and even as a standard of length.
Impact of the variation in the length of Pendulum on its time period
• The longer the length of the pendulum, the lesser will be its time period.
• If a clock is slow, the length of pendulum should be decreased to correct it.
• A common pendulum clock gets fast in winter season because both the length of pendulum becomes shorter

due to contraction. This reduces the time period.
• A common pendulum clock gets slow in summer because both the length of pendulum becomes longer due to
expansion. This increases the time period.
• The pendulum and balance wheel are made up of alloy because the coefficient of linear expansion of alloy is
very less, so there is a minimum difference of its dimension in summer.
• If the length of a pendulum is increased by four times, its oscillation period will be twice. Impact of the variation in gravitational force on the time period of Pendulum
• Ifapendulum clocktobetakeninmines,itwillbeslowbecause aswegodeeperinto the earth,the gravitational
force becomes less.
• The time period of pendulum will be increased on moon because the gravitational force of the moon is lesser
than earth.
• Pendulum clock gets fast at sea shore because the gravitational force is maximum at sea level.
• Pendulum clock gets slower at high altitude (at mountains) because as we go up or as the altitude increases,
the gravitational force becomes less.
Laws of motion
First law of motion

• The first law of motion is stated that an object continues to remain in a state of rest or of uniform motion in a
straight line unless compelled to change that state by an applied force.
• In other words, all objects resist a change in their state of motion.
Second law of motion
• The second law of motion states that the rate of change of momentum of an object is proportional to the
applied unbalanced force in the direction of force. This gives us an alternative statement of the third law of
motion i.e., to every action there is an equal and opposite reaction.
Third law of motion
• To every action, there is an equal and opposite reaction and they act on two different bodies.
• If we fire a bullet it exerts backward push which satisfies the third law of Newton.
• Rocket propulsion is based on the third law of Newton.
Inertia
• The natural tendency of objects to resist a change in their state of rest or of uniform motion is called inertia.
• The mass of an object is a measure of its inertia. Its SI unit is kilogram (kg).
Momentum
• The momentum of an object is the product of its mass and velocity and has the same direction as that of the
velocity. Its SI unit is kg m s^{-1}.
• In an isolated system, the total momentum remains conserved.
• The working of jet engine is based on conservation of linear momentum.
• Hands are pulled backward while taking catch by the fielder so that the conservation of momentum can be
taken place and he can be saved from hurt.

INSIGHT GENERAL STUDIES

TOPIC

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ELECTRONICS

RADAR (Radio Detection and Ranging) :

• The Radar was firstly invented by Robert Watson but its first prototype was designed by the two American scientists Taylor and Young.
• It is a device through which the actual location (position) and the configuration of the unwanted bodies are detected and measured by the electromagnetic wave of the flying aircraft at higher altitudes.
• The radars are also used to detect and measure the position (or location) and distance (or height) of the cloud, to explore the evidence of any metal or oil reserve, to detect the outer layer of the atmosphere and to obtain the height of ionosphere etc. ,
LASER (Light Amplification by Stimulated Emission of Radiation) :
• Laser is a device that produces an intense, coherent and highly directional beam of the single frequency. It can be transmitted over a great distance without being spread. The light beam can be intense enough to vaporise the hardest and the most heat resistant materials. The first ruby A laser was demonstrated by Theodore H. Miaman in 1960.
• Any laser device , consists of three main components— the active medium, the pumping source and the optical resonator. All lasers work on the basic principle that whenever electricity, heat, light or chemical reaction excites an atom it accommodates the extra energy by rearranging its electrons, shifting some of them (from ground energy level) to higher energy levels.
• This excited state of electron is unstable and to become stable the electron falls back to its ground state emitting the extra energy in the form of light.This kind of emissionis called stimulated emission. The important kinds of lasers include optically pumped lasers, liquid lasers, gas discharge lasers, semiconductor lasers etc. Laser works up to femto (10^{-15}) second, while super fast computer works only up to nano (10^{-9}) second.
Applications of Laser:
In Information Technology (IT):

• Laser is frequently used in the fabrication and composition of CD (Compact Disc), DND (Digital Versatile Disc) and in the collection of data and its storage in CD.

To measure time and distance:

• By the help of laser distance and time both can be measured most accurately and precisely Also through it not only the longest distance be measured accurately but the smallest distances, even inter atomic distances are measured in the most excellent and accurate form.

• That's why by the laser inter atomic distances and so internal Structure of the atoms are authentically studied.

To Construct hologram :

• By the help of laser a special type of three dimensional photograph is drawn in the hologram form.

To sketch path (trajectory) of flight :

• For the security point of view the accurate path of the aircrafts and aeroplanes are sketched through the powerful Iaser which is very convenient for air traffic control and comfortable journey Also rockets and satellites follow this technique for their Smooth and perfect destinations in the space.

In Industry :

• In the industrial sector lasers are mainly used in surveying, to facilitate data network, the processing of objects or commodities, to examine non-decomposed substances etc.

• Today lasers are also utilized frequently into the cutting of extremely hard object, cloth, in the construction of buildings, metallic pipes, in the exploration of mines, in the furnishing of diamonds and gems-jewellery. Through the special cutting technique the diamonds look has become fascinating and stylish.

In defence:
• The lasers are used to measure the accurate position and distance of the missiles and other sophisticated weapons. Under the star war programmes, the destructive power of the laser is being utilized to destroy missiles in the sky.
• In chemistry : In chemistry lasers are used as remedial equipment and in the Chemical reactions lasers are used as catalyst or autolyst.
In health and medical science:
• Today lasers are playing a Significant end relevant role specially for the incurable and undiagnosed diseases. Though the laser today cancer has become curable, the barrier produced in the blood clotting in the veins of heartis beingsortout, andmanysurgical operationsin humaneye are beingcompletedwithoutanycomplicacy and problem in perfect way Specially in the treatment of eye modern technique which is called Eximer Lassic Laser, through it the human eye glass can be permanently discarded or abandoned.
• Argon or krypton ion lasers are frequently used in the treatment of the retina of the eye and some other problems of the human eyes. The laser radial keratotomy techniques are used to adjust the abnormal shape of the eye lens.
• Through the laser and optical fiber endoscope the blood clotted ulcers has been easily become curable in very convenient and simplest way. By the laparoscopic treatment the stones of gall bladder and kidney are removed without any rigorous surgical means in very short interval of time.
Laser technology in India:
• In 1964 first laser as Gallium Arsenide (GaA) semiconductor laser was designed and fabricated by Bhabha Atomic ResearchCentre (BARC). The BARC is the largest centre for developing laser technology in very exclusive

way in India.
• The lasers developed so far are He-Ne laser, He-Cd laser, copper vapor laser, ruby laser etc.
• Some others centre where lasers are designed and fabricated are centre for Advanced Technology (CAT), Defence Research and Development Institute of science; Bangalore, and Indian Institute of Technology (IIT) Kanpur.
• An exclusive centre for the laser research is IIT-Kanpur whose laboratories are very enriched and where research works on Laser plasmas, quantum optics, ultrafast process, nonlinear optics etc are going on through the American Collaboration.
MASER (Microwave Amplification by Stimulated Emission of Radiation :
• The maser was invented by three American scientists Gorden, Gieger and H. Townes in 1952 and it is similar to the laser upto maximum extent. In tact maser is an optical device which uses microwave in amplified form of longer wavelength of the light, while ordinary laser uses light rays simply through the masers the actual position of the artificial satellites, fighter planes, unwanted missiles etc are detected by the help of radar.
• In ocean water masers are today utilized to communicate some important messages and in details whatever needed, Also through the masers remedial measures are performed similar to the lasers.

INSIGHT GENERAL STUDIES

TOPIC

11

ASTRONOMYANDSPACE

The Solar System
• The Sun is nearly 150,000,000 kilometres (150 million km) away from the Earth. The next nearest star is Alpha

Centauri. It is at a distance of about 40,000,000,000,000 km from the Earth. Some stars are even further away.
• Such large distances are expressed in another unit known as light year. It is the distance travelled by light in
one year. Remember that the speed of light is about 300,000 km per second. Thus, the distance of the Sun from
the Earth may be said to be about 8 light minutes. The distance of Alpha Centauri is about4.3 light years. Constellation
• The stars forming a group that has a recognisable shape is called a constellation. One of the most famous
constellations which you can see during summer time in the early part of the night is Ursa Major.
• Orion is another well-known constellation that can be seen duringwinter in the late evenings. It is one of the
most magnificent constellations in the sky. It also has seven or eight bright stars. The star Sirius, which is the
brightest star in the sky, is located close to Orion.
• Cassiopeia is another prominent constellation in the northern sky. It is visible during winter in the early part
of the night. It looks like a distorted letter W or M. Till 2006 there were nine planets in the solar system. The Sun
• The Sun is the nearest star from us. It is continuously emitting huge amounts of heat and light.
• The Sun is the source of almost all energy on the Earth. In fact, the Sun is the main source of heat and light for
all the planets.

• The Sun is at the centre of solar system.
• The time between one sunrise and the next was called a day. Similarly, a month was measured from one new
moon to the next. A year was fixed as the time taken by the earth to complete one revolution of the sun. The Planets
• The planets look like stars, but they do not have light of their own. They merely reflect the sunlight that falls
on them.
• The simplest method of identifying planets from stars is that stars twinkle, whereas planets do not. Also the
planets keep changing their positions with respect to the stars.
• A planet has a definite path in which it revolves around the Sun. This path is called an orbit. The time taken by
a planet to complete one revolution is called its period of revolution. The period of revolution increases as
the distance of the planet increases from the sun.
• The first four planets, Mercury, Venus, Earth and Mars are much nearer the Sun than the other four planets.
They are called the inner planets. The inner planets have very few moons. The planets outside the orbit of
Mars, namely Jupiter, Saturn, Uranus and Neptune are much farther off than the inner planets. They are called
the outer planets. They have a ring system around them. The outer planets have large number of moons. TheEarth
• The Earth can be said to be a satellite of the Sun, though generally we call it a planet of the Sun. We use the
term satellite for the bodies revolving around planets. Moon is a satellite of the Earth.
• There are many man-made satellites revolving round the Earth. These are called artificial satellites.
• The Earth rotates from west to east.

• The Earth is the only planet in the solar system on which life is known to exist. Some special environmental conditions are responsible for the existence and continuation of life on the Earth. These include just the right distancefromtheSun,sothatithastherighttemperaturerange,thepresenceofwatera and a blanket of ozone.
• From space, the Earth appears blue-green due to the reflection of light from water and landmass on its surface. The axis of rotation of the Earth is not perpendicular to the plane of its orbit. The tilt is responsible for the change of seasons on the Earth.
• The plane of the equator is called the equatorial plane. The plane in which the Earth revolves round the Sun is called the orbital plane of the Earth. These two planes are inclined to each other at an angle of 23.5º. This means that the axis of the Earth is inclined to its orbital plane at an angle of 66.5º.
• The outer crust of the Earth is called the lithosphere. Water covers 75% of the Earth's surface. It is also found underground. These comprise the hydrosphere. The air that covers the whole of the Earth like a blanket, is called the atmosphere. Living things are found where these three exist. This life-supporting zone of the Earth where the atmosphere, the hydrosphere and the lithosphere interact and make life possible, is known as the biosphere. Living things constitute the biotic component of the biosphere. The air, the water and the soil form the non-living or abiotic component of the biosphere.

Mercury
• The planet mercury is nearest to the Sun. It is the smallest planet of our solar system.
• Because Mercury is very close to the Sun, it is very difficult to observe it, as most of the time it is hidden in the

glare of the Sun. However, it can be observed just before sunrise or just after sunset, near the horizon. So it is visible only at places where trees or buildings do not obstruct the view of the horizon.
• Mercury has no satellite of its own.
Venus

• Venus is earth's nearest planetary neighbour. It is the brightest planet in the night sky.
• Sometimes Venus appears in the eastern sky before sunrise. Some times it appears in the western sky just after sunset. Therefore it is often called a morning or an evening star, although it is not a star.
• Venus has no moon or satellite of its own. Rotation of Venus on its axis is somewhat unusual. It rotates from east to west while the Earth rotates from west to east.
• Carbon dioxide constitutes up to 95-97% of the atmosphere on Venus and Mars.
• The atmosphere of Venus is made up of thick white and yellowish clouds of sulphuric acid.

Mars

• The next planet, the first outside the orbit of the Earth is Mars.
• It appears slightly reddish and, therefore, it is also called the red planet.
• Mars has two small natural satellites.

Jupiter

• Jupiter is the largest planet of the solar system.
• It is so large that about 1300 earths can be placed inside this giantJupiter has a large number of satellites.
• It also has faint rings around it. You can easily recognise Jupiter as it appears quite bright in the sky. If you observe it with the help of a telescope, you can also see four of its large moons.

Saturn

• Beyond Jupiter is Saturn which appears yellowish in colour. What makes it unique in the solar system is its beautiful rings. These rings are not visible with the naked eye. You can observe them with a small telescope.
• Saturn also has a large number of satellites. One interesting thing about Saturn is that it is the least dense among all the planets. Its density is less than that of water.

Uranus and Neptune

• These are the outermost planets of the solar system. They can be seen only with the help of large telescopes. Like Venus, Uranus also rotates from east to west.

• The most remarkable feature of Uranus is that it has highly tilted rotational axis. As a result, in its orbital motion it appears to roll on its side.
• Neptune was discovered on September 23, 1846 by Johann Gottfried Galle, of the Berlin Observatory.

Pluto

• Pluto was the farthest planet from the Sun. In 2006, the International Astronomical Union (IAU) adopted a new definition of a planet. Pluto does not fit this definition. It is no longer a planet of the solar system.

Asteroids

• There is a large gap in between the orbits of Mars and Jupiter. This gap is occupied by a large number of small objects that revolve around the Sun. These are called asteroids.
• Asteroids can only be seen through large telescopes.

Comets

• Comets are also members of our solar system. They revolve around the Sun in highly elliptical orbits. However, their period of revolution round the Sun is usually very long.
• A Comet appears generally as a bright head with a long tail. The length of the tail grows in size as it approaches the sun. The tail of a comet is always directed away from the sun.
• Many comets are known to appear periodically. One such comet is Halley's comet, which appears after nearly every 76 years. It was last seen in 1986.

Meteor

• A meteor is usually a small object that occasionally enters the earth's atmosphere. At that time it has a very high speed.
• The friction due to the atmosphere heats it up. It glows and evaporates quickly. That is why the bright steak lasts for a very short time.

Meteorites

• Some meteors are large so that they can reach the Earth before they evaporate completely. The body that reaches the Earth is called a meteorite.
• Meteorites help scientists in investigating the nature of the material from which the solar system was formed. They are also known as shooting star.

The Moon

• The day on which the whole disc of the moon is visible is known as the full moon day. Thereafter, every night the size of the bright part of the moon appears to become thinner and thinner.
• On the fifteenth day the moon is not visible. This day is known as the new moon day.
• The next day, only a small portion of the moon appears in the sky. This is known as the crescent moon.
• Then again the moon grows larger every day. On the fifteenth day once again we get a full view of the moon.
• On July 21, 1969 (Indian time) the American astronaut Neil Armstrong landed on the moon for the first time followed by Edwin Aldrin.

Eclipse

When the shadow of one celestial body falls on the other, an eclipse occurs. When the shadow of the earth falls on the moon, a lunar eclipse occurs during the full moon period. The solar eclipse occurs when the moon comes between the sun and the earth. It occurs during the new moon period.

Solar Eclipse

When moon comes between sun and earth then the shadow of moon falls on the earth and from the shadow region sun is not visible and this position is called solar eclipse and this eclipse may be full or partial. Full solar eclipse occurs on the day of full moon.

Lunar Eclipse

When earth comes between sun and moon then the shadow of earth falls on the moon then the shadow region of the moon is not visible and this position is called lunar eclipse and this eclipse may also be full or partial. Full lunar eclipse occurs on the day of new moon.

INSIGHT GENERAL STUDIES

Satellite

• The Satellite is a body which revolves around a larger body; generally a planet.
• The satellites are of two types – Natural satellites and artificial satellites.
• An artificial satellite is a manufactured object that continuously orbits the Earth or some other body in space. Most artificial satellites orbit the Earth. People use them to study the universe, help forecast weather, transfer telephonecallsovertheoceans,assistinthenavigationof shipsandaircraft, monitorcropsandotherresources, and support military activities.

Various types of orbit
Geosynchronous orbits
• Lie one the equatorial plane and are usually circular. Their altitude above the earth is around 36,000 km and

inclination with equatorial plane is within few degrees (=2°). Communication satellites are placed in a geosynchronous orbit at a suitable parking slot to suit the mission's objectives. Indian satellite INSAT-1B is placed at 74°E

Near earth orbits
• IT can be either circular or elliptical with altitude, under normal conditions, varying from a few hundred kilo meters to about 1000kms. Their inclination with equator usually varies from 0° to 100°. Satellites, which is in orbit, pass over the north and south poles, are called polar orbiting satellites.
Sun-synchronous orbits
• Enable photography of the earth form the satellite under constant illumination condition of the sun. such orbits have sun angle with respect to the satellite, constant for all the year round. In other words, the satellite crosses any point on the earth at the same local times. This is realised by adjusting the precession rate of the orbital plane to that of the diuranal angular change of the earth in its revolution round the sun. i.e. 360°/365 days=0.98% day. This involves suitable choice of orbit altitude and

inclination. The precession of orbit plane arises as a natural consequence of the perturbative force arising from the oblate nature of the earth's shape.

• Remote sensing satellites are normally placed in near earth orbits, specifically in sun-synchronous orbits. Deep space probes have special orbits normally elliptical in nature and tuned to fly past many planets as per the mission objectives. For all normal manned missions so far conducted, near earth orbits have been chosen in view of the nature of goals set for such mission. Typically manned spacecrafts are placed at orbital altitudes of 300 to 450 kms and inclination (w.r. to equatorial plane) around 50°.

TYPESOF SATELLITES

1. Killer Satellites are satellites that are armed and designed to take out enemy warheads, satellites and other space assets. They may have particle weapons, energy weapons, kinetic weapons, nuclear and/or conventional missiles and/or a combination of these weapons. Anti-satellite weapons (ASATs) are space weapons designed toincapacitateordestroy satellitesforstrategicmilitary purposes.Currently,only the USA, theformer USSR and the People\'s Republic of China are known to have developed these weapons.
2. Astronomical satellites are satellites used for observation of distant planets, galaxies, and other outer space objects.
3. Biosatellites are satellites designed to carry living organisms, generally for scientific experimentation.
4. Communication satellites are satellites stationed in space for the purpose of telecommunications. Modern communication satellites typically use geosynchronous orbits, Molniya orbits or Low Earth orbits (polar and non-polar Earth orbits). For fixed (point-to-point) services, communication satellites provide a microwave radio relay technology complementary to that of submarine communication cables. They are also used for mobile applications such as communications to ships, vehicles, planes and hand-held terminals, and for TV and radio broadcasting, for which application of other technologies, such as cable, is impractical or impossible.
5. Miniaturized satellites are satellites of unusually low weights and small sizes. New classifications are used to categorize these satellites: minisatellite (500–200 kg), microsatellite (below 200 kg), nanosatellite (below 10 kg).

6. Navigational satellites are satellites which use radio time signals transmitted to enable mobile receivers on

the ground to determine their exact location. The relatively clear line of sight between the satellites and receivers on the ground, combined with ever-improving electronics, allows satellite navigation systems to measure location to accuracies of the order of a few metres in real time.

7. Reconnaissance satellites are observation satellites deployed for military or intelligence applications. Little is known about the full power of these satellites, as governments who operate them usually keep information pertaining to their reconnaissance satellites classified.

8. Earth observation satellites are satellites intended for non-military uses such as environmental monitoring, meteorology, map making etc.
9. Space stations are man-made structures that are designed for human beings to live in outer space. A space station is distinguished from other manned spacecraft by its lack of major propulsion or landing facilities — instead, other vehicles are used as transport to and from the station. Space stations are designed for mediumterm living in orbit, for periods of weeks, months, or even years.
10. Tether satellites are satellites which are connected to another satellite by a thin cable called a tether.
11. Weather satellites are primarily used to monitor Earth\'s weather and climate.
Important Points
• A geo-stationary satellite is established at the height of 36,000 km from the earth a its time period is hours.
• When a big star explodes, it is known as Supernova and the remains after the explosion of supernova is known as white dwarf.
• When a big star splits, a large gravitational field would form, which is know as black hole.
• Uranus and Venus moves round the sun in clockwise direction.

• When a object is taken on moon, then its weight becomes 1/6, whereas its mass remains same.
• The temperature of the outer surface of the sun is 6000°C.
• Sky looks black from space.
• The theory of motion of satellites has been given by Kepler.
• Copernicus was the first person to state that “Sun is the Centre of universe” not earth.
• Ptolemy stated that Earth is centre of universe.
• Andromeda is the closest gallexy to our milky way.
• Space flight laws were propounded by Newton.
• Dr. Vikram Sarabhai is the father of Indian space programme.
• Nicholas Copernicus was the first man who told that planets move around the Sun the not around the earth. He was the first personto putforward the heliocentric theorythatsun isthe centre of universe. His heliocentric model, with the Sun at the centre of the universe, demonstrated that the observed motions of celestial objects can be explained without putting Earth at rest in the centre of the universe. His work stimulated further scientific investigations, becoming a landmark in the history of science that is often referred to as the Copernican Revolution.
• Flying path of projectile is known as Ballistics.
• Space junk is a non active object or satellite which keeps on moving in the orbit of the earth.
• Telecommunication satellites are established in Ionosphere.
• The light from moon reaches on the earth only in 1.3 second.
• The sun completed its one revolution around the Galaxy in 250 million years, which is known as cosmic year.
• In Perihelion, the earth is nearest from the sun while in Aphelion it is farthest from the sun.
• The brightest star in the sky is known as Sirius.
• The earth is the densest planet of the solar system.
• Dark plain of the moon is known as lunar sea.
• Venus is known as Morning Star.

INSIGHT GENERAL STUDIES

• If an apple is left from moving satellite, the apple will move with the satellite with the same velocity of the satellite.
• The limit, below which a star can not exist, is known as Chandrasekhar limit.
• At the time of full solar eclipse, the part of the sun seen is known as Corona.
• The average distance between the centre of the sun the centre of the earth is known as Astronomical Unit.
• Besides sun, the star which is the nearest to the earth is Proxima Centauri.
• Pole star seems stationary because it is in straight to the axis of rotation of the earth.
• There are prominent rings around the Saturn.
• Besides sun, the Alpha Centauri star is seen with naked eyes.
• Saturn is having maximum number of satellites i.e. 21.
• Halley's comet is seen at every 76^{th}years.
• In artificial satellite, the source of electrical energy is solar cells.
• Stars seem moving round east to west, because the earth moves round west to east.
• The rocks of Saturn can float into water.
• The Venus is identical to the earth because both are approx. similar in mass, size and density.
• There is the biggest year on Pluto.
• Approx. 59% part of the surface of the moon is visible from the earth.
• The largest planet is Jupiter.
• The Pluto is the coldest (-214°C) and the Venus is the hottest (419°C) planet.
• Mars is known as red planet.
• The colour of a star depends on the temperature of the star.
• When a planet is near to the sun its velocity will be maximum and when it is far from the sun its velocity will be minimum.
• The 90% part of the sun is made up of hydrogen and helium.
• The related facts of sun spots is Wilson effect.
• The satellite of the Jupiter, LEO is the first astronomical matter on which live volcanoes are found

• Uranus is known as first modern planer.
• There is no atmosphere and no magnetic field on the moon.
• Solar wind is made up of plasma.
• The formation of universe can be understood by big bang theory.
• Full solar eclipse can never be of more than 8 minutes (480 seconds)
• Cosmic rays are discovered by VictorHes.
• Venus and mercury do not have satellites
• Mercury completes its revolution around the sun in 88 days.
• The density of Saturn is less than that of water and so it can float into water.
• There are maximum gases available around Uranus.
• Meteorite is a matter which enters in the atmosphere of earth from outer space.
• Mars is a planet which can be seen with naked eyes.
• When the moon is farthest from the earth, the lunar eclipse will be linger, because on this condition it takes more time to moon to pass from the centre of the shadow of the earth.
• Brittle star is not an astronomical matter like pulsar, quasar or black hole.
• Infrared rays are used for the distant photography.
• The rocket launcher which can be reused is known as hyper plane.
• First geo-stationary satellite of India was apple.

• The cold region of the sun which gives red dim light is known as photometer.

• The source of the energy of stars is nuclear fusion.
• Mercury is the closest planet to the sun.
• Saturn has 21 satellites and Jupiter has 16 satellites.
• Moon is the only satellite of earth.
• Venus is the planet that is nearest to the earth.

• Moon completes one revolution around earth in days.

• Days and nights are caused due to earth's rotation.
• The changing of weather on earth is caused due to it being tilted on its axis at 23.5° and revolution round the sun.

• Earth takes 365 days to complete one revolution round the sun.

• There is no atmosphere on the moon.
• Uranus takes 84 years to complete one revolution round the sun.
• Jupiter is the largest planet and
• Jupiter is the heaviest planet.
• Orbit of Halley's comet is elliptical in shape.
• Dog star is the brightest star.
• American astronaut Neil Armstrong was the first person to land on moon.
• Leunic II is the first space shuttle to land on moon. It was launched in Apollo II mission.
• 'Ingel' (Lunar Exploration model) was the first human space shuttle to land on moon.
• U. S. S. R. is the first country to launch artificial satellite.
• U. S. A. is the first country to send a human astronaut on moon.
• Alexi Niyonar of Soviet Union is the first space traveller.
• The first space traveller of India is Rakesh Sharma.
• Radio waves are reflected from ionosphere.

• The satellite projection centre of India is in Sri Harikota (Andhra Pradesh).
• The Head office of ISRO is in Bangalore.
• India's first communication satellite centre is established in Maharashtra ' Arvy'.
• Retrorockets are used to slow down the speed of space shuttle.
• The major satellite of India was projected from cosmodrome of Russia.
• When a satellite is at a distance of 35,880 km (about 36,000 km) from earth in space then the .period of revolution of this satellite and that of earth become same. Such a satellite is called the Geostationary satellite and its orbit is called Geostationary orbit.
• Geostationary satellite appears stationary with respect to earth. Therefore INSAT-IB satellite is always stationary over Indonesia.
• Aryabhatta was the first satellite launched by India on 19 April, 1975 from erstwhile Soviet Union (USSR).
• Indian Space Research Organization (ISRO) has four space centres. These centres are

↘ Vikram Sarabhai Space Centre, Tiruvantapuram (Kerala)
↘ Indian Space Research Organization SatelliteCentre, Bangaore (Karnataka)
↘ SHAR Centre, Sri Harikota (Andhra Pradesh) and
↘ Space Application Centre, Ahmedabad (Gujarat)

• Theory of Black Hole was proposed by S. Chandrashekhar.
• Red Giant is the last stage of the lifecycle of a star.

INSIGHT GENERAL STUDIES

• One cosmic year is the time taken by the sun to complete one revolution around the Akash Ganga.

• Radio telescopes are more suitable than the optical telescopes for the detection of radio sources.
• Radio telescopes can be used even in cloudy weather. It can penetrate the interstellar clouds.
• Asteroids are rocky debris of different shapes revolving around the sun, which are found between the orbits of Jupiter and Saturn.
• If the mass of a star is double of sun then the resultant star will end as neutron star.
• Depletion of ozone layer results in the increase of ultraviolet radiations in space.
• Cosmosome is a detective satellite.
• Shoemaker Levi 9 comet collided with sun.
• The surface temperature of Red star is less than the surface temperature of Blue star.
• A star whose mass is more than 1.4 times the mass of sun, ends up forming Black hole.
• Doppler’s effect is used in determining the speed of heavenly bodies in the line of vision.
• Red giant is the last stage in the life of a star.
• The shape and density of Mars is like the shape and density of the earth.
• Saturn is surrounded by rings.
• Black Hole is an object with a tremendously high density.
• Ozone layer is found in stratosphere.
• Venus is the planet which is nearest to earth.
• Saturn has seven satellites.
• All the normal stars whose original mass is less than 1.4 times the mass of the sun get converted into white dwarfs. This limit is called the Chandrashekhar limit.
• Chlorofluoro carbons cause the depletion of ozone layer.
• Sirius is the brightest star in the sky.

• The tail of a comet always points away from the sun because of solar radiation pressure and the effect of the solar wind.
• Sun is the star that is nearest to Earth.
• Man first landed on moon in 1969.

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INSIGHT GENERAL STUDIES

TOPIC

12

POLLUTION

Greenhouse Effect

• The Sun’s rays warm the earth’s surface. A part of the radiation that falls on the earth is absorbed by it and a part is reflected back into space. A part of the reflected radiation is trapped by the atmosphere. The trapped radiations further warm the earth.

• If you have seen a greenhouse in a nursery or elsewhere, recall that the sun’s heat is allowed to get in but is not allowed to go out. The trapped heat warms the green house. The trapping of radiations by the earth’s atmosphere is similar. That is why it is called the greenhouse effect.

• Without this process, life would not have been possible on the earth. But now it threatens life. $CO_2$is one of the gases responsible for this effect. Air pollution is the contamination of air by impurities which may have a harmful impact on the living organisms and the non-living components.

Nitrogen-Cycle

• Nitrogen gas makes up 78% of our atmosphere and nitrogen is also a part of many molecules essential to life like proteins, nucleic acids (DNA and RNA) and some vitamins. Nitrogen is found in other biologically important compounds such as alkaloids and urea too. Nitrogen is thus an essential nutrient for all life-forms and life would be simple if all these life-forms could use the atmospheric nitrogen directly.

• Other thana few forms ofbacteria, life-formsare notable to convert thecomparatively inertnitrogen molecule into forms like nitrates and nitrites which can be taken up and used to make the required molecules. These ‘nitrogen-fixing’ bacteria may be free-living or be associated with some species of dicot plants.Most commonly, the nitrogen-fixing bacteria are found in the roots of legumes (generally the plants which give us pulses) in special structures called root nodules.

• Other than these bacteria, the only other manner in which the nitrogen molecule is converted to nitrates and nitrites is by a physical process. During lightning, the high temperatures and pressures created in the air convert nitrogen into oxides of nitrogen. These oxides dissolve in water to give nitric and nitrous acids and fall on land along with rain. These are then utilised by various life forms.

• Plants generally take up nitrates and nitrites and convert them into amino acids which are used to make proteins. Some other biochemical pathways are used to make the other complex compounds containing nitrogen. These proteins and other complex compounds are subsequently consumed by animals. Once the animal or the plant dies, other bacteria in the soil convert the various compounds of nitrogen back into nitrates and nitrites. A different type of bacteria converts the nitrates and nitrites into elementalnitrogen.

• Thus, there is a nitrogen-cycle in nature in which nitrogen passes from its elemental form in the atmosphere into simple molecules in the soil and water, which get converted to more complex molecules in living beings and back again to the simple nitrogen molecule in the atmosphere.

Carbon-Cycle

• Carbon is found in various forms on the Earth. It occurs in the elemental form as diamonds and graphite. In the combined state, it is found as carbon dioxide in the atmosphere, as carbonate and hydrogen-carbonate salts in various minerals, while all life-forms are based on carbon-containing molecules like proteins, carbohydrates, fats, nucleic acids and vitamins.

• The endoskeletons and exoskeletons of various animals are also formed from carbonate salts. Carbon is incorporated into life-forms through the basic process of photosynthesis which is performed in the presence

of Sunlight by all life-forms that contain chlorophyll. This process converts carbon dioxide from the atmosphere
or dissolved in water into glucose molecules. These glucose molecules are either converted into other substances or used to provide energy for the synthesis of other biologically important molecules.

• The utilisation of glucose to provide energy to living things involves the process of respiration in which oxygen may or may not be used to convert glucose back into carbon dioxide. This carbon dioxide then goes back into the atmosphere. Another process that adds to the carbon dioxide in the atmosphere is the process of combustion where fuels are burnt to provide energy for various needs like heating, cooking, transportation and industrial processes.
• In fact, the percentage of carbon dioxide in the atmosphere is said to have doubled since the industrial revolution when human beings started burning fossil fuels on a very large scale. Carbon, like water, is thus cycled repeatedly through different forms by the various physical and biological activities.

Oxygen-Cycle
• Oxygen is a very abundant element on our Earth. It is found in the elemental form in the atmosphere to the extent of 21%. It also occurs extensively in the combined form in the Earth's crust as well as also in the air in the form of carbon dioxide.
• In the crust, it is found as the oxides of most metals and silicon, and also as carbonate, sulphate, nitrate and other minerals. It is also an essential component of most biological molecules like carbohydrates, proteins, nucleic acids and fats (or lipids). But when we talk of the oxygen-cycle, we are mainly referring to the cycle that maintains the levels of oxygen in the atmosphere. Oxygen from the atmosphere is used up in three processes, namely combustion, respiration and in the formation of oxides of nitrogen.
• Oxygen is returned to the atmosphere in only one major process, that is, photosynthesis. And this forms the broad outline of the oxygen-cycle in nature Though we usually think of oxygen as being necessary to life in the

process of respiration, it might be of interest to you to learn that some forms of life, especially bacteria, are poisoned by elemental oxygen. In fact, even the process of nitrogen-fixing by bacteria does not take place in the presence of oxygen.

Ozone Layer

• Elemental oxygen is normally found in the form of a diatomic molecule. However, in the upper reaches of the atmosphere, a molecule containing three atoms of oxygen is found. This would mean a formula of $O_3$and this is called ozone.

• Unlike the normal diatomic molecule of oxygen, ozone is poisonous and we are lucky that it is not stable nearer to the Earth’s surface. But it performs an essential function where it is found. It absorbs harmful radiations from the Sun. This prevents those harmful radiations from reaching the surface of the Earth where they may damage many forms of life.

• Recently it was discovered that this ozone layer was getting depleted. Various man-made compounds like CFCs (carbon compounds having both fluorine and chlorine which are very stable and not degraded by any biological process) were found to persist in the atmosphere. Once they reached the ozone layer, they would react with the ozone molecules. This resulted in a reduction of the ozone layer and recently they have discovered a hole in the ozone layer above the Antarctica.

Acid rain

• The industries located in and around Agra like rubber processing, automobile, chemicals and especially the Mathura oil refinery, have been responsible for producing pollutants like sulphur dioxide and nitrogen dioxide.

• These gases react with the water vapour present in the atmosphere to form sulphuric acid and nitric acid. The acids drop down with rain, making the rain acidic. This is called acid rain. Acid rain corrodes the marble of the monument. The phenomenon is also called “Marble cancer”.

Quick Review

• Oxides of Sulphur and Nitrogen are the main causes of acid rain.

• Hydrogen produces minimum pollution but it is not used as fuel because it is of explosive in nature.

• Smog which is made up of smoke and fog.

- Chlorofluorocarbons (CFCs) are pollutants used in refrigerators, air conditioners and aerosol sprays. CFCs damage the ozone layer of the atmosphere.
- The ozone layer protects us from harmful ultraviolet rays of the sun.
- Pollutants are the substances which contaminate air and water.
- Carbon monoxide, Nitrogen oxides, Carbon dioxide, Methane and Sulphur dioxide are the major pollutants of air.
- Increasing levels of greenhouse gases like CO_2 are leading to global warming.
- Various nutrients are used again and again in a cyclic fashion. This leads to a certain balance between the various components of the biosphere.

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INSIGHT GENERAL STUDIES

TOPIC

13

VARIOUSINSTRUMENTS

PURPOSE
Very low temprerature
Height (in aeroplane)
General electric current
Speed of air
It is fitted in ear for aid in hearing
Man-made satellite that revolves around the earth and helps in the study of a specific area.
Weight and density of air and gas
Intensity of solar radiations
Store electrical energy. It supplies electricity when required. Intensity of sound
Distant objects
Atmospheric pressure
Measures the change in atmospheric pressure
Measuring current in micro-amperes.
Speed of storm
Amount of heat
It measures the internal and external radio of cylindrical objects. It can also measure their thickness.
An arrangement in internal combustion engines to mix air with petroleum vapours
The record obtained from a cardiograph.
Medical instrument used for tracing the movement of the heart. It is used to focus the films on the screen. It consists of a number of lenses arranged to project on a screen an enlarged image of photographs.
This satellite is used in communications.
A device that indicates the North and Sourth directions at any place An apparatus for electromagnetic acceleration of charged atoms. An instrument used in recording growth of plants. It was invented by Dr. J.C. Bose.

An instrument for comparing intensities of colour
Intensity of primary colours
Right time (used in ship
Low temperature
INSTRUMENT
Alcohol Thermometer Altimeter
Ammeter
Anemometer
Audiophone
Artificial Satellite

Aerometer
Actiometer
Accumulator
audiometer
Binocular
barometer
barograph
Ballistic Galvanometer Beaufort Scale
Calorimeter
Callipers

Carburettor

Cardiogram
Cardiograph
Cinematograph

Communication Satellite Compass box
Cyclotron
Crescograph

Colorimeter Chromometer Chronometer Cryometer

INSIGHT GENERAL STUDIES

It is sued as a source of direct current in a circuit.
Density is measured by this instrument
A machine which first records what is spoken into it and then reproduces it. It is generally used in offices
It is an instrument which converts the heat produced by the combustion of diesel into mechanical energy.
An instrument to determine the angle between the directions of the earth's magnetic field and the horizontal at a place. This particular angle is known as dip at that place.
An instrument for measuring the electrical power.
An electrical instrument in which the mechanical energy is converted into electrical energy. The principle of electromagnetic induction is involved in it.
Its filament emits white light on heating when electric current is passed through it.
It is an instrument that converts electrical energy into mechanical energy.
Used to record and interpret the electrical activity of the brain. An instrument for measuring electricity
It is used to see very minute organisms called microbes. Its magnification power is one thousand times of a simple microscope.
An instrument for generating statical electricity by induction. An instrument for detecting the presence of electric charge. Used to project films and images of opaque articles on the screen.
It consists of a metallic container filled with sodium carbonate solution and a small glass bottle. This bottle is fitted with a metallic rod whose end emerges out. The extinguisher is strucked at this end at the time of use, due to which the bottle breaks and the acid in it comes in contact with the sodium carbonate. Carbon dioxide is evolved by their reaction which extinguishes fire. Depth of sea
Low electric current
An instrument to issustrate the dynamics of rotating bodies An instrument to record oil deposits under water
A device used to detect the presence of radiation of a radioactive source
Specific Gravity of liquid

To record the sound into water
To see the object into the water
Humidity
To know the change in atmospheric humidity
An instrument to measure the height above sea level.
Daniel Cell
Density Meter Dictaphone

Diesel engine
Dip circle
Dynamometer Dynamo
Electric bulb
Electric motor

Electroencephalograph Electrometer
Electron microscope

Electrophorus Electroscope Epidiascope

Fire Extinguisher

Fathometer
galvanometer
Gyroscope
Gravimeter
Geiger Muller Counter

Hydrometer Hydrophone Hydroscope Hygrometer Hygroscope Hypsometer

A vehicle that moves on the cushion of air. It can move at a fast speed on land, marshy and snowy fields and deserts. This vehicle moves above the ground and has no contact with it.
Used in the surgery of heart and lungs.

Projects the jet planes in forward direction.
Used to see various types of geometrical designs.
An instrument to record graphically various physiological movements i.e. blood pressure, heart beat, study of lungs etc. in living beings.
It is placed on the roofs of high rise building for the prevention of the building from lightning.
It is an instrument that amplifies the sound. It converts electric waves into sound waves.
Purity fo milk
An instrument used to compare the magnetic moments and fields.
An instrument for carrying sound to long distances.
An instrument to calculate the fraction of the lowest division of a given scale.
An instrument used for converting sound waves into electrical signals. An optical instrument that produces enlarged images of minute Objects.
An instrument used to cut an object into thin parts for microscopic inspection
Pressure of the vapour
Distance travelled by motor Vehicle
An instrument that graphically represents the electrical and mechanical vibrations.
To study the activities of ship
To hear complete sound
Illuminating power of two sources of light
Evaporation
High temperature
An instrument that sends photograph from one place to another. It is used in communication systems
An apparatus used to take the real photograph of an object or a person.
Used to compare the e.m.f. of cells, to measure the thermal e.m.f. to

determine the large potential difference currents and measure the low resistances.
An instrument used to create artificial weather.
An instrument used to measure the density and coefficient of expansion of liquid.
An instrument for measuring the solar radiations.
Hovecraft

Heart-lungs machine
Internal combustion engine Kaleidoscope
Kymegraph

Lightning Conductor
Loud Speaker
Lactometer
magnetometer
Megaphone Micrometer
Microphone Microscope
Microtome

Manometer Odometer Oscillograph

Periscope
Phonograph
Photometer
Photometer
Pyrometer
Photo telegraph

Photographic Camera
Potentiometer
Psytotrone Pyknometer Pyrheliometer

It is used to detect the direction and range of a flying aircraft by means of radiowaves.
It is used in car engines and regulates the temperature of the engine. It acts as a colling agent.
Instrument that enables one to see the events taking place at one place at the other place by the means of wireless system. An instrument for measuring the emission of radiant energy. An instrument for recording the rainfall at a particular place. It is an instrument used to measure the refractive indices of transparent media.
It keeps the temperature of a room constant. In it liquid ammonia is used which lowers the temperature by vaporisation. Used for determining the electrical resistance of a conductor. It is used for travelling in space. Oxygen and hydrogen are used as fuel in it. It also goes beyond atmosphere.
An instrument used to measure the amount of sugar content in a solution
An instrument used for lightening in mines. Explosion in mines can be prevented by its use.
Used to determine the concentration of salt solution by measuring their densities.
An instrument used to record the intensity and distance of an earthquake.
An instrument used for spectrum analysis.
It is used to accurately measure the radius of curvature of a spherical object.
An instrument that measures arterial blood pressure. An instrument by virtue of which arterial pulsations become visible.
An instrument with the help of which a pulse beat can be heard. An instrument by which a double photograph snapped from two different angles by a two lensed camera can be viewed. An instrument used to hear and analyse the movements of heart and longs. It is used by doctors.
An instrument that brings fast moving objects in view as if they were at rest.
Height of place

To find submerged object Nature of vibrating string Speed of motor vehicle A little interval of time Revolutions per minute Vertical & horizontal angle
Radar

Radiator
Radio telescope

Radiometer
Rain Guage
Refractometer

Refrigerator
Resistance Thermometer Rocket
Saccharimeter
Safety Lamp
Salinometer
Seismograph
Spectroscope Spherometer
Sphygmomanometer Sphygmoscope
Spygmophone Stereoscope
Stethoscope
Stroboscope

Sextant (Used for sun and other astronomical matters)
Sonar
Sonometer
Speedometer
Stop Watch/Atomic Watch Tachometer
Theodolite

An instrument that determines speeds of aero planes, motor boats etc.
An instrument used to record and hear sound.
An instrument by virtue of which two persons at different places can communicate.
The picture of a moving object can be telecast at another place by it. An instrument which prints automatically the messages sent from Various places.
An instrument used to observe astronomical objects.
An instrument which receives images of moving object transmitted by radio waves and converts into real sound and sight.
It helps in direct ex-change of information between two countries. It is a space satellite by which overseas communication are made possible
An instrument for measuring horizontal and vertical angles with a rotating telescope.
An instrument based on thermo-electricity used for measuing temperatures.
An instrument, self registering the record made by thermometer It is a device that can maintain the temperature of the materials kept in it constant for about 24 hours.
An apparatus to measure temperature to a particular degree. It is used in refrigeration.
It regulates the potential of a source.
It receives and transmits the sound waves. It is a mode of transmission.
It is an instrument used to determine the viscosity of liquids. It is an instrument which can send messages from one place to another without the use of wire.

TEMPERATUREOF DIFFERENTCOLOURS Temperature

1,700K
1,850K
2,700–3,300 K
3,350K
3,400K
4,100K

5,000K
5,500–6,000 K
6,500K
9,300K
Source

Match flame Tachometer
Tape recorder Telephone
Telephotography Teleprinter
Telescope Television
Telex Telstar
Theodolite
Thermocouple
Thermograph Thermos Flask
Thermostat
Transformer Transistor
Viscometer Wireless

Candle flame, sunset/sunrise Incandescent light bulb
Studio “CP” light
Studio lamps, photofloods, etc. Moonlight, xenon arc lamp Horizon daylight
Vertical daylight, electronic flash Daylight, overcast
CRT screen

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INSIGHT GENERAL STUDIES

TOPIC

14

MISCELLANEOUSFACTS

• Spark plug and carburettor are used in petrol engine but these are absent in diesel engine.
• CO_2(Carbon dioxide) is used in fire extinguisher.
• Retina works like a film of a camera.
• Ammonia gas is used in refrigerator.
• Liquid crystals are used in calculator and digital watches for display.
• In petrol engine carburettor produces the mixture of petrol and air.
• Red, green and blue are known as primary colours, whereas red, blue and yellow are known as primary pigments.
• When a bulb breaks, it sounds much because air rushes to fill the vacuum.
• Alfa-rays are negative, Beeta-rays are positive and gamma-rays are neutral.
• The penetrating power of gamma-rays is maximum and ionizing power is minimum.
• To extinguish the fire of petrol, the mixture of water and halogenated hydrocarbon is used.
• The fire of electricity is extinguished by carbon tetra-chloride (CCI_4)
• Cleansing of clothes with soap is due to emulsification.
• The weight of a object is lesser on equator than on pole. The mass of a object remains same, while its weight keeps on changing.
• If the centre of gravity of a truck is upward, then the possibility to turn down the truck will be more.
• Mercury is used in Barometer because it is opaque, does not wet the glass-tube, is not evaporated early and in a minimum length, maximum liquid can be filled.
• Dry ice means solid Carbon dioxide (CO_2), which is of acidic in nature and used in refrigerators.
• The metal which can be stretched in the form of wire is known as Ductile.
• When the weight of a object is equal to the weight of the water displaced by the object, the object will be able to float.

• Various gases mix with one another because of diffusion.
• Neutron continues the process of nuclear fission.
• Alpha-rays (alpha-rays) are the most ionised, whereas gamma-rays are the most penetrating.
• The crystal of Germanium and Silicon is used in transistor.
• The study of reactions at very low temperature is known as Cryogenics.
• The weight of a person is greater in standing position than in bending position.
• If the value of barometer dips suddenly, it means storm is likely to come. If the value of pressure in barometer is high, it denotes the clear weather.
• If the weight of a ship is greater than the displaced water, the ship will sink.
• On putting lead into petrol its octane number is increased which lessen the knocking of the engine.
• Liquid hydrogen is known as Hydrazine, which is used as fuel.
• The system of reading by blind was innovated by Bralley. Bralley himself was a blind.
• Dr. HomiJahangirDhabha was the father of Indian atomic programme.
· A man bents down when climbing on the hill, so that the centre of gravity can come in the centre and it remains get stability.

• When aeroplane takes off suddenly, the passengers experience pain in their ear because, pressure changes suddenly.
• Caesium (Cs) is used in atomic watch.
• In refrigerator the materials are maintained at so low temperature so that fermentation can not take place in it and materials can be preserved for linger duration.
• When a lift is coming down with uniform acceleration, the apparent weight of the passenger is lower than the actual weight.
• If the earth stops rotating on its axis, there will not be any effect of the weight of a object on north pole.
• If a person is moving upward with uniform acceleration, the weight will be more.
• If a person is falling freely or moving round in a satellite, the weight of the person will be zero.
• If a object is carried on pole from equator the weight will be increased.
• Bleeding form nose takes place at hilly regions because internal pressure in veins is increased in comparison to external pressure on veins
• The rain drops are spherical because the area of a round surface is minimum for a specific volume.
• If the temperature of water becomes 1°C from 8°C its volume will first decrease and then increase.
• The powder of ferromagnetic substance is used on the tape of tape recorder.
• Neutron bomb gives impact only on human being not on houses and monuments
• Radio broadcast is more clear in night than in day because sun rays intervene in it to some extent.
• The fourth stage of matter is plasma.
• Earthquake waves move fastest in solid.
• If thunder is seen while moving in a vehicle, the driver should come out from the vehicle and lay down on the earth.
• Ozone layer is depleted by supersonic jet.
• In the absence of atmosphere, the sky would look black.
• Descending order of the efficiency – Diesel Engine – Petrol Engine – Steam

Engine

• The problem of using natural gas instead of petrol in motor vehicle is that it occupies more space than petrol and it maintains more effective medium of information.

• In colour TV, red, green and yellow colours are used.

• Telephone is connected with micro-computer by modem. Binary system is used in modern digital computers.

• CharlesBawej is known as the father of computer.

• The measure of a word in computer system is done by bits.

• The difference between nuclear reactor and atomic bomb is that in nuclear reactor the chain reaction is controlled. The wavelength of some electro-magnetic waves are in following order – X-rays < Ultraviolet rays < microwave < Radio wave.

• Holography is the technique of recording and reproducing 3-D images.

• Bodies which allow a part of the light to pass though it and things cannot be distinctly seen.

• 1 mL= $1cm^3$

• Light year is the unit of distance. One light year = 9.46×10^{12}km.

• Astronomical Unit (AU) is equal to the average distance between the sun and earth. It is $1.496 \text{ X } 10^8$km.

• Parsec is the unit of distance and 1 parsec = 3×10^{16}km.

• Oil rises due to capillary ascent in the wick of a lamp. It happens due to surface tension.

• Planck's constant and angular momentum have the same units.

• In a uniform circular motion there is a change in both amplitude and velocity but the speed remains constant.

• The atmospheric pressure at sea level is 1 bar.

INSIGHT GENERAL STUDIES

• An instrument that marks the changes in the atmospheric pressure, in a certain time interval, on the paper is called Barograph.
• Manometer is an instrument that measures the pressure of a gas. Retro rockets are used to reduce the speed of a space ship.
• Vikram Sarabhai space centre is in Trivandrum.
• Neil Armstrong was the first person to land on moon.
• Lunic-II was the first space ship to land on moon.
• The average density on earth is 5.5 cm^3.
• The weight of an object increases on taking it from the equator towards the pole at sea level.
• Rain drops are spherical due to surface tension.
• Nuclear radii are measured in Fermi.
• 1 fermi = 10^{-15}m.
• The speed of a ship is measured in naut.
• 1naut =1852m/hr
• Mercury is a liquid. It is also known as quick silver. It is used in thermometer, barometer, manometer and other instruments.
• The path of the Halley's comet is elliptical.
• Indian Institute of Astrophysics is in Kodaicanal (Tamil Nadu).
• Halley's comet is seen after 76 years.
• India's first satellite was launched from the Russia's cosmodrome.
• Length of days and nights are always equal at the equator.
• National Science Day is celebrated on 28 February .This day is celebrated because the discovery of 'Raman effect' by C. V. Raman became known to the world on this day.
• C. V. Raman was awarded with Nobel prize in 1930.
• There is no force of attraction between the molecules of an ideal gas and hence, no energy change takes place on increase in its volume.
• Goniometer is used to measure the angle of the crystal.
• Purity, of milk is measured by lactometer.
• There is no change in the level of water due to the melting of ice in it.
• Solar eclipse takes place when moon comes between the earth and the sun.

• Lunar eclipse takes place due to the coming of earth between the sun and the moon.
• Intensity of an earthquake is measured by Richter scale.
• An earthquake is detected by a seismograph.
• Fathom is the unit for measuring depth.

• Greenwich time lags behind Indian Standard Time by 5 hours.
• There is no change in the mercury level when the radius of the tube in the barometer is increased.
• Pascal is the unit of pressure. 1 pascal = 1 newton /m^2.
• Flow of fluids is measured in Cusec which is equal to 1 cubic foot/sec.

• 1cusec= 0.028317m^3/sec.
• Electrons are present in all substances.
• Water contracts on heating from 0°C to 4°C.
• The time period of a second’s pendulum is 2 seconds.
• A sudden fall in the barometer reading indicates a storm.
• If the barometer reading gradually falls it indicates rain fall.

• Ozone layer in atmosphere absorbs ultraviolet rays.

• Anemometer measures the speed of air.
• Altimeter is used to measure the height of planes.
• Speed of air planes (or motor boats) is measured by Tachometer.
• Periscope is used to see the objects outside the submarine.
• Clouds float in air due the viscosity of air and their low density.
• The coefficient of viscosity is measured in poise.
• Viscosity of gases increases with temperature.
• Soap decreases the surface tension of solution hence clothes get cleansed.
• Needle floats on water due to surface tension.
• The attractive force acting between the molecules of the same substance is called cohesive force.
• The attractive force acting between the molecules of different substances is called adhesive force.
• Rocket propulsion is based on the conservation of linear momentum.
• A space traveller in a space ship revolving around earth feels weightlessness because the gravitational force acting on the ship is used in providing it the necessary centripetal force.
• The moment of inertia in rotational motion plays the same role as the mass does in translational motion.
• Colur of stars exhibits their temperature.
• The product of mass and velocity of a body is called its momentum.
• If a force is acting for a small duration, then the product. Of force and time is called impulse.
• The change in momentum is equal to impulse.
• The rate of change of impulse is equal to the force applied.
• Relative density is measured by hydrometer.
• When milk is skimmed, cream separates out due to the centripetal force.
• If a hollow pipe passes across the centre of gravity of the earth and a ball is dropped in the pipe, the ball with execute SHM to and fro about the centre of the earth.
• The periodic time of revolution around the earth of a communication

satellite is 24 hours.
• The value of bulk modulus for an incompressible liquid is infinite.
• The viscous force limits the speed of the body falling in a liquid and it attains a constant velocity called the ‘terminal velocity’.
• The order of the layers of atmosphere on moving up from the earth’s surface is Troposphere, Stratosphere, Ozonosphere, Ionosphere, Exosphere.
• 1 picogram = 10^{-12}gram.
• When a lift is moving up then weight of a person standing in it increases.
• If a lift is falling freely the weight of a person becomes zero.
• The weight of a body at poles is maximum.
• The weight of a body at the centre of earth is zero.
• If the velocity of a body is doubled its kinetic energy, becomes 4 times.
• The average density of earth is about 5.5 gm/cm^3.
• The frequency of oscillation of a simple pendulum decreases when it is taken on moon.
• A floating iceberg instead of melting from the upper surface melts at the base because due to the higher pressure at the bottom surface the melting point decreases.
• When speed of a car is doubled four times brake pressure has to be applied for stopping it.
• Both impulse and momentum have the same dimensional formula
• On doubling the radius of a capillary tube the ascent of water in it becomes half.

INSIGHT GENERAL STUDIES

• Velocities of the rain drops of different sizes are different.

• A pendulum clock becomes fast in winters.
• Brass is an alloy of copper and zinc.
• Man-made satellites are established in thermosphere (external atmosphere).
• Stainless steel is an alloy of iron, nickel and chromium.
• The velocity of escape from earth's gravitation into space is 11.2 km/sec.
• A feather and a piece of lead fall freely with the same velocity in vacuum.
• Mass is a scalar quantity but weight is a vector quantity.
• A body falling in a fluid acquires velocity due to the viscosity of the fluid.
• Bernoulli's theorem is based on energy-conservation.
• 1 light year = 946 x 10^{12}km.
• There is no atmosphere at moon because the rms velocity of gas molecules on it is greater than the escape velocity.
• Density remains unchanged on changing the amount of a substance.
• The speed of revolution of earth round the sun is maximum when earth is nearest to the sun.
• Pure gold is of 24 carats.
• Detergents decrease the surface tension of water due to which dirt and oil are easily removed from the clothes. .
• Parsec is a unit for measuring the distances of stars.
• 1 parsec = 3.25 light years. .
• Most of the weather disturbances take place in troposphere.
• The study of friction and lubricants is done in Tribology.
• A glass can be scratched by diamond or hydrofluoric acid.
• For the dilution of sulphuric acid, acid is mixed in water and not water in acid.
• F. Hile suggested that evolution of earth took place from gas and dust particles.
• The extent of pollution of water in rivers is measured by the amount of oxygen dissolved in it.
• A
truck,carormotorcyclemovingwiththesamekineticenergywillstopatthesamedista

of t brakes.
• The tendency of a liquid drop to occupy the minimum surface area is due to surface tension.
• Silver iodide is used for bringing artificial rain.
• Diamond is an allotropic form of carbon.
• Rocket works on the principle of conservation of momentum.
• A solid iron ball floats on the surface of mercury because the relative density of mercury is greater than the relative density of iron.
• The cause of the spreading of a drop of water on a clean glass plate is that cohesive force is lesser than the adhesive force.
• Barometer was invented by Toricelli.
• Theory of relativity was put forward by Einstein.
• Air consists of maximum amount of nitrogen.
• Atmospheric pressure is measured by barometer.
• Steel is more elastic than rubber.
• Purity of milk is tested by lactometer by measuring the density of milk.
• The surface tension of a liquid is due to the cohesive force between its molecules.
• The cause of atmospheric pressure on earth is the gravitational attraction.

• The increase in barometer reading indicates fair weather.

• The SI unit of work is joule.
• The pressure inside a soap bubble is greater than the atmospheric pressure.
• An iron needle floats on mercury but gets drowned in water because the density of iron is less than the density of mercury but greater than the density of water.
• Oil spreads on the surface of water because the surface tension of oil is less than the surface tension of water.
• It is difficult to walk on ice than on road because the frictional force on ice is lesser than on road.
• Pendulum clocks become slow in summers because the length of the pendulum increases with increase in temperature, due to which the time period increases.
• Lactometers, which are used to determine the purity ofa sample of milk andhydrometers usedfordetermining density of liquids, are based on this principle.
• The law of gravitation states that the force of attraction between any two objects is proportional to the product of their masses and inversely proportional to the square of the distance between them. The law applies to objects anywhere in the universe. Such a law is said to be universal.

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INSIGHT GENERAL STUDIES

TOPIC

1

MATTER

Fundamental properties of materials

• Objects around us are made up of a large variety of materials and different types of materials have different properties.
• A given material could be used to make a large number of objects. It is also possible that an object could be made of a single material or of many different types of materials.
• Some materials are shiny in appearance while others are not. Some are rough, some smooth. Similarly, some materials are hard, whereas some others are soft.
• Some materials are soluble in water whereas some others are insoluble.
• Materials are grouped together on the basis of similarities and differences in their properties.
• Things are grouped together for convenience and to study their properties.
• Since metals produce ringing sounds, they are said to be sonorous.

Appearance

• Materials usually look different from each other. Wood looks very different from iron. Iron appears different from copper or aluminium. At the same time, there may be some similarities between iron, copper and aluminium that are not there in wood.
• Materials that have such lustre are usually metals. Iron, copper, aluminium and gold are examples of metals. Some metals often lose their shine and appear dull, because of the action of air and moisture on them. We therefore, notice the lustre, only on their freshly cut surface.

Hardness

• Different materials have different degree of hardness. While some materials can be easily scratched while some cannot be scratched so easily.
• Materials which can be compressed or scratched easily are called soft while some other materials which are difficult to compress are called hard.
• For example, cotton or sponge is soft while iron is hard. In appearance,

materials canhave different properties, like lustre, hardness, be rough or smooth.

Transparency

• Those substances or materials, through which things can be seen, are called transparent. Glass, water, air and some plastics are examples of transparent materials. Shopkeepers usually prefer to keep biscuits, sweets and other eatables in transparent containers of glass or plastic, so that buyers can easily see these items.

• On the other hand, there are some materials through which you are not able to see. These materials are called opaque Wood, cardboard and metals, are examples of opaque materials.

• The materials through which objects can be seen, but not clearly, are known as translucent.

Changes in matter

Physical Change

• Properties such as shape, size, colour and state of a substance are called its physical properties. A change in which a substance undergoes a change in its physical properties is called a physical change.

• Theinterconversionofstatesisaphysicalchangebecausethese changesoccurwithoutachangeincomposition and no change in the chemical nature of the substance.

• A physical change is generally reversible. In such a change no new substance is formed. Example – Conversion of ice into water.

• Although ice, water and water vapour all look different and display different physical properties, they are chemically the same.

Chemical Change

• A change in which one or more new substances are formed is called a chemical change. A chemical change is also called a chemical reaction.

• Burning is a chemical change. During this process one substance reacts with another to undergo a change in chemical composition. Chemical change brings change in the chemical properties of matter and we get new substances. A chemical change is also called a chemical reaction

• During burning of a candle, both physical and chemical changes take place.

• For rusting, the presence of both oxygen and water (or water vapour) is essential.The process of depositing a layer of zinc on iron is called galvanisation.

INSIGHT GENERAL STUDIES

TOPIC

2

COMPOSITIONOFMATTER

Introduction

• In 1803 Dalton asserted and propounded that every matter around us is made up from Small particles and are said to be atoms. Dalton also speculated that the atom is the basic constitutent of all matters and can not be divided by any physical or chemical method.

• Later atom was also divided into electron, proton and neutron and these are called fundamental or elementary particles.

• Lately, these are also assumed to be made up from quarks.

• Some more micro particles also appeared along with the research and development activities of Atomic & Nuclearphysicswhicharekeptinthe classofelementaryparticlesandatpresentthere areabout 30elementary particles.

Electron

• Firstly invented fundamental particle is electron. In 1897 the electron was invented by J. J. Thomson.

• The electron is basically a negatively charged particle which is moving around the central massive core called nucleus of the atom and it is distributed in various energy level and sub-level.

• The electron has negative charge of 1.6×10^{-19}coulomb, while electronicmass (mass of the electron) is 9.1×10^{-31}kg.

• The mass of an electron is about 12000 Times the mass of an hydrogen atom. The mass of a proton and a neutron is taken as one unit each.

• The electron is a stable fundamental particle.

Proton

• The proton is another fundamental particle which was invented by E. Goldstein in 1919.

• Elements are defined by the number of protons they possess.

• It is basically a positively charged particle and has positive charge of 1.6×10^{-19}coulomb and the mass of the proton is $l.6 \times 10^{-27}$kg.

• The proton is confined in the nucleus of the atom. The proton is also a stable fundamental particle.

Neutron

• This was invented in 1932 by James Chadwick. It is a neutral fundamental particle (no charge) confined to the nucleus.

• Themassoftheneutronisapproximatelyequaltothatofmassoftheproton.Neutronis particle whose half life period is of 17 minutes.

• It is utilized in life sciences and medical science frequently. Since it has no any charge and thus due to this characteristic it is used in nuclear fission.

• Neutrons are present in the nucleus of all atoms, except hydrogen. In general, a neutron is represented as 'n'.

Positron

• It is the fundamental particle which has the same mass, anti-spin as that of electron and opposite charge of the electron. Thus positron is also called positive electron.

• Alsopositronwasthe firstfundamentalparticleintheform of antiparticleoftheelectron whichwas discovered in 1932 by Anderson in a cloud chamber experiment exposed to cosmic rays.

• When a positron comes to rest in matter, it is quickly annihilated by an electron resulting in two gamma photons.

Neutrino

• This fundamental particle was invented in 1930 by Pauli.
• This is a mass–less and charge–less fundamental particle.
• The antiparticle of the neutrino is called anti–neutrino which has anti-spin.

Pi-meson

• It was invented in 1935 by H. Yukawa a Japanese physicist when he was propounding, Yukawa's meson theory of nuclear forces.
• The mechanism responsible for the strongly-attractive, non-electrical and non gravitational, short-range nuclear forces between nucleons (protons + neutrons) remained a mystery for a long time. In this regard Yukawa predicted the existence of a new fundamental particle called pi-meson (at-meson) whose rest mass is about 230 times the rest mass of the electron involves these ð-masons.
Mole
• The word "mole" was introduced around 1896 by Wilhelm Ostwald who derived the term from the Latin word moles meaning a 'heap' or 'pile'. A substance may be considered as a heap of atoms or molecules.
• The unit mole was accepted in 1967 to provide a simple way of reporting a large number– the massive heap of atoms and molecules in a sample.
• The mole is the amount of substance that contains the same number of particles (atoms/ ions/ molecules/ formula units etc.) as there are atoms in exactly 12 g of carbon-12.
• The number of particles (atoms, molecules or ions) present in 1 mole of any substance is fixed, with a value of 6.022×10^{23}. This is an experimentally obtained value. This number is called the Avogadro Constant or Avogadro Number(represented by N_0), named in honour of the Italian scientist, Amedeo Avogadro.
• Mass of 1 mole of a substance is called its molar mass.
Laws of Chemical combinations
Law of Conservation of Mass

• During a chemical reaction, the sum of the masses of the reactants and products remains unchanged. This is known as the Law of Conservation of Mass.
• The principle of conservation of mass was first outlined clearly by Antoine Lavoisier.

Law of Definite Proportions

• In a pure chemical compound, elements are always present in a definite proportion by mass. This is known as the Law of Definite Proportions.
• The Law of Definite Proportions was propounded by French chemist Joseph Proust.

Atomic Number

• It is the number of protons or electrons of an atom, which determines its atomic number. It is denoted by 'Z'.
• All atoms of an element have the same atomic number, Z. In fact, elements are defined by the number of protons they possess.
• For hydrogen, $Z = 1$, because in hydrogen atom, only one proton is present in the nucleus. Similarly, for carbon, $Z = 6$. Therefore, the atomic number is defined as the total number of protons present in the nucleus of an atom.

Mass Number

• The mass of an atom is practically due to protons and neutrons alone. These are present in the nucleus of an atom.
• Hence protons and neutrons are also called nucleons. Therefore, the mass of an atom resides in its nucleus.
• Thus the mass number of an atom is the sum of total number of protons and the neutrons present in its nucleus.

Isotopes

• Isotopes have the same atomic number but different mass numbers.
• Isotopes are variants of atoms of a particular chemical element, which have differing numbers of neutrons.

Atoms of a particular element by definition must contain the same number ofprotons but may have a distinct
number of neutrons which differs from atom to atom, without changing the designation of the atom as a particular element.

• Forexample, carbon-12, carbon-13 and carbon-14 arethreeisotopesoftheelement carbon withmassnumbers 12, 13 and 14 respectively. The atomic number of carbon is 6 (every carbon atom has 6 protons); therefore the neutron numbers in these isotopes are 6, 7 and 8 respectively.

Applications of Isotopes

• Since the chemical properties of all the isotopes of an element are the same, normally we are not concerned about taking a mixture. But some isotopes have special properties which find them useful in various fields. Some of them are :

• An isotope of uranium is used as a fuel in nuclear reactors.

• An isotope of cobalt is used in the treatment of cancer.

• An isotope of iodine is used in the treatment of goitre.

Isobars

• Atoms of different elements with different atomic numbers, which have the same mass number, are known as isobars.

• Isobars are atoms of different chemical elements that have the same number of nucleons. Correspondingly, isobars differ in atomic number (or number of protons) but not in mass number.

• An example of a series of isobars would be^{40}S,^{40}Cl,^{40}Ar,^{40}K, and^{40}Ca. The nuclei of these nuclides all contain 40 nucleons, however they contain varying numbers of protons and neutrons.

Misc. important points

• An atom is the smallest particle of the element that can exist independently and retain all its chemical properties.

• A molecule is the smallest particle of an element or a compound capable of independent existence under ordinary conditions. It shows all the properties of the substance.

- A chemical formulaof a compound shows its constituent elements and the number of atoms of each combining element.
- Clusters of atoms that act as an ion are called polyatomic ions. They carry a fixed charge on them.
- The chemical formula of a molecular compound is determined by the Valency of each element.
- In ionic compounds, the charge on each ion is used to determine the chemical formula of the compound.
- Scientists use the relative atomic mass scale to compare the masses of different atoms of elements. Atoms of carbon-12 isotopes are assigned a relative atomic mass of 12 and the relative masses of all other atoms are obtained by comparison with the mass of a carbon-12 atom.
- J.J. Thomson proposed that electrons are embedded in a positive sphere.
- Rutherford’s alpha-particle scattering experiment led to the discovery of the atomic nucleus.
- Rutherford’s model of the atom proposed that a very tiny nucleus is present inside the atom and electrons revolve around this nucleus. The stability of the atom could not be explained by this model.
- Neils Bohr’s model of the atom was more successful. He proposed that electrons are distributed in different shells with discrete energy around the nucleus. If the atomic shells are complete, then the atom will be stable and less reactive.
- J. Chadwick discovered presence of neutrons in the nucleus of an atom. So, the three sub-atomic particles of an atom are: (i) electrons, (ii) protonsand(iii)neutrons. Electrons are negatively charged, protonsare positively charged and neutrons have no charges.
- Shells of an atom are designated as K,L,M,N,….
- Valency is the combining capacity of an atom.

INSIGHT GENERAL STUDIES

TOPIC

3

SYNTHETICFIBRESANDPLASTICS

Fibres

• A fibre was obtained by chemical treatment of wood pulp. This fibre was called rayon or artificial silk.

• Nylon is another man-made fibre. In 1931, it was made without using any natural raw material (from plant or

animal). It was prepared from coal, water and air. It was the first fully synthetic fibre.

• Polyester is another synthetic fibre. Fabric made from this fibre does not get wrinkled easily. It remains crisp
and is easy to wash. So, it is quite suitable for making dress material.

• Terylene is a popular polyester. It can be drawn into very fine fibres that can be woven like any other yarn.

• PET is a very familiar form of polyester. It is used for making bottles, utensils, films, wires and many other
useful products. sweaters and use shawls or blankets in the winter.

• Many of these are actually not made from natural wool, though they appear to resemble wool.

• These are prepared from another type of synthetic fibre called acrylic. Such plastic which gets deformed
easily on heating and can be given different shapes.

Plastics

• While natural fibres are obtained from plants and animals, synthetic fibres are obtained by chemical processing
of petrochemicals. Like natural fibres, these fibres can also be woven into fabrics.

• Today if we think of storing a food item, water, milk, pickles, dry food, etc., plastic containers seem most
convenient. This is because of their light weight, lower price, good strength and easy handling.

• Being lighter as compared to metals, plastics are used in cars, aircrafts and spacecrafts, too. The list is endless
if we start counting articles like slippers, furniture and decoration pieces, etc.
• Today, life without plastics cannot be imagined. Be it home, or outside, plastic is every where. Characteristic properties of plastics
Plastic is non-reactive
• The metals like iron get rusted when left exposed to moisture and air. But plastics do not react with water and
air. They are not corroded easily. That is why they are used to store various kinds of material, including many
chemicals.
Plastic is light, strong and durable
• Plastic is very light, strong, durable and can be moulded into different shapes and sizes, it is used for various
purposes.
• Plastics are generally cheaper than metals. They are widely used in industry and for household articles. Important points
• The plastics which can be bent easily are known as thermoplastics. On the other hand, there are some plastics
which when moulded once, cannot be softened by heating. These are called thermosetting plastics. Two
examples are Bakelite and Melamine.
• Melamine is a versatile material. It resists fire and can tolerate heat better than other plastics. It is used for
making floor tiles, kitchenware and fabrics which resist fire.
• Therefore we need to use synthetic fibres and plastics in such a manner that we can enjoy their good qualities
and at the same time minimise the environmental hazards for the living communities.
• Synthetic fibres and plastics, like natural fibres, are made of very large units called polymers. Polymers are
made up of many smaller units.

• Synthetic fibres find uses ranging from many household articles like ropes, buckets, furniture, containers, etc. to highly specialized uses in aircrafts, ships, spacecrafts, healthcare, etc.
• Depending upon the types of chemicals used for manufacturing synthetic fibres, they are named as Rayon, Nylon, Polyester and Acrylic.
• The different types of fibres differ from one another in their strength, water absorbing capacity, nature of burning, cost, durability, etc.
•
Amaterialwhichgetsdecomposedthroughnaturalprocesses,suchasactionbybacte
• A material which is not easily decomposed by natural processes is termed as non-biodegradable. The plastics are non-biodegradable. The waste created by plastics is not environment friendly. On burning plastics release poisonous gases. On dumping in the ground they may take years to degenerate. This is because of their nonbiodegradable nature.

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INSIGHT GENERAL STUDIES

TOPIC

4

METALSANDNON-METALS

Characteristic properties of metals and non-metals

• Elements can be classified as metals and non-metals. Metals and non-metals are used widely in every day life. Metals occur in nature as free elements or in the form of their compounds. The extraction of metals from their ores and then refining them for use is known as metallurgy.

• Generally, metals are good conductors of heat and electricity but non-metals are poor conductors. The best conductors of heat are silver and copper. Lead and mercury are comparatively poor conductors of heat and electricity.

• Metals are solids at room temperature, except mercury which is a liquid.

• Generally, metals are malleable and ductile. Non-metals do not have these properties. The property of metals by which they can be beaten into thin sheets is called malleability. The property of metal by which it can be drawn into wires is called ductility. A wire of about 2 km length can be drawn from one gram of gold. gold and silver are the most malleable and ductile metals.

• Metals are lustrous whereas non-metals have no lustre. Iodine is a non-metal but it is lustrous.

• Non-metals have properties opposite to that of metals. They are neither malleable nor ductile. They are bad conductors of heat and electricity, except for graphite, which conducts electricity. Non-metals form negatively charged ions by gaining electrons when reacting with metals.

• Non-metals form oxides which are either acidic or neutral. Non-metals do not displace hydrogen from dilute acids. They react with hydrogen to form hydrides.

• The metals are generally hard. Alkali metals (lithium, sodium, potassium) are so soft that they can be cut.

• The non-metals are either solids or gases except bromine which is a liquid.

• On burning, metals react with oxygen to produce metal oxides which are basic in nature. Non-metals react with oxygen to produce non- metallic oxides which are acidic in nature.

• Some metals react with water to produce metal hydroxides and hydrogen

gas. Generally, non-metals do not react with water.
• Metals can form positive ions by losing electrons to non-metals.
• Metals combine with oxygen to form basic oxides. Aluminium oxide and zinc oxide show the properties of both basic as well as acidic oxides. These oxides are known as Amphoteric oxides.
• Different metals have different reactivities with water and dilute acids.
• Metals react with acids and produce metal salts and hydrogen gas. Generally, non-metals do not react with acids. Hydrogen gas is not evolved when a metal reacts with nitric acid. It is because $HNO_3$is a strong oxidising agent. It oxidises the H_2produced to water and itself gets reduced to any of the nitrogen oxides (N_2O, NO, NO_2). But magnesium (Mg) and manganese (Mn) react with very dilute $HNO_3$to evolve H_2gas.
• Some metals react with bases to produce hydrogen gas.
• More reactive metals displace less reactive metals from their compounds in aqueous solutions. Some metals are very reactive. Metals such as potassium and sodium react so vigorously that they catch fire if kept in the open. Hence, to protect them and to prevent accidental fires, they are kept immersed in kerosene oil.
• A list of common metals arranged in order of their decreasing reactivity is known as an activity series. A more reactive metal displaces a less reactive metal from its salt solution.

• At ordinary temperature, the surfaces of metals such as magnesium, aluminium, zinc, lead, etc., are covered with a thin layer of oxide. The protective oxide layer prevents the metal from further oxidation.
• All metals except mercury exist as solids at room temperature. Generally the metals have high melting points but gallium and caesium have very low melting points. These two metals will melt if you keep them on your palm.
• All living structures are carbon based.
• Iron does not burn on heating but iron filings burn vigorously when sprinkled in the flame of the burner. Copper does not burn, but the hot metal is coated with a black coloured layer of copper(II) oxide. Silver and gold do not react with oxygen even at high temperatures.
• Anodising is a process of forming a thick oxide layer of aluminium. Aluminium develops a thin oxide layer when exposed to air. This aluminium oxide coat makes it resistant to further corrosion. The resistance can be improved further by making the oxide layer thicker.
• During anodising, a clean aluminium article is made the anode and is electrolysed with dilute sulphuric acid. The oxygen gas evolved at the anode reacts with aluminium to make a thicker protective oxide layer. This oxide layer can be dyed easily to give aluminium articles an attractive finish.
• Aqua regia, (Latin for ‘royal water’) is a freshly prepared mixture of concentrated hydrochloric acid and concentrated nitric acid in the ratio of 3:1. It can dissolve gold, even though neither of these acids can do so alone. Aqua regia is a highly corrosive, fuming liquid. It is one of the few reagents that is able to dissolve gold and platinum.
• Silver articles become black after some time when exposed to air. This is because it reacts with sulphur in the air to form a coating of silver sulphide.
• Copper reacts with moist carbon dioxide in the air and slowly loses its shiny brown surface and gains a green coat. This green substance is copper carbonate.
• Iron when exposed to moist air for a long time acquires a coating of a brown flaky substance called rust.

Prevention of Corrosion of Metals

• The surface of some metals, such as iron, is corroded when they are exposed to moist air for a long period of time. This phenomenon is known as corrosion.

- The rusting of iron can be prevented by painting, oiling, greasing, galvanising, chrome plating, anodising or making alloys.
- Galvanisation is a method of protecting steel and iron from rusting by coating them with a thin layer of zinc. The galvanised article is protected against rusting even if the zinc coating is broken.

Alloys

- An alloy is a homogeneous mixture of two or more metals, or a metal and a non-metal. It is prepared by first melting the primary metal, and then, dissolving the other elements in it in definite proportions. It is then cooled to room temperature.
- Alloying is a very good method of improving the properties of a metal. We can get the desired properties by this method.
- For example, iron is the most widely used metal. But it is never used in its pure state. This is because pure iron is very soft and stretches easily when hot. But, if it is mixed with a small amount of carbon (about 0.05 %), it becomes hard and strong.
- When iron is mixed with nickel and chromium, we get stainless steel, which is hard and does not rust. Thus, if iron is mixed with some other substance, its properties change. In fact, the properties of any metal can be changed if it is mixed with some other substance. The substance added may be a metal or a non-metal.
- Pure gold, known as 24 carat gold, is very soft. It is, therefore, not suitable for making jewellery. It is alloyed with either silver or copper to make it hard. Generally, in India, 22 carat gold is used for making ornaments. It means that 22 parts of pure gold is alloyed with 2 parts of either copper or silver.
- If one of the metals is mercury, then the alloy is known as an Amalgam.

• The electrical conductivity and melting point of an alloy is less than that of pure metals. For example, brass, an alloy ofcopperand zinc (Cuand Zn), and bronze,an alloy ofcopper and tin(Cuand Sn), are notgood conductors of electricity whereas copper is used for making electrical circuits.
• Solder, an alloy of lead and tin (Pb and Sn), has a low melting point and is used for welding electrical wires together.

Organic chemistry
• The earth's crust has only 0.02% carbon in the form of minerals (like carbonates, hydrogen-carbonates, coal and petroleum) and the atmosphere has 0.03% of carbon dioxide. In spite of this small amount of carbon available in nature, the importance of carbon seems to be immense.
• Carbon is a non-metal that can exist in different forms. Each form is called an allotrope. Diamond, an allotrope of carbon, is the hardest natural substance known and has a very high melting and boiling point. Graphite, another allotrope of carbon, is a conductor of electricity.
• Organic chemistry is a sub-discipline within chemistry involving the scientific study of the structure, properties, composition, reactions, and preparation (by synthesis or by other means) of carbon-based compounds, hydrocarbons, and their derivatives.
• The Valencies of all the atoms are satisfied by single bonds between them. Such carbon compounds are called saturated compounds. These compounds are normally not very reactive.
• Such compounds of carbon having double or triple bonds betweenthe carbon atoms are known as unsaturated carbon compounds and they are more reactive than the saturated carbon compounds.
• Initially it was believed that the organic compounds are natural in character but Friedrich Wöhler disproved this in 1828 by preparing Urea (NH_4CONH_2) from Ammonium Cyanate.
• Urea (NH_4CONH_2) was the first artificial organic compound.
Important points
• Rhodium is the rarest metal.

• Osmium is the densest metal.
• Mercury is the only metal which is liquid at room temperature. It is very poisonous and affects mentalhealth.
• Helium has the lowest boiling point than any other element.
• Fluorine is often added to toothpaste in the form of fluoride ions.
• Both fluorine and chlorine are added to water supplies; for their germicidal properties.
• Cesium is used in atomic clocks.
• Pure silicon is a semi—conductor and is used in electronic devices as the base for minute integrated circuits (ICs).
• Diamond (carbon) is the hardest natural substance.
• The most abundant gas in atmosphere is nitrogen.
• Fluorine is the most electronegative element.
• Chlorine has the maximum electron affinity.
• Helium has the maximum ionization -potential.
• Cesium or Francium has the lowest ionization potential.
• Aluminium is the most abundant element.
• Helium and Francium are smallest and largest atoms respectively.
• Boron has the lowest atomic volume.
• Silver is the best conductor of electricity.
• Aluminium is the most abundant metal.
• Lithium is the lightest metal. its density is 0.54 g cm^{-3}
• Iron is the most abundant transition metal.

• Oxygen is the most abundant element on the earth.

• $H^-$and I^-ions are the smallest and largest anions respectively.
• H+ and Cs^+ions are the smallest and largest anions respectively.
• Caesium is the most electropositive element.
• Hydrogen is the most abundant element in the universe.
• This large variety of compounds is formed by carbon because of its tetravalency and the property of catenation that it exhibits.
• Covalent bonds are formed by the sharing of electrons between two atoms so that both can achieve a completely filled outermost shell.
• Carbon forms covalent bonds with itself and other elements such as hydrogen, oxygen, sulphur, nitrogen and chlorine.
• Carbon also forms compounds containing double and triple bonds between carbon atoms. These carbon chains may be in the form of straight chains, branched chains or rings.
• The ability of carbon to form chains gives rise to a homologous series of compounds in which the same functional group is attached to carbon chains of different lengths.
•
Thefunctionalgroupssuchasalcohols,aldehydes,ketonesandcarboxylicacidsbest to the carbon compounds that contain them.
• Carbon and its compounds are some of our major sources of fuels.
• Ethanol and ethanoic acid are carbon compounds of importance in our daily lives.
• The action of soaps and detergents is based on the presence of both hydrophobic and hydrophilic groups in the molecule and this helps to emulsify the oily dirt and hence its removal.

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INSIGHT GENERAL STUDIES

TOPIC

5 SOLUTIONS,MIXTURE ANDCOMPOUNDS

Elements or Compounds
• Pure substances can be elements or compounds.
• An element is a form of matter that cannot be broken down by chemical reactions into simpler substances.
• Robert Boyle was the first scientist to use the term element in 1661.
• Antoine Laurent Lavoisier (1743-94), a French chemist, wasthe first to establish an experimentally useful

definition of an element. He defined an element as a basic form of matter that cannot be broken down into simpler substances by chemical reactions.
• Elements can be normally divided into metals, non-metals and metalloids.
• A compound is a substance composed of two or more different types of elements, chemically combined in a fixed proportion.
Mixture
• A mixture contains more than one substance (element and/or compound) mixed in any proportion.
• Mixtures can be separated into pure substances using appropriate separation techniques.
• Properties of a compound are different from its constituent elements, whereas a mixture shows the properties of its constituting elements or compounds.
Solution
• A solution is a homogeneous mixture of two or more substances.
• The major component of a solution is called the solvent, and the minor, the solute.
• The concentration of a solution is the amount of solute present per unit volume or per unit mass of the solution/solvent.
• Examples : Lemonade, soda water etc. are all examples of solutions.
• Usually we think of a solution as a liquid that contains either a solid, liquid or a gas dissolved in it. But, we can also have solid solutions (alloys) and gaseous solutions (air).

• In a solution there is homogeneity at the particle level. For example, lemonade tastes the same throughout. This shows that particles of sugar or salt are evenly distributed in the solution.
• A solution of sugar in water is a solid in liquid solution. In this solution, sugar is the solute and water is the solvent.
• A solution of iodine in alcohol known as 'tincture of iodine', has iodine (solid) as the solute and alcohol (liquid) as the solvent.
• Aerated drinks like soda water etc., are gas in liquid solutions. These contain carbon dioxide (gas) as solute and water (liquid) as solvent.
• Air is a mixture of gas in gas. Air is a homogeneous mixture of a number of gases. Its two main constituents are: oxygen (21%) and nitrogen (78%). The other gases are present in very small quantities.

Properties of a solution

• A solution is a homogeneous mixture.
• The particles of a solution are smaller than 1 nm (10^{-9}metre) in diameter. So, they cannot be seen by naked eyes.

• Because of very small particle size, they do not scatter a beam of light passing through the solution. So, the path of light is not visible in a solution.
• The solute particles cannot be separated from the mixture by the process of filtration. The solute particles do not settle down when left undisturbed, that is, a solution is stable.

Suspension

• Non-homogeneous systems in which solids are dispersed in liquids, are called suspensions. A suspension is a heterogeneous mixture in which the solute particles do not dissolve but remain suspended throughout the bulk of the medium. Particles of a suspension are visible to the naked eye.
• The particles of a suspension scatter a beam of light passing through it and make its path visible. The solute particles settle down when a suspension is left undisturbed, that is, a suspension is unstable. They can be separated from the mixture by the process of filtration.

Saturated Solution

• After adding a few spoons of salt, when some salt remains undissolved and settles at the bottom of the beaker this indicates that no more salt can be dissolved in the amount of water we have taken. The solution is now said to be saturated.
• A saturated solution is one in which no more of that substance can be dissolved.
• More of a substance can be dissolved in a solution by heating it.
• Water dissolves different amount of soluble substances in it.

Alloys

• Alloys are homogeneous mixtures of metals and cannot be separated into their components by physical methods. But still, an alloy is considered as a mixture because it shows the properties of its constituents and can have variable composition.
• For example, brass is a mixture of approximately 30% zinc and 70% copper.

Colloids/Colloidal Solution

• Colloids are heterogeneous mixtures in which the particle size is too small to be seen with the naked eye, but is big enough to scatter light.

• The components of a colloidal solution are the dispersed phase and the dispersion medium. The solute-like component or the dispersed particles in a colloid form the dispersed phase, and the component in which the dispersed phase is suspended is known as the dispersing medium. Colloids are classified according to the state (solid, liquid or gas) of the dispersing medium and the dispersed phase.
• The size of particles of a colloid is too small to be individually seen by naked eyes. Colloids are big enough to scatter a beam of light passing through it and make its path visible. They do not settle down when left undisturbed, that is, a colloid is quite stable.
• They cannot be separated from the mixture by the process of filtration. But, a special technique of separation known as centrifugation, can be used to separate the colloidal particles.
• Tyndall effect is the result of a colloidal solution. It can be observed when sunlight passes through the canopy of a dense forest. In the forest, mist contains tiny droplets of water, which act as particles of colloid dispersed in air.
• Tyndall effect can also be observed when a fine beam of light enters a room through a small hole. This happens due to the scattering of light by the particles of dust and smoke in the air. The particles of a colloid are uniformly spread throughout the solution. Due to the relatively smaller size of particles, as compared to that of a suspension, the mixture appears to be homogeneous. But actually, a colloidal solution is a heterogeneous mixture, for example, milk.
• Colloids are useful in industry and daily life. The particles are called the dispersed phase and the medium in which they are distributed is called the dispersion medium.
•

Common examples of colloids

Dispersed Dispersing Type Phase Medium
Liquid Gas Aerosol Solid Gas Aerosol Gas Liquid Foam Liquid Liquid Emulsion Solid Liquid Sol Gas Solid Foam Liquid Solid Gel Solid Solid Solid Sol

Separation of Mixtures and Compounds
Example

Fog, clouds, mist
Smoke, automobile exhaust Shaving cream
Milk, face cream
Milk of magnesia, mud
Foam, rubber, sponge, pumice Jelly, cheese, butter
Coloured gemstone, milky glass

• Most of the natural substances are not chemically pure. Different methods of separation are used to get individual components from a mixture. Separation makes it possible to study and use the individual components of a mixture.
• Heterogeneous mixtures can be separated into their respective constituents by simple physical methods like handpicking, sieving, filtration that we use in our day-to-day life.
• Sometimes special techniques have to be used for the separation of the components of a mixture.

Handpicking and Winnowing

• Husk and stones could be separated from grains by handpicking. Husk is separated from heavier seeds of grain by winnowing.
• Difference in the size of particles in a mixture is utilised to separate them by the process of sieving and filtration.

• Filtration can be used to separate components of a mixture of an insoluble solid and a liquid.

Sedimentation and Decantation

• In a mixture of sand and water, the heavier sand particles settle down at the bottom and the water can be separated by sedimentation or decantation.

• Sometimes, it may not be possible to separate components of a mixture by winnowing and handpicking. For example, there may be lighter impurities like dust or soil particles in rice or pulses. How are such impurities separated from rice or pulses before cooking? Rice or pulses are usually washed before cooking. When you add water to these, the impurities like dust and soil particles get separated. These impurities go into water, which becomes a little muddy.

• Whenthe heavier component ina mixturesettles afterwater is addedto it, theprocess is called sedimentation.

• When the water (along with the dust) is removed, the process is called decantation.

• The same principle is used for separating a mixture of two liquids that do not mix with each other. For example, oil and water from their mixture can be separated by this process. If a mixture of such liquids is allowed to stand for some time, they form two separate layers. The component that forms the top layer can then be separated by decantation.

Filtration

• This process of filtration is used to separate a mixture of a solid and liquid. This method is used to separate tea leaves from prepared tea.

Evaporation

• Evaporation is the process in which a liquid gets converted into its vapour. Evaporation can be used to separate a solid dissolved in a liquid.

• This method is used in the separation/removal of insoluble impurities like soil/salt from the water. The process of evaporation takes place continuously wherever water is present.
• Sea water contains many salts mixed in it. One of these salts is the common salt. When sea water is allowed to stand in shallow pits, water gets heated by sunlight and slowly turns into water vapour, through evaporation. In a few days, the water evaporates completely leaving behind the solid salts. Common salt is then obtained from this mixture of salts by further purification.

Condensation

• When the steam comes in contact with the metal plate cooled with ice, it condenses and forms liquid water. The water drops that you observed falling from the plate, were due to condensation of steam. The process of conversion of water vapour into its liquid form is called condensation.

Crystallisation

• The crystallisation method is used to purify solids. For example, the salt we get from sea water can have many impurities in it. To remove these impurities, the process of crystallisation is used.
• Crystallisation is a process that separates a pure solid in the form of its crystals from a solution. Crystallisation technique is better than simple evaporation technique as some solids decompose or some, like sugar, may get charred on heating to dryness and at times some impurities may remain dissolved in the solution even after filtration. On evaporation these contaminate the solid.

Applications

• Purification of salt that we get from sea water.
• Separation of crystals of alum (phitkari) from impure samples.

Centrifugation

• Sometimes the solid particles in a liquid are very small and pass through a filter paper. For such particles the filtration technique cannot be used for separation.
• Such mixtures are separated by centrifugation. The principle is that the denser particles are forced to the bottom and the lighter particles stay at the

top when spun rapidly.
• The centrifugation is used in diagnostic laboratories for blood and urine tests, in dairies and home to separate butter from cream and in washing machines to squeeze out water from wet clothes.
Chromatography
• This process of separation of components of a mixture is known as chromatography. Kroma in Greek means colour. This technique was first used for separation of colours, so this name was given.
• Chromatography is the technique used for separation of those solutes that dissolve in the same solvent.
• With the advancement in technology, newer techniques of chromatography have been developed.
Applications
• To separate colours in a dye
• To separate pigments from natural colours
• To separate drugs from blood.
Distillation and fractional distillation
• The method of distillation is used to separate the component parts of those mixtures where there is considerable difference in the boiling points of the component parts.
• Distillation is used for the separation of components of a mixture containing two miscible liquids that boil without decomposition and have sufficient difference in their boiling points.
• Fractional distillation is the separation of a mixture into its component parts, or fractions, such as in separating chemical compounds by their boiling point by heating them to a temperature at which several fractions of the compound will evaporate.
• It is a special type of distillation. Generally the component parts boil at less than 25 °C from each other under a pressure of one atmosphere (atm).

- If the difference in boiling points is greater than 25 °C, a simple distillation is used.
- Fractional distillation is used in the purification of petroleum.

Air is a homogeneous mixture and can be separated into its components by fractional distillation.

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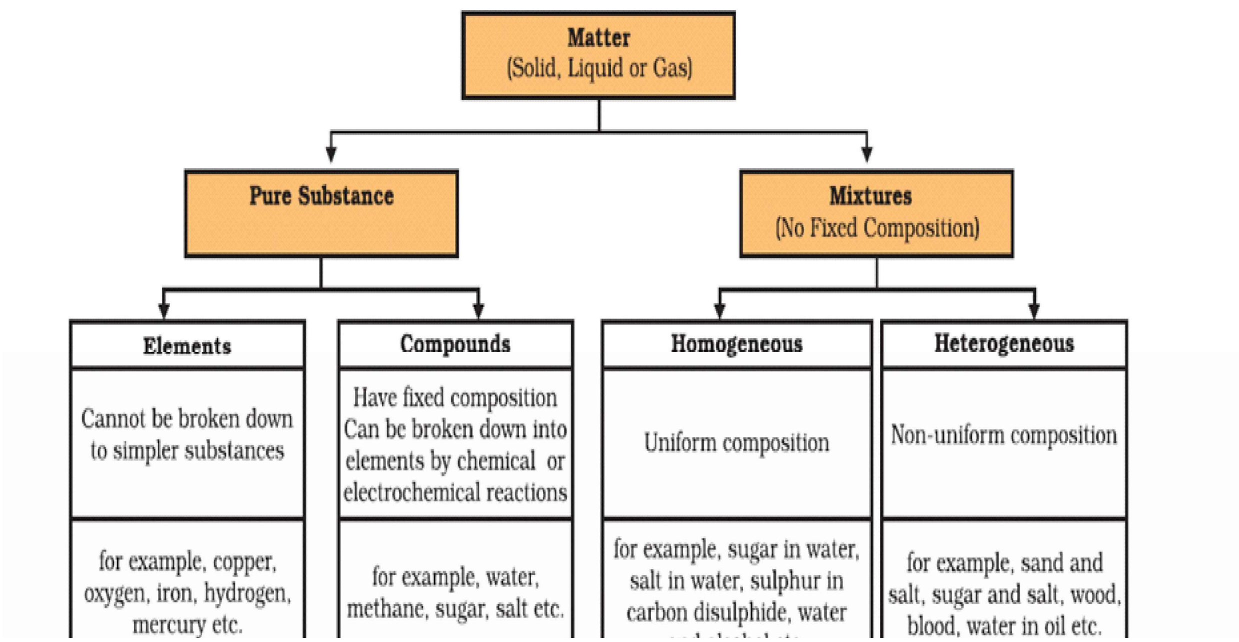

		and alcohol etc.	

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INSIGHT GENERAL STUDIES

TOPIC

6

PERIODICTABLE

• Elements are classified on the basis of similarities in their properties.
• 1817, Johann Wolfgang Döbereiner, a German chemist, tried to arrange the elements with similar properties into groups. He identified some groups having three elements each. So he called these groups ‘triads’.
• In 1866, John Newlands, an English scientist, arranged the then known elements in the order of increasing atomic masses. He started with the element having the lowest atomic mass (hydrogen) and ended at thorium which was the 56^{th}element. He found that every eighth element had properties similar to that of the first. He compared this to the octaves found in music. Therefore, he called it the ‘Law of Octaves’. It is known as ‘Newlands’ Law of Octaves’.
• Mendeléev formulated a Periodic Law, which states that ‘the properties of elements are the periodic function oftheiratomicmasses’.ModernPeriodicTableandtheModernPeriodicLawcanbes of elements are a periodic function of their atomic number.’
• Mendeleev arranged the elements in increasing order of their atomic masses and according to their chemical properties.
• Mendeleev even predicted the existence of some yet to be discovered elements on the basis of gaps in his Periodic Table.
• Anomalies in arrangement of elements based on increasing atomic mass could be removed when the elements were arranged in order of increasing atomic number, a fundamental property of the element discovered by Moseley.
• Elements in the Modern Periodic Table are arranged in 18 vertical columns called groups and 7 horizontal rows called periods.
• Elements thus arranged show periodicity of properties including atomic size, Valency or combining capacity and metallic and non-metallic character.
• The Valency of an element is determined by the number of valence electrons present in the outermost shell of its atom.

INSIGHT GENERAL STUDIES

TOPIC

7

ACIDANDBASE

Acid

• An acid can be identified as tasting sour, reacting with metals such as calcium, and bases like sodium carbonate. Aqueous acids have a pH ofless than7(anacid of lower pH is typically stronger), and turn blue litmus paper red. Chemicals or substances having the property of an acid are said to be acidic.

• Common examples of acids include acetic acid (in vinegar), sulfuric acid (used in car batteries), and tartaric acid (used in baking). As these three examples show, acids can be solutions, liquids, or solids. Gases such as hydrogen chloride can be acids as well.

• There are three common definitions for acids: the Arrhenius definition, the Brønsted-Lowry definition, and the Lewis definition.

• The reason why pHs of acids are less than 7 i.e. between 0 to 7.

• Some common acids:

Name of acid
Acetic acid
Formic/Methanoic acid Citric acid
Lactic acid
Oxalic acid
Ascorbic acid
Tartaric acid

All the acids mentioned above occur in nature Base
Found in
Vinegar
Ant’s sting, Nettle sting
Citrus fruits such as oranges, lemons, etc. Curd
Spinach
Amla, Citrus fruits (Vitamin C)

Tamarind, grapes, unripe mangoes, etc.

• A base is a chemical species that donates electrons or hydroxide ions or that accepts protons.
• A base is thought of as any chemical compound that yields hydroxide ions (OH^-) in solution. It is also commonly referred to as any substance that can react with an acid to decrease or neutralize its acidic properties, change the color of indicators (e.g. turn red litmus paper blue), feel slippery to the touch when in solution, taste bitter, react with acids to form salts, and promote certain chemical reactions (e.g. base catalysis).
• Example of simple bases are sodium hydroxide and ammonia. Sodium hydroxide (NaOH), also known as caustic soda or lye, dissociates in water to form hydroxide ions (OH^-) and sodium ions (Na^+).
• Bases have many practical uses, and several of them are commonly found in the home. Household ammonia is a familiar cleaning agent. Lye is used for cleaning clogs and sink drains. Potassium hydroxide, also called caustic potash, is used to make soft soap that dissolves in water with ease. Magnesium hydroxide in water (also called milk of magnesia) is used as an antacid or laxative.
•

Some common acids:

Name of Base
Calcium hydroxide Ammonium hydroxide Sodium hydroxide/ Soap
Magnesium hydroxide

Plants and animals are pH sensitive Found in
Lime water
Window cleaner
Potassium hydroxide Milk of magnesia

• Our body works within the pH range of 7.0 to 7.8. Living organisms can survive only in a narrow range of pH change. When pH of rain water is less than 5.6, it is called acid rain. When acid rain flows into the rivers, it lowers the pH of the river water. The survival of aquatic life in such rivers becomes difficult.

pH in our digestive system
• It is very interesting to note that our stomach produces hydrochloric acid. It helps in the digestion of food without harming the stomach. During indigestion the stomach produces too much acid and this causes pain and irritation.
• To get rid of this pain, people use bases called antacids.
• These antacids neutralise the excess acid. Magnesium hydroxide (Milk of magnesia), a mild base, is often used for this purpose.
pH change as the cause of tooth decay
• Tooth decay starts when the pH of the mouth is lower than 5.5. Tooth enamel, made up of calcium phosphate is the hardest substance in the body. It does not dissolve in water, but is corroded when the pH in the mouth is below 5.5. Bacteria present in the mouth produce acids by degradation of sugar and food particles remaining in the mouth after eating.
• The best way to prevent this is to clean the mouth after eating food. Using toothpastes, which are generally basic, for cleaning the teeth can neutralise

the excess acid and prevent tooth decay.
Self defence by animals and plants through chemical warfare

- Bee-sting leaves an acid which causes pain and irritation. Use of a mild base like baking soda on the stung area gives relief.
- Stinging hair of nettle leaves inject Ethanoic acid causing burning pain.

Important points

- Solutions of substances that show different colour in acidic, basic and neutral solutions are called indicators. The most commonly used natural indicator is litmus.
- Litmus solution is a purple dye, which is extracted from lichen, a plant belonging to the division Thallophyta, and is commonly used as an indicator. When the litmus solution is neither acidic nor basic, its colour is purple.
- There are many other natural materials like red cabbage leaves, turmeric, coloured petals of some flowers such as Hydrangea, Petunia and Geranium, which indicate the presence of acid or base in a solution. These are called acid-base indicators or sometimes simply indicators. hydrogen seems to be common to all acids.
- Acid turns blue litmus red. Bases turn red litmus blue.
- Substances which are neither acidic nor basic are called neutral.
- An acid and a base neutralise each other and form a salt. A salt may be acidic, basic or neutral in nature.
- All bases do not dissolve in water. An alkali is a base that dissolves in water. They are soapy to touch, bitter and corrosive. Never taste or touch them as they may cause harm.
- A scale for measuring hydrogen ion concentration in a solution, called pH scale has been developed. The p in pH stands for ‘potenz’ in German, meaning power. On the pH scale we can measure pH from 0 (very acidic) to 14 (very alkaline). pH should be thought of simply as a number which indicates the acidic or basic nature of a solution.

• Higher the hydronium ion concentration, lower is the pH value. The pH of a neutral solution is 7. Values less than 7 on the pH scale represent an acidic solution.

• As the pH value increases from 7 to 14, it represents an increase in OH^-ion concentration in the solution, that is, increase in the strength of alkali.

• Generally paper impregnated with the universal indicator is used for measuring pH.

• The rain becomes acidic because carbon dioxide, sulphur dioxide and nitrogen dioxide (which are released into the air as pollutants) dissolve in rain drops to form carbonic acid, sulphuric acid and nitric acid respectively. Acid rain can cause damage to buildings, historical monuments, plants and animals.Acids are sour in taste. Bases are bitter in taste and soapy to touch.

• Acidic nature of a substance is due to the formation of $H^+(aq)$ ions in solution. Formation of $OH^-(aq)$ ions in solution is responsible for the basic nature of a substance.

• When an acid reacts with a metal, hydrogen gas is evolved and a corresponding salt is formed.

• When a base reacts with a metal, along with the evolution of hydrogen gas a salt is formed which has a negative ion composed of the metal and oxygen.

• When an acid reacts with a metal carbonate or metal hydrogencarbonate, it gives the corresponding salt, carbon dioxide gas and water.

• Acidic and basic solutions in water conduct electricity because they produce hydrogen and hydroxide ions respectively. The strength of an acid or an alkali can be tested by using a scale called the pH scale (0-14) which gives the measure of hydrogen ion concentration in a solution.

• A neutral solution has a pH of exactly 7, while an acidic solution has a pH less than 7 and a basic solution a pH more than 7.

• Living beings carry out their metabolic activities within an optimal pH range.

• Mixing concentrated acids or bases with water is a highly exothermic process.

• Acids and bases neutralise each other to form corresponding salts and water.

• Water of crystallisation is the fixed number of water molecules chemically attached to each formula unit of a salt in its crystalline form.
• Salts have various uses in everyday life and in industries.

INSIGHT GENERAL STUDIES

TOPIC

8

CHEMICALREACTIONS

Chemical Equations

• A complete chemical equation represents the reactants, products and their physical states symbolically.

• A chemical equation is balanced so that the numbers of atoms of each type involved in a chemical reaction are

the same on the reactant and product sides of the equation. Equations must always be balanced. Combination Reaction

• In a combination reaction two or more substances combine to form a new single substance. Decomposition reactions

• Decomposition reactions are opposite to combination reactions. In a decomposition reaction, a single

substance decomposes to give two or more substances.

Exothermic Reactions

• Reactions in which heat is given out along with the products are called exothermic reactions. Endothermic Reactions

• Reactions in which energy is absorbed are known as endothermic reactions.

Displacement Reaction

• When an element displaces another element from its compound, a displacement reaction occurs. Double Displacement Reaction

• Two different atoms or groups of atoms (ions) are exchanged in double displacement reactions. Precipitation Reactions

• Precipitation reactions produce insoluble salts.

INSIGHT GENERAL STUDIES

TOPIC

9

OXIDATIONANDREDUCTION

Oxidation

• Oxidation is defined as the interaction between oxygen molecules and all the different substances they may contact, from metal to living tissue. Technically, however, with the discovery of electrons, oxidation came to be more precisely defined as the loss of at least one electronwhen two or more substances interact. Those substances may or may not include oxygen.

• Reactions also involve the gain or loss of oxygen or hydrogen by substances. Oxidation is the gain of oxygen or loss of hydrogen.

• When it involves oxygen, the process of oxidation depends on the amount of oxygen present in the air and the nature of the material it touches. True oxidation happens on a molecular level — we only see the largescale effects as the oxygen causes free radicals on the surface to break away. In the case of fresh fruit, the skin usually provides a barrier against oxidation. This is why most fruits and vegetables arrive in good condition at the grocery store. Once the skin has been broken, however, the individual cells come in direct contact with air andtheoxygenmoleculesstartburningthem.Theresultisaformofrustweseeasbrow blemishes.

• Oxidation can also be a problem for car owners, since the outermost layers of paint are constantly exposed to air and water. If the car's outer finish is not protected by a wax coating or polyurethane, the oxygen molecules in the air will eventually start interacting with the paint. As the oxygen burns up the free radicals contained in the paint, the finish becomes duller and duller. Restoration efforts may include removing several layers of affected paint and reapplying a new layer of protectant. This is why professional car detailers recommend at least one layer of wax or other protectant be used every time the car is washed.

• The secret of preventing oxidation caused by oxygen is to provide a layer of protection between the exposed material and the air. This could mean a wax or polyurethane coating on a car, a layer of paint on metal objects or a quick spray of an anti-oxidant, like lemon juice, on exposed fruit. Destructive oxidation cannot occur if the oxygen cannot penetrate a surface to reach the free radicals it craves.

- The stainlesssteel has a thin coating ofanother metal which does not contain free radicals. Thisis why stainless steel doesn't rust and ordinary steel does. Regular steel may be painted for protection against oxidation, but oxygen can still exploit any opening, no matter how small. This is why you may find a painted metal bicycle still damaged by rust.
- Sometimes oxidation is not such a bad thing, as in the formation of super-durable anodized aluminium. Other times, oxidation can be destructive, such as the rusting of an automobile or the spoiling of fresh fruit.
- A freshly-cut apple turns brown, a bicycle fender becomes rusty and a copper penny suddenly turns green due to oxidation.

Oxidation number

- The oxidation number (step) of an element is a convenient way to keep track of electron transfer.
- It defines the number of electrons that are lost or gained by an element.

Reduction

- The opposite of oxidation is reduction. It results in the addition of at least one electron when substances come into contact with each other.
- Reduction is the loss of oxygen or gain of hydrogen.

INSIGHT GENERAL STUDIES

$$\text{Oxidant} + e^- \xrightarrow{\text{Reduction}} \text{Product}$$

(Electrons gained; oxidation number decreases)

$$\text{Reductant} \xrightarrow{\text{Oxidation}} \text{Product} + e^-$$

(Electrons lost; oxidation number increases)

Redox Reaction

• Redox (shorthand for REDuction-OXidation) reactions describe all chemical reactions in which atoms have their oxidation number (oxidation state) changed.
• This can be either a simple redox process, such as the oxidation of carbon to yield carbon dioxide (CO_2) or the reduction of carbon by hydrogen to yield methane (CH_4), or a complex process such as the oxidation of sugar ($C_6H_{12}O_6$) in the human body through a series of complex electron transfer processes.
• Non-redox reactions, which do not involve changes in formal charge, are known as metathesis reactions.

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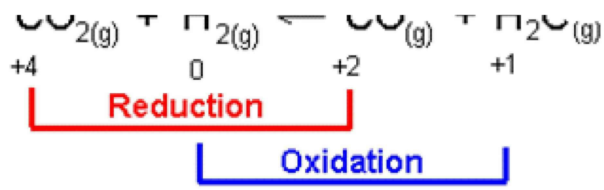

Effects of oxidation reactions in everyday life

Rusting

Effects of oxidation reactions in everyday life
Rusting

• The words oxidation and rust are often used interchangeably, but not all materials which interact with oxygen molecules actually disintegrate into rust.

• Iron articles are shiny when new, but get coated with a reddish brown powder when left for some time. This process is commonly known as rusting of iron.In the case of iron, the oxygen creates a slow burning process, which results in the brittle brown substance we call rust.

• When oxidation occurs in copper, on the other hand, the result is a greenish coating called copper oxide. The metal itself is not weakened by oxidation, but the surface develops a patina after years of exposure to air and water.

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Corrosion

Corrosion

• Some other metals also get tarnished in this manner. When a metal is attacked by substances around it such as moisture, acids, etc., it is said to corrode and this process is called corrosion. It is the result of oxidation reaction.

• The black coating on silver and the green coating on copper are other

examples of corrosion. Corrosion causes
damage to car bodies, bridges, iron railings, ships and to all objects made of metals, specially those of iron.
Corrosion of iron is a serious problem. It is the result of oxidation reaction.
Rancidity
• When fats and oils are oxidised, they become rancid and their smell and taste change. You can see it if you
taste or smell the fat/oil containing food materials left for a long time.
• Usually substances which prevent oxidation (antioxidants) are added to foods containing fats and oil. Keeping
food in air tight containers helps to slow down oxidation.
• The chips manufacturers usually flush bags of chips with gas such as nitrogen to prevent the chips from getting
oxidised.

INSIGHT GENERAL STUDIES

TOPIC

10

COMMONCHEMICALCOMPOUNDS

Bleaching powder

• Chlorine is produced during the electrolysis of aqueous sodium chloride (brine). This chlorine gas is used for the manufacture of bleaching powder.
• Bleaching powder is produced by the action of chlorine on dry slaked lime [Ca(OH)2].
• Bleaching powder is represented as $CaOCl_2$, though the actual composition is quite complex.
• The bleaching powder to on exposure to air is deteriorates and gives off chlorine.
Bleaching powder is used as
• For bleaching cotton and linen in the textile industry, for bleaching wood pulp in paper factories and for bleaching washed clothes in laundry;
• As an oxidising agent in many chemical industries; and
• For disinfecting drinking water to make it free of germs.
Bakingsoda
• The soda commonly used in the kitchen for making tasty crispy pakoras is baking soda. Sometimes it is added for faster cooking.
• The chemical name of the compound is sodium hydrogencarbonate (NaHCO3). It is produced using sodium chloride as one of the raw materials.
Uses of sodium hydrogencarbonate (NaHCO3)
• For making baking powder, which is a mixture of baking soda (sodium hydrogencarbonate) and a mild edible acid such as tartaric acid. Carbon dioxide produced during the reaction causes bread or cake to rise making them soft and spongy.
• Sodium hydrogencarbonate is also an ingredient in antacids. Being alkaline, it neutralises excess acid in the stomach and provides relief.
• It is also used in soda-acid fire extinguishers.
Washing soda
• Another chemical that can be obtained from sodium chloride is

$Na_2CO_3.10H_2O$ (washing soda).

• Re-crystallisation of sodium carbonate gives washing soda.

• Sodium carbonate (soda ash) is alkaline in nature and has detergent (cleaning) properties. In a crystalline state it possesses water of crystallization. On exposure to air, crystals lose water and lose into white opaque powder.

Uses of washing soda

• Sodium carbonate (washing soda) is used in glass, soap and paper industries.

• It is used in the manufacture of sodium compounds such as borax.

• Sodium carbonate can be used as a cleaning agent for domestic purposes.

• The action of giving up of water of crystallization to the atmosphere is termed as efflorescence.

• Sodium carbonate is used as a cleansing agent for domestic purposes.

• It is used for removing permanent hardness of water. It is also used in manufacturing of chemicals like borax, caustic soda, glass and water glass. It is a constituent of many dry soap powders.

Plaster of Paris

• It is a calcium sulphate hemihydrates ($CaSO_4.2H_2O$). It is prepared by heating gypsum ($CaSO_4.2H_2O$). $2(CaSO_4.\ 2H_2O)$ ——> $(CaSO_4)_2.H_2O + 3H_2O$
• Plaster of Paris is a white powder.
• It has a remarkable property of hardening when mixed with proper quantity of water, it changes to gypsum once again giving a hard solid mass.
• It is used in the laboratories for sealing the gaps, where sunlight arrangement is required. It is also used for making casts for statues, and in surgery to maintain joints in a fixed position.
Common Salt:
• Common salt is sodium chloride (NaCl). Common salt when kept open absorbs moisture from air. This is because of the presence of magnesium chloride in common salt. Magnesium chloride is deliquescent, that is, it absorbs water.
• Sodium chloride is a very important chemical, It is an essential ingredient in our daily meal. It can be convened into useful chemicals like caustic soda, washing soda and baking soda. It also yields hydrochloric acid, an important chemical used in chemical industry, and chlorine which is used as bleaching agent.
Caustic Soda :
• Chemically caustic soda is sodium hydroxide (NaOH). It is obtained by electrolysis of brine (NaCl solution).
• Sodium hydroxide is a deliquescent solid. On dissolving in water it gives a strong alkaline solution.
Washing Soda :
• Washing soda is sodium carbonate decahydrate $Na_2CO_3.10H_2O$.
$Na_2CO_3.10H_2O$ ——> $Na_2CO_3.H_2O + 9\ H_20$
Lime :
• Calcium oxide is commonly knows as quicklime or just lime. It is prepared by heating limestone ($CaCO_3$) in a kiln.

$CaCO_3$————> $CaO + CO_2$
• Calcium oxide reacts vigorously with water producing slaked lime [$Ca(OH)_2$] which is used for making mortar and for white washing.
• A solution of slaked lime is known as the lime water which is used for testing carbon dioxide. Calcium oxide is used for making cement and glass.
Important Chemical Compounds

Common Names
Ammonium
Aspirin
Battery acid or Oil of vitriol Blue vitriol
Baking soda
Bleaching powder
Borax

Butter of tin Caustic soda Caustic Potash Carbolic acid Chile saltpetre Chemical Names Chemical Formula Ammonium Aluminium Sulphate $(NH_4)_2SO_4$. Al_2. $(SO_4)_3$. $24H_2O$ Acetyl Salicyclic acid $C_9H_8O_4$
Sulphuric acid H_2SO_4
Copper Sulphate pentahydrate $CuSO_4$. $5H_2O$
Sodium bicarbonate $NaHCO_3$
Calcium hypochlorite $CaOCl_2$
Sodium tetraboratehydrated $Na_2B_4O_7$. 10 H_2O sodium borate
Stannice chloride pentahydrate $SnCl_4$. $5H_2O$
Sodium hydroxide NaOH
Potassium hydroxide KOH
Phenol C_6H_5OH
Sodium nitrate $NaNO_3$

Carborundurn
Corrosive sublimate Calomel
Dry ice
Formalin
Grain alcohol (Spirit) Green Vitriol
Gypsum
Gammexane (BHC) Hydrolith
Hypo (Antichlor) Indian nitre
Lime stone
Lunar caustic
Laughing gas
Litharge
Muratic acid
Mohr’s salt
Milk of magnesia Microcosmic salt

Marsh gas (Damp-tire) Oleum
Oxcne
Plaster of Paris
Philosopher’s wool
Phosgene
Pearl ash
Carbon Tet
Picric acid
Quick lime
Red lead (Minium)
Sugar
Slaked lime (Milk of lime) Sal ammoniac
Sugar of lead
Sand
Table salt (Common salt) TEL
Tear gas
Washing soda

Water glass
White Vitriol
Silicon carbide SiC
Mercuric chloride $HgCl_2$
Mercurous chloride Hg_2Cl_2
Carbon dioxide (Solid) CO_2
Formaldehyde (40% solution) $HCHO$
Ethyl alcohol C_2H_5OH
Ferrous sulphate $FeSO_4 . 7H_2O$ Calcium sulphate $CaSO_4 . 2H_2O$ Benzene hexachloride $C_6H_6Cl_6$
Calcium hydride CaH_2
Sodium thio sulphate $Na_2S_2O_3 . 5H_2O$ Potassium nitrate KNO_3
Calcium carbonate $CaCO_3$
Silver nitrate $AgNO_3$
Nitrous oxide N_2O
Lead monoxide PbO
Hydrochloric acid HCl
Ferrous ammonium sulphate $FeSO_4,(NH_4)_2SO_4.6H_2O$ Magnesium hydroxide $Mg(OH)_2$
Sodium ammonium hydrogen $Na(NH_4)HPO_4$ phosphate
Methane CH_4
Sulphuric acid (fuming) $H_2S_2O_7$
Potassium peroxomonosulphate $KHSO_5$
Calcium sulphate hemihydrate $CaSO_4 . 1/2\ H_20$ Zinc oxide ZnO
Carbonyl dichloride $COCI_2$
Potassium carbonate K_2CO_3
Carbon tetrachloride CCI_4
2 ; 4 ; 6 Trinitrophenol $C_6H_2(OH)(NO_2)_3$ Calcium oxide CaO
Lead tetroxide Pb_3O_4
Sucrose $C_{12}H_{22}O_{11}$
Calcium hydroxide $Ca(OH)_2$
Ammonium chloride NH_4Cl

Lead acetate $(CH_3COO)_2Pb$ Silicon dioxide, Silica SiO_2
Sodium chloride NaCl
Tetra-ethyl lead $Pb(C_2H_5)_4$
Chloropicrin CCl_3NO_2
Sodium carbonate $Na_2CO_3 . 10H_2O$ Sodium silicate Na_2SiO_3
Zinc Sulphate $ZnSO_4 . 7H_2O$

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INSIGHT GENERAL STUDIES

TOPIC

11

SOURCESOFENERGY

Inexhaustible Natural Resources

• These resources are present in unlimited quantity in nature and are not likely to be exhausted by human activities. Examples are: sunlight, air.
Exhaustible Natural Resources
• The amount of these resources in nature is limited. They can be exhausted by human activities Examples of these resources are forests, wildlife, minerals, coal, petroleum, natural gas etc About 300 million years ago the earth had dense forests in low lying wetland areas. Due to natural processes, like flooding, these forests got buried under the soil. As more soil deposited over them, they were compressed. The temperature also rose as they sank deeper and deeper.
• Under high pressure and high temperature, dead plants got slowly converted to coal. As coal contains mainly carbon, the slow process of conversion of dead vegetation into coal is called carbonisation. Since it was formed from the remains of vegetation, coal is also called a fossil fuel.
• Petroleum gas, petrol, diesel, kerosene, paraffin wax, lubricating oil are obtained by refining petroleum.
Formation of coal and petroleum
• Coal and petroleum have been formed from biomass which has been subjected to various biological and geological processes. Coal is the remains of trees, ferns, and other plants that lived millions of years ago. These were crushed into the earth, perhaps by earthquakes or volcanic eruptions. They were pressed down by layers of earth and rock. They slowly decayed into coal.
• Oil and gas are the remains of millions of tiny plants and animals that lived in the sea. When they died, their bodies sank to the sea bed and were covered by silt. Bacteria attacked the dead remains, turning them into oil and gas under the high pressures they were being subjected to. Meanwhile, the silt was slowly compressed into rock. The oil and gas seeped into the porous

parts of the rock, and got trapped like water in a sponge.
Coke
• It is a tough, porous and black substance. It is almost pure form of carbon.
• Coke is used in the manufacture of steel and in the extraction of many metals.
Coaltar
• It is a black, thick liquid with unpleasant smell. It is a mixture of about 200 substances. Products obtained from coal tar are used as starting materials for manufacturing various substances used in everyday life and in industry, like synthetic dyes, drugs, explosives, perfumes, plastics, paints, photographic materials, roofing materials, etc.
• Interestingly, naphthalene balls used to repel moths and other insects are also obtained from coal tar. These days, bitumen, a petroleum product, is used in place of coal-tar for metalling the roads.
Coal gas
• Coal gas is obtained during the processing of coal to get coke. It is used
Coal, petroleum and natural gas are fossil fuels.
Ignition Temperature
• The lowest temperature at which a substance catches fire is called its ignition temperature.
• The substances which have very low ignition temperature and can easily catch fire with a flame are called

inflammable substances. Examples of inflammable substances are petrol, alcohol, Liquified Petroleum Gas

(LPG), etc.
Rapid Combustion and Spontaneous Combustion
• There are various types of combustions such as rapid combustion, spontaneous combustion, explosion, etc.
• The substances which burn in air are called combustible.The gas burns rapidly and produces heat and light.

Such combustion is known as rapid combustion.
• There are substances like phosphorus which burn in air at room temperature. The type of combustion in
which a material suddenly bursts into flames, without the application of any apparent cause is called
spontaneous combustion.
• There are three different zones of a flame -dark zone, luminous zone and non-luminous zone.
• An ideal fuel is cheap, readily available, readily combustible and easy to transport. It has high calorific value.
It does not produce gases or residues that pollute the environment. Increased percentage of carbon dioxide
in air has been linked to global warming. Oxides of sulphur and nitrogen produced by the burning of coal,
diesel and petrol cause acid rain which is harmful for crops, buildings and soil.
Fuel Efficiency
• The amount of heat energy produced on complete combustion of 1 kg of a fuel is called its calorific value. The
calorific value of a fuel is expressed in a unit called kilojoule per kg (kJ/kg). It indicates the efficiency of the
fuel.
• Fuel efficiency is expressed in terms of its calorific value which is

expressed in units of kilojoule per kg.
• Fuels differ in their efficiency and cost. Unburnt carbon particles in air are dangerous pollutants causing
respiratory problems. Incomplete combustion of a fuel gives poisonous carbon monoxide gas. Matchstick
• The history of the matchstick is very old. More than five thousand years ago small pieces of pinewood dipped
in sulphur were used as matches in ancient Egypt.
• The modern safety match was developed only about two hundred years ago.
• A mixture of antimony trisulphide, potassium chlorate and white phosphorus with some glue and starch was
applied on the head of a matchmade of suitable wood. When struck against a roughsurface, white phosphorus
got ignited due to the heat of friction. This started the combustion of the match.
• However, white phosphorus proved to be dangerous both for the workers involved in the manufacturing of
matches and for the users. These days the head of the safety match contains only antimony trisulphide and
potassium chlorate.
• The rubbing surface has powdered glass and a little red phosphorus (which is much less dangerous). When the
match is struck against the rubbing surface, some red phosphorus gets converted into white phosphorus. This
immediately reacts with potassium chlorate in the matchstick head to produce enough heat to ignite antimony
trisulphide and start the combustion.
Fire Extinguisher
• Oxygen (in air) is essential for combustion.During the process of combustion, heat and light are given out.
• Fire can be controlled by removing one or more requirements essential for producing fire.Water is commonly
used to control fires. Water cannot be used to control fires involving electrical equipments or oils.
• The most common fire extinguisher is water. But water works only when things like wood and paper are on
fire.

• If electrical equipment is on fire, water may conduct electricity and harm those trying to douse the fire. For fires involving electrical equipment and inflammable materials like petrol, carbon dioxide (CO_2) is the best extinguisher. CO_2, being heavier than oxygen, covers the fire like a blanket. Since the contact between the fuel and oxygen is cut off, the fire is controlled. The added advantage of CO_2 is that in most cases it does not harm the electrical equipment. The carbon dioxide can be stored at high pressure as a liquid in cylinders.So, it not only forms a blanket around the fire, it also brings down the temperature of the fuel.

• Water is also not suitable for fires involving oil and petrol. water is heavier than oil, so, it sinks below the oil, and oil keeps burning on top.
• Another way to get CO_2 is to release a lot of dry powder of chemicals like sodium bicarbonate (baking soda) or potassium bicarbonate. Near the fire, these chemicals give off CO_2.

Negative of burning of fuel

• Burning of coal and diesel releases sulphur dioxide gas. It is an extremely suffocating and corrosive gas. Moreover, petrol engines give off gaseous oxides of nitrogen. Oxides of sulphur and nitrogen dissolve in rain water and form acids. Such rain is called acid rain. It is very harmful for crops, buildings and soil.
• The use of diesel and petrol as fuels in automobiles is being replaced by CNG (Compressed Natural Gas), because CNG produces the harmful products in very small amounts. CNG is a cleaner fuel.

Alcohols

How do alcohols affect living beings

• When large quantities of ethanol are consumed, it tends to slow metabolic processes and to depress the central nervous system. This results in lack of coordination, mental confusion, drowsiness, lowering of the normal inhibitions, and finally stupour. The individual may feel relaxed but does not realise that his sense of judgement, sense of timing, and muscular coordination have been seriously impaired. Unlike ethanol, intake of methanol in very small quantities can cause death. Methanol is oxidised to Methanal in the liver.
• Methanal reacts rapidly with the components of cells. It causes the protoplasm to get coagulated, in much the same way an egg is coagulated by cooking. Methanol also affects the optic nerve, causing blindness. Ethanol is an important industrial solvent. To prevent the misuse of ethanol produced for industrial use, it is made unfit for drinking by adding poisonous substances like methanol to it. Dyes are also added to colour the alcohol blue so that it can be identified easily. This is called denatured alcohol.

Alcohol as a fuel

• Sugarcane plants are one of the most efficient convertors of sunlight into chemical energy. Sugarcane juice can be used to prepare molasses which is fermented to give alcohol (ethanol). Some countries now use alcohol as an additive in petrol since it is a cleaner fuel which gives rise to only carbon dioxide and water on burning in sufficient air (oxygen).

• Ethanoic acid is commonly called acetic acid and belongs to a group of acids called carboxylic acids. 5-8% solution of acetic acid in water is called vinegar and is used widely as a preservativein pickles.

• The melting point of pure Ethanoic acid is 290 K and hence it often freezes during winter in cold climates. This gave rise to its name glacial acetic acid. Carbon is a versatile element that forms the basis for all living organisms and many of the things we use.

Application of nitrogen and nitrogen compounds

• Hydrazine (N_2H_4) is used as a rocket fuel in space shuttle, in guided missiles etc.

• Ammonia has been used as cooling liquid in refrigerators.

• Nitrous Oxide (N_2O) is often called as laughing gas, it is used as anesthetic by dentists.

• Covalent nitrates are less stable than ionic nitrates. Nitroglycerine, nitrocellulose, Trinitrotoluene (TNT) and fluorene nitrate are explosive.

Important Facts

Oil Gas

• It is a mixture of H_2, CH_4, C_2H_4, CO and other gases like CO_2, It is obtained by the thermal cracking of Kerosene oil. It is used in laboratories.

Gobar Gas

• It contains CH_4, $CO_2$and $H_2$and is produced by the fermentation of gobar in absence of air.

Natural Gas

• Natural gas is a mixture of gaseous hydrocarbons viz. methane (85%), ethane, propane, butane etc. Liquefied petroleum gas (LPG) is also a mixture gaseous hydrocarbons mainly butane and propane.

Natural diamond

• Natural diamond varies in size, colour and lustre. The cost of diamond depends upon its lustre, colour and size. The weight of diamond is measured in carats.
• One carat weighs 0.2054 gm.
• Cullinan, the largest diamond, weighed about 3026 carats. The following are some well known varieties of diamond.

Diamond	Weight in Carat
Cullinan	3026
Excelsier	97.2
Hope	44.6
Kohinoor	11.6

• Compound of carbon with elements nearly the same or lower electronegativity than itself (including hydrogen) are called carbides.
• Coal gas is a mixture of H_2, CH_4, CO and other gases like N_2, C_2H_4, CO_2etc. It is obtained by the destructive distillation of coal at about 1000°C.
• Acetone is used for making chloroform, artificial leather and a plastic called perspex.
Dilute Acetic Acid is called vinegar, used as food preservative.

INSIGHT GENERAL STUDIES

TOPIC

12

NUCLEARSCIENCE

Nuclear fission

• In 1939 two German scientists Otto Hahn and Fritz Strassman discovered a strange and new type of nuclear reaction.
• They found that when uranium nucleons ($_{92}U^{235}$) is bombarded with neutron the nucleus splits up into almost equal fragments with the release of some free neutrons and tremendous energy of about 200 MeV per$_{92}U^{235}$ nucleus Such a nuclear reaction is called nuclear fission.
• Thus the process (or nuclear reaction) in which a heavy nucleus splits up into two nuclei of nearly comparable masses with tremendous release of energy and some free neutrons is called nuclear fission.
• In the fission process of$_{92}U^{235}$slow neutrons participate and its products are not always barium and krypton, so many possible pair of fragments occur. The average number of neutrons which are released in uranium fission is 2.5.
Nuclear chain reaction
• As 2.5 neutrons are produced per fission of a uranium atom and these neutrons produced in nuclear fission under favourable circumstances cause further atoms of uranium to undergo fission and in turn emit more neutrons which will cause further fission explosion. Thus a chain reaction is established in a short time releasing enormous sum of energy.
• One gram of$_{22}U^{255}$evolves upon fission about 2×10^7kilo calorie of energy.
• The ratio of the rate of production of neutrons to the rate of their disappearance is called the reproduction factor (k).
• lf k is less than 1, the , chain reaction will not be sustained, at k = 1, the reaction will just be sustained and if k is greater than 1, the reaction will proceed vigorously.
Types of nuclear fission
• The fission chain reaction is of two types ; namely
Controlled chain reaction

• A fission chain reaction which proceeds slowly and in balanced way without any explosion and in which the energy released can be controlled is called controlled chain reaction.
• Nuclear reactors operate on this principle, which are the main sources of the nuclear power and in which controlled nuclear chain reaction takes place. In a nuclear reactor the energy released through fission is used to generate electricity Several nuclear power plants for the generation of electricity are operating in India and in the various countries of the world.
Uncontrolled or Explosive chain reaction
• A nuclear chain reaction in which fission neutrons keep on increasing until the whole of the fissionable material is consumed is known as explosive or uncontrolled chain reaction.
• Such a reaction proceeds very quickly with the liberation of huge amount of energy in a short time. An atom bomb works on this principle and it is a practical example of uncontrolled/explosive fission.
Nuclear Fusion
• When two or more light nuclei moving with very high speeds are fused together to form a single nucleus, then this process is called nuclear fusion. The mass of the product nucleus is less than the sum of the masses of the nuclei which are fused. The lost mass is converted into energy which is released in the form of fusion energy.

• The energy output in a fusion reaction is 24.6 MeV which is too much less than energy released in the fission of a U^{235}nucleus which is about 200 MeV. But this doesn‘t mean that fusion is a weaker energy source than fission. The number of deutrons (material or reactants of die fusion reaction) in 1 g of heavy hydrogen is much larger than the number of U^{235}nuclei in 1 gm of uranium. Thus the energy output per unit mass of the material consumed is much greater in the case of fusion of the light nuclei than in the case of the fission of heavy nuclei.
• The process responsible for solar energy is the fusion of light nuclei and here four hydrogen nuclei fuse together directly to form a helium nucleus.
• The fusion process is very difficult to carry out, as the nuclei to be fused are positively charged, so they would repel one another strongly. Hence they must be brought very close together not only by high pressure but also with high kinetic energies of about 0.1 MeV and for it a temperature of the order of 10^8kelvin is required. Such high temperatures are available in the sun and stars.
• On earth fusion may be produced by exploding a nuclear fission bomb. Thus a very high temperatures are needed for the fusion of nuclei, the process is called a thermo nuclear reaction and the corresponding energy as thermo nuclear energy. Also at the temperature of 10^8K fusion materials (hydrogen, deutron, tritum etc) become ionized and electrons are stripped and along with nuclei, these materials behave like ionized gas which is called plasma (fourth state of matter).

RADIOACTIVITY

Alpha particles
• Positively charged having charge of +2 units and a mass of 4 units.
• If one particle is emitted, then its atomic number decreases by 2 and mass number decreases by 4.
• Have little penetrating power.
• Deflect towards negative plate of an electric field.
• Speed upto 10% of the speed of light.

Beta particles
• Negatively charged having a charge of1 and a mass of zero.
• Emission of 1 B-particle cause increase in atomic number by 1, but mass no remains same of an element.
• Greater penetrating power.
• Deflected towards positive plate of an electric field
• Speed upto 90 per cent of the speed of light.
Gamarays
• Electromagnetic wave having high frequency and short wave length.
• Have no charge and no mass.
• Emission of gamma ray does not change atomic no. or mass no.
• Most penetrating of the three radiations.
• Fastest, having speed equal to that of light.
• Not deflected by an electric field.
Uses of radioactivity
• Radioactive isotopes are used as tracers to detect tumors and blood dot in human body.
• Radioactive isotopes are used as tracers to detect tumors and blood dot in human body.
• Used in the treatment of cancer (Radiotherapy).
• Used in industry to detect leakage.
• A controlled nuclear fission reaction is used in nuclear reactors to generated electricity.
• A nuclear fusion reaction is used in making hydrogen bomb. The sun also produces energy by nuclear fusion.

• Also used for preserving food.

• Used in agriculture for producing new varieties.
• Gamma rays originate from the nuclus in radioactivity.
• The spontaneous disintegration of heavy and stable nuclus is known as radioactivity.

• Nuclear change in a atom results the origin of
γ
-rays (Gamma—rays).

• The unit of radioactivity is curie or Backeral.
• There is no effect of temperature, pressure etc. on radioactivity.
• Tritium (an isotope of hydrogen) is the highest radio activeelement.

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TOPIC

13

WATERPULLUTION

Water
• The process of seeping of water into the ground is called infiltration.
• At places the groundwater is stored between layers of hard rock below the water table. This is known as an

aquifer.
• Water exists in three forms: solid, liquid and vapour.
• Though water is maintained by the water cycle, yet there is an acute scarcity of water in many parts of the

globe.
• Rapid growth of industries, increasing population, growing irrigation requirements and mismanagement are
some of the causes for water shortage.
Hardness of water
Temporary Hardness
• Temporary hardness is caused by a combination of calcium ions and bicarbonate ions in the water.
• It is due to the presence of calcium hydrogen-carbonate $Ca(HCO_3)_{2(aq)}$and magnesium hydrogen-carbonate
$Mg(HCO_3)_{2(aq)}$.
Solution
• Temporary hardness is hardness that can be removed by boiling or by the addition of lime (calcium hydroxide).
By boiling the water, it promotes the formation of carbonate from the bicarbonate and will precipitate calcium
carbonate (the limescale) out of solution, leaving water that is less hard after it has cooled.
• When it has been heated, less carbon dioxide is able to dissolve into the water. Since there is not enough

carbon dioxide around, the reaction cannot take place, and therefore the calcium carbonate will not “dissolve”
as readily. Instead, the reaction is forced to re-establish equilibrium, and the solid calcium carbonate is formed.
• Heating water will remove hardness as long as the limescale that precipitates out is removed. After cooling, if
enough time passes the water will pick up carbon dioxide from the air and the reaction will again proceed,
allowing the calcium carbonate to “redissolve” in the water.
• Both calcium hydrogencarbonate and magnesium hydrogencarbonate decompose when heated. The original
insoluble carbonate is reformed. This happens when water is boiled. The precipitation reactions are as follows:

$Ca(HCO_3)_{2(aq)}\ CO_{2(g)} + H_2O_{(l)} + CaCO_{3(s)}$

$\rightarrow Mg(HCO_3)_{2(aq)} CO_{2(g)} + H_2O_{(l)} + MgCO_{3(s)}$

• In this way the boiling the water causes the precipitation of solid calcium carbonate or solid magnesium carbonate. This removes the calcium ions or magnesium ions from the water, and so removes the hardness. Therefore, hardness due to hydrogencarbonates is said to be temporary.
• Generally an increase in water temperature causes an increase in the solubility of most salts. But as you may have understood from above there are exceptions like $CaCO_3$, $CaSO_4$, $MgCO_3$, $Mg(OH)_2$all of which become less soluble as the temperature increases.

Permanent Hardness
• Permanent hardness is hardness (mineral content) that cannot be removed by boiling. When this is the case, it is usually caused by the presence of calcium and magnesium sulphates and/or chlorides in the water, which become more soluble as the temperature rises.

Solution

• The Permanent hardness of the water can be easily removed using a water softener, Clark method or ion exchange method.
• In Clark's method a calculated amount of calcium hydroxide $Ca\,(OH)_2$is added to hard water. Due to reaction, insoluble carbonates are obtained which are separated by filtration.
• In ion exchange method sodium zeolite is used as ion-exchanger. Na-zeolite is passed through the pipes containing hard water. Sodium zeolite is converted into calcium-zeolite or magnesium-zeolite. These are insoluble in water and are separated from water by filtration.
Problems caused by hard water
Domestic:
• Hard water affect cleaning ability of soap.
• When hard water is used for washing, large amount of soap is consumed.
Industrial:
• Hard water can cause "Scaling" inside the pipes that transport water . Therefore if we use hard water in turbines and heat exchangers, their pipes will be corroded.
Health:
• Hard water when used for drinking for long period can leadto stomach disorders. Especially hard water contains magnesium sulphate can weaken the stomach permanently.

INSIGHT GENERAL STUDIES

TOPIC

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ELEMENTSINEARTHS'SCRUST

Element Percentage Element Percentage

Oxygen 47.4% Manganese 0.095% Silicon 28.2% Fluorine 0.062% Aluminium 8.2% Barium 0.042% Iron 5.6% Carbon 0.030% Calcium 4.2% Sulphur 0.026% Sodium 2.6% Zirconium 0.016% Potassium 2.4% Vanadium 0.0135% Magnesium 2.0% Chlorine 0.013% Titanium 0.57% Chromium 0.010% Hydrogen 0.14% Zinc 0.007% Phosphorus 0.12% Nitrogen 0.005%

Use of chemicals in medical field

Arsenic - 74 To detect tumours
Sodium 24 Presence for blood helot in circulatory system. Iodine 131 To determine activity of thyroid gland. Cobalt 60 Presence of cancer.

INSIGHT GENERAL STUDIES

TOPIC

15

SOMEIMPORTANTALLOYS

Alloy Brass Composition
Cu60-80%,Zn20-40%

Bronze
German
Gun metal
Rolled gold Magnalium Electrum
Duralumin
Type metal Solder
Britannia
Wood's Metal Nichrome
Constantan Monel Metal Invar
Cu 75—90%, Sn 10-25%
Cu 56%, Zn 20%, silver Ni 24% Cu 87%, Sn 1 %, Zn 3%
Cu 95%, Al 5%
Al 94%, Mg 6%
Au 80% ,Ag 20%
Al 95%, Cu 4%, Mn 0.5%, Mg 0.5% Pb 82%, Sb 5%, Sn 3%
Pb 50-70%,Sn 30-50%
Sn 93%, Sb 5%, Cu 2%
Bi 50%, Pb 25%,Sn 12.5%, Cd 12.5% Ni 60%, Cr 15%, Fe 25%
Ni 40%, Cu 60%
Ni 67%, Cu 30% ,Fe 3%
Ni 35%, Steel-65%

Stainless Steel Fe 89.4%, Cr10%, Mn 0.35%,C 0.25%

Main Uses
Utensils, condenser, tubes,
electrical goods, cartridge shell. Coins, statues, utensils

Utensils, resistence coils.
Machine parts, guns
Artificial jewellery
Balance beams, light instrument , Jewellery
Making aeroplanes
Making printing types
Soldering
Table Ware
Electric fuses and other safety devices Electrical resistance
Electrical resistance
Chemical plants
Surveying Instrument, pendulums, Chronometers
Utensils, ornamental pieces

INSIGHT GENERAL STUDIES

TOPIC

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IMPORTANTMISC.POINTS

• Electron was discovered by Sir J. J. Thomson.
• An electron has 1.6 x 10-19 coulomb negative charge.
• Cathode rays consist of moving electrons.

• For an electron
$\frac{e}{m}$ = 1.76 x 1011 coulomb/kg.

• Mass of an electron m = 9.1 x 10^{-31}kg.
• Isotopes are the elements with same atomic number but different mass number. Like $^{I}H_1$,$^{2}H_1$,$^{3}H_1$,
• Elements whose nuclei consist of same number of nucleons but different number of protons and neutrons are called isobars.
Like$_1H^3$and$_2He^3$,$_6C^{14}$and$_7N^{14}$,$_8O^{17}$and$_9F^{17}$
• When a â-particle is emitted from a radioactive nucleus the obtained nucleus is an isobar of the original one.
• The elements which have different atomic number (Z) and mass number (A) but have same number of neutrons are called isotones. Like$_3Li^7$,$_4Be^8$.
• A diode valve acts as a rectifier.
• A triode valve consists of three electrodes anode, cathode and grid.
• A triode valve is used as an amplifier.
• The relation between the amplification factor (μ), internal resistance (r_p) and mutual conductance (g_p) of a triode valve is- μ =

r_pX gm
• Voltage amplification of a triode valve is A =
$\frac{\mu}{\frac{r_p}{R}+1}$where R is the load resistance.

• Germanium and silicon are the pure semiconductors.
• A transistor is an electronic device of p and n type semiconductors which is used in place of a triode valve.
• The invention of transistor (transfer resistor) was the most important electronics event of 20th century as it made possible the integrated circuit and micro- processor, basis of modern electronics.
• Integrated circuit chips are made of silicon.
• The thermal emission of electrons from a metal surface is called thermionic emission.
• The emission of electrons from a metal surface by the incidence of light radiations is called photo electric effect.
• The rate of emission of photo electrons is directly proportional to the intensity of incident radiation.
• The maximum energy of the photo electrons increases with an increase in the frequency of incident light.
• The minimum frequency of the incident light that can emir electrons from a metal surface is called the threshold frequency.
• The photo-electric effect of light was explained by Einstein on the basis of quantum theory for which he was honoured with a Nobel prize.

• Einstein's photo-electric equation is
$\frac{1}{2}$ $mvv^2 = h\ (v- v_0)._{max}$
• Work function (Ö) or threshold energy of a metal is that minimum energy which is required to bring a free electron from interior of the metal to its surface.

• Ö = hv_o where v_o is the threshold frequency.

• Good absorbers are also good emitters.
• The ratio of the emissive power (eë) to the absorptive power (a5ØÌÞ) for radiation of a given wave length is the same for all bodies at the same temperature and is equal to the emissive power (a5ØÌÞ) of a perfectly black body at that temperature.
• Stefan's law states that the total radiant energy emitted per second per unit surface area of a black body is proportional to the fourth power of the absolute temperature of the body.
• E = Ö T^4, where Ö is the Stefan's constant.
• The unit of Ö is joule/(meter^{2}second-K^4) or watt/(meter^2.K^4).
• According to Newton's law of cooling, when a hot body is cooled in air, the rate of loss of heat by the body is proportional to the temperature difference between the body and its surroundings.

• According to Wien's displacement law
5ØÌÞ T = constant = 2.9 x 10^{-3}
$_m$ m-kelvin.

• According to Planck's hypo thesis, the emission of radiation is not continuous but takes place in the form of small bundles or packets of definite amount of energy which are called quanta. These bundles are also called photons.

• Energy of a photon K = hv = $\frac{hc}{\lambda}$
• Rest mass of a photon is zero.
• Momentum of a photonp = $\frac{h}{\lambda}$ = hv = $\frac{hv}{c}$

• Rutherford discovered that atom consists of a nucleus in which the positive charge and (approximately) whole mass of an atom resides.
• According to Bohr, electrons revolve round the nucleus only in those orbits for which their angular momentum

is an integral multiple of
$\frac{h}{2\pi}$ i. e. mvr =
$\frac{nh}{2\pi}$
• Electrons do not emit any energy while revolving in these orbits. When an electron transits from a higher energy level (E_2) to a lower energy level (El) then I energy (E_2–E_1) is evolved during transition in the form of monochromatic radiations, i.e.E_2-E_1= hv =
$\frac{hc}{\pi}$ where h is the Planck's constant.
• When an electron makes a transition from $n_2$to $n_1$energy level then the wavelength (5ØÌÞ) of the emitted radiation is obtained by the relation
•
$\frac{1}{\lambda}$ = R (
$\frac{1}{n12} - \frac{1}{\pi n22}$) where R is the Rydberg's constant whose value is 1.097 x 107 per meter..
• Hydrogen spectrum is classified into various spectral series. In which Layman series lies in ultra violet region,

Balmer series lies in visible region and Paschen, Brackett and Pfund series lie in infrared region.
• Fraunhofer lines are the black lines found in solar spectrum. These lines are formed by the absorption of
characteristic wave lengths of sunlight by the vapours of several elements present in the interior region of the
sun called chromosphere.
• Fluorescence is the phenomenon of light emission inwhich a substance onbeing illuminated by a high frequency
light (blue, ultraviolet) emit light of relatively low frequency as long as the substance is being illuminated.
• Phosphorescence is the phenomenon of light emission in which the

substance continues to emit light for
some time after the light incident on it is stopped.

• X-rays are produced when fast moving cathode rays strike a metal piece of high atomic weight and high melting
point, like tungsten.

• X-rays are emitted by the transition of electron from the inner energy levels of an atom.

• The intensity of X-rays depends upon the number of electrons emitted per second from the filament. It is
controlled by variation of the current through the filament.

• The penetrating power of X-rays depends upon their frequency and it can be controlled by changing the potential difference applied between the ends of the tube.
• The maximum frequency of the X-rays depends upon the accelerating potential V. It is given asv_{max}=
$\frac{eV}{h}$
• The minimum wavelength corresponding the maximum frequency
v
$_{max}$is5ØÌÞ$_{min}$=
$\frac{c}{Vmax}=\frac{hc}{eV}$

• Radioactivity was discovered by Sir Henry Becquerel. In it there is a spontaneous emission of á, â and ã rays from the nucleus of an atom.
• á -particles are doubly ionised helium atoms. They are represented as$_2He^4$.
They possess 2 x 1.6 x 10^{-19}coulomb positive charge. The mass of an á -particle is 6.645 x 10-27 kg.
• â -particles are fast moving electrons. A â -particle has 1.6 x 10-19 coulomb of negative charge.
• Since the velocity of â -particles is of the order of the velocity of light their mass increases with increase in velocity. If the rest mass of a â -particle be m_0, and that in the state of velocity v be m, then according to

Einstein's theory of relativity, we haveM =
$\frac{m0}{\sqrt{(1-\frac{v2}{c2})}}$
• ã-rays are electromagnetic waves. The energy of ã-photons is very large (of the order of million electron volt

Me V.) Hence they have short wavelengths.
• The energy of a photon of energy. 1MeV (= 10^6eV) is about 0.01 A.
• Any radioactive element does not emit both á-and â -particles simultaneously. Some elements emit á -particles

while some elements emit â -particles.
• ã-rays are emitted with both á and â -particles.
• At any instant the rate of decay of radioactive atoms is proportional to the number of atoms present at that

instant. It is represented by the following relation
• $N=N_oe^{-ët}$where ëis the decay constant.
• The time interval in which the mass of a radioactive substance or the number of its atoms, is reduced to half its

initial value is called the half life of that substance. It is given as-T = $\frac{0.06931}{\lambda}$

• The number of atoms left after n half lives is given by$N = N_o(1/2)^n$
• The unit of radioactivity is curie. 1 curie = 3.7×10^{10}decays per second.
• The atomic number of an element reduces by 2 and its mass number reduces by 4 by the emission of an (Xparticle.
• Atomic number increases by 1 and mass number remains unchanged by the â -particle emission.
• By the emission of 1 positron from the nucleus the mass number (i.e. nucleons) remains the same but the number of neutrons is increased by 1 and the number of protons is decreased by 1.
• Due to gamma emission, there is no change in the atomic and mass numbers of the nucleus.
• Proton was discovered by Ruther ford.
• Charge = + 1.6×10^{-19}coulomb. Mass = 1.673×10^{-27}kg.
• Neutron was discovered by Chadwick. Its charge = 0 and its mass = 1.675×10^{-27}kg.
• Positron was discovered by Anderson. It is an anti-particle of electron. Its mass is equal to that of electron but charge is opposite to electron.
• Age of fossils is determined by carbon dating.
• Einstein’s mass -energy relation E= “m x c^2
• Where c is the velocity of light
• The 12th part of mass of carbon atom ($_6C^{12}$) is called the atomic mass unit (amu).
• 1 amu= 1.6×10^{-27}kg. Also 1 amu= 931 MeV.

• The binding energy of a nucleus is the energy required to take its nucleons away from one another. The larger is the binding energy per nucleon of a nucleus the more stable will be the nucleus.
• In the process of nuclear fission a heavy nucleus breaks into two nearly equal fragments with the release of a large amount of energy.
• In nuclear fusion two lighter nuclei moving at very high speeds fuse together to form a single heavier nucleus and a large amount of energy is liberated.
• Atomic bomb is based on nuclear fission and hydrogen bomb is based on nuclear fusion.
• Atom bomb was invented by Otto Hann.
• Nuclear fusion reactions taking place within the sun are the source of solar energy.
• In the nuclear reactor controlled chain reactions take place.
• Cadmium being a good absorber of neutrons is used as a controller in nuclear reactor.
• To slow down the speed of 4 neutrons heavy water (D_2O) or graphite or beryllium oxide is used as a moderator in the reactor.
• TheApsara reactorin India is calledthe ‘swimmingpoolreactor’ because init heavywater isusedasa moderator.
• Thorium is used as a fuel in the fast breeder reactor of Kalpakkam.
• Polar reactor of India is in Trombay.
• First atomic explosion in India took place in Pokhran (Rajasthan)
• Atomic reactor ‘Kamini’ in Madras (Chennai) is the reactor made completely by the Indian technique.
• Polonium is the first man-made element.
• ‘Apsara’ is the first nuclear research reactor of India.
• Mass of a neutron is slightly greater than the mass of a proton. India’s first power reactor that used natural uranium as a fuel is in Kalpakkam.
• All the elements with atomic number greater than 83 are radioactive in nature.
• When an energetic ã-ray photon falls on a heavy substance, it is absorbed by

some nucleus of the substance and an electron and a positron are produced. This phenomenon is called ‘pair production’.

• The minimum energy of ã-photon for pair production should be 1.02 MeV.

• The rest-mass energy of an electron is 0.51 MeV.

• The reverse phenomenon of pair production is called pair annihilation.

• Whenever an electron and a positron come very close to each other, they annihilate each other by combining together and two ã-photons are produced. This phenomenon is called pair annihilation.

• Polonium was discovered by Madam Marie Curie. She named the newly discovered element Polonium in honour of her native land Poland.

• Cobalt 60 is generally used in radiation therapy because it emits ã-rays.

• Fission reaction series is controlled in a nuclear reactor whereas it is uncontrolled in an atom bomb.

• Hydrogen nucleus does not contain neutron.

• Solar energy is produced by the process of nuclear fusion.

• 1 kg mass is equivalent to 9×10^{16}J or 2.5×10^{10}kWh of energy. The energy so obtained is called the nuclear energy.

• The tape of a tape recorder is coated by a ferromagnetic substance.

• X-rays are used for the determination of crystal structure.

• When some information is required about patient’ s stomach by X-ray, the patient is administered some heavy atomic substance, like barium sulphate solution. Heavy atoms diffract X-ray sufficiently. So, those parts of the stomach where this solution goes are photographed on the plate. The parts where this solution does not reach are not clearly photographed.

• Transistor was invented by Bardeen, Shockley and Brattain.

• The unit of Planck's constant h is joule second.

• If the energy of a photon is E = hv and momentum is p = its velocity will be
• Proton is the ionised hydrogen atom.
• The Master Control Facility of ISRO is in Hasan.
• The charge on a positron is 1.6x 10^{-19}coulomb.
• By the â emission from $_{11}Na^{22}$, Mg is produced.
• Thermo nuclear device is related with nuclear fusion.
• Cryogenic engine is used in space shuttle.
• Titanium is called the metal of future.
• Uranium oxide is called the yellow cake. It is smuggled in border areas.
• Deuterium oxide (D_2O) is the heavy water.
• Tritium is a radioactive isotope of hydrogen.
• Radio Tuning is an example of resonance.
• About 200 Me V energy is liberated in the fission of uranium -235 nucleus.
• Computer chips are made by silicon.
• Selenium, silicon, gallium arsenide are semiconductors. Fused sodium is used as a coolant in the fast breeder reactor in Kalpakkam.
• If the amount of a radioactive substance is doubled then the rate of radioactive decay will also be doubled.
• Cabalt-60 radioactive isotope is used to control Leukemia.
• The conductivity of semiconductor at OK is zero.
• Zerconium is used in nuclear reactors because it is an absorber of neutrons.
• Semiconductors can conduct at room temperatures but not at low temperatures.
• Param is the first super computer of India.
• H.C.L. is related with manufacturing of computers.
• 'Param 1000' computer was developed by C-DAC.
• Filament of a halogen lamp is made up of an alloy of tungsten and iodine.
• Atomic pile is used in nuclear fission reaction.
• Ceramic is a newly discovered super conductor.
• Storage in a compact disc (CD) is done by optical method.

• Radar was invented by Robert A. Watson.
• Satellite testing centre is at Sri Harikota.
• In an electronic watch ‘crystalline bob’ is used in place of pendulum in a pendulum clock.

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INSIGHT GENERAL STUDIES

TOPIC

1

INTRODUCTIONTOBIOLOGY

Introduction

•

Biology is a natural science concerned with the study of life and living organis
function, growth, origin, evolution, distribution, and taxonomy.

•

It is the study of the structure, functioning, etc., of a particular organism or gr

• The term biology have been introduced by Karl Friedrich Burdach (1800).

Braches of Biology

Acarology
Adenology
Agrobiology
Agraology
Agrastology
Algology or Phycology Anthology
Anthropology
Apiculture
Arthrology
Bacteriology
Batrachology
Biogeny
Biophysics
Bonsai
Biometrology
Cardiology
Cetology
Chaondrology
Chidology
Cosmology

Cytogenetics
Demography
Dentistry
Dietetics
Dermatology
Entomology
Ethology
Medical Engineering Study of ticks and mites
Study of glands
Science of plant life and plant nutrition
Soil Science related to crop production
Study of grasses
Study of algae
Study of flowers
Study of natural history of humans
Study of bee keeping
Study of joints- and their types
Study of Bacteria
Study of frog
Study of evolution of organisms comprising ontogeny and phylogeny
Physical study of biological structures and processes
Study of growing plants in-trees and- shrubs in dwarf forms in
Study of effects of atmospheric changes on living beings pots. Study of heart
Study of whales and dolphins
Study of cartilages
Study of shells
Study of structure and evolution of universe
Study of cytological basis of inheritance
Study of populations
Study of teeth, their diseases and cure
Nutritional planning
Study of skin
Study of insects
Study of Animal Behaviour
Improvement of body functions and development through genetic engineering, medical and other means

Exobiology
Floriculture
Forensic Science

Genecology

Genobiotics
Gynaecology
Hydroponics
Hypnotherapy
Ichthyology
Immunology
Karyology
Limnobiology
Livestock
Laryngology
Melanologyi
Miasmology
Monerology
Myology or (Sarcology) Mycology
Nephrology
Nidology
Neonatology
Oenology
Ontogeny
Ophthalmology
Orthopedics
Osteology
Paediatrics
Paleontology
Parasitology
Phylogeny
Pisciculture

Psychology
Rhinology
Reflexology
Saurology
Serpentology
Sonography
Spermology(Seed Biology) Spelaeology
Study of living organisms in space or planets other than earth.
Study of cultivation of flower bearing plants.
Study of fingerprinting and blood typing to detect crime for the purpose of justice.
Study of genetic composition of populations in relation to habitat or environment.
Germ free culture/life
Study of female reproductive organs and related diseases.
Study of propagation of plants for fruits and ornamental value.
Treatment through hypnotism
Study of fishes
Study of natural and acquired resistance of body against diseases
Study of cell nucleus and chromosomes
Life in freshwater bodies
Study of keeping animals for our profit
Study of larynx
Study of development and loss of body pigments
Study of air pollutants in relation to human health
Study of Monera
Study of muscles
Study of fungi
Study of kidneys
Study of nests of birds
Scientific study of new born
Study of vines
Study of development and growth of an individual
Study of eyes
Diagnosis and repair of disorders of bone, joints etc.
Study of bones
Study of diseases and disorders of children

Study of fossils, tracks and impressions of extinct and past organisms.
Study of parasites
Study of evolution and development of plants
Study of rearing, catching and management of fishes
Study of human mind and behavior
Study of nose and olfactory organs
Study of reflex action as they affect behavior
Study of lizards
Study of snakes
Study of ultrasound imaging
Study of seeds
Study of caves and cave life

Taphonomy

Tactology
Teratology Termitology Urology

Virology
Xenology
Zoopharmacology Zootaxy
Zymology
Study of conditions conducive to the fossilisation of organisms in the past
Study of functional anatomy
Study of abnormalities during embryogenesis
Study of termites
Science dealing with structure, functions and disorders of urinary tract.
Study of viruses
Study of hosts in relation to life history of parasites
Veterinary pharmacy
Classitication of animals
Study of fermentation processes

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INSIGHT GENERAL STUDIES

TOPIC

2

BIOLOGICALGLASSIFICATION

Biological classification of plants and animals was first proposed by Aristotle characters. Linnaeus later classified all living organisms into two kingdoms – Plantae and Animalia. Whittaker
proposed an elaborate five kindgom classification –

• Monera
• Protista
• Fungi
• Plantae
• Animalia

The main criteria of the five kingdom classification was
• Cell structure
• Body organisation
• Mode of nutrition and reproduction
• Phylogenetic relationships.

***
In the five kingdom classification, bacteria are included in Kingdom Monera. distribution. These organisms show the most extensive metabolic diversity. Ba heterotrophic in their mode of nutrition.

*** Kingdom Protista includes all single-
celled eukaryotes such as Chrysophytes, Dianoflagellates, Euglenoids, Slime-moulds and Protozoans. Protists have defined nucleus and other membrane bo reproduce both asexually and sexually.

***
Members of Kingdom Fungi show a great diversity in structures and habitat. M their mode of nutrition. They show asexual and sexual reproduction. Phycomy

Basidiomycetes and Deuteromycetes are the four classes under this kingdom.

*** The plantae includes all eukaryotic chlorophyll-
containing organisms. Algae, bryophytes, pteridophytes,
gymnosperms and angiosperms are included in this group. The life cycle of pl
generations – gametophytic and sporophytic generations.

***
The heterotrophic eukaryotic, multicellular organisms lacking a cell wall are i
Animalia.Animals are divided into ten groups: Porifera, Coelenterata, Platyhe
Arthropoda, Mollusca, Echinodermata, Protochordata and Vertebrata. The mo
is holozoic. They reproduce mostly by the sexual mode. Some acellular organ
well as the lichens are not included in the five kingdom system of classificatio

Classification of Animal Kingdom
The broad classification of Animalia based on common fundamental features:
Phylum – Porifera
***
Members of this phylum are commonly known as sponges. They are generally

animals.
***
These are primitive multicellular animals and have cellular level of organisati
or canal system. Water enters through minute pores (ostia) in the body wall in
from where it goes out through the osculum. This pathway of water transport i
respiratory exchange and removal of waste. Choanocytes or collar cells line th
***

Digestion is intracellular. The body is supported by a skeleton made up of spic
***
Sexes are not separate (hermaphrodite), i.e., eggs and sperms are produced by
reproduce asexually by fragmentation and sexually by formation of gametes. F
development is indirect having a larval stage which is morphologically distinc
Examples for Porifera : (a) Sycon (b) Euspongia (c) Spongilla

Phylum – Coelenterata (Cnidaria)
*** They are aquatic, mostly marine, sessile or free-
swimming, radially symmetrical animals. The name cnidaria
is derived from the cnidoblasts or cnidocytes (which contain the stinging caps
the tentacles and the body. Cnidoblasts are used for anchorage, defense and fo
***
Cnidarians exhibit tissue level of organisation and are diploblastic. They have
vascular cavity
with a single opening, hypostome. Digestion is extracellular and intracellular.
corals have a skeleton composed of calcium carbonate.
***
Cnidarians exhibit two basic body forms called polyp and medusa. The former
like Hydra, Adamsia, etc. whereas, the latter is umbrella-shaped and free-
swimming like Aurelia or jelly fish.
Those cnidarians which exist in both forms exhibit alternation of generation (M
produce medusae asexually and medusae form the polyps sexually (e.g., Obeli
Examples: Physalia (Portuguese man-of-
war), Adamsia (Sea anemone), Pennatula (Sea-
pen), Gorgonia (Seafan) and Meandrina (Brain coral).
Phylum – Ctenophora
***
Ctenophores, commonly known as sea walnuts or comb jellies are exclusively
diploblasticorganisms with tissue level of organisation.
***
The body bearseight external rows of ciliated comb plates, which help inlocon
extracellular andintracellular. Bioluminescence (the property of a livingorgani

marked in ctenophores.
**
*
Sexesare not separate. Reproduction takes place only by sexualmeans. Fertilis
development.
Examples: Pleurobrachia and Ctenoplana.
Phylum – Platyhelminthes
** They have dorso-
ventrally flattened body, hence are called flatworms. These are mostly endopa
in animals including human beings.
**
*
Flatworms are bilaterally symmetrical, triploblastic and acoelomate animals w
Hooks and suckers are present in the parasitic forms. Some of them absorb nu
through their body surface. Specialised cells called flame cells help in osmore
**
*
Sexes are not separate. Fertilisation is internal and development is through ma
like Planaria possess high regeneration capacity.
Examples of Platyhelminthes : (a) Tape worm (b) Liver fluke
Phylum – Aschelminthes
** The body of the aschelminthes is circular in cross-
section, hence, the name roundworms. They may be
freeliving, aquatic and terrestrial or parasitic in plants and animals.
** Roundworms have organ-
system level of body organisation. They are bilaterally symmetrical, triploblas
and pseudocoelomate animals.
**
*
Alimentary canal is complete with a welldeveloped muscular pharynx. An exc
wastes from the body cavity through the excretory pore.
**
*
Sexes are separate (dioecious), i.e., males and females are distinct. Often fema
Fertilisation is internal and development may be direct (the young ones resem
Examples :Ascaris (Round Worm), Wuchereria (Filaria worm), Ancylostoma

Phylum – Annelida

⁂ They may be aquatic (marine and fresh water) or terrestrial; free-living, and sometimes parasitic. ⁂ They exhibit organ-system level of body organisation and bilateral symmetry. They are triploblast metamerically segmented and coelomate animals. Their body surface is distin or metameres (Latin, annulus : little ring) and, hence, the phylum name Annel and circular muscles which help in locomotion. Aquatic annelids like Nereis p parapodia, which help in swimming.

⁂

A closed circulatory system is present. Nephridia (sing. nephridium) help in o Neural system consists of paired ganglia (sing. ganglion) connected by lateral nerve cord. Nereis, an aquatic form, is dioecious, but earthworms and leeches is sexual.

Examples :Nereis, Pheretima (Earthworm) and Hirudinaria (Blood sucking lee

Phylum – Arthropoda

⁂ This is the largest phylum of Animalia which includes insects. Over two-thirds of all named species on earth are arthropods. They have organ-system level of organisation.

⁂

They are bilaterally symmetrical, triploblastic, segmented and coelomate anim covered by chitinous exoskeleton.

⁂

The body consists of head, thorax and abdomen. They have jointed appendage joint, podaappendages). Respiratory organs are gills, book gills, book lungs or

⁂

Circulatory system is of open type. Sensory organs like antennae, eyes (compo balance organs are present. Excretion takes place through malpighian tubules. Fertilisation is usually internal. They are mostly oviparous. Development may

Examples:

⁂ Economically important insects –

Apis (Honey bee), Bombyx (Silkworm), Laccifer (Lac insect)

*** Vectors – Anopheles, Culex and Aedes (Mosquitoes)
*** Gregarious pest – Locusta (Locust)
*** Living fossil – Limulus (King crab).
Phylum – Mollusca
***
This is the second largest animal phylum. Molluscs are terrestrial or aquatic (r
organ-
system level of organisation. They are bilaterally symmetrical, triploblastic an
***
Body is covered by a calcareous shell and is unsegmented with a distinct head
A soft and spongy layer of skin forms a mantle over the visceral hump.
***
The space between the hump and the mantle is called the mantle cavity in whi
They have respiratory and excretory functions. The anterior head region has se
*** The mouth contains a file-
like rasping organ for feeding, called radula. They are usually dioecious and o
with indirect development.
Examples: Pila (Apple snail), Pinctada (Pearl oyster), Sepia (Cuttlefish), Lolig
Aplysia (Seahare), Dentalium (Tusk shell) and Chaetopleura (Chiton).
Phylum – Echinodermata
***
These animals have an endoskeleton of calcareous ossicles and, hence, the nar
bodied). All are marine with organ-
system level of organisation. The adult echinoderms are radially symmetrical
but larvae are bilaterally symmetrical.
***
They are triploblastic and coelomate animals. Digestive system is complete wi
side and anus on the upper (dorsal) side. The most distinctive feature of echino
water vascular system which helps in locomotion, capture and transport of foo
***
An excretory system is absent. Sexes are separate. Reproduction is sexual. Fer
Development is indirect with free-swimming larva.

Examples: Asterias (Star fish), Echinus (Sea urchin), Antedon (Sea lily), Cucu
(Brittlestar).

Phylum – Hemichordata

v Hemichordata was earlier considered as a sub-phylum under phylum Chordata. But now it is placed as a separate phylum under non-chordata. This phylum consists of a small group of worm-like marine animals with organ-system level of organisation.

v

Theyare bilaterally symmetrical, triploblastic and coelomateanimals. The body of ananterior proboscis, a collar and a long trunk. Circulatory system is of ope through gills. Excretory organ is proboscis gland.

v Sexes are separate. Fertilisation is external. Development is indirect.

Examples: Balanoglossus and Saccoglossus.

Phylum – Chordata

v

Animals belonging to phylum Chordata are fundamentally characterised by th dorsalhollow nerve cord and paired pharyngealgill slits. These are bilaterally s coelomate with organ-system level of organisation. They possess a post anal tail and a closed circula system.

v

Phylum Chordata is divided into three subphyla: Urochordata or Tunicata, Ce Vertebrata.Subphyla Urochordata and Cephalochordata are often referred to a exclusively marine. In Urochordata, notochord is present only in larval tail, w extends from head to tail region and is persistent throughout their life.

Examples: Urochordata – Ascidia, Salpa, Doliolum; Cephalochordata – Branchiostoma (Amphioxus or Lancelet). v

The members of subphylum Vertebrata possess notochord during the embryon replaced by a cartilaginous or bony vertebral column in the adult. Thus all ver chordates are not vertebrates. Besides the basic chordate characters, vertebrate heart with two, three or four chambers, kidneys for excretion and osmoregulat which may be fins or limbs.Vertebrata is further divided into different classes:

Class – Cyclostomata
v
All living members of the class Cyclostomata are ectoparasites on some fishes
bearing 6-15 pairs of gill slits for respiration.
v
Cyclostomes have a sucking and circular mouth without jaws .Their body is de
Cranium and vertebral column are cartilaginous.
v
Circulation is of closed type. Cyclostomes are marine but migrate for spawnin
within a few days, they die. Their larvae, after metamorphosis, return to the oc
Examples: Petromyzon (Lamprey) and Myxine (Hagfish).
Class – Chondrichthyes
v
They are marine animals with streamlined body and have cartilaginous endosk
ventrally. Notochord is persistent throughout life. Gill slits are separate and wi
v
The skin is tough, containing minute placoid scales. Teeth are modified placoi
directed. Their jaws are very powerful. These animals are predaceous. Due to
have to swim constantly to avoid sinking.
v Heart is two-
chambered (one auricle and one ventricle). Some of them have electric organs
and some possess poison sting (e.g., Trygon). They are cold-
blooded (poikilothermous) animals, i.e., they lack
the capacity to regulate their body temperature.
v
Sexes are separate. In males pelvic fins bear claspers. They have internal fertil
viviparous.
Examples: Scoliodon (Dog fish), Pristis (Saw fish), Carcharodon (Great white

Class – Osteichthyes

**
*
It includes both marine and fresh water fishes with bony endoskeleton. Their b
mostly terminal. They have four pairs of gills which are covered by an opercul
**
*
Skin is covered with cycloid/ctenoid scales. Air bladder is present which regul
twochambered(one auricle and one ventricle). They arecold-
blooded animals. Sexes are separate. Fertilisation is usually external.
**
* They are mostly oviparous and development is direct.
Examples: Marine –
Exocoetus (Flying fish), Hippocampus (Sea horse); Freshwater –
Labeo (Rohu), Catla (Katla), Clarias (Magur); Aquarium –
Betta (Fighting fish), Pterophyllum (Angel fish).
Class – Amphibia
**
*
As the name indicates (Gr., Amphi : dual, bios, life), amphibians can live in ac
habitats. Most of them have two pairs of limbs. Body is divisible into head and
some.
**
*
The amphibian skin is moist (without scales). The eyes have eyelids. A tympa
canal, urinary and reproductive tracts open into a common chamber called clo
**
* Respiration is by gills, lungs and through skin.
**
*
The heart is threechambered (two auricles and one ventricle). These are cold-
blooded animals. Sexes are
separate. Fertilisation is external. They are oviparous and development is direc
Examples: Bufo (Toad), Rana (Frog), Hyla (Tree frog), Salamandra (Salaman
amphibia).
Class – Reptilia
**
*
The class name refers to their creeping or crawling mode of locomotion (Latin

crawl). They are mostly terrestrial animals and their body is covered by dry ar
scales or scutes.
***
They do not have external ear openings. Tympanum represents ear. Limbs, wh
is usually three-chambered, but four-chambered in crocodiles.
***
Reptiles are poikilotherms. Snakes and lizards shed their scales as skin cast. S
is internal. They are oviparous and development is direct.
Examples: Chelone (Turtle), Testudo (Tortoise), Chameleon (Tree lizard), Cal
(Crocodile), Alligator (Alligator). Hemidactylus (Wall lizard), Poisonous snak
Naja (Cobra), Bangarus (Krait), Vipera (Viper).
Class – Aves
***
The characteristic features of Aves (birds) are the presence of feathers and mo
flightless birds (e.g., Ostrich).
***
They possess beak. The forelimbs are modified into wings. The hind limbsgen
modified for walking, swimming or claspingthe tree branches.
***
Skin is dry without glands except the oil gland at thebase of the tail. Endoskel
the long bonesare hollow with air cavities (pneumatic).
*** The digestive tract of birds hasadditional chambers, the crop and gizzard.
*** Heart is completely fourchambered.They are warm-
blooded (homoiothermous) animals, i.e.,they are able to
maintain a constant body temperature.
***
Respiration is bylungs. Air sacs connected to lungs supplement respiration. Se
internal. They are oviparous and development isdirect.
Examples :Corvus (Crow), Columba (Pigeon), Psittacula (Parrot), Struthio (O
Aptenodytes (Penguin), Neophron (Vulture).

Class – Mammalia INSIGHT GENERAL STUDIES

** * They are found in a variety of habitats –
polarice caps, deserts, mountains, forests, grasslands and dark caves.

Some of them have adapted to fly or live in water.

** *
The most unique mammalian characteristic is the presence of milk producing g
which the young ones are nourished.

** *
They have two pairs of limbs, adapted for walking, running, climbing, burrow
of mammals is unique in possessing hair. External ears or pinnae are present. I
present in the jaw. Heart is fourchambered.

** *
They are homoiothermous. Respiration is by lungs. Sexes are separate and fer
viviparous with few exceptions and development is direct.
Examples: Oviparous-
Ornithorhynchus (Platypus); Viviparous - Macropus (Kangaroo), Pteropus (Fl
bat), Camelus (Camel), Macaca (Monkey), Rattus (Rat), Canis (Dog), Felis (C
(Horse), Delphinus (Common dolphin), Balaenoptera (Blue whale), Panthera t

┐┐┐┐┐

INSIGHT GENERAL STUDIES

TOPIC

3

CELL

Introduction

•

The cell is the functional basic unit of life. It is the smallest unit of life that is
often called the building block of life. Hence, cell is the fundamental structura
organisms.

• Anton Von Leeuwenhoek first saw and described a live cell.

• Robert Brown later discovered the nucleus.

•

Unicellular organisms are capable of (i) independent existence and (ii) perforr
life.

• Animal cells contain another non-
membrane bound organelle called centriole which helps in cell division.

•

Cells differ greatly in size, shape and activities. For example, Mycoplasmasis
largest isolated single cell is the egg of an ostrich.

•

Nerve cells are the longest cells. Cells also vary greatly in their shape. They m
like, polygonal, columnar, cuboid, thread like, or even irregular

TYPEOF CELLS

The living organisms have two types of cells: Prokaryotic and Eukaryotic.

PROKARYOTICCELLS

• The prokaryotic cells are represented by bacteria, blue-
green algae, mycoplasma and PPLO (Pleuro Pneumonia Like Organisms).

•

They are generally smaller and multiply more rapidly than the eukaryotic cell

• They may vary greatly in shape and size.

•

The four basic shapes of bacteria are bacillus (rod like), coccus (spherical), vil
(spiral).

• There is no well-defined nucleus.

•

The genetic material is basically naked, not enveloped by a nuclear membrane

•

In addition to the genomic DNA (the single chromosome/circular DNA), many
outside the genomic DNA. These smaller DNA are called plasmids.

•

The plasmid DNA confers certain unique phenotypic characters to such bacter
to antibiotics.

•

No organelles, like the ones in eukaryotes, are found in prokaryotic cells excep
have something unique in the form of inclusions. A specialised differentiated
mesosome is the characteristic of prokaryotes. They are essentially infoldings

EUKARYOTIC CELLS

• The eukaryotes include all the protists, plants, animals and fungi.

•

In eukaryotic cells there is an extensive compartmentalisation of cytoplasm th
bound organelles.

•

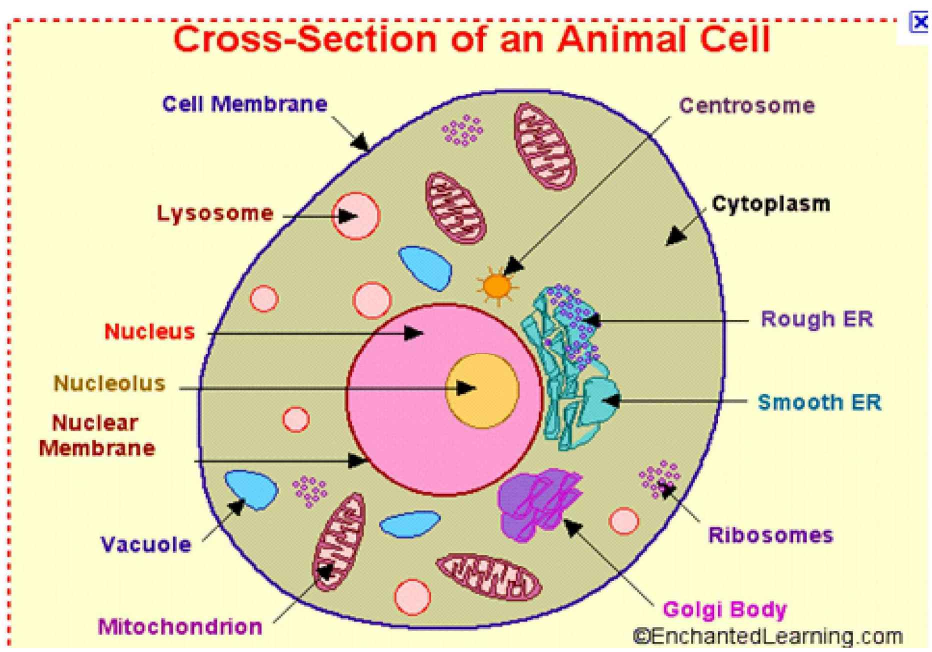
Eukaryotic cells possess an organised nucleus with a nuclear envelope. In add
variety of complex locomotory and cytoskeletal structures.

• Their genetic material is organised into chromosomes.

•

All eukaryotic cells are not identical. Plant and animal cells are different as th
plastids and a large central vacuole which are absent in animal cells. On the ot
centrioles which are absent in almost all plant cells.

- Their genetic material is organised into chromosomes.
- All eukaryotic cells are not identical. Plant and animal cells are different as the former possess cell walls, plastids and a large central vacuole which are absent in animal cells. On the other hand, animal cells have centrioles which are absent in almost all plant cells.



PARTSOFCELL

A single cell made up of different cell components, these components include
Cell Membrane

•

The cell membrane is composed of lipids that are arranged in a bilayer, the lip

membrane with the polar head towards the outer sides and the hydrophobic tai

•
This ensures that the nonpolar tail of saturated hydrocarbons is protected from
•
The lipid component of the membrane mainly consists of phosphoglycerides.
• Cell membranes also possess protein and carbohydrate.

PARTS OF CELL

A single cell made up of different cell components, these components includes:

Cell Membrane

- The cell membrane is composed of lipids that are arranged in a bilayer, the lipids are arranged within the membrane with the polar head towards the outer sides and the hydrophobic tails towards the inner part.
- This ensures that the nonpolar tail of saturated hydrocarbons is protected from the aqueous environment.
- The lipid component of the membrane mainly consists of phosphoglycerides.
- Cell membranes also possess protein and carbohydrate.

•
The ratio of protein and lipid varies considerably in different cell types. In hu

erythrocyte has approximately 52 per cent protein and 40 per cent lipids.
•
Depending on the ease of extraction, membrane proteins can be classified as i
•
Peripheral proteins lie on the surface of membrane while the integral proteins

the membrane.
•
An improved model of the structure of cell membrane was proposed by Singe
accepted as fluid mosaic model.
•
The fluid nature of the membrane is also important from the point of view of f
formation of intercellular junctions, secretion, endocytosis, cell division etc.
•
One of the most important functions of the plasma membrane is the transport
•
The membrane is selectively permeable to some molecules present on either s
•
Many molecules can move briefly across the membrane without any requirem
the passive transport.

•

Neutral solutes may move across the membrane by the process of simple diffu
gradient, i.e., from higher concentration to the lower.

•

Water may also move across this membrane from higher to lower concentratio
diffusion is called osmosis.

•

As the polar molecules cannot pass through the nonpolar lipid bilayer, they re
membrane to facilitate their transport across the membrane.

•

A few ions or molecules are transported across the membrane against their co
lower to the higher concentration.

Cell Wall

• Non-
living rigid structure called the cell wall forms an outer covering for the plasm
plants.

•

Cell wall not only gives shape to the cell and protects the cell from mechanica
helps in cell-to-
cell interaction and provides barrier to undesirable macromolecules.

•

Algae have cell wall, made of cellulose, galactans, mannans and minerals like
other plants it consists of cellulose, hemicellulose, pectins and proteins.

•

The cell wall of a young plant cell, the primary wall is capable of growth, whi
matures and the secondary wall is formed on the inner (towards membrane) si

•

The middle lamella is a layer mainly of calcium pectate which holds or glues t
together.

•

The cell wall and middle lamellae may be traversed by plasmodesmata which
neighbouring cells.

The Endoplasmic Reticulum (ER)

•
Eukaryotic cells reveal the presence of a network or reticulum of tiny tubular s
cytoplasm that is called the endoplasmic reticulum (ER).
•
ER divides the intracellular space into two distinct compartments, i.e., luminal
(cytoplasm) compartments.
• The ER often shows ribosomes attached to their outer surface.
•
The endoplasmic reticulum bearing ribosomes on their surface is called rough
•
In the absence of ribosomes they appear smooth and are called smooth endopl
•
RER is frequently observed in the cells actively involved in protein synthesis a
and continuous with the outer membrane of the nucleus.
•
The smooth endoplasmic reticulum is the major site for synthesis of lipid. In a
like steroidal hormones are synthesised in SER.

Golgi apparatus

•
Camillo Golgi (1898) first observed densely stained reticular structures near th
named Golgi bodies after him.
• They consist of many flat, disc-shaped sacs or cisternae.
•
These are stacked parallel to each other. Varied number of cisternae are presen
•
The Golgi cisternae are concentrically arranged near the nucleus with distinct
and concave transor the maturing face. The cis and the transfaces of the organ
interconnected.
•
The golgi apparatus principally performs the function of packaging materials,
intra-cellular targets or secreted outside the cell.
•
Materials to be packaged in the form of vesicles from the ER fuse with the cis
move towards the maturing face. This explains, why the golgi apparatus remai
endoplasmic reticulum.

•

A number of proteins synthesised by ribosomes on the endoplasmic reticulum
the golgi apparatus before they are released from its trans face.

•

Golgi apparatus is the important site of formation of glycoproteins and glycoli
Lysosomes

•

These are membrane bound vesicular structures formed by the process of pack

•

The isolated lysosomal vesicles have been found to be very rich in almost all t
(hydrolases –
lipases, proteases, carbohydrases) optimally active at the acidic pH.

•

These enzymes are capable of digesting carbohydrates, proteins, lipids and nu
Vacuoles

• The vacuole is the membrane-bound space found in the cytoplasm.

•

It contains water, sap, excretory product and other materials not useful for the

• The vacuole is bound by a single membrane called tonoplast.

•

In plant cells the vacuoles can occupy up to 90 per cent of the volume of the c

•

In plants, the tonoplast facilitates the transport of a number of ions and other n
gradients into the vacuole, hence their concentration is significantly higher in

•

In Amoeba the contractile vacuole is important for excretion. In many cells, as
formed by engulfing the food particles.
Mitochondria

•

Mitochondria, unless specifically stained, are not easily visible under the micr

•

The number of mitochondria per cell is variable depending on the physiologic
shape and size also, considerable degree of variability is observed.

• Each mitochondrion is a double membrane-
bound structure with the outer membrane and the inner membrane
dividing its lumen distinctly into two aqueous compartments, i.e., the outer co
compartment.

• The inner compartment is called the matrix.

•

The outer membrane forms the continuous limiting boundary of the organelle.

•

The inner membrane forms a number of infoldings called the cristae towards t

•

The cristae increase the surface area. The two membranes have their own spec
the mitochondrial function.

•

Mitochondria are the sites of aerobic respiration. They produce cellular energy
are called 'power houses' of the cell.

•

The matrix also possesses single circular DNA molecule, a few RNA molecul
components required for the synthesis of proteins. The mitochondria divide by
Plastids

•

Plastids are found in all plant cells and in euglenoides. These are easily observ
are large.

•

They bear some specific pigments, thus imparting specific colours to the plant
plastids can be classified into chloroplasts,chromoplasts and leucoplasts.

•

The chloroplasts contain chlorophyll and carotenoid pigments which are respo
essential for photosynthesis.

•

In the chromoplasts fat soluble carotenoid pigments like carotene, xanthophyll
gives the part of the plant a yellow, orange or red colour.

•

The leucoplasts are the colourless plastids of varied shapes and sizes with stor

•

Amyloplasts store carbohydrates (starch), e.g., potato; elaioplasts store oils an
store proteins.

•
Majority of the chloroplasts of the green plants are found in the mesophyll cel
• These are lens-shaped, oval, spherical, discoid or even ribbon-
like organelles having variable length (5-10mm) and width (2-4mm).
•
Their number varies from 1 per cell of the Chlamydomonas, a green alga to 2(
40 per cell in the mesophyll, chloroplasts are double membrane bound.
•
Of the two, the inner chloroplast membrane is relatively less permeable. The s
membrane of the chloroplast is called the stroma.
•
A number of organised flattened membranous sacs called the thylakoids, are p
•
Thylakoids are arranged in stacks like the piles of coins called grana or the int
there are flat membranous tubules called the stroma lamellae connecting the th
grana.
• The membrane of the thylakoids enclose a space called a lumen.
•
The stroma of the chloroplast contains enzymes required for the synthesis of c
also contains small, double-stranded circular DNA molecules and ribosomes.
• Chlorophyll pigments are present in the thylakoids.
•
The ribosomes of the chloroplasts are smaller (70S) than the cytoplasmic ribos

Ribosomes
•
Ribosomes are the granular structures first observed under the electron micros

George Palade (1953).
•
They are composed of ribonucleic acid (RNA) and proteins and are not surrou
an important role in protein synthesis.
•

The eukaryotic ribosomes are 80S while the prokaryotic ribosomes are 70S. ‘S
coefficient; it indirectly is a measure of density and size.
• Both 70S and 80S ribosomes are composed of two subunits.

Cytoskeleton

•

An elaborate network of filamentous proteinaceous structures present in the cy
to as the cytoskeleton.

•

The cytoskeleton in a cell are involved in many functions such as mechanical
the shape of the cell.

Cilia and Flagella

• Cilia and are hair-like outgrowths of the cell membrane.

•

Cilia are small structures which work like oars, causing the movement of eithe
fluid.

• Flagella are comparatively longer and responsible for cell movement.

•

The prokaryotic bacteria also possess flagella but these are structurally differe
flagella.

•

The electron microscopic study of a cilium or the flagellum show that they are
Their core called the axoneme, possesses a number of microtubules running pa

•

The axoneme usually has nine pairs of doublets of radially arranged periphera
centrally located microtubules.

•

Such an arrangement of axonemal microtubules is referred to as the 9+2 array

•

The central tubules are connected by bridges and is also enclosed by a central
one of the tubules of each peripheral doublets by a radial spoke. Thus, there ar

•

The peripheral doublets are also interconnected by linkers. Both the cilium and
centriole-like structure called the basal bodies.

INSIGHT GENERAL STUDIES

Centrosome and Centrioles

•

Centrosome is an organelle usually containing two cylindrical structures callec
by amorphous pericentriolar materials.

•

Both the centrioles in a centrosome lie perpendicular to each other in which ea
cartwheel.

•

They are made up of nine evenly spaced peripheral fibrils of tubulin. Each of t
adjacent triplets are also linked.

•

The central part of the centriole is also proteinaceous and called the hub, whic
the peripheral triplets by radial spokes made of protein.

•

The centrioles form the basal body of cilia or flagella, and spindle fibres that g
during cell division in animal cells.

Nucleus

•

Nucleus as a cell organelle was first described by Robert Brown as early as 18

•

Later the material of the nucleus stained by the basic dyes was given the name

•

The interphase nucleus (nucleus of a cell when it is not dividing) has highly ex
nucleoprotein fibres called chromatin, nuclear matrix and one or more spheric

•

Electron microscopy has revealed that the nuclear envelope, which consists of
space between (10 to 50 nm) called the perinuclear space, forms a barrier betw
inside the nucleus and that of the cytoplasm.

•

The outer membrane usually remains continuous with the endoplasmic reticul
on it.

•

At a number of places the nuclear envelope is interrupted by minute pores, wh
its two membranes.
•
These nuclear pores are the passages through which movement of RNA and pr
both directions between the nucleus and the cytoplasm.
• The nuclear matrix or the nucleoplasm contains nucleolus and chromatin.
•
The nucleoli are spherical structures present in the nucleoplasm. The content c
the rest of the nucleoplasm as it is not a membrane bound structure. It is a site
synthesis.
•
Larger and more numerous nucleoli are present in cells actively carrying out p
•
Every chromosome essentially has a primary constriction or the centromere on
structures called kinetochores are present.
•
Based on the position of the centromere, the chromosomes can be classified in
v
The metacentric chromosome has middle centromere forming two equal arms
v The sub-
metacentric chromosome has centromere nearer to one end of the chromosome
shorter arm and one longer arm.
v
The acrocentric chromosome the centromere is situated close to its end formin
very long arm,
v
The telocentric chromosome has a terminal centromere. Sometimes a few chro
staining
secondary constrictions at a constant location. This gives the appearance of a s
Microbodies
•
Many membrane bound minute vesicles called microbodies that contain variou
plant and animal cells.
Phases of Cell life cycle
The cell cycle consists of four distinct phases: G_1phase, Sphase (synthesis),
G_2phase (collectively known as interphase) and M phase (mitosis).

State
quiescent/ senescent Phase Abbreviation Gap 0 G_0

Gap 1 G_1
Interphase Synthesis S
Gap 2 G_2
Cell division Mitosis M

Description
A resting phase where the cell has left the cycle and has stopped dividing.
Cells increase in size in Gap 1.
The G_1 checkpoint control mechanism ensures
that everything is ready for DNA synthesis.
DNA replication occurs during this phase.
During the gap between DNA synthesis and
mitosis, the cell will continue to grow

The G_2 checkpoint control mechanism ensures
that everything is ready to enter the M (mitosis) phase and divide.
Cell growth stops at this stage and cellular
energy is focused on the orderly division into
two daughter cells. A checkpoint in the middle
of mitosis (Metaphase Checkpoint) ensures that
the cell is ready to complete cell division.

CELLTHEORY
According to the cell theory, cells arise from preexisting cells. The process by
Any sexually reproducing organismstarts its life cycle from a single-
celled zygote. Cell division does not stop
withthe formation of the mature organism but continues throughout its life cyc
passes from one division to the next is calledthe cell cycle. Cell cycle is divide
– aperiod of preparation for cell division, and (ii) Mitosis (M phase) –

the actualperiod of cell division. Interphase is
further subdivided into G1, S and G2.

•

G1 phase is the period when the cell grows and carries out normal metabolism

also occurs during this phase.

• S phase marks the phase of DNA replication and chromosome duplication.

• G2 phase is the period of cytoplasmic growth.

•

Mitosis is divided into four stages namely prophase, metaphase, anaphase and

equational division in which the chromosome number of the parent is conserv

In contrast to mitosis, meiosis occurs in the diploid cells, which are destined t
reduction division since it reduces the chromosomenumber by half while maki
reproduction when the twogametes fuse the chromosome number is restored t
is divided into two phases –
meiosis I and meiosis II.Meiosis I has a long prophase, which is divided furth
five phases.These are leptotene, zygotene, pachytene, diplotene and diakinesis
Thus atthe end of meiosis four haploid cells are formed.

Mitosis

Mitosis is the transferring of the parent cell's genome
into two daughter cells. These two cells are identical and do
not differ in any way from the original parent cell. The genome is composed o
chromosomes— complexes of tightly-coiled DNA that contain
genetic information vital for proper cell function. Because each
resultant daughter cell should be genetically identical
to the parent cell, the parent cell must make a copy of each
chromosome before mitosis. This occurs during the S phase of
interphase, the period that precedes the mitotic
phase in the cell cycle where preparation for mitosis occurs. Each chromosom
and together the two are called homologus pairs. The homologus pairs are hel
the chromosome known as the
centromere. Each homologus pair is not considered a chromosome in itself, an
chromosome always contains 2 chromatids. The process of mitosis is fast and

The stages are interphase, prophase, prometaphase, metaphase, anaphase and telophase. During mitosis the pairs
of chromatids condense and attach to fibers that pull the sister chromatids
to opposite sides of the cell. The cell then divides in
cytokinesis, to produce two identical daughter cells
(a) Interphase
• The mitotic phase is a relatively short period of the
cell cycle. It alternates with the much longer interphase,

where the cell prepares itself for cell division. Interphase is therefore not part (
•
Interphase is divided into three phases, G_1(first gap), S (synthesis), and G_2(sec
phases, the cell grows by producing proteins and cytoplasmic organelles.
• Chromosomes are replicated only during the
S phase. Thus, a cell grows (G_1), continues to grow as it duplicates
its chromosomes (S), grows more and prepares for mitosis (G_2), and finally it
cycle.
•
All these phases in the interphase are highly regulated, mainly via proteins. Th
strict order and there are "checkpoints" that gives the cell, the cues to proceed
(b) Preprophase
• In plant cells only, prophase is preceded by a pre-prophase stage. In highly vacuolated plant cells, the nucleus
has to migrate into the center of the cell before mitosis can begin. This is achie
a
phragmosome, a transverse sheet of cytoplasm that bisects the cell along the fu
•
In addition to phragmosome formation, preprophase is characterized by the fo
and actin filaments (called
preprophase band) underneath the plasma membrane around the equatorial pla
of the future mitoticspindle. This band marks the position where the cell will e
• The cells of higher plants (such as the flowering plants) lack

centrioles; instead, microtubules form a spindle
on the surface of the nucleus and are then being organized into a spindle by th
after the nuclear membrane breaks down.
•
The preprophase band disappears during nuclear envelope disassembly and sp
prometaphase.
(c) Prophase
• The genetic material in the nucleus is in a loosely bundled coil called
chromatin.
•
At the onset of prophase, chromatin condenses together into a highly ordered s
Since the genetic material has already been duplicated earlier in S phase, the r
two sister chromatids, bound together at the centromere by the cohesin
protein complex.
• Close to the nucleus are structures called
centrosomes, which are made of a pair of centrioles. The centrosome
is the coordinating center for the cell's microtubules.
•
Cell inherits a single centrosome at cell division, which is replicated by the ce
before a new mitosis begins, giving a pair of centrosomes.
•
The two centrosomes nucleate microtubules (which may be thought of as cellu
spindle by polymerizing soluble tubulin.
• Molecular motor
proteins then push the centrosomes along these microtubules to opposite sides
Although centrioles help organize microtubule assembly, they are not essentia
spindle, since they are absent from plants, and centrosomes are not always use
(d) Prometaphase
•
The nuclear envelope disassembles and microtubules invade the nuclear space
open mitosis,
and it occurs in most multicellular organisms.
• Fungi and some protists, such as algae or
trichomonads, undergo a variation called closed mitosis where the
spindle forms inside the nucleus, or its microtubules are able to penetrate an in
• Each chromosome forms two kinetochores
at the centromere, one attached at each chromatid.

- A kinetochore is a complex protein structure that is analogous to a ring for the where microtubules attach themselves to the chromosome (about 1-40 in number, on an average 20).

•
Although the kinetochore structure and function are not fully understood, it is
form of molecular motor.
When a microtubule connects with the kinetochore, the motor activates, using
from ATP
to “crawl” up the tube toward the originating centrosome. This motor activity,
polymerisation and depolymerisation of microtubules, provides the pulling for
the chromosome’s two chromatids.
• When the spindle grows to sufficient length, kinetochore microtubules
begin searching for kinetochores to attach to. A number of
nonkinetochore microtubules
find and interact with corresponding nonkinetochore
microtubules from the opposite centrosome to form the mitotic spindle.
• Prometaphase is sometimes considered part of prophase.

(e) Metaphase

• Metaphase comes from the Greek meta
meaning “after.”Microtubules find and attach to kinetochores in
prometaphase.
•
The two centosomes start pulling the chromosomes through their attached cen
ends of the cell. As a result of this the chromosomes come uder longitudinal te
cell.
• The centromeres of the chromosomes, in some sense, convene along the
metaphase plate or equatorial plane,
an imaginary line that is equidistant from the two centrosome poles.
•
This even alignment is due to the counterbalance of the pulling powers genera
analogous to a tug-of-war between people of equal strength.
•
In certain types of cells, chromosomes do not line up at the metaphase plate ar
between the poles randomly, only roughly lining up along the midline. Becaus

requires that every kinetochore be attached to a bundle of microtubules (spind
unattached kinetochores generate a signal to prevent premature progression to
anaphase without all chromosomes being aligned. The signal creates the
mitotic spindle checkpoint.

(f) Anaphase

•

When every kinetochore is attached to a cluster of microtubules and the chrom
metaphase plate, the cell proceeds to anaphase (from the Greek
anameaning “up,” “against,” “back,” or “re-”).

•

Two events occur: first, the proteins that bind sister chromatids together are cl
These sister chromatids, which have now become distinct sister chromosomes
kinetochore microtubules and move toward the respective centrosomes to whi

•

Next, the nonkinetochore microtubules elongate, pulling the centrosomes (and
which they are attached) apart to opposite ends of the cell.

•

The force that causes the centrosomes to move towards the ends of the cell is s
a theory that suggests that the rapid assembly and breakdown of microtubules
may cause this movement.

•

These two stages are sometimes called early and late anaphase. Early anaphase
separation of the sister chromatids, while late anaphase is the elongation of the
chromosomes being pulled farther apart.

•

At the end of anaphase, the cell has succeeded in separating identical copies o
distinct populations.

(g) Telophase

•

Telophase is a reversal of prophase and prometaphase events. It “cleans up” th

•

At telophase, the nonkinetochore microtubules continue to lengthen, elongatin
Corresponding sister chromosomes attach at opposite ends of the cell.

•

A new nuclear envelope, using fragments of the parent cell’s nuclear membran
separated sister chromosomes.

•

Both sets of chromosomes, now surrounded by new nuclei, unfold back into c
but cell division is not yet complete.

Cytokinesis

Cytokinesis is often mistakenly thought to be the final part of telophase; howe
that begins at the same time as telophase. Cytokinesis is technically not even a
separate process, necessary for completing cell division. In animal cells, a clea
contractile ring develops where the metaphase plate used to be, pinching off th
and plant cells, cell division is also driven by vesicles derived from the Golgi a
microtubules to the middle of the cell. In plants this structure coalesces into a
the phragmoplast and develops into a cell wall, separating the two nuclei. The
structure typical for higher plants, whereas some green algae use a phycoplast
cytokinesis. Each daughter cell has a complete copy of the genome of its parer
the end of the M-phase.

Meiosis I

Meiosis I separates homologous chromosomes, producing two haploid cells (N
meiosis I is referred to as a reductional division. After meiosis I, although the
considered as being N, with 23 chromosomes. This is because later, in Anapha
together as the spindle fibres pull the pair toward the pole of the new cell. In n
to mitosis will occur whereby the sister chromatids are finally split, creating a
N) per daughter cell from the first division.

Prophase I

- In prophase I, DNA is exchanged between homologous chromosomes in a pro

recombination. This often results in chromosomal crossover.

- The new combinations of DNA created during crossover are a significant sour
result in beneficial new combinations of alleles.
- The paired and replicated chromosomes are called bivalents or tetrads, which
four chromatids, with one chromosome coming from each parent.
- Non-sister chromatids may cross-over at points called chiasmata (chiasma).

Leptotene

•

The first stage of prophase I is the leptotene stage, also known as leptonema, f
“thin threads”.

• In this stage of prophase I, individual chromosomes—
each consisting of two sister chromatids—change from
the diffuse state they exist in during the cell’s period of growth and gene expre
visible strands within the nucleus.

•

The two sister chromatids are still so tightly bound that they are indistinguisha

•

During leptotene, lateral elements of the synaptonemal complex assemble.Lep
and progressive condensation and coiling of chromosome fibers takes place.

•

Chromosome assume a long thread like shape,they contract and become thick.

•

At the beginning chromosomes are present in diploid number as in mitotic pro
made up of only one chromosome and half of the total chromosome are patern
paternal chromosome there is a corresponding maternal chromosome similar i
inherited characters and are called homologous chromosome.

Zygotene

•

The zygotene stage, also known as zygonema, from Greek words meaning “pa
chromosomes approximately line up with each other into homologous chromo

•

This is called the bouquet stage because of the way the telomeres cluster at on

•

At this stage, the synapsis (pairing/coming together) of homologous chromoso
assembly of central element of the synaptonemal complex.

•

Pairing is brought about by a zipper like fashion and may start at the centrome
ends(proterminal),or at any other portion(intermediate).

•

Individuals of a pair are equal in length and in position of centromere. Thus pa
• The paired chromosomes are called Bivalent or tetrad chromosome.

Pachytene

•

The pachytene stage, also known as pachynema, from Greek words meaning "
when chromosomal crossover (crossing over) occurs.

•

Nonsister chromatids of homologous chromosomes randomly exchange segme

•

Sex chromosomes, however, are not wholly identical, and only exchange infor
homology.

•

At the sites where exchange happens, chiasmata form. The exchange of inform
sister
chromatids results in a recombination of information; each chromosome has th
it had before, and there are no gaps formed as a result of the process.

•

Because the chromosomes cannot be distinguished in the synaptonemal compl
over is not perceivable through the microscope, and chiasmata are not visible

Diplotene

• During the diplotene stage, also known as diplonema, from Greek words meaning "two
threads",the synaptonemal complex degrades and homologous chromosomes s
little.

•

The chromosomes themselves uncoil a bit, allowing some transcription of DN

•

The homologous chromosomes of each bivalent remain tightly bound at chias

•

The chiasmata remain on the chromosomes until they are severed in anaphase
•
In human fetal oogenesis all developing oocytes develop to this stage and stop
state is referred to as the dictyotene stage and remains so until puberty. In mal
(spermatogenesis) exist until meiosis begins at puberty.
Diakinesis
•
Chromosomes condense further during the diakinesis stage, from Greek words
•
This is the first point in meiosis where the four parts of the tetrads are actually
•
Sites of crossing over entangle together, effectively overlapping, making chias
• Other than this observation, the rest of the stage closely resemblesprometaphase of mitosis;
the nucleoli disappear, the nuclear membrane disintegrates into vesicles, and t
form.
Synchronous processes
•
During these stages, two centrosomes, containing a pair of centrioles in anima
of the cell. These centrosomes, which were duplicated during S-phase, function as microtubule organizing
centers nucleating microtubules, which are essentially cellular ropes and poles
•
The microtubules invade the nuclear region after the nuclear envelope disinte
chromosomes at the kinetochore.
•
The kinetochore functions as a motor, pulling the chromosome along the attac
originating centriole, like a train on a track.
•
There are four kinetochores on each tetrad, but the pair of kinetochores on eac
functions as a unit during meiosis I.
•
Microtubules that attach to the kinetochores are known as kinetochore microtu
•
Other microtubules will interact with microtubules from the opposite centriole
microtubules or polar microtubules. A third type of microtubules, the aster mi
centrosome into the cytoplasm or contacts components of the membrane skele

Metaphase I

Homologous pairs move together along the metaphase plate: As kinetochore m
attach to their respective kinetochores, the homologous chromosomes align al
the spindle, due to continuous counterbalancing forces exerted on the bivalent
from the two kinetochores of homologous chromosomes. The physical basis o
chromosomes is the random orientation of each bivalent along the metaphase
of the other bivalents along the same equatorial line.

Anaphase I

- Kinetochore (bipolar spindles) microtubules shorten, severing the recombinati

homologous chromosomes apart.

- Each chromosome has only one functional unit of a pair of kinetochores, whol
toward opposing poles, forming two haploid sets.
- Each chromosome still contains a pair of sister chromatids.
- Nonkinetochore microtubules lengthen, pushing the centrioles farther apart. T
for division down the center.

Telophase I

- The last meiotic division effectively ends when the chromosomes arrive at the
- Each daughter cell now has half the number of chromosomes but each chromo
chromatids.
- The microtubules that make up the spindle network disappear, and a new nucl
haploid set.
- The chromosomes uncoil back into chromatin.
- Cytokinesis, the pinching of the cell membrane in animal cells or the formatio

occurs, completing the creation of two daughter cells. Sister chromatids remai
•
Cells may enter a period of rest known as interkinesis or interphase II. No DN
stage.
Meiosis II
Meiosis II is the second part of the meiotic process. Much of the process is sin
production of four haploid cells (23 chromosomes, N in humans) from the two
The four main steps of Meiosis II are: Prophase II, Metaphase II, Anaphase II,
•
In prophase II , the disappearance of the nucleoli and the nuclear envelope aga
thickening of the chromatids. Centrioles move to the polar regions and arrange
meiotic division.
•
In metaphase II, the centromeres contain two kinetochores that attach to spind
(centrioles) at each pole. The new equatorial metaphase plate is rotated by 90
meiosis I, perpendicular to the previous plate
•
In anaphase II, the centromeres are cleaved, allowing microtubules attached to
sister chromatids apart. The sister chromatids by convention are now called si
toward opposing poles.
•
The process ends with telophase II, which is similar to telophase I, and is marl
of the chromosomes and the disappearance of the spindle. Nuclear envelopes r
formation eventually produces a total of four daughter cells, each with a haplo
• Meiosis is now complete and ends up with four new daughter cells.

┐┐┐┐┐

INSIGHT GENERAL STUDIES

TOPIC

4

TISSUE

Introduction

•

Tissue is a cellular organizational level intermediate between cells and a comp

•

A tissue is an ensemble of cells, not necessarily identical, but from the same o

specific function. Organs are then formed by the functional grouping together

•

The study of tissue is known as histology or, in connection with disease, histo

ANIMAL TISSUES

Animal tissues can be grouped into four basic types: connective, muscle, nerv
types comprise organs and body structures.

Connective tissue

• Connective tissues are fibrous tissues.

• They are made up of cells separated by non-
living material, which is called extracellular matrix.

•

Connective tissue gives shape to organs and holds them in place. Both blood a

connective tissue.

Muscle tissue

•

Muscle cells form the active contractile tissue of the body known as muscle ti

•

Muscle tissue functions to produce force and cause motion, either locomotion

organs.

• Muscle tissue is separated into three distinct categories:

• visceral or smooth muscle, which is found in the inner linings of organs;

•

skeletal muscle, in which is found attached to bone providing for gross moven
•
cardiac muscle which is found in the heart, allowing it to contract and pump b
Nervous tissue
•
Cells comprising the central nervous system and peripheral nervous system ar
•
In the central nervous system, neural tissue forms the brain and spinal cordanc

system forms the cranial nerves and spinal nerves, inclusive of the motor neur
Epithelial tissue
•
The epithelial tissues are formed by cells that cover organ surfaces such as the

the reproductive tract, and the inner lining of the digestive tract.
• The cells comprising an epithelial layer are linked via semi-
permeable, tight junctions; hence, this tissue
provides a barrier between the external environment and the organ it covers.
•
Epithelial tissue may also be specialized to function in secretion and absorptio
•
Epithelial tissue helps to protect organisms from microorganisms, injury, and
PLANT TISSUES
Plant tissues are categorized broadly into three tissue systems: the epidermis, t
tissue. Together they are often referred to as biomass.
•
Epidermis - Cells forming the outer surface of the leaves and of the young pla
•
Vascular tissue - The primary components of vascular tissue are the xylem anc
and nutrients internally.

INSIGHT GENERAL STUDIES

•

Ground tissue - Ground tissue is less differentiated than other tissues. Ground
by photosynthesis and stores reserve nutrients.

Plant tissues can also be divided differently into two types:

1. Meristematic tissues
2. Permanent tissues

Meristematic tissues

•

Meristematic tissue consist of actively dividing cells this is found in regions su
and lead to increase in length and thickness of the plant.

•

New cells produced by meristem are initially those of meristem itself, but as th
characteristics slowly change and they become differentiated as components o

•

Depending on the region of occurrence of meristimatic tissues they are classifi

(a)

Apical Meristem - It is present at the growing tips of stems and roots and incre
and root.

(b)

Lateral Meristem - This meristem consist of cells which mainly divide in one p
increase in diameter and growth.

(c)

Intercalary Meristem - This meristem is located in between permanent tissues.
base of node, inter node and on leaf base. They are responsible for growth in l
growth in the girth of stem.

Permanent tissues

•

The meristematic tissues that take up a specific role lose the ability to divide.

•

This process of taking up a permanent shape, size and a function is called cellu

•

Cells of meristematic tissue differentiate to form different types of permanent
permanent tissues:

(a) Simple permanent tissues
(b) Complex permanent tissues
(a) Simple permanent tissues
These tissues are called simple because they are composed of similar types of
function. They are further classified into: 1. Parenchyma
3. Aerenchyma
5. Sclerenchyma
Parenchyma
2. Chlorenchyma 4. Collenchyma 6. Epidermis

•
Parenchyma is Greek word where “parn” means besides and “enchien” means
most specialized primitive tissue.
• It mainly consist of thin-walled cells which have inter-
cellular spaces between them.
• The cell wall is made up of cellulose.
•
They mainly occur in the cortex epidermis, and pith, as well as in the mesophy
•
The main function of parenchymatous tissue is assimilation and storage of res
fats and proteins.
•
They also store waste products such as gums, resins, and inorganic waste mate
Chlorenchyma
•
The cells of this tissue are characterized by having chloroplasts (containing ch
•
It is found in the palisade and spongy tissues in the green leaves and the stem
photosynthesis occurs.
Aerenchyma
• Aerenchyma is a type of parenchyma.

• In aquatic plants the intercellular spaces form large air cavities.
•
They give buoyancy to the plant and help them float in water. Such parenchym
Collenchyma
• It is a living tissue of primary body like Parenchyma.
• Cells are thin-
walled but possess thickening of cellulose and pectin substances at the corners

of cells join together.
•
This tissue gives a tensile strength to the plant and the cells are compactly arra
cellular spaces.
• It found chiefly in hypodermisof stems and leaves.
• It is absent in monocots and in roots.
•
Collenchymatous tissue acts as a supporting tissue in stems of young plants. It
elasticity, and tensile strength to the plant body. It helps in manufacturing suga
present in margin of leaves and resist tearing effect of the wind.
Sclerenchyma
•
Sclerenchyma is Greek word where “Sclrenes” means hard and “enchyma” me
• This tissue consists of thick-walled, dead cells.
•
These cells have hard and extremely thick secondary walls due to uniform dist
• The cells of sclerenchymatous cells can be classified as :
• Fibres- Fibres are long, elongated sclerenchymatous cells with pointed ends.
•
Sclerides- Sclerenchymatous cells which are short and possess extremely thick
with long singular piths. They are called sclerides.
•
The main function of Sclerenchymatous tissues is to give support to the plant.
Epidermis
•

The entire surface of the plant consists of a single layer of cells called epiderm
• It is also called surface tissue.
• It protects all parts of the plant.
(b) Complex permanent tissue
A complex permanent tissue may be classified as a group of more than one tyı and working together as a unit to perform a function. These tissues are concerı mineral, nutrients and organic substances. The important complex tissues in vɑ
Xylem
• Xylem is a chief, conducting tissue of vascular plants.
• It is responsible for conduction of water and mineral ions.
• Xylem is an important plant tissue as it is part of the 'plumbing' of a plant.
•
It carries water and dissolved substances throughout and consists of a combinɑ fibers, vessels, tracheids and ray cells.
Phloem
•
Phloem is an equally important plant tissue as it also is part of the 'plumbing'
•
Phloem carries dissolved food substances throughout the plant. This conductiɑ sieve-tube member and companion cells, that are without secondary walls.
•
Phloem transports food and materials in plants in upwards and downwards as

INSIGHT GENERAL STUDIES

TOPIC

5

VIRUS

Introduction

• Viruses are the smallest known pathogenic entities which are non-
cellular, nucleoproteinaceous in nature, are obligate intra—
cellular parasites and multiply inside the host cell using host cellular machiner
• Viruses may be defined as non-
cellular organisms whose genomes consist of nucleic acid.
• The inert phase of viruses is while living out side the Host cell.
•
These cell consist of piece of DNA (or RNA) which is surrounded by protein c
• Two viral diseases like—
small pox and polio are known since prehistoric times, but their causative agen
viruses were discovered only in 1892 by Russian Scientist Dimitri Ivanowski w
diseased Tobacco plant and found it to have a filterable agent of disease. Virus
'poisons'. Martinue Beijerinck gave the name Virus.
• Arboviruses - are Arthropod—
borne viruses i.e. which are arthropods as vector. e.g. Dengue virus.
• Adenoviruses — viruses commonly found in of animals. (DNA viruses)
VIRAL DISEASES IN HUMANS

Disease
Small Pox
Chicken Pox Common Cold Influenza/Flu Causative Pathogen Variola virus
Varicella virus
Rhinovirus
Orthomixo-virus

Measles

Mumps Measles virus (Paramyxo virus) Mumps virus

Encephalitis Encephalitis virus

Poliomyelities Rabies
Dengue fever Herpes simplex Herpes Zoster Polio virus
Rabies virus
Dengue virus
Herpes virus simplex Herpes virus zoster

Acquired lmmuno Human T-cell Deficiency (Leukemia virus Mode of Transmission
Direct contact (droplets), indirectby infected articles
Direct contact (droplets), indirectby infected objects Contact
Contact (droplets), virus transmitted through discharge
from respiratory tracts of persons infected with disease
Direct contact, virus transmitted through air by
droplets during talking,coughing and sneezing.
Direct contact, virus in saliva & secretion of nose invades salivary glands
Some domestic animals-reservoir of virus, transmitted
by mosquito bite to man.
Contact, houseflies, fleas, food and water
Bite of a mad (rabid) dog
Mosquito (Aeds) bite
Contact, Saliva, stools, contaminated articles. Contact droplets
Via blood and sperm among homosexuals,
heterosexuals, intravenous drug users, hemophiliacs,

Syndrome (AIDS) (HTLV-lll), also called LAV
promiscuous individuals and prostitutes VIRAL DISEASES IN PLANTS

Diseases
TMV(tobacco mosaic virus) Potato Mosaic
Bunchy top of banana Causative Agents Tobacco mosaic virus
Potato Virus- x
Banana Virus-1

INSIGHT GENERAL STUDIES

TOPIC

6

BACTERIA

Introduction

• Bacteria aresingle-
celled, prokaryote microorganisms, bacteria have wide range of shapes, rangir
from spheres to rods and spirals.
• Bacteria were first observed by Antonie van Leeuwenhoek in 1676.
•
Bacteria found in everyhabitat on Earth, there are typically 40 million bacteria
million bacterial cells in a millilitre of fresh water; and there are approximatel
•
Majority of the bacteria in the body are rendered harmless by the protective ef
and a few are beneficial. However, a few species of bacteria are pathogenic .
BACTERIALDISEASESIN HUMAN

Diseases
Leprosy (Hansen's Disease) Tetanus
Whooping Cough
Paratyphoid Fever
Typhoid Fever
Cholera
Plague
Tuberculosis
Meningitis
Bacterial Pneumonia
Anthrax
Botulism
Bacterial Dysentry
Diarrhoea

Food Poisoning

Gas Gangrene
Syphilis
Diphtheria
Gonorrhoeu
H-1 lnfluenza
Typhus Fever
Lyme Disease
Tooth Decay
Scarlet Fever
Tonsilitis
Gasteroenteritis
Food Poisoning
Peptic Ulcers
Causative Agents

Mycobacterium leprae
Clostridium tetani
Bordetella pertussis
Salmonella paratyphi
Salmonella typhi
Vibrio cholorae
Yersinia pestis
Mycobacterium tuberculosis Neisseria meningitidis
Streptococcus pneumoniae Bacillus anthracis
Clostridium botulinum Shigella dyenteriae
Escherichia coli
Salmonella enterititis
Clostridium perfringens Treponema pallidum
Corynebacterium diptheriae Neisseria gonorrheoae Haemophilus influenzae
Reckettsia prowazekii
Burrelio burgdorferi
Streptococcus sps.
Streptococcus pyrogenes Streptococcus pyrogenes Escherichia coli
Clostridium perfringens Helicobacter pylori

BACTERIALDISEASESIN PLANTS

Disease
Wilt of potato
Black arm of cotton Citrus canker
Bacterial blight of rice Causative agent
Pseudomonas solanacearum bacteria Xanthomonas
Xanthomonas citri
Xanthomonas oryzae bacteria

¬ ¬ ¬ ¬ ¬

INSIGHT GENERAL STUDIES

TOPIC

7

FUNGUS

Introduction

• Fungus is a single-celled or multicellular organism.

•

Fungi can be true pathogens that cause infections in healthy persons or they ca

causes infections in immunocompromised persons (including cancer patients, with AIDS).

•

A common fungus yeast organism causes thrush and diaper rash (diaper derma

•

Fungi are also used for beneficial purposes like for the development of antibi that used to control various human diseases.

FUNGAL DISEASES IN HUMAN

DISEASE Ringworm Athlete’s foot Scabies

FUNGAL DISEASES IN PLANTS

DISEASE

Late blight of Potato
Foot Rot of Papaya
Downy mildew of grapes Down mildew of Pear millet White rust of crucifers
Powdery mildew wheat

Loose Smut of Wheat Karnal bunt
Bunt of rice
Smut of Bajra
Covered smut of barley Black rust
Brown rust
Coffee rust

Wilt of Pigeon pea
Early blight of potato Ikki disease
Wilt of cotton
Red rot
Ergot of bajra
Foot rot of Paddy
CAUSATIVE AGENT Tricophyton Fungi Tricophyton Fungi
Acarus scabies Fungi

PLANT

Potato Papaya Grapevine & other species Bajra
Cabbage, mustard, etc. Wheat, barley, oat, rice and many other grasses.
Wheat
Wheat
Rice
Bajra
Barley
Wheat
Wheat
Coffee
Arhar
Potato
Groundnut
Cotton
Surgarcane
Bajra
Rice
NAME OF FUNGUS

Phylophthora infestans Phythium-alphanidermatur Plasmopara viticola.
Sclerospora graminicola. Albugo Candida.
Erysiphe graminis.

Ustilago tritici
Tilletia Indica
Tilletia
Ustilago nuda.

Ustilago hordei
Puccinia graminis tritici Punocinia recondita Hemileia vastatrix
Fusarium oxysporum. Alternaria soloni
Cercaspora arachidicola F. Oxysporum var
Colletotrichum falcatum Claviceps suiformis
Fusarium moniliformas.

TOPIC

8

PROTOZOA

Introduction
•
Protozoa is a group of single cell eukaryotic organisms, many of which are mo
• Protozoa were defined as single cell protists with animal-
like behaviour, e.g.movement. PROTOZOANS DISEASES IN HUMAN

DISEASE
Malaria
Kalazar
Sleeping sickness Dysentry
Piarrhoea
Diarrhoea

COMMON GENETIC DISORDER IN HUMAN CAUSATIVE AGENT
Plasmodium
Leishmania donovani Trypanosoma brucei Entamoeba hystolitica
Entamoeba gingivalis Giardia intestinalis

Disorder

Down's syndrome or Mongolian
Syndrome
Type of
Disorder
Autosomal Aneuploidy Result of
Disorder
47, (+21
chromosome)

Patau's Syndrome Autosomal

Aneuploidy 47, (+13
chromosome)

Klinefelter's
Syndrome
Turner's Syndrome

Alkaptonuria Sex chromosomal Aneuploidy
Sex chromosomal Aneuploidy
Autosomal gene mutation

Phenyl Ketonuria Autosomal gene

mutation
44+XXY=47 + 1 Barr body
44+X=45

Lack of activity of enzyme
homogentisate oxidase
Absense of
enzyme
phnylalanine hydroxilase Symptom of
Disorder
Broad forehead, opened mouth, extended toungue, Mongolian
eyelid fold, projecting overlip, brain formed with little intelligence, short neck etc.
Prominence of the posterior part of the heel, cleft lip and palate, deafness, mental deficiency, malformation of external and internal organs etc.
Sterile male with under developed genitalia and mentally retarded
Sterile female with under developed ovaries and under developed breasts.
Blackening of urine on exposure to air, darkening of cartilage.

Mental backwardness in child

Albinism

Huntington's Disease
Autosomal gene mutation
Autosomal gene mutation
Lack of enzyme tyrosinanse
Production of an inhibitor of brain cell
metabolism
Absense of dark pigment in skin, hair and iris
Gradual degradation of brain tissue in middle age

Cystic fibrosis Autosomal mutation
Sickel cell anemia Autosomal mutation
Myscular dystrophy Sex chromosomal

Incompatibility of Rh factor
Erythroblastosis foetalis
Edward's syndrome Autosomal

Aneuploidy Failure of choliride Mucus clogging in Lungs, ion transport
mechanism
Formation of heamoglobins in RBCs
Lack of protein dystrophin
Destruction of RBCs
Extra 8,9 and 13 chromosome abnormalities in liver and pancreas

Rupturing of RBCs, blocking of O2 supply to tissues, jaundice.

Muscle degradation most sufferers are male
Anemia of baby, damage of brain.

Mental deficiency, multiple congenital malformation involving virtually
organ system mostly infants die at early age

IMPORTANT MICROBES

•

Microbes are a very important component of life on earth. Not all microbes ar

•

Many microbes are very useful to human beings. Bacteria called lactic acid ba

convert it into curd. The dough, which is used to make bread, is fermented by cerevisiae. Certain dishes such as idli and dosa, are made from dough ferment

•

Bacteria and fungi are used to impart particular texture, taste and flavor to che

•

Microbes are used to produce industrial products like lactic acid, acetic acid a variety of processes in the industry.

•

Antibiotics like penicillins produced by useful microbes are used to kill diseas causing harmful microbes. For more than a hundred years, microbes are being used to treat sewage (waste wa sludge formation and this helps in recycling of water in nature.

•

Methanogens produce methane (biogas) while degrading plant waste. Biogas a source of energy in rural areas.

•

Microbes can also be used to kill harmful pests, a process called as biocontrol.

Name of Antibiotic Chloromycetin
Aureomycin
Terramycin
Streptomycin
Subtilin
Bacteria Produces
Streptomyces venezuelae S. aurefaciens
S. ramosus
S. griseus
Bacillus subtilis

INSIGHT GENERAL STUDIES

TOPIC

9

NUTRITION

Introduction

•

The nutrients enable living organisms to build their bodies, to grow, to repair (
and provide the energy to carry out life processes.

•

Nutrition is the mode of taking food by an organism, the mode of nutrition in v
themselves from simple substances is called autotrophic (auto = self; trophos =
Therefore,plants are called autotrophs.

•

Animals and most other organisms take in ready made food prepared by the pl
heterotrophs (heteros = other).

•

An essential nutrient is a nutrient required for normal body functioning that ei
the body at all, or cannot be synthesized in amounts adequate for good health ,
from a dietary source.

•

Some categories of essential nutrients include vitamins, dietary minerals, essen
amino acids.

•

Water and oxygen are also essential for human health and life, as oxygen cann
and water, while a biochemical reaction product of metabolism, is not created
BALANCEDDIET

•

A balanced diet contains sufficient amounts of fibre and the various nutrients (
vitamins, and minerals) to ensure good health.

•

Food should also provide the appropriate amount of energy and adequate amo

•

The diet should not contain items that are harmful. In other words, a balanced

and wholesome.
• The main components of balanced diet are:
Proteins
•
Protein is an essential nutrient for cell maintenance and repair, and regulation
functions.
• Protein is made up of amino acids, like building blocks.
• Proteins from different foods in our diet contain different amino acids.
• There are 22 amino acids, divided into essential and non-
essential amino acids.
•
Essential amino acids must appear in our diet because they cannot be made by
•
The 8 essential amino acids we must eat in our diet include: isoleucine, leucin
phenylalanine, threonine, tryptophan and valine.
Carbohydrates
• Carbohydrates are the body's main source of energy.
•
There are three different kinds of carbohydrates. They include starch, sugar, a
•
Starch is made from chains of small sugars. When these chains are broken do
energy.

• 4 calories release from each gram of starch (or sugar).
•
No calories release from fiber because our bodies do not break fiber down dur
Fats
• Fat is a nutrient that is an important source of calories.
•
One gram of fat supplies 9 calories - more than twice the amount get from carl
• Fat also is needed to carry and store essential fat-
soluble vitamins, like vitamins A and D.
•
There are two basic types of fat. They are grouped by their chemical structure.
•
Each type of fat is used differently in our bodies and has a different effect on c
•
Eating too much fat may also increase the risk of getting diseases like cancer,

pressure or stroke.
•
Health experts recommend that we should get no more than 30% of our calori
getting these diseases.
•
Fat is found in many foods. Some of the fat that we eat comes from the fat we
breads, vegetables or other foods. A lot of fat is hidden in foods that we eat as
meals.
Minerals
• Minerals are inorganic substances.
•
They are not formed by living matter and contain no carbon. All organic mate
part of, or was produced by, living plants or animals.
•
Some minerals are: sodium, potassium, calcium, magnesium, and many others
• The most common combination is sodium chloride, or ordinary table salt.
Vitamins

•
The discovery of vitamins began early in the 20th century. It is likely that som
•
Eating a wide variety of foods ensures getting enough vitamins whether or not
•
All living things need vitamins for growth and health. The body either cannot
cannot normally manufacture them in sufficient amounts, and so must absorb
•
Each vitamin has specific roles to play. Many reactions in the body require se
excess of any one can interfere with the function of another.
Water
•
Water is often called the "forgotten nutrient." Next to air, although it is rarely
most important nutrient of all-vital to health and life itself.
• In order to live, every cell in the body must be bathed in water.
•
Water takes an active part in many chemical reactions and is needed to carry c
temperature, and to help eliminate wastes.
•
Water makes up about 60 percent of an adult's body weight. Requirements for
• Most fruits are more than 90 percent water.
DEFICIENCY DISEASES
•
A person may be getting enough food to eat, but sometimes the food may not
this continues over a long period of time, the person may suffer from its defici
•
Deficiency of one or more nutrients can cause diseases or disorders in our bod
•
Diseases that occur due to lack of nutrients over a long period are called defici

INSIGHT GENERAL STUDIES

NUTRITIONALDISORDERS

Nutrients Protein
Disorders
Kwashiorkor(Protein energy malnutrition, PEM)

Protein and Calorie Marasmus
Iron Anaemia, failure to mature RBC
Iodine Goitre
Flouride Dental caries
Vitamin C
(Ascorbic Acid) Scurvy
Vitamin A(Retinol) XerophthalmiaNight blindness (Nyctalopia)

Vitamin D
(Calciferol)
Vitamin B12
(Cyanocobalamin) Vitamin K
(Phylloquinone) Vitamin B9
(Folic acid)
Vitamin B
5(Niacin/
pantothenic acid) Vitamin B6
(Pyridoxine)
Vitamin B2
(Riboflavin)
Vitamin B1
(Thiamine)
Vitamin E
(Tocopherol)
Rickets in children

Calciferol

Pernicious Anaemia Haemorrhage
(Menadione)
Macrocytic anaemia Deficiency Symptoms
Stunted growth in the children; loss of apetite;
anaemia; bulging eyes; protruded belly; darkening of
the skin; repeated diarrhoea; atrophy of muscles,
oedema of hands, feet and face
Shrivelled appearance, subcutaneous fat used. ribs
prominent, skin dry and wrinkled, stunted growth and repeated diarrhoea,
extreme thinning of limbs emaciatien).
Reduced number and size of RBC, reduced haemoglobin
content, reduced learning ability. increased risk of
infection and even death during child birth.
Enlargement of thyroid gland, cretinism in childhood
causes retarded physical, mental and sexual growth
Appearance of cavities in the teeth due to acids
produced during anaerobic respiration of bacteria.
Bleeding gums, loosening and falling of teeth ,pain in muscles
Non-functioning of lacrymal glands; dryness and
keratinization of conjunctiva and cornea.Inability to see at night
Weak and soft bones, distorted skeleton, poor muscular development.
Osteomalacia in adult
Enlarged size but reduced number of erythrocytes.
Deficiency of prothrombin in the blood deficiency
of factor VII. IX and X required for blood coagulation.
Impairment of antibody synthesis, stunted growth.

Pellagra (4- D syndrome) Dermatitis, dementia, diarrhoea and death.
Marasmus

Cheilosis Convulsions, dermatitis, impairment of antibody synthesis
Cracking of skin at corners of mouth and base of nose

Beri-Beri
Sterility
Vitamin B3 (niacin)

Ageing Weight loss, emotional disturbance, weakness and pain

in limbs, irregular heart rate, swelling of body tissues.
ln adult female, foetus is resorbed in the uterus after
sometime. Atrophy of seminiferous tubules of testes in adult male.
Poor growth, early ageing and greying of hair.

PLANT NUTRIENT

(a)
The element must be absolutely necessary forsupporting normal growth and re
the element the plants do notcomplete their life cycle or set the seeds.
(b)
The requirement of the element must be specificand not replaceable by anothe
deficiency of any one elementcannot be met by supplying some otherelement.
(c)
The element must be directly involved in themetabolism of the plant. absolute
and metabolism. These elementsare further divided into two broad
categories based on their quantitativerequirements.
(i) Macronutrients, and
(ii) Micronutrients

•

Macronutrientsare generally present in plant tissues in large amounts (in exces
1 of dry
matter). The macronutrients include carbon, hydrogen, oxygen, nitrogen, phos
calcium and magnesium. Of these, carbon, hydrogen and oxygen are mainly o
the others are absorbed from the soil as mineral nutrition.

•

Micronutrientsor trace elements, are needed in very small amounts (less than 1
1 of dry matter).
These include iron, manganese, copper, molybdenum, zinc, boron, chlorine an

•

In addition to the essential elements named above, there are some beneficial e
silicon, cobalt and selenium. They are required by higher plants.
Role Of Mineral Elements In Plants

Plant Nutrient Deficiency Effects
Nitrogen Light green to yellow appearance of leaves, especially older leaves;
stunted growth; poor fruit development.

Excess Effects
Dark green foliage which may be susceptible
 to lodging, drought, disease and insect invasion.
 Fruit and seed crops may fail to yield.

Phosphorus Leaves may develop purple coloration;
Excess phosphorus may cause micronutrient
Potassium

Calcium stunted plant growth and delay in plant
 deficiencies, especially iron or zinc development
Older leaves turn yellow initially around margins and die; irregular
fruit development
Reduced growth or death of growing
Excess potassium may cause deficiencies in
magnesium and possibly calcium.

Excess calcium may cause deficiency in either tips; blossom-
end rot of tomato; poor magnesium or potassium with calcium and
fruit development and appearance.

Magnesium Initial yellowing of older leaves between leaf veins spreading to
younger leaves; poor fruit
development and production.

Sulfur Initial yellowing of young leaves spreading to whole plant; similar
symptoms to nitrogen deficiency but occurs on new growth.

Iron Initial distinct yellow or white areas potassium may reduce growth.
High concentration tolerated in plant; however,
imbalance with calcium and potassium may reduce growth.

Excess of sulfur may cause premature dropping of leaves.

Possible bronzing of leaves with tiny brown
between veins of young leaves leading spots. to spots of dead leaf tissue.

Manganese Older leaves have brown spots
Interveinal yellowing or mottling of surrounded by a chlorotic circle
young leaves.
or zone.

Zinc Interveinal yellowing on young
Excess zinc may cause iron deficiency in some leaves; reduced leaf size.
plants.
Boron Death of growing points and
Leaf tips become yellow followed by necrosis. deformation of leaves with
Leaves get a scorched appearance and later fall areas of discoloration. off.

┐ ┐ ┐ ┐ ┐

INSIGHT GENERAL STUDIES

TOPIC

10

DIGESTIVE SYSTEM

Introduction

The human digestive system consists of the alimentary canal and theassociate

Alimentary Canal

Buccalcavity

• The alimentary canal begins with an anterior opening –
the mouth, and it opens out posteriorly through the

anus.

• The mouth leads to the buccal cavity or oral cavity.

• The oral cavity has a number of teeth and a muscular tongue.

•

Each tooth is embedded in a socket of jaw bone. This type of attachment is ca

•

Majority of mammals including human being forms two sets of teeth during t

or deciduous teeth replaced by a set of permanent or adult teeth.

• This type of dentition is called diphyodont.

•

An adult human has 32 permanent teeth which are of four different types (Het

incisors (I), canine (C), premolars (PM) and molars (M).

•

The hard chewing surface of the teeth, made up of enamel, helpsin the mastic

•

The tongue is a freely movable muscular organattached to the floor of the oral

upper surfaceof the tongue has small projections called papillae, some of whic

Oesophagus

•

The oral cavity leads into a short pharynx which serves as a common passage

• The oesophagus and the trachea (wind pipe) open into the pharynx.
•
A cartilaginous flap called epiglottis prevents the entry of food into the glottis
opening of the wind pipe –

during swallowing.
•
The oesophagus is a thin, long tube which extends posteriorly passing through
and leads to a 'J' shaped bag like structure called stomach.
• A muscular sphincter (gastro-
oesophageal) regulates the opening of oesophagus into the stomach. Stomach
•
The stomach, located in the upper left portion of the abdominal cavity, has thr
• A cardiac portion into which the oesophagus opens,
• A fundic region and
• A pyloric portion which opens into the first part of small intestine
Intestine
•
Small intestine is distinguishable into three regions, a 'U' shaped duodenum, a
jejunum and a highly coiled ileum.
•
The opening of the stomach into the duodenum is guarded by the pyloric sphi
•
Ileum opens into the large intestine. It consists of caecum, colon and rectum.
• Caecum is a small blind sac which hosts some symbiotic micro-organisms.
• A narrow finger-
like tubular projection, the vermiform appendix which is a vestigial organ, aris
caecum.

• The caecum opens into the colon.
• The colon is divided into three parts –
an ascending, a transverse and a descending part. The descending part opens into the rectum which opens out through the anus.

•

Ileum has the largest size in comparision to Jejunum followed by Duodenum.

•

The wall of alimentary canal from oesophagus to rectum possesses four layers sub-mucosa and mucosa.

•

Serosa is the outermost layer and is made up of a thin mesothelium (epitheliur connective tissues.

•

Muscularis is formed by smooth muscles usually arranged into an inner circul layer. An oblique muscle layer may be present in some regions.

•

The submucosal layer is formed of loose connective tissues containing nerves, duodenum, glands are also present in sub-mucosa.

• The innermost layer lining the lumen of the alimentary canal is the mucosa.
• This layer forms irregular folds (rugae) in the stomach and small finger-like foldings called villi in the small intestine.

•

The cells lining the villi produce numerous microscopic projections called mic appearance. These modifications increase the surface area enormously.

•

Villi are supplied with a network of capillaries and a large lymph vessel callec

•

Mucosal epithelium has goblet cells which secrete mucus that help in lubricati

•

Mucosa also forms glands in the stomach (gastric glands) and crypts in betwee intestine (crypts of Lieberkuhn). All the four layers show modifications in diff canal.

• Appendix is found attached to the large intentine.

Digestive Glands

•

The digestive glands associated with the alimentary canal include the salivary

•

Saliva is mainly produced by three pairs of salivary glands, the parotids (cheel maxillary/submandibular (lower jaw) and the sublinguals (below the tongue).

•

These glands situated just outside the buccal cavity secrete salivary juice into human. It is situated in the abdominal cavity, just below the diaphragm and ha

•

The hepatic lobules are the structural and functional units of liver containing h form of cords. Each lobule is covered by a thin connective tissue sheath called

•

The bile secreted by the hepatic cells passes through the hepatic ducts and is s muscular sac called the gall bladder.

•

The duct of gall bladder (cystic duct) along with the hepatic duct from the live The bile duct and the pancreatic duct open together into the duodenum as the c pancreatic duct which is guarded by a sphincter called the sphincter of Oddi.

•

The pancreas is a compound (both exocrine and endocrine) elongated organ si the ‘U’ shaped duodenum.

•

The exocrine portion secretes an alkaline pancreatic juice containing enzyme a secretes hormones, insulin and glucagon.

Digestion Of Food

•

The process of digestion is accomplished by mechanical and chemical process

•

The buccal cavity performs two major functions, mastication of food and facil

•

The teeth and the tongue with the help of saliva masticate and mix up the food helps in lubricating and adhering the masticated food particles into a bolus.

•

The bolus is then conveyed into the pharynx and then into the oesophagus by s

•

The bolus further passes down through the oesophagus by successive waves o
peristalsis.

• The gastro-
oesophageal sphincter controls the passage of food into the stomach. The saliv
oral cavity contains electrolytes (Na^+, K^+, Cl^-, HCO^-) and enzymes, salivary

•

The chemical process of digestion is initiated in the oral cavity by the hydroly
splitting enzyme, the salivary amylase.

•

About 30 per cent of starch is hydrolysed here by this enzyme (optimum pH 6
maltose.

Lysozyme present in saliva acts as an antibacterial agent that prevents infectio

•

The mucosa of stomach has gastric glands. Gastric glands have three major ty
(i) Mucus neck cells which secrete mucus;
(ii) Peptic or chief cells which secrete the proenzyme pepsinogen; and
(iii)
Parietal or oxyntic cells which secrete HCl and intrinsic factor(factor essential

• The stomach stores the food for 4-
5 hours. The food mixes thoroughly with the acidic gastric juice of the
stomach by the churning movements of its muscular wall and is called the chy

•

The proenzyme pepsinogen, on exposure to hydrochloric acid gets converted i
the proteolytic enzyme of the stomach.

•

Pepsin converts proteins into proteoses and peptones (peptides). The mucus an
gastric juice play an important role in lubrication and protection of the mucosa
by the highly concentrated hydrochloric acid.

•

HCl provides the acidic pH (pH 1.8) optimal for pepsins. Rennin is a proteoly
of infants which helps in the digestion of milk proteins.

• Small amounts of lipases are also secreted by gastric glands.

•

Various types of movements are generated by the muscularis layer of the smal
help in a thorough mixing up of the food with various secretions in the intestir
digestion.

•

The bile, pancreatic juice and the intestinal juice are the secretions released in
juice and bile are released through the hepato-pancreatic duct.

• The pancreatic juice contains inactive enzymes –
trypsinogen, chymotrypsinogen, procarboxypeptidases,
amylases, lipases and nucleases.

•

Trypsinogen is activated by an enzyme, enterokinase, secreted by the intestina
which in turn activates the other enzymes in the pancreatic juice.

•

The bile released into the duodenum contains bile pigments (bilirubin and bili-
verdin), bile salts, cholesterol and phospholipids but no enzymes.

•

Bile helps in emulsification of fats, i.e., breaking down of the fats into very sn
lipases.

• The intestinal mucosal epithelium has goblet cells which secrete mucus.

•

The secretions of the brush border cells of the mucosa alongwith the secretion
the intestinal juice or succus entericus.

•

This juice contains a variety of enzymes like disaccharidases (e.g., maltase), d
nucleosidases, etc.

•

The mucus alongwith the bicarbonates from the pancreas protects the intestina
provide an alkaline medium (pH 7.8) for enzymatic activities. Sub-
mucosal glands (Brunner's glands) also help in this.

•

Proteins, proteoses and peptones (partially hydrolysed proteins) in the chyme
acted upon by the proteolytic enzymes of pancreatic juice as given below:

•

Carbohydrates in the chyme are hydrolysed by pancreatic amylase into disacc
by lipases with the help of bile into di-
and monoglycerides. Nucleases in the pancreatic juice acts on nucleic

acids to form nucleotides and nucleosides

•

The enzymes in the succus entericus act on the end products of the above reac
simple absorbable forms. These final steps in digestion occur very close to the
intestine.

•

The breakdown of biomacromolecules occurs in the duodenum region of the s

•

The simple substances thus formed are absorbed in the jejunum and ileum reg
undigested and unabsorbed substances are passed on to the large intestine.

•

No significant digestive activity occurs in the large intestine. The functions of

• Absorption of some water, minerals and certain drugs;

•

Secretion of mucus which helps in adhering the waste (undigested) particles to
easy passage.

•

The undigested, unabsorbed substances called faeces enters into the caecum o
ileo-
caecal valve, which prevents the back flow of the faecal matter. It is temporari
defaecation.

• The activities of the gastro-
intestinal tract are under neural and hormonal control for proper coordination
different parts. The sight, smell and/or the presence of food in the oral cavity
saliva.

•

Gastric and intestinal secretions are also, similarly, stimulated by neural signa

•

The muscular activities of different parts of the alimentary canal can also be m
both local and through CNS.

•

Hormonal control of the secretion of digestive juices is carried out by the loca
gastric and intestinal mucosa.

Absorption Of Digested Products

•

Absorption is the process by which the end products of digestion pass through
blood or lymph.

•

It is carried out by passive, active or facilitated transport mechanisms. Small a
glucose, amino acids and some of electrolytes like chloride ions are generally

•

The passage of these substances into the blood depends upon the concentratio
the substances like fructose and some amino acids are absorbed with the help
mechanism is called the facilitated transport.

•

Transport of water depends upon the osmotic gradient. Active transport occur
gradient and hence requires energy.

•

Various nutrients like amino acids, monosacharides like glucose, electrolytes
blood by this mechanism. Fatty acids and glycerol being insoluble, cannot be

•

They are first incorporated into small droplets called micelles which move int

• They are re-
formed into very small protein coated fat globules called the chylomicrons wh
into the lymph vessels (lacteals) in the villi. These lymph vessels ultimately re
into the blood stream.

•

Absorption of substances takes place in different parts of the alimentary canal
intestine and large intestine. However, maximum absorption occurs in the sma

•

The absorbed substances finally reach the tissues which utilise them for their
assimilation.

•

The digestive wastes, solidified into coherent faeces in the rectum initiate a ne
desire for its removal.

┐ ┐ ┐ ┐ ┐

INSIGHT GENERAL STUDIES

TOPIC

11

RESPIRATION

Introduction

•

The process of oxidation of food stuff is called respiration, this process of inha
complex respiratory system. Mechanisms of breathing vary among different g
mainly on their habitats and levels of organisation.

•

Lower invertebrates like sponges, coelenterates, flatworms, etc., exchange O_2
over their entire body surface.

•

Earthworms use their moist cuticle and insects have a network of tubes (trache
air within the body.

•

Special vascularised structures called gills are used by most of the aquatic artl
vascularised bags called lungs are used by the terrestrial forms for the exchang

•

Among vertebrates, fishes use gills whereas reptiles, birds and mammals respi
like frogs can respire through their moist skin also. Mammals have a well dev
Human Respiratory System

•

A pair of external nostrils opening out above the upper lips, leads to a nasal ch
passage.

•

The nasal chamber opens into nasopharynx, which is a portion of pharynx, the
air.

• Nasopharynx opens through glottis of the larynx region into the trachea.

•

Larynx is a cartilaginous box which helps in sound production and hence calle
glottis can be covered by a thin elastic cartilaginous flap called epiglottis to pr
larynx.

• Trachea is a straight tube extending up to the mid-

thoracic cavity, which divides at the level of 5th thoracic
vertebra into a right and left primary bronchi.

•

Each bronchi undergoes repeated divisions to form the secondary and tertiary
up in very thin terminal bronchioles.

•

The tracheae, primary, secondary and tertiary bronchi, and initial bronchioles
cartilaginous rings.

•

Each terminal bronchiole gives rise to a number of very thin, irregularwalled a
like structures
called alveoli. The branching network of bronchi, bronchioles and alveoli com

•

Human being have two lungs which are covered by a double layered pleura, w
It reduces friction on the lungsurface.

•

The outer pleural membrane is in close contact with the thoracic lining wherea
is in contact with the lung surface. The part starting with the external nostrils u
constitute the conducting part whereas the alveoli and their ducts form the res
the respiratory system.

•

The conducting part transports the atmospheric air to the alveoli, clears it from
and also brings the air to body temperature. Exchange part is the site of actual
between blood and atmospheric air.

• The lungs are situated in the thoracic chamber which is anatomically an air-tight chamber.

INSIGHT GENERAL STUDIES

•
The thoracic chamber is formed dorsally by the vertebral column, ventrally by
ribs and on the lower side by the dome-shaped diaphragm.
•
The anatomical setup of lungs in thorax is such that any change in the volume
reflected in the lung (pulmonary) cavity. Such an arrangement is essential for
alter the pulmonary volume.
• Respiration involves the following steps:
•
Breathing or pulmonary ventilation by which atmospheric air is drawn in and
out.
• Diffusion of gases (O_2 and CO_2) across alveolar membrane.
• Transport of gases by the blood.
• Diffusion of O_2 and CO_2 between blood and tissues.
•
Utilisation of O_2 by the cells for catabolic reactions and resultant release of C
Mechanism of breathing
•
Breathing involves two stages :inspiration during which atmospheric air is dra
the alveolar air is released out.
•
The movement of air into and out of the lungs is carried out by creating a pres
and the atmosphere.
• Inspiration occur if the pressure within the lungs (intra-
pulmonary pressure) is less than the atmospheric pressure.
• Expiration takes place when the intra-
pulmonary pressure is higher than the atmospheric pressure.
• The diaphragm and a specialised set of muscles –
external and internal intercostals between the ribs, help in
generation of such gradients.
•
Inspiration is initiated by the contraction of diaphragm which increases the vo

antero-posterior axis.
• Relaxation of the diaphragm and the inter-
costal muscles returns the diaphragm and sternum to their normal
positions and reduce the thoracic volume and thereby the pulmonary volume.
• A healthy human breathes 12-16 times/minute.
•
The volume of air involved in breathing movements can be estimated by using
clinical assessment of pulmonary functions.
Exchange of gases
• Alveoli are the primary sites of exchange of gases.
•
Exchange of gases also occur between blood and tissues. O_2 and CO_2 are exch
diffusion mainly based on pressure/concentration gradient.
•
Solubility of the gases as well as the thickness of the membranes involved in c
factors that affect the rate of diffusion.
Transport of gases
Blood is the medium of transport for O2 and CO2. About 97 per cent of O2 is
remaining 3 per cent of O2 is carriedin a dissolved state through the plasma. N
25 per cent of CO2 istransported
by RBCs whereas 70 per cent of it is carried as bicarbonate.About 7 per cent c
through plasma.
(a) Transportation of Oxygen
•
Haemoglobin is a red coloured iron containing pigment present in the RBCs.
•
O_2 can bind with haemoglobin in a reversible manner to form oxyhaemoglobi
• Each haemoglobin molecule can carry a maximum of four molecules of O_2.
•
Binding of oxygen with haemoglobin is primarily related to partial pressure of
•
Partial pressure of CO_2, hydrogen ion concentration and temperature are the o
with this binding.

•

In the alveoli, where there is high pO2(partial pressure of oxygen), low pCO2(
oxide), lesser H+ concentration and lower temperature, the factors are all favo
oxyhaemoglobin, whereas in the tissues, where low pO2, high pCO2, high H+
temperature exist, the conditions are favourable for dissociation of oxygen fro

•

O_2 gets bound to haemoglobin in the lung surface and gets dissociated at the ti
blood can deliver around 5 ml of O_2 to the tissues under normal physiological

(b) Transport of Carbon dioxide

• CO_2 is carried by haemoglobin as carbamino-
haemoglobin, pO2 is a major factor which could affect this binding.

•

When pCO2 is high and pO2 is low as in the tissues, more binding of carbon c

pCO2 is low and pO2 is high as in the alveoli, dissociation of CO2 from carba
haemoglobin takes place,
i.e., CO2 which is bound to haemoglobin from the tissues is delivered at the al

•

RBCs contain a very high concentration of the enzyme, carbonic anhydrase an
is present in the plasma too. This enzyme facilitates the reaction in both direc

•

At the tissue site where partial pressure of CO2 is high due to catabolism, CO2
plasma) and forms HCO3- and H+.

•

At the alveolar site where pCO2 is low, the reaction proceeds in the opposite c
of CO2 and H2O. Thus, CO2 trapped as bicarbonate at the tissue level and tra
out as CO2.

•

Every 100 ml of deoxygenated blood delivers approximately 4 ml of CO2 to t
Regulation Of Respiration

•

Human beings have a significant ability to maintain and moderate the respirat
of the body tissues. This is done by the neural system.

•

A specialised centre present in the medulla region of the brain called respirato
responsible for this regulation.

•

Another centre present in the pons region of the brain called pneumotaxic cen
of the respiratory rhythm centre. Neural signal from this centre can reduce the
thereby alter the respiratory rate.

•

A chemosensitive area is situated adjacent to the rhythm centre which is highl
ions. Increase in these substances can activate this centre, which in turn can si
necessary adjustments in the respiratory process by which these substances ca

•

Receptors associated with aortic arch and carotid artery also can recognize ch
and send necessary signals to the rhythm centre for remedial actions. The role
respiratory rhythm is quite insignificant.

Gas Inhaled Air (%) Exhaled air (%)
Oxygen 21 16
Carbon dioxide 0.4 4
Water vapour trace varies 1
Nitrogen 79 79

•

There are two types of respiration (i) aerobic respiration and (ii) anaerobic res

•

Aerobic respiration is a process that requires oxygen, but in anaerobic respirat
Therefore aerobic and anaerobic respiration differs in terms of the amount of e

•

During the process of aerobic respiration, the molecules of food are broken do

•

Oxygen is present at the end point of the electron acceptor. The molecules of f
the cells of the body during the process of the respiration are composed of glu
acids.

- A lot of energy is produced during aerobic respiration, which may be as high a glucose molecule. This means that during aerobic respiration only one molecu about thirty-eight energy units.

$C_6H_{12}O_6{}^{23}_{11}$ $2C_2H_6OH + 2CO_26O_2$+ Energy

- Anaerobic means where there is no air and thus anaerobic respiration is a term occurs without the use of oxygen.
- In this process, the molecules carry oxidation, when oxygen is absent. This res or ATP.
- This type of respiration is also equivalent to fermentation when energy produc is functioning in one cell.
- There are two processes of this respiration (i) alcoholic fermentation, where th and produces Energy (ATP), Ethanol and Carbon Dioxide as well as (ii) Lacta breaks itself into Energy and Lactic Acid.

$C_6H_{12}O_6$ ${}^{23}_{11}2$ $C_2H_5OH + 2CO_2$+ energy
(glucose) (ethyl alcohol)

$C_6H_{12}O_6{}^{23}_{11}2C_3H_6O_3$+ energy
(glucose) (Lactic acid)

- Anaerobic respiration produces less energy when compared with the process c be best illustrated with the fact that during the anaerobic respiration only two r for one glucose molecule
- Anaerobic respiration produces less energy in comparison to aerobic respiratio

Respiratory Volumes and Capacities

• Tidal Volume
(TV):Volume of air inspired or expired during a normal respiration. It is appro
healthy man can inspire or expire approximately 6000 to 8000 mL of air per m
• Inspiratory Reserve Volume (IRV):
Additional volume of air, a person can inspire by a forcible inspiration. This averages 2500 mL to 3000 mL.
• Expiratory Reserve Volume
(ERV):Additional volume of air, a person can expire by a forcible expiration. averages 1000 mL to 1100 mL.
• Residual Volume
(RV):Volume of air remaining in the lungs even after a forcible expiration. Th
1100 mL to 1200 mL. By adding up a few respiratory volumes described abov
capacities, which can be used in clinical diagnosis.
• Inspiratory Capacity
(IC):Total volume of air a person can inspire after a normal expiration. This in
volume and inspiratory reserve volume (TV+IRV).
• Expiratory Capacity
(EC):Total volume of air a person can expire after a normal inspiration. This i
volume and expiratory reserve volume (TV+ERV).
• Functional Residual Capacity
(FRC):Volume of air that will remain in the lungs after a normal expiration. T
includes ERV+RV.
• Vital Capacity
(VC):The maximum volume of air a person can breathe in after a forced expir
ERV, TV and IRV or the maximum volume of air a person can breathe out aft
• Total Lung
Capacity:Total volume of air accommodated in the lungs at the end of a force
includes RV, ERV, TV and IRV or vital capacity + residual volume.

ㄱ ㄱ ㄱ ㄱ ㄱ

TOPIC

12

HUMANCIRCULATORYSYSTEM

Introduction

•

Human circulatory system composed of two parts- Blood circulatory system a
blood vascular system consists of a muscular chambered heart, a network of c
and blood, the fluid which is circulated.

•

Heart, the mesodermally derived organ, is situated in the thoracic cavity, in be
tilted to the left. It has the size of a clenched fist. It is protected by a double wa
pericardium, enclosing the pericardial fluid.

•

Heart has four chambers, two relatively small upper chambers called atria and
called ventricles.

•

A thin, muscular wall called the interatrial septum separates the right and the l
ventricular septum, separates the left and the right ventricles.

•

The atrium and the ventricle of the same side are also separated by a thick fibr
chambers of the same side are connected.

•

The opening between the right atrium and the right ventricle is guarded by a v
flaps or cusps, the tricuspid valve, whereas a bicuspid or mitral valve guards tl
atrium and the left ventricle.

•

The openings of the right and the left ventricles into the pulmonary artery and
provided with the semilunar valves.

•

The valves in the heart allows the flow of blood only in one direction, i.e., fro
from the ventricles to the pulmonary artery or aorta. These valves prevent any

•

The entire heart is made of cardiac muscles. The walls of ventricles are much

•

A specialised cardiac musculature called the nodal tissue is also distributed in
is present in the right upper corner of the right atrium called the sino-
atrial node (SAN).

•

Another mass of this tissue is seen in the lower left corner of the right atrium c
ventricular septum called the atrio-ventricular node (AVN).

•

A bundle of nodal fibres, atrioventricular bundle (AV bundle) continues from
the atrio-
ventricular septa to emerge on the top of the interventricular septum and imme
a right and left bundle.

•

These branches give rise to minute fibres throughout the ventricular musculatu
are called purkinje fibres. These fibres alongwith right and left bundles are kn

•

The nodal musculature has the ability to generate action potentials without any
autoexcitable. However, the number of action potentials that could be generate
parts of the nodal system.

• The SAN can generate the maximum number of action potentials, i.e., 70-
75 min–1, and is responsible for
initiating and maintaining the rhythmic contractile activity of the heart, it is ca

• Our heart normally beats 70-75 times in a minute (average 72 beats min^1).

Double circulation

•

Blood pumped by the right ventricle enters the pulmonary artery, whereas the
into the aorta.

•

The deoxygenated blood pumped into the pulmonary artery is passed on to the
oxygenated blood is carried by the pulmonary veins into the left atrium. This p
circulation.

•

The oxygenated blood entering the aorta is carried by a network of arteries, ar
tissues from where the deoxygenated blood is collected by a system of venules
emptied into the right atrium. This is the systemic circulation .

•

The systemic circulation provides nutrients, O2 and other essential substances
and other harmful substances away for elimination.

•

A unique vascular connection exists between the digestive tract and liver calle

•

The hepatic portal vein carries blood from intestine to the liver before it is deli

•

A special coronary system of blood vessels is present in our body exclusively
and from the cardiac musculature.

DISORDERS OF CIRCULATORY SYSTEM

High Blood Pressure (Hypertension)

•

Hypertension is the term for blood pressure that is higher than normal (120/80

Hg (millimetres of mercury pressure) is the systolic, or pumping, pressure and
resting, pressure.

•

If repeated checks of blood pressure of an individual is 140/90 (140 over 90) c

•

High blood pressure leads to heart diseases and also affects vital organs like b

Coronary Artery Disease (CAD)

•

Coronary Artery Disease, often referred to as atherosclerosis, affects the vesse heart muscle.

•

It is caused by deposits of calcium, fat, cholesterol and fibrous tissues, which r
narrower.

Angina

•

It is also called 'angina pectoris'. A symptom of acute chest pain appears whe
the heart muscle.

•

Angina can occur in men and women of any age but it is more common amon
aged and elderly.

• It occurs due to conditions that affect the blood flow.

Heart Failure

•

Heart failure means the state of heart when it is not pumping blood effectively
the body.

•

It is sometimes called congestive heart failure because congestion of the lungs
of this disease.

•

Heart failure is not the same as cardiac arrest (when the heart stops beating) or
muscle is suddenly damaged by an inadequate blood supply).

LYMPH (TISSUE FLUID)

•

As the blood passes through the capillaries in tissues, some water along with m
substances move out into the spaces between the cells of tissues leaving the la
formed elements in the blood vessels.

•

This fluid released out is called the interstitial fluid or tissue fluid. It has the sa
in plasma.

•

Exchange of nutrients, gases, etc., between the blood and the cells always occu

•

An elaborate network of vessels called the lymphatic system collects this fluid
veins. The fluid present in the lymphatic system is called the lymph.

•

Lymph is a colourless fluid containing specialised lymphocytes which are resp of the body.

•
Lymph is also an important carrier for nutrients, hormones, etc. Fats are absor
lacteals present in the intestinal villi.
Human blood and circulatory system
Blood is the circulatory fluid of the circulatory system. It is a specialized conn
following vital functions:
•
In respiration, transport of oxygen from the lungs to the tissues and of carbon
lungs.
• In nutrition, transport of absorbed food substances to the cells .
•
In excretion, transport of metabolic wastes to the kidneys, skin and intestine fo
•
ln regulation of metabolism, transport of hormones from their site of productio
• In other regulatory mechanisms, maintenance of body temperature, osmo-regulation, and acid-base balance.
• In clotting of blood.
Blood and its Composition
• Blood is a red sticky fluid, slightly alkaline in nature.
•
Blood is a special connective tissue consisting of a fluid matrix, plasma, and fo
of a fluid portion, the plasma (50-
55% of the volume) and three types of corpuscles (45-50% of the blood
volume) namely erythrocytes (red blood corpuscles, RBC), leucocytes (white
blood platelets.
• The corpuscles are embedded in the plasma.
• Plasma is light yellow fluid with 90-92% water, 6-
9% .proteins and 1% of dissolved substances.
•
Plasma acts in blood clotting and in defence of the body against diseases. Plas
is called serum.
•
RBC or red blood cells or erythrocytes number about 5 million per cubic mm

devoid of nuclei.

•

RBC mainly consist of haemoglobin, a pigment which transports oxygen. The marrow. Their average life span is 110 to 120 days. Worn out cells are destroy 8 ìm.

•

WBC or white blood cells or leucocytes, are larger, fewer about 5 to 9 thousar contain one nucleus each. They are of five different types namely- neutrophils eosinophils and monocytes. Their major function is to provide immunity to th span of less than 2 weeks and they are produced in the red bone narrow. An ov into a disease called leukemia.Cell size is 7-21 ìm.

(21ìm in human macrophage)

•

Platelets or thrombocytes are small spherical bodies numbering about 300,000 play an important role in the formation of a solid plug called clot at the site of prevent further loss of blood. Blood platelets are enucleated. They live for onl

•

CO binds 200 times more strongly in comparision to Oxygen and form carbox not found in Earth worm blood.

Human blood chemistry

Water 90-92% Proteins

(Albumen, Globulin, Properdin, Prothrombin, Fibrinogen) 6-8% Inorganic Salts (Cations are Na, K, Mg,Ca, Fe and Mn. Anions are chloride, 1-2% bicarbonate and phosphate)

Others

(i) Food Materials (Glucose, Amino Acids, Fatty Acids, Triglycerides) 0.2-1% (ii) Waste Materials (Urea, Uric Acid and Creatinine)

(iii) Regulatory Substances (Hormones, Vitamins, Enzymes)

(iv) Anticoagulants (Heparin)

(v) Cholesterol
(vi) Antibodies
(vii) Dissolved Gases (O_2, CO_2, N_2)
(viii)Ph of Blood is7.4

Blood Groups

•
The four types of blood are called blood groups, and are known by the letters
•
Before the blood transfusion can take place it is necessary to make sure that th

will mix together without agglutination. Blood groups which mix without agg
compatible.

•
Blood compatibility depends upon chemicals called agglutinogen or antigens
and chemicals called agglutinin or antibodies in the plasma.
•
There are two types of antigens: A and B; and two types of antibodies: anti- a
b.
• Blood group A has A antigen on its red cells and anti-
b antibody in its plasma.
• Blood group B has B antigen on its red cells and anti-
a antibody in its plasma.
• Blood group AB
has A and B antigens on its red cells and no antibodies in its plasma.
• Blood group O has no antigens on its red cells but has both anti—a and anti-
b antibodies in its plasma.

Blood Transfusion

Anti-a plasma agglutinates A red cells, and anti-
b plasma agglutinates B red cells. So these combinations of plasma
and red cell are incompatible as far as blood transfusion is concerned.
These facts have given rise to a rule for blood transfusions: the donor's red ce

recipient’s plasma. Thus blood can be safely transfused as follows:

Blood Group Transfused or donated to persons with blood groups A
A and AB B B and AB

AB AB only O All groups

Receive blood from Persons with blood groups A and O
B and O
All groups
O only

•
People with Group O blood are called universal donors. Their red cells have n
agglutinated by blood of any other group.
•
People with Group AB are called universal recipients. Their plasma has no ant
agglutinate blood from the other groups.
Rhesus Factor
•
About 85% of humans have an antigen on their red cells called the Rhesus fac
•
People with the Rhesus factor are called Rhesus positive (Rh^+) and those with
(Rh^-).
•
Rh^- patients can receive one transfusion of Rh^+ blood without harm because th
antibody to react with the incoming red cells.
•
Subsequent transfusion, however, may be dangerous because Rh^+ blood stimu
into producing a plasma antibody which agglutinates Rh^+ blood. Such recipien
to Rh^+ blood and will agglutinate any which is transfused into them.
•
Rh^- blood can be transfused into Rh^+ people any number of times without harm
•
A Rh^+ father and Rh^- mother could have a Rh^+ child. During pregnancy the de
enter the mother’s blood. perhaps through a fault in the placenta. The mother’s
antibody which destroys Rh^+ cells. This anti-

body will not harm her first child but if she has a second Rh^+ child

and its red cells enter her blood. she will produce more antibody and there is a
embryo, destroy its red cells, a condition known as erythroblastosis foetalis wl
disorders or death.

•

This danger can be avoided. A Rh^- mother with a new born Rh^+ child can be i
her body producing the Rhesus antibody.

INSIGHT GENERAL STUDIES

TOPIC

13

HUMAN EXCRETORYSYSTEM

Introduction

The biological process through which the toxic residual substances of human l

In humans, the excretory system consistsof a pair of kidneys, one pair of urete

Kidney

•

Kidneys are reddish brown, bean shaped structures situated between the levels

lumbar vertebra close to the dorsal inner wall of the abdominal cavity.

• Each kidney of an adult human measures 10-12 cm in length, 5-
7 cm in width, 2-3 cm in thickness with an
average weight of 120- 170 g.

•

Towards the centre of the inner concave surface of the kidney is a notch callec
blood vessels and nerves enter.

•

Inner to the hilum is a broad funnel shaped space called the renal pelvis with p

• The outer layer of kidney is a tough capsule.

• Inside the kidney, there are two zones, an outer cortex and an inner medulla.

•

The medulla is divided into a few conical masses (medullary pyramids) projec
calyx).

•

The cortex extends in between the medullary pyramids as renal columns callec

•

Each kidney has nearly one million complex tubular structures called nephron
units.

Structure of nephron

• Each nephron has two parts – the glomerulus and the renal tubule.

• Glomerulus is a tuft of capillaries formed by the afferent arteriole –
a fine branch of renal artery. Blood from

the glomerulus is carried away by an efferent arteriole.
• The renal tubule begins with a double walled cup-
like structure called Bowman’scapsule, which encloses the
glomerulus.
•
Glomerulus alongwith Bowman’s capsule, is called the malpighian body or re
• The tubule continues further to form a highly coiled network –
proximal convoluted tubule (PCT).
•
A hairpin shaped Henle’s loop is the next part of the tubule which has a desce
•
The ascending limb continues as another highly coiled tubular region called di
•
The DCTs of many nephrons open into a straight tube called collecting duct, r
into the renal pelvis through medullary pyramids in the calyces.
•
The Malpighian corpuscle, PCT and DCT of the nephron are situated in the cc
whereas the loop of Henle dips into the medulla.
•
In majority of nephrons, the loop of Henle is too short and extends only very l
nephrons are called cortical nephrons.
•
In some of the nephrons, the loop of Henle is very long and runs deep into the
• These nephrons are called juxta medullary nephrons.
•
The efferent arteriole emerging from the glomerulus forms a fine capillary net
called the peritubular capillaries.

•

A minute vessel of this network runs parallel to the Henle's loop forming a 'U
absent or highly reduced in cortical nephrons.

URINE FORMATION (Working process of Kidney)

•

Urine formation involves three main processes namely, glomerular filtration, r
that takes place in different parts of the nephron.

•

The first step in urine formation is the filtration of blood, which is carried out
glomerular filtration.

• On an average, 1100-
1200 ml of blood is filtered by the kidneys per minute which constitute roughl
the blood pumped out by each ventricle of the heart in a minute.

•

The glomerular capillary blood pressure causes filtration of blood through 3 la
glomerular blood vessels, the epithelium of Bowman's capsule and a basemen
two layers.

•

The epithelial cells of Bowman's capsule called podocytes are arranged in an
some minute spaces called filtration slits or slit pores.

•

Blood is filtered so finely through these membranes, that almost all the constit
proteins pass onto the lumen of the Bowman's capsule. Therefore, it is conside
filtration.

•

The amount of the filtrate formed by the kidneys per minute is called glomeru
a healthy individual is approximately 125 ml/minute, i.e., 180 litres per day.

• The kidneys have built-
in mechanisms for the regulation of glomerular filtration rate. One such efficie
mechanism is carried out by juxta glomerular apparatus (JGA).

•

JGA is a special sensitive region formed by cellular modifications in the distal
afferent arteriole at the location of their contact.

•
A fall in GFR can activate the JG cells to release renin which can stimulate th
thereby the GFR back to normal.
•
A comparison of the volume of the filtrate formed per day (180 litres per day)
(1.5 litres), suggest that nearly 99 per cent of the filtrate has to be reabsorbed l
process is called reabsorption.
•
The tubular epithelial cells in different segments of nephron perform this eithe
mechanisms.For example, substances like glucose, amino acids, Na+, etc., in t
actively whereas the nitrogenous wastes are absorbed by passive transport.
•
Reabsorption of water also occurs passively in the initial segments of the neph
•
During urine formation, the tubular cells secrete substances like H+, K+ and a
•
Tubular secretion is also an important step in urine formation as it helps in the
base balance of body fluids.
Other Exceretory Organs
•
Lung performs the excretory function, it excretes gaseous substances like carb
and some substances like garlic, onion and some other substance in which vol
• Skin secrets sibum and sweat respectively.
•
Liver transform the excessive amino acids and ammonia of the blood into urea
•
Intestine also helps in pumping out the excretory substances like residual wast
DISORDEROFTHEEXCRETORYSYSTEM
Kidney Failure
•
Malfunctioning of kidneys can lead to accumulation of urea in blood, a condit
highly harmful and may lead to kidney failure. In such patients, urea can be re
hemodialysis. Blood drained from a convenient artery is pumped into a dialysi

anticoagulant like heparin.The unit contains a coiled cellophane tube surround
having the same composition as that of plasma except the nitrogenous wastes.
membrance of the tube allows the passage of molecules based on concentratio
wastes are absent in the dialysing fluid, these substances freely move out, ther
cleared blood is pumped back to the body through a vein after adding anti-heparin to it. This method is a boon
for thousands of uremic patients all over the world.

•

Kidney transplantation is the ultimate method in the correction of acute renal f
functioning kidney is used in transplantation from a donor, preferably a close r
of rejection by the immune system of the host. Modern clinical procedures hav
such a complicated technique.

Renal calculi

•

Stone or insoluble mass of crystallised salts (oxalates, etc.) formed within the
Glomerulonephritis

• Inflammation of glomeruli of kidney.

┓┓┓┓┓

INSIGHT GENERAL STUDIES

TOPIC

14

MUSCLE

Introduction
• Muscle is a specialised tissue of mesodermal origin.
• About 40-
50 percent of the body weight of a human adult is contributed by muscles.
•
They have special properties like excitability, contractility, extensibility and e
•
Muscles have been classified using different criteria, namely location, appeara

their activities. Based on their location, three types of muscles are identified :
Cardiac.

•
Skeletal muscles are closely associated with the skeletal components of the bo
appearance under the microscope and hence are called striated muscles. As the
voluntary control of the nervous system, they are known as voluntary muscles
in locomotory actions and changes of body postures.
•
Visceral muscles are located in the inner walls of hollow visceral organs of the
reproductive tract, etc. They do not exhibit any striation and are smooth in app
smooth muscles (nonstriated muscle). Their activities are not under the volunt
system and are therefore known as involuntary muscles. They assist, for exam
food through the digestive tract and gametes through the genital tract.
•
Cardiac muscles are the muscles of heart. Many cardiac muscle cells assemble
a cardiac muscle. Based on appearance, cardiac muscles are striated. They are
nervous system does not control their activities directly.

SKELETAL SYSTEM

•
Skeletal system consists of a framework of bones and a few cartilages. This sy
movement shown by the body .
• Bone and cartilage are specialised connective tissues.
•
The former has a very hard matrix due to calcium salts in it and the latter has s
chondroitin salts.
•
In human beings, this system is made up of 206 bones and a few cartilages. It
divisions – the axial and the appendicular skeleton.
Axial skeleton
Axial skeletoncomprises 80 bones distributed along the main axis of the body.
and ribs constitute axial skeleton.
Skull
• It is composed of two sets of bones –
cranial and facial, that totals to 22 bones.
•
Cranial bones are 8 in number. They form the hard protective outer covering,
region is made up of 14 skeletal elements which form the front part of the sku
• A single U-
shaped bone called hyoid is present at the base of the buccal cavity and it is al
skull.
• Each middle ear contains three tiny bones –
Malleus, Incus and Stapes, collectively called Ear Ossicles.
•
The skull region articulates with the superior region of the vertebral column w
condyles (dicondylic skull).

Vertebral column

- Itis formed by 26 serially arranged units called vertebrae and is dorsally place skull and constitutes the main framework of the trunk.
- Each vertebra has a central hollow portion (neural canal) through which the sp is the atlas and it articulates with the occipital condyles.
- The vertebral column is differentiated into cervical (7), thoracic (12), lumbar (fused) and coccygeal (1-fused) regions starting from the skull.
- The number of cervical vertebrae are seven in almost all mammals including h
- The vertebral column protects the spinal cord, supports the head and serves as ribs and musculature of the back.

Sternum

- Sternumis a flat bone on the ventral midline of thorax.

Ribs

- There are 12 pairs of ribs.
- Each rib is a thin flat bone connected dorsally to the vertebral column and ven
- It has two articulation surfaces on its dorsal end and is hence called bicephalic
- First seven pairs of ribs are called true ribs. Dorsally, they are attached to the t connected to the sternum with the help of hyaline cartilage.
- The 8th, 9th and 10th pairs of ribs do not articulate directly with the sternum b help of hyaline cartilage. These are called vertebrochondral (false) ribs.
- Last 2 pairs (11th and 12th) of ribs are not connected ventrally and are therefo

• Thoracic vertebrae, ribs and sternum together form the rib cage.
•
The bones of the limbs alongwith their girdles constitute the appendicular skel
•
Each limb is made of 30 bones. The bones of the hand (fore limb) are humerus
bones – 8 in number), metacarpals (palm bones –
5 in number) and phalanges (digits – 14 in number).
• Femur (thigh bone –
the longest bone), tibia and fibula, tarsals (ankle bones –
7 in number), metatarsals (5 in number) and phalanges (digits –
14 in number) are the bones of the legs (hind limb).
• A cup shaped bone called patella cover the knee ventrally (knee cap).
Pectoral and Pelvic girdle Bones
•
Pectoral and Pelvic girdle bones help in the articulation of the upper and the lo
the axial skeleton.
•
Each girdle is formed of two halves. Each half of pectoral girdle consists of a
•
Scapula is a large triangular flat bone situated in the dorsal part of the thorax b
seventh ribs.
•
The dorsal, flat, triangular body of scapula has a slightly elevated ridge called
flat, expanded process called the acromion.
•
The clavicle articulates with this. Below the acromion is a depression called th
with the head of the humerus to form the shoulder joint.
•
Each clavicle is a long slender bone with two curvatures. This bone is commo
• Pelvic girdle consists of two coxal bones .
• Each coxal bone is formed by the fusion of three bones –
ilium, ischium and pubis. At the point of fusion of the
above bones is a cavity called acetabulum to which the thigh bone articulates.
•
The two halves of the pelvic girdle meet ventrally to form the pubic symphysi

TOPIC

15

JOINTS

Introduction

•

Joints are essential for all types of movements involving the bony parts of the

• Joints are points of contact between bones, or between bones and cartilages.

•

Force generated by the muscles is used to carry out movement through joints,

fulcrum.

• The movability at these joints vary depending on different factors.

•

Joints have been classified into three major structural forms,- fibrous, cartilagi

•

Fibrous joints do not allow any movement. This type of joint is shown by the
end with the help of dense fibrous connective tissues in the form of sutures, to

•

Cartilaginous joints, the bones involved are joined together with the help of ca
adjacent vertebrae in the vertebral column is of this pattern and it permits limi

•

Synovial joints are characterised by the presence of a fluid filled synovial cavi
surfaces of the two bones. Such an arrangement allows considerable movemen
locomotion and many other movements. Ball and socket joint (between humer
joint (knee joint), Pivot joint (between atlas and axis), Gliding joint (between t
(between carpal and metacarpal of thumb) are some examples.

Important FactsAbout Bones

• Cheek prominences are formed due to zygomatic or molar bones.

•

Stapes is the smallest bone of human body, while femur is the longest bone of

• Ribs of birds and mammals are double—
headed, while those of reptiles are mono—headed. There are no ribs

in fishes and amphibians.
• Tibula is the thinnest bone of human body.
•
Patella (knee cap) is a sesamoid bone present on front side of knee joint and pı
•
Ball and socket joints are called enarthroses; hinge joints as gingulum; angulaı
joints; pivot or rotatory joints; while gliding joints are called arthrodials.
• Stapes is modified hyomandibular.
• Shin bone of body is Tibia.
• At birth, human skeleton is made up of 305 bones.
•
As the body matures, some of these bones fuse together leaving only 206 bone
major systems of bone—
the axial skeleton and the appendicular skeleton. The axial skeleton is compris
80 bones in the skull, ribs and sternum. The appendicular skeleton has 126 boı
attached limbs.
•
Each bone is comprised of three major sections, the compact bone, the soft bo
marrow and the sponge bone.
• Red blood cells are produced in soft bone marrow.
•
ln hinge joints, movement occurs in one plane only. As in the knee and the elb
—and-socket
joints, movement occurs in three planes. eg. the hip, the shoulder. In pivot joiı
another. A pivot joint occurs where a peg on the axis vertebra fits into a socke
or gliding joint the surfaces which rub together are flat. e. g the vertebrae joint

Disorders of the skeletal system
(a) Arthritis (Inflammation of one or more joints)
Over 200 diseases may cause arthritis, including osteoarthritis, rheumatoid art
infections.
Effects: Swelling, warmth, redness of the overlying skin, pain, restriction of m
(b) Osteo Arthritis (Degenerative joint disease)
Osteo-
arthritis is due to wear of the articulatory cartilage, and may lead to secondary
bone. Lt may be primary, or it may occur secondarily to abnormal load to the
inflammation or trauma.
Effects
: The joints are painful and stiff with restricted movement. Osteoarthritis is rec
— ray by
narrowing of the joint space (due to loss of cartilage) and the presence of osteo
the bone.
(c) Rheumatoid Arthritis (The second common form of arthritis, after: osteo arthritis) Rheumatoid Arthritis is a
disease of the synovial lining of joints: The joints are initially painful, swollen
symmetrically.
Effects: As the disease progresses the ligaments supporting the joints are dama
bone, leading to deformity of the joints, Tendon sheaths can be affected, leadi
(d) Bone Cancer
Bone cancer may occur as a secondary cancer form, for example, prostate can
Effects : Damage to stem cells (the cause of leukaemia).
(e) Gout
Gout is caused by a defect in uric acid balance in the metabolism — resulting
(urates) which then accumulate in the bloodstream and joints, respectively,
Effects
: Gout can result in attacks of acute gouty arthritis, chronic destruction of the j
(tophi) in the skin and cartilage especially of the ears. The excess urates also d
may form.
(f) Osteoporosis (Loss of bone tissue)
Infection, injury and synovitis can cause localized osteoporosis of adjacent bo

common in the elderly, and in women often follows the menopause. lt is also a
prolonged steroid therapy.
Effects : Bones that are brittle and liable to fracture,
(g) Rickets (Childhood disease)
Rickets is a childhood condition caused by insufficient vitamin D and Calcium
Effects: Bow legs.

INSIGHT GENERAL STUDIES

TOPIC

16

NERVOUSSYSTEM

Introduction

•

The system through which human being conceive, understand and memorise s
and have a good balance among the various organs of human body is called ne

•

The neural system of all animals is composed of highly specialised organs like
nerve cells, which can detect, receive and transmit different kinds of stimuli.

HUMAN NEURAL SYSTEM

The human neural system is divided into two parts :

(i) Central neural system (CNS)

(ii) Peripheral neural system (PNS)

•

The CNS includes the brain and the spinal cord and is the site of information p

•

The PNS comprises of all the nerves of the body associated with the CNS (bra
fibres of the PNS are of two types :

(a) Afferent fibres

(b) Efferent fibres

•

The afferent nerve fibres transmit impulses from tissues/organs to the CNS an
regulatory impulses from the CNS to the concerned peripheral tissues/organs.

•

The PNS is divided into two divisions called somatic neural system and auton

•

The somatic neural system relaysimpulses from the CNS to skeletal muscles w
transmits impulses from the CNS to the involuntary organs andsmooth muscle

•

The autonomic neural system is furtherclassified into sympathetic neural syste
system.

NEURON

•

A neuron is a microscopic structure composed of three major parts, namely, ce

•

The cell body contains cytoplasm with typical cell organelles and certain gran

•

Short fibres which branch repeatedly and project out of the cell body also cont
called dendrites. These fibres transmit impulses towards the cell body.

•

The axon is a long fibre, the distal end of which is branched. Each branch term
like structure
called synaptic knob which possess synaptic vesicles containing chemicals cal

•

The axons transmit nerve impulses away from the cell body to a synapse or to
muscular junction.

•

Based on the number of axon and dendrites, the neurons are divided into three
one axon and two or more dendrites; found in the cerebral cortex), bipolar(wit
found in the retina of eye) and unipolar (cell body with one axon only; found

• There are two types of axons, namely, myelinated and nonmyelinated.

•

The myelinated nerve fibres are enveloped with Schwann cells, which form a
The gaps between two adjacent myelin sheaths are called nodes ofRanvier.

• Myelinated nerve fibres are found in spinal and cranial nerves.

•

Unmyelinated nerve fibre is enclosed by a Schwann cell that does not form a
and is commonly found in autonomous and the somatic neural systems.

INSIGHT GENERAL STUDIES

CENTRALNEURALSYSTEM

•

The brain is the central information processing organ of our body, and acts as
system'. It controls the voluntary movements, balance of the body, functionin
(e.g., lungs, heart, kidneys, etc.), thermoregulation, hunger and thirst, circadia
hour) rhythms of our
body, activities of several endocrine glands and human behaviour.

•

It also the site for processing of vision, hearing, speech, memory, intelligence,

•

The human brain is well protected by the skull. Inside the skull, the brain is co
consisting of an outer layer called dura mater, a very thin middle layer called a
(which is in contact with the brain tissue) called pia mater.

•

The brain can be divided into three major parts: (i) forebrain, (ii) midbrain, an
Forebrain

• The forebrain consists of cerebrum, thalamus and hypothalamus.

•

Cerebrum forms the major part of the human brain. A deep cleft divides the ce
halves, which are termed as the left and right cerebral hemispheres.

•

The hemispheres are connected by a tract of nerve fibres called corpus callosu

•

The layer of cells which covers the cerebral hemisphere is called cerebral cort
folds.

•

The cerebral cortex is referred to as the grey matter due to its greyish appeara
concentrated here giving the colour.

•

The cerebral cortex contains motor areas, sensory areas and large regions that
motor in function. These regions called as the association areas are responsibl
intersensory associations, memory and communication.

•

Fibres of the tracts are covered with the myelin sheath, which constitute the in
They give an opaque white appearance to the layer and, hence, is called the wl
•
The cerebrum wraps around a structure called thalamus, which is a major coor
motor signaling. Another very important part of the brain called hypothalamus
•
The hypothalamus contains a number of centres which control body temperatu
It also contains several groups of neurosecretory cells, which secrete hormone
•
The inner parts of cerebral hemispheres and a group of associated deep structu
etc., form a complex structure called the limbic lobe or limbic system. Along v
involved in the regulation of sexual behaviour, expression of emotional reactio
rage and fear), and motivation.

Midbrain

•
The midbrain is located between the thalamus/hypothalamus of the forebrain a
• A canal called the cerebral aqueduct passess through the midbrain.
•
The dorsal portion of the midbrain consists mainly of four round swellings (lo
• Midbrain and hindbrain form the brain stem.

Hindbrain

•
The hindbrain comprises pons, cerebellum and medulla (also called the medul
• Pons consists of fibre tracts that interconnect different regions of the brain.
•
Cerebellum has very convoluted surface in order to provide the additional spa
• The medulla of the brain is connected to the spinal cord.
•
The medulla contains centres which control respiration, cardiovascular reflexe

REFLEXACTIONANDREFLEXARC

•
The entire process of response to a peripheral nervous stimulation, that occurs
conscious effort or thought and requires the involvment of a part of the central
reflex action.

•

The reflex pathway comprises at least one afferent neuron (receptor) and one e
neuron appropriately arranged in a series .

•

The afferent neuron receives signal from a sensory organ and transmits the im
into the CNS (at the level of spinal cord).

• The efferent nueuron then carries signals from CNS to the effector.

Various specific sense-organs

•

Tounge has four type of receptors or taste buds helps in identify and detect the

• Nose has small receptors to identify the specific smell.

• Eye Hman eye is a photo receptive organ work as visionary sense organ.

•

Ear not only receive the sound wave but also maintain the balance of human b

INSIGHT GENERAL STUDIES

TOPIC

17

REPRODUCTION

Introduction

Reproduction is defined as a biological process in which an organism gives ris itself. The offspring grow, mature and in turn produce new offspring. Thus, th death. Reproduction enables the continuity of the species, generation after gen reproduction are broadly grouped into two main types: sexual and asexual.

Asexual reproduction

•

Asexual reproduction is the process by which an organism creates a geneticall

itself without a contribution of genetic material from another individual in thes itself a mode of reproduction.

• Many single-
celled organisms reproduce by binary fission, where a cell divides into two ha rapidly grows into an adult (e.g., Amoeba,Paramecium).

•

In yeast, the division is unequal and small buds are produced that remain attac which, eventually gets separated and mature into new yeast organisms (cells).

•

Members of the Kingdom Fungi and simple plants such as algae reproduce thr structures.

•

Other common asexual reproductive structures are conidia (Penicillium), buds

Vegetative reproduction

•

In vegetative propagation such as runner,rhizome, sucker, tuber, offset, bulb a new offspring .

• These structures are called vegetative propagules.

Sexual reproduction & its mechanism

•

Sexual reproduction is a biological process by which organisms create descend
of genetic material contributed from two (usually) different members of the sp
fertilization requires only one organism.)

- Each of two parent organisms contributes half of the offspring's genetic make

- Most organisms form two different types of gametes.Most animals (including sexually.

- Sexually reproducing organisms have different sets of genes for every trait (ca

- Offspring inherit one allele for each trait from each parent, thereby ensuring th of the parents genes.

- Diploid having two copies of every gene within an organism, Sexualreproduct fusion (or fertilisation) of the male andfemale gametes, the formation of zygot

- For conveniencethese sequential events may be grouped into three distinct sta fertilisation, fertilisation and the post-fertilisation events.

Pre-fertilisation Events

These include all the events of sexual reproduction prior to the fusion of game
fertilisation
events are gametogenesis and gamete transfer.

a) Gametogenesis

Gametogenesis refers to the process of formation of the two types of gametes - male and female. Gametes are haploid cells.

b) Gamete Transfer

After their formation, male and female gametes must be physically brought to (fertilisation).

Fertilisation

The most vital event of sexual reproduction is perhaps the fusion of gametes. in the formation of a diploid zygote. The term fertilisation is also often used fo and fertilisation are frequently used though , interchangeably.

Post-fertilisation Events

Events in sexual reproduction after the formation of zygote are called post-fertilisation events. The Zygote

- Formation of the diploid zygote is universal in all sexually reproducing organi
- In organisms with external fertilisation, zygote is formed in the external mediu

those exhibiting internal fertilisation, zygote is formed inside the body of the o

- In organisms belonging to fungi and algae, zygote develops a thick wall that is damage.
- Every sexually reproducing organism, including human beings begin life as a the zygote. Embryogenesis
- Embryogenesis refers to the process of development of embryo from the zygo
- During embryogenesis, zygote undergoes cell division (mitosis) and cell differ
- While cell divisions increase the number of cells in the developing embryo; ce of cells to undergo certain modifications to form specialised tissues and organ
-

Animals are categorised into oviparous and viviparous based on whether the d
place outside the body of the female parent or inside, i.e., whether they lay fer
give birth to young ones.

•

In flowering plants, the zygote is formed inside the ovule. After fertilisation th
the flower wither and fall off.

HUMAN REPRODUCTION

Male reproductive system

• The male reproductive system is located in the pelvis region.

•

It includes a pair of testes alongwith accessory ducts, glands and the external g

•

The testes are situated outside the abdominal cavity within a pouch called scro

• The scrotum helps in maintaining the low temperature of the testes (2–
2.5°C lower than the normal internal
body temperature) necessary for spermatogenesis.

•

In adults, each testis is oval in shape, with a length of about 4 to 5 cm and a w

•

The testis is covered by a dense covering. Each testis has about 250 compartm

•

Each lobule contains one to three highly coiled seminiferoustubules in which s

•

Each seminiferous tubule is lined on its inside by two types of cells called mal
and Sertoli cells.

•

The male germ cells undergo meiotic divisions finally leading to sperm forma
nutrition to the germ cells.

•

The regions outside the seminiferous tubules called interstitial spaces, contain
interstitial cells or Leydig cells.

- Leydig cells synthesise and secrete testicular hormones called androgens. Oth
cells are also present.
- The male sex accessory ducts include rete testis, vasa efferentia, epididymis a
- The seminiferous tubules of the testis open into the vasa efferentia through ret
- The vasa efferentia leave the testis and open into epididymis located along the
testis.
- The epididymis leads to vas deferens that ascends to the abdomen and loops o
- It receives a duct from seminal vesicle and opens into urethra as the ejaculator
transport the sperms from the testis to the outside through urethra.
- The urethra originates from the urinary bladder and extends through the penis
urethral meatus.
- The penis is the male external genitalia .It is made up of special tissue that hel
facilitate insemination.
- The enlarged end of penis called the glans penis is covered by a loose fold of s
- The male accessory glands include paired seminal vesicles, a prostateand pair
Secretions of theseglands constitute the seminal plasma which is rich in fructo
- The secretions of bulbourethral glands also helpsin the lubrication of the penis
Female reproductive system
- The female reproductive system consists of a pair of ovaries alongwith a pair
vagina and the external genitalia located in pelvic region. These parts of the sy
mammary glands are integrated structurally and functionally to support the pr

pregnancy, birth and child care.

•

Ovaries are the primary female sex organs that produce the female gamete (ov
hormones (ovarian hormones).

• The ovaries are located one on each side of the lower abdomen .

•

Each ovary is about 2 to 4 cm in length and is connected to the pelvic wall anc

•

Each ovary is covered by a thin epithelium which encloses the ovarian stroma

• The stroma is divided into two zones –
a peripheral cortex and an inner medulla.

•

The oviducts (fallopian tubes), uterus and vagina constitute the female access(

• Each fallopian tube is about 10-
12 cm long and extends from the periphery of each ovary to the uterus, the pa
closer to the ovary is the funnel-shaped infundibulum.

• The edges of the infundibulum possess finger-
like projections called fimbriae, which help in collection of the
ovum after ovulation.

•

The infundibulum leads to a wider part of the oviduct called ampulla. The last
a narrow lumen and it joins the uterus.

•

The uterus is single and it is also called womb. The shape of the uterus is like
by ligaments attached to the pelvic wall.

• The uterus opens into vagina through a narrow cervix.

•

The cavity of the cervix is called cervical canal which alongwith vagina forms

•

The wall of the uterus has three layers of tissue. The external thin membranou
layer of smooth muscle, myometrium and inner glandular layer called endome
cavity.

•

The endometrium undergoes cyclical changes during menstrual cycle while th
contraction during delivery of the baby.

•

The female external genitalia include mons pubis, labia majora, labia minora, is a cushion of fatty tissue covered by skin and pubic hair.

INSIGHT GENERAL STUDIES

•

The labia majora are fleshy folds of tissue, which extend down from the mons
opening. The labia minora are paired folds of tissue under the labia majora.

•

The opening of the vagina is often covered partially by a membrane called hyı

• The clitoris is a tiny finger-
like structure which lies at the upper junction of the two labia minora above th
urethral opening.

• A functional mammary gland is characteristic of all female mammals.

•

The mammary glands are paired structures (breasts) that contain glandular tiss

• The glandular tissue of each breast is divided into 15-
20 mammary lobes containing clusters of cells called
alveoli .The cells of alveoli secrete milk, which is stored in the cavities (lumer
into mammary tubules.

•

The tubules of each lobe join to form a mammary duct. Several mammary duc
ampulla which is connected to lactiferous duct through which milk is sucked c

GAMETOGENESIS

The primary sex organs –
the testis in the males and the ovaries in the females –
produce gametes, i.e, sperms and
ovum, respectively, by the process called gametogenesis.

•

In testis, the immature male germ cells (spermatogonia) produce sperms by sp
puberty.

•

The spermatogonia present on the inside wall of seminiferous tubules multiply
in numbers.

• Each spermatogonium is diploid and contains 46 chromosomes.

•

Some of the spermatogonia called primaryspermatocytes periodically undergo

•

A primary spermatocyte completes the first meiotic division (reduction divisio
equal, haploid cells called secondary spermatocytes, which have only 23 chro
•
The secondary spermatocytes undergo the second meiotic division to produce
•
The spermatids are transformed into spermatozoa (sperms) by the process call
spermiogenesis, sperm heads become embedded in the Sertoli cells, and are fi
seminiferous tubules by the process called spermiation.
•
Spermatogenesis starts at the age of puberty due to significant increase in the s
releasing hormone (GnRH). This, if you recall, is a hypothalamic hormone.
•
The increased levels of GnRH then acts at the anterior pituitary gland and stim
gonadotropins –
luteinising hormone (LH) and follicle stimulating hormone (FSH).
•
LH acts at the Leydig cells and stimulates synthesis and secretion of androgen
the process of spermatogenesis.
•
FSH acts on the Sertoli cells and stimulates secretion of some factors which he
spermiogenesis.
•
Sperm: It is a microscopic structure composed of a head, neck, a middle piece
envelops the whole body of sperm.
•
The sperm head contains an elongated haploid nucleus, the anterior portion of
like structure, acrosome.
•
The acrosome is filled with enzymes that help fertilisation of the ovum. The m
mitochondria, which produce energy for the movement of tail that facilitate sp
fertilisation.
•
The human male ejaculates about 200 to 300 million sperms during a coitus of
least 60 per cent sperms must have normal shape and size and for at least 40 p
vigorous motility.
•
Sperms released from the seminiferous tubules, are transported by the accesso

INSIGHT GENERAL STUDIES

•

Secretions of epididymis, vas deferens, seminal vesicle and prostate are essent
of sperms. The seminal plasma along with the sperms constitute the semen.

•

The functions of male sex accessory ducts and glands are maintained by the te

•

The process of formation of a mature female gamete is called oogenesis which
spermatogenesis.

•

Oogenesis is initiatedduring the embryonic development stage when a couple
(oogonia) are formed within each fetal ovary; no more oogoniaare formed and

• These cells start division and enter intoprophase-
I of the meiotic division and get temporarily arrested at that
stage,called primary oocytes. Each primary oocyte then gets surrounded by ala
called the primary follicle

•

A large number of these follicles degenerate during the phase from birth to pu
only 60,000-80,000 primary follicles are left in each ovary.

•

The primary follicles get surrounded by more layers of granulosa cells and a n
follicles.

•

The secondary follicle soon transforms into a tertiary follicle which is characte
called antrum.

•

The theca layer is organised into an inner theca interna and an outer theca exte

•

At this stage that the primary oocyte within the tertiary follicle grows in size a
division.

•

It is an unequal division resulting in the formation of a large haploid secondary
body.

•

The secondary oocyte retains bulk of the nutrient rich cytoplasm of the primar
•
The secondary oocyte forms a new membrane called zona pellucid surroundin
•
The Graafian follicle now ruptures to release the secondary oocyte (ovum) fro
called ovulation.

PLANT REPRODUCTION

•
Sexual reproduction in plants occurs when the pollen from an anther is transfe
• Plants can fertilize themselves: called self-fertilization.
• Self-
fertilization occurs when the pollen from an anther fertilizes the eggs on the sa
• Cross-
fertilization occurs when the pollen is transferred to the stigma of an entirely d
• When the ovules are fertilized, they will develop into seeds.
•
The petals of the flower fall off leaving only the ovary behind, which will dev

┐ ┐ ┐ ┐ ┐

INSIGHT GENERAL STUDIES

TOPIC

18

ENDOCRINEGLANDSAND HORMONES

Introduction

•

Endocrine glands lack ducts and are hence, called ductless glands. Their secre

• Hormones are non-

nutrient chemicals whichact as intercellular messengers and are produced in tr

•

The new definition covers a number of new molecules in addition to the horm

endocrine glands.

•

Invertebrates possess very simple endocrine systems with few hormones wher
act as hormones and provide coordination in the vertebrates.

HUMAN ENDOCRINE SYSTEM

•

The endocrine glands and hormone producing diffused tissues/cells located in
constitute the endocrine system.

•

Pituitary, pineal, thyroid, adrenal, pancreas, parathyroid, thymus and gonads (
females) are the organized endocrine bodies in our body.

•

In addition to these, some other organs, e.g., gastrointestinal tract, liver, kidne

The Hypothalamus

•

The hypothalamus is the basal part of diencephalon, forebrain and it regulates
functions.

•

It contains several groups of neurosecretory cells called nuclei which produce

•

These hormones regulate the synthesis and secretion of pituitary hormones. H
by hypothalamus are of two types, the releasing hormones (which stimulate se

and the inhibiting hormones (which inhibit secretions of pituitary hormones).

•

Hypothalamic hormone called Gonadotrophin releasing hormone (GnRH) stin
and release of gonadotrophins. On the other hand, somatostatin from the hypo
of growth hormone from the pituitary.

•

These hormones originating in the hypothlamic neurons, pass through axons a
nerve endings.

•

These hormones reach the pituitary gland through a portal circulatory system a
the anterior pituitary.

•

The posterior pituitary is under the direct neural regulation of the Hypothalam
The Pituitary Gland

•

The pituitary gland is located in a bony cavity called sella tursica and is attach
• It is divided anatomically into an adenohypophysis and a neurohypophysis.

•

Adenohypophysis consists of two portions, pars distalis and pars intermedia.

•

The pars distalis region of pituitary, commonly called anterior pituitary, produ
prolactin (PRL), thyroid stimulating hormone (TSH), adrenocorticotrophic hor
hormone (LH) and folliclestimulating hormone (FSH).

•

Pars intermedia secretes only one hormone called melanocytestimulating horm
humans, the pars intermedia is almost merged with pars distalis.

•

Neurohypophysis (pars nervosa) also known as posterior pituitary, stores and
oxytocin and vasopressin, which are actually synthesised by the hypothalamus
to neurohypophysis.

• Over-
secretion of GH stimulates abnormal growth of the body leading to gigantism
results in stunted growth resulting in pituitary dwarfism.

•

Prolactin regulates the growth of the mammary glands and formation of milk i

•

TSH stimulates the synthesis and secretion of thyroid hormones from the thyr

•

ACTH stimulates the synthesis and secretion of steroid hormones called gluco
cortex.

•

LH and FSH stimulate gonadal activity and hence are called gonadotrophins.
synthesis and secretion of hormones called androgens from testis. In males, F
spermatogenesis. In females, LH induces ovulation of fully mature follicles (g
the corpus luteum, formed from the remnants of the graafian follicles after ov
and development of the ovarian follicles in females.

•

MSH acts on the melanocytes (melanin containing cells) and regulates pigmen

•

Oxytocin acts on the smooth muscles of our body and stimulates their contract
vigorous contraction of uterus at the time of child birth, and milk ejection fron

•

Vasopressin acts mainly at the kidney and stimulates resorption of water and e
and thereby reduces loss of water through urine (diuresis). Hence, it is also cal
diuretichormone (ADH).

The Pineal Gland

• The pineal gland is located on the dorsal side of forebrain.

• The pineal gland is located on the dorsal side of forebrain.

hour (diurnal) rhythm of our body.
• It helps in maintaining the normal rhythms of sleep-
wake cycle, body temperature.
•
In addition, melatonin also influences metabolism, pigmentation, the menstrua

capability.
Thyroid Gland
•
The thyroid gland is composed of two lobes which are located on either side o

interconnected with a thin flap of connective tissue called isthmus.
• The thyroid gland is compose of follicles and stromal tissues.
•
Each thyroid follicle is composed of follicular cells, enclosing a cavity. These

hormones, tetraiodothyronine or thyroxine (T4) and triiodothyronine (T3).
•
Iodine is essential for the normal rate of hormone synthesis in the thyroid. Def
results in hypothyroidism and enlargement of the thyroid gland, commonly ca
•
Hypothyroidism during pregnancy causes defective development and maturati
to stunted growth (cretinism), mental retardation, low intelligence quotient, ab
mutism,
etc. In adult women, hypothyroidism may cause menstrual cycle to become irr
•
Due to cancer of the thyroid gland or due to development of nodules of the thy
synthesis and secretion of the thyroid hormones is increased to abnormal high
called hyperthyroidism which adversely affects the body physiology.
•
Thyroid hormones play an important role in the regulation of the basal metabo
support the process of red blood cell formation.
•
Thyroid hormones control the metabolism of carbohydrates, proteins and fats.
electrolyte balance is also influenced by thyroid hormones.
•
Thyroid gland also secretes a protein hormone called thyrocalcitonin (TCT) w

levels.

Parathyroid Gland

- In humans, four parathyroid glands are present on the back side of the thyroid lobes of the thyroid gland.
- The parathyroid glands secrete a peptide hormone called parathyroid hormone regulated by the circulating levels of calcium ions.
- Parathyroid hormone (PTH) increases the Ca^{2+} levels in the blood. PTH acts c process of bone resorption (dissolution/ demineralisation).
- PTH also stimulates reabsorption of Ca^{2+} by the renal tubules and increases C food.
- PTH is a hypercalcemic hormone, i.e., it increases the blood Ca^{2+} levels. Alon role in calcium balance in the body.

Thymus

- The thymus gland is a lobular structure located on the dorsal side of the heart
- The thymus plays a major role in the development of the immune system.
- This gland secretes the peptide hormones called thymosins.
- Thymosins play a major role in the differentiation of Tlymphocytes, which pr mediated immunity.

In addition, thymosins also promote production of antibodies to provide humo

- Thymus is degenerated in old individuals resulting in a decreased production c immune responses of old persons become weak.

Adrenal Gland

- Human body has one pair of adrenal glands, one at the anterior part of each ki

•
The gland is composed of two types of tissues. The centrally located tissue is c
outside this lies the adrenal cortex
•
The adrenal medulla secretes two hormones called adrenaline or epinephrine a
norepinephrine. These are commonly called as catecholamines.
•
Adrenaline and noradrenaline are rapidly secreted in response to stress of any
situations and are called emergency hormones or hormones of Fightor Flight.
•
These hormones increase alertness, pupilary dilation, piloerection (raising of h
hormones increase the heart beat, the strength of heart contraction and the rate
•
Catecholamines also stimulate the breakdown of glycogen resulting in an incr
in blood. In addition, they also stimulate the breakdown of lipids and proteins.
•
The adrenal cortex can be divided into three layers, called zonareticularis (inn
(middle layer) and zonaglomerulosa (outer layer).
• The adrenal cortex secretes many hormones, commonly called as corticoids.
•
The corticoids, which are involved in carbohydrate metabolism are called gluc
•
In our body, cortisol is the main glucocorticoid. Corticoids, which regulate the
in our body are called mineralocorticoids.
• Aldosterone is the main mineralocorticoid in our body.
•
Glucocorticoids stimulate, gluconeogenesis, lipolysis and proteolysis; and inh
of amino acids.
• Cortisol is also involved in maintaining the cardio-
vascular system as well as the kidney functions.
•
Glucocorticoids, particularly cortisol, produces antiinflamatory reactions and s
• Cortisol stimulates the RBC production.
•
Aldosterone acts mainly at the renal tubules and stimulates the reabsorption of
of K+ and phosphate ions. Thus, aldosterone helps in the maintenance of elect
osmotic pressure and blood pressure.

•

Small amounts of androgenic steroids are also secreted by the adrenal cortex v
of axial hair, pubic hair and facial hair during puberty.

Pancreas

•

Pancreas is a composite gland which acts as both exocrine and endocrine glan

•

The endocrine pancreas consists of 'Islets of Langerhans'. There are about 1 t
a normal human pancreas representing only 1 to 2 per cent of the pancreatic ti

• The two main types of cells in the Islet of Langerhans are called á-
cells and â-cells. The á-cells secrete a hormone called glucagon, while the â-
cells secrete insulin.

•

Glucagon is a peptide hormone, and plays an important role in maintaining the

•

Glucagon acts mainly on the liver cells (hepatocytes) and stimulates glycogen
blood sugar (hyperglycemia). In addition, this hormone stimulates the process
contributes to hyperglycemia.

•

Glucagon reduces the cellular glucose uptake and utilisation. Thus, glucagon i

•

Insulin is a peptide hormone, which plays a major role in the regulation of glu
mainly on hepatocytes and adipocytes (cells of adipose tissue), and enhances c
utilisation. As a result, there is a rapid movement of glucose from blood to he
resulting in decreased blood glucose levels (hypoglycemia).

•

Insulin also stimulates conversion of glucose to glycogen (glycogenesis) in the
homeostasis in blood is thus maintained jointly by the two –
insulin and glucagons.

•

Prolonged hyperglycemia leads to a complex disorder called diabetes mellitus
of glucose through urine andformation of harmful compounds known as keton

• Diabeticpatients are successfully treated with insulin therapy.

Testis

•

A pair of testis is present in the scrotal sac (outside abdomen) of male individu

•

Testis performs dual functions as a primary sex organ as well as an endocrine

• Testis is composed of seminiferous tubules and stromal or interstitial tissue.

•

The Leydigcells or interstitial cells, which are present in the intertubular space called androgens mainly testosterone.

•

Androgens regulate the development, maturation and functions of the male ac epididymis, vas deferens, seminal vesicles, prostate gland, urethra etc.

•

These hormones stimulate muscular growth, growth of facial and axillary hair voice etc. Androgens play a major stimulatory role in the process of spermato spermatozoa).

•

Androgens act on the central neural system and influence the male sexual beh

•

These hormones produce anabolic (synthetic) effects on protein and carbohyd

Ovary

• Females have a pair of ovaries located in the abdomen .

•

Ovary is the primary female sex organ which produces one ovum during each

•

In addition, ovary also produces two groups of steroid hormones called estrog

•

Ovary is composed of ovarian follicles and stromal tissues. The estrogen is sy by the growing ovarian follicles. After ovulation, the ruptured follicle is conve luteum, which secretes mainly progesterone.

•

Estrogens produce wide ranging actions such as stimulation of growth and act organs, development of growing ovarian follicles, appearance of female secon pitch of voice, etc.), mammary gland development.

• Estrogens also regulate female sexual behaviour.

• Progesterone supports pregnancy.
•
Progesterone also acts on the mammary glands and stimulates the formation o
like structures which store milk) and milk secretion.

HORMONESOFHEART,KIDNEYAND GASTROINTESTINALTRACT

•
The atrial wall of our heart secretes a very important peptide hormone called a
which decreases blood pressure.
•
When blood pressure is increased, ANF is secreted which causes dilation of th
the blood pressure. The juxtaglomerular cells of kidney produce a peptide hor
which stimulates erythropoiesis (formation of RBC).
• Endocrine cells present in different parts of the gastro-
intestinal tract secrete four major peptide hormones,
namely gastrin, secretin, cholecystokinin (CCK) and gastric inhibitory peptide
•
Gastrin acts on the gastric glands and stimulates the secretion of hydrochloric
•
Secretin acts on the exocrine pancreas and stimulates secretion of water and bi
•
CCK acts on both pancreas and gall bladder and stimulates the secretion of pa
respectively.
• GIP inhibits gastric secretion and motility. Several other non-
endocrine tissues secrete hormones called
growth factors. These factors are essential for the normal growth of tissues an
MECHANISM OF HORMONE ACTION
•
Hormones produce their effects on target tissues by binding to specific protein
located in the target tissues only.
•
Hormone receptors present on the cell membrane of the target cells are called

bound receptors
and the receptors present inside the target cell are called intracellular receptors
(present in the nucleus).
• Binding of a hormone to its receptor leads to the formation of a hormone-
receptor complex. Each receptor is
specific to one hormone only and hence receptors are specific.
• Hormone-
Receptor complex formation leads to certain biochemical changes in the target
•
Target tissue metabolism and hence physiological functions are regulated by h
chemical nature, hormones can be divided into groups :
Peptide, polypeptide, protein hormones
(e.g., insulin, glucagon, pituitary hormones, hypothalamic hormones, etc.)
Steroids (e.g., cortisol, testosterone, estradiol and progesterone)
Iodothyronines (thyroid hormones)
Amino-acid derivatives (e.g., epinephrine).
• Hormones which interact with membrane-
bound receptors normallydo not enter the target cell, but generate
second messengers (e.g., cyclicAMP, IP3, Ca++ etc) which in turn regulate ce
•
Hormones which interact with intracellular receptors (e.g., steroidhormones, i
regulate gene expression orchromosome function by the interaction of hormor
receptor complexwith the genome.
•
Cumulative biochemical actions result in physiologicaland developmental effe

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INSIGHT GENERAL STUDIES

TOPIC

19

GENETICS

Introduction

•

Genetics is a branch of biology which deals with principles of inheritance and

•

The fundamental character which transfer from generation to generation from

called genetic character and the studies of their causes are called genetics.

•

Progeny resembling the parents in morphological and physiologycal features h
many biologists.

Mendel's Law

Mendel was the first to study this phenomenon systematically. While studying
plants of contrasting characters, Mendel proposed the principles of inheritance
'Mendel's Laws of Inheritance'.

•

He proposed that the 'factors' (later named as genes) regulating the characters
alleles.

•

He observed that the expression of the characters in the offspring follow a def
first
generations (F1), second (F2) and so on.

•

Some characters are dominant over others. The dominant characters are expres
heterozygous condition (Law of Dominance).

•

The recessive characters are only expressed in homozygous conditions. The ch
heterozygous condition.A recessive character that was not expressed in hetero
again when it becomes homozygous. Hence, characters segregate while forma
Segregation).

•

Not all characters show true dominance. Some characters show incomplete, ar
dominance.
When Mendel studied the inheritance of two characters together, it was found
assort and combine in all permutations and combinations (Law of Independen

•

The factors (now known as gene) on chromosomes regulating the characters a
physical expression of the chraracters is called phenotype.

DNAANDRNA

•

Deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) are the two types c
systems.

•

DNA acts as the genetic material in most of the organisms. RNA though it als
some viruses, mostly functions as a messenger.

• DNA consists of two long polymers of simple units called nucleotides,
with backbones made
of sugars and phosphategroups joined by ester bonds. These two strands run ir
other and are therefore anti-
parallel. Attached to each sugar is one of four types of molecules called bases.
is the sequence of these four bases along the backbone that encodes informatic
using the genetic code, which specifies the sequence of the amino acids withir

•

The code is read by copying stretches of DNA into the related nucleic acid RN

Structure of Polynucleotide Chain

• A nucleotide has three components –
a nitrogenous base, a pentose sugar (ribose in case of RNA, and deoxyribose for DNA), and a phosphate group.
• There are two types of nitrogenous bases –
Purines (Adenine and Guanine), and Pyrimidines (Cytosine, Uracil and Thymine). Cytosine is common for both DNA and RNA and Thymine is p
RNA at the place of Thymine.
• A nitrogenous base is linked to the pentose sugar through a N-glycosidic linkage to form a nucleoside, such as
adenosine or deoxyadenosine, guanosine or deoxyguanosine, cytidine or deox
deoxythymidine.
• When a phosphate group is linked to 5'-OH of a nucleoside through phosphoester linkage, a corresponding
nucleotide (or deoxynucleotide depending upon the type of sugar present) is fo
linked through 3'-5' phosphodiester linkage to form a dinucleotide.
•
More nucleotides can be joined in such a manner to form a polynucleotide cha
at one end a free phosphate moiety at 5'-end of ribose sugar, which is referred to as 5'-end of polynucleotide chain. Similarly, at the other end of the polymer the ribose has a free 3'-OH group which is referred to as 3' end of the polynucleotide chain.
•
The backbone in a polynucleotide chain is formed due to sugar and phosphate
to sugar moiety project from the backbone .
• In RNA, every nucleotide residue has an additional –OH group present at 2' -position in the ribose. Also, in RNA the uracil is found at the place of thymine (5-methyl uracil, another chemical name for thymine).
• In 1953 that James Watson and Francis Crick, based on the X-ray diffraction data produced by Maurice Wilkins
and Rosalind Franklin, proposed a very simple but famous Double Helixmode

• The salient features of the Double-helix structure of DNA are as follows:
•
It is made of two polynucleotide chains, where the backbone is constituted by
phosphate, and the bases project inside.
• The two chains have anti-
parallel polarity. It means, if one chain has the polarity 5''!3', the other has 3''!
• The bases in two strands are paired through hydrogen bond (H-
bonds) forming base pairs (bp). Adenine forms
two hydrogen bonds with Thymine from opposite strand and vice-versa.
• Guanine is bonded with Cytosine with three H-bonds.
•
As a result, always a purine comes opposite to a pyrimidine. This generates ap
between the two strands of the helix .
• The two chains are coiled in a right-
handed fashion. The pitch of the helix is 3.4 nm (a nanometre is one
billionth of a metre, that is 10^{-9} m) and there are roughly 10 bp in each turn. Consequently, the distance
between a bp in a helix is approximately equal to 0.34 nm.
•
The plane of one base pair stacks over the other in double helix. This, in addit
bonds, confers stability of the helical structure
GENETICCODE
•
During replication and transcription a nucleic acid was copied to form another
processes are easy to conceptualise on the basis of complementarity.
•
The process of translation requires transfer of genetic information from a poly
of amino acids. Neither does any complementarity exist between nucleotides a
be drawn theoretically.
•
George Gamow, a physicist, suggested that in order to code for all the 20 amin
made up of three nucleotides. This was a very bold proposition, because a perm
× 4 × 4) would generate 64 codons; generating many more codons than requir

• The salient features of genetic code are as follows:

•

The codon is triplet. 61 codons code for amino acids and 3 codons do not cod
function as stop codons.

•

One codon codes for only one amino acid, hence, it is unambiguous and speci

•

Some amino acids are coded by more than one codon, hence the code is degen

•

The codon is read in mRNA in a contiguous fashion. There are no punctuatio

•

The code is nearly universal: for example, from bacteria to human UUU woul
Some exceptions to this rule have been found in mitochondrial codons, and in

• AUG has dual functions. It codes for protein synthesis also.

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TOPIC

20

IMMUNITY

Introduction

Everyday we are exposed to large number of infectious agents. However,only disease. This is due to thefact that the body is able to defend itself from most ability of the host to fight the disease-
causing organisms,conferred by the immune system is called immunity.

Immunity is of two types: (i) Innate immunity and (ii) Acquiredimmunity.

Innate Immunity

• Innate immunity is non-
specific type of defence, that is present at the time of birth.

•
This is accomplished by providing different types of barriers to the entry of th

• Innate immunity consist of four types of barriers. These are —

(i) Physical barriers

Skin on our body is the main barrier whichprevents entry of the micro-
organisms. Mucus coating of theepithelium
lining the respiratory, gastrointestinal and urogenitaltracts also help in trappin

(ii) Physiological barriers

Acid in the stomach, saliva in the mouth,tears from eyes–
all prevent microbial growth.

(iii) Cellular barriers

Certain types of leukocytes (WBC) of our bodylike polymorpho-
nuclear leukocytes (PMNL-neutrophils)monocytes
and natural killer (type of lymphocytes) in the blood aswell as macrophages in destroymicrobes.

(iv) Cytokine barriers

Virus-infected cells secrete proteins called interferonswhich protect non-
infected cells from further viral infection. Acquired Immunity

• Acquired immunity, on the other hand, is pathogen specific.

•
It is characterised by memory. This means that our body when it encounters a

produces a response called primary response which is of low intensity. Subsec
pathogen elicits a highly intensified secondary or anamnestic response.
•
This is ascribed to the fact that our body appears to have memory of the first e
•
The primary and secondary immune responses are carried out with the help of
present in our blood, i.e., B-lymphocytes and T-lymphocytes.
Active and Passive Immunity
•
When a host is exposed to antigens, which may be in the form of living or dea
antibodies are produced in the host body. This type of immunity is called activ
• Active immunity is slow and takes time to give its full effective response.
•
Injecting the microbes deliberately during immunisation or infectious organisı
during natural infection induce active immunity. When ready-
made antibodies are directly given to protect
the body against foreign agents, it is called passive immunity.
•
The yellowish fluid colostrum secreted by mother duringthe initial days of lac
(IgA) to protect the infant.

•

The foetus also receives some antibodies from their mother, through the place
are some examples of passive immunity.

Auto Immunity

• Memory-
based acquired immunity evolved in higher vertebrates based on the ability to
organisms (e.g., pathogens) from selfcells.

•

Higher vertebrates can distinguish foreign molecules as well as foreign organi
immunology deals with this aspect.

•

Sometimes, due to genetic and other unknown reasons, the body attacks self-
cells. This results in damage to the body and is called auto-immunedisease.

• Rheumatoid arthritis which affects many people in our society is an auto-
immune disease.

Vaccination and Immunisation

•

The principle of immunisation or vaccination is based on the property of 'men
vaccination, a preparation of antigenic proteins of pathogen or inactivated/wea
introduced into the body.

•

The antibodies produced in the body against these antigens would neutralise th
actual infection.

• The vaccines also generate memory – B and T-
cells that recognize the pathogen quickly on subsequent exposure
and overwhelm the invaders with a massive production of antibodies.

•

If a person is infected with some deadly microbes to which quick immune resp
we need to directly inject the preformed antibodies, or antitoxin (a preparation
toxin). Even in cases of snakebites, the injection which is given to the patients
against the snake venom. This type of immunisation is called passive immunis

•

Recombinant DNA technology has allowed the production of antigenic polype

or yeast. Vaccines produced using this approach allow large scale production a
immunisation, e.g., hepatitis B vaccine produced from yeast.

Allergies

•

The exaggerated response of the immune system to certain antigens present in
allergy. The substances to which such an immune response is produced are ca
produced to these are of IgE type. Common examples of allergens are mites in
etc. Symptoms of allergic reactions include sneezing, watery eyes, running no

•

Allergy is due to the release of chemicals like histamine and serotonin from th

•

For determining the cause of allergy, the patient is exposed to or injected with
allergens, and the reactions studied.

The use of drugs like anti-
histamine, adrenalin and steroids quickly reduce the symptoms of allergy.

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INSIGHT GENERAL STUDIES

TOPIC

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BIOTECHNOLOGY

Biotechnology is a field of applied biology that involves the use of living orga
medicine and genetic engineering as well as cell and tissue culture technologi
products for manufacturing purpose.

TISSUE CULTURE

•

Tissue culture is the formation of whole plant from explants, i.e., any part of a

test tube, under sterile conditions in special nutrient media.

•

This capacity to generate a whole plant from any cell/explant is called totipote

•

It is important to stress here that the nutrient medium must provide a carbon s

inorganic salts, vitamins, amino acids and growth regulators like auxins, cytok

•

By application of these methods it is possible to achieve propagation of a larg
durations. This method of producing thousands of plants through tissue cultur

Somaclones

•

Each of the plant obtained from mother plant which is genetically identical to
they were grown, i.e., they are somaclones.

Somatic hybrids andsomatic hybridisation.

•

Scientists have even isolated single cells from plants and after digesting their
isolate naked protoplasts (surrounded by plasma membranes).

• Isolated protoplasts from two different varieties of plants –
each having a desirable character – can be fused
to get hybrid protoplasts, which can be further grown to form a new plant.

•

These hybrids are called somatic hybrids while the process is called somatic h

Genetic engineering
•
Techniques to alter the chemistry of genetic material (DNA and RNA), to intr
and thus change the phenotype of the host organism.
BIOTECHNOLOGICAL APPLICATIONS
IN AGRICULTURE
•
Plants, bacteria, fungi and animals whose genes have been altered by manipul
Modified Organisms (GMO).
•
GM (genetically modified) plants have been useful in increasing crop yields, r
make crops more tolerant of stresses.
•
There are several GM crop plants with improved nutritional value of foods an
chemical pesticides (pest-resistant crops).
•
Green Revolutionsucceeded in tripling the food supply but yet it was not enou
population.
•
Increased yields have partly been due to the use of improved crop varieties, bu
better management practices and use of agrochemicals (fertilisers and pesticid
the developing world, agrochemicals are often too expensive, and further incre
varieties are not possible using conventional breeding.
• GM plants have been useful in many ways. Genetic modification has:

• Made crops more tolerant to abiotic stresses (cold, drought, salt, heat).
• Reduced reliance on chemical pesticides (pest-resistant crops).
• Helped to reduce post harvest losses.
•
Increased efficiency of mineral usage by plants (this prevents early exhaustion
• Enhanced nutritional value of food, e.g., Vitamin 'A' enriched rice.
• In addition to these uses, GM has been used to create tailor-made plants to supply alternative resources to industries, in the form of starches, fuels and pharmaceuticals.
•
Some of the applications of biotechnology in agriculture are the production of could decrease the amount of pesticide used.
• Bt toxin is produced by a bacterium called Bacillus thuringiensis (Bt for short).
•
Bt toxin gene has been cloned from the bacteria and been expressed in plants t without the need for insecticides; in effect created a bio-pesticide. Examples are Bt cotton, Bt corn, rice, tomato, potato and soyabean etc.

BtCotton

•
Some strains of Bacillus thuringiensis produce proteins that kill certain insects budworm, armyworm), coleopterans (beetles) and dipterans (flies, mosquitoes
•
B. thuringiensis forms protein crystals during a particular phase of their growt insecticidal protein. The activated toxin binds to the surface of midgut epitheli cause cell swelling and lysis and eventually cause death of the insect.
•
The toxin is coded by a gene named cry. There are a number of them, for exar the genes cryIAc and cryIIAb control the cotton bollworms, that of cryIAb co
Pest Resistant Plants

- Several nematodes parasitise effect wide variety of plants and animals includi
- A nematode Meloidegyneincognitia infects the roots of tobacco plants and cau
A novel strategy was adopted to prevent this infestation which was based on t
(RNAi).
- RNAi takes place in all eukaryotic organisms as a method of cellular defense.
- This method involves silencing of a specific mRNA due to a complementary c
prevents translation of the mRNA (silencing).

Plant breeding

- Plant breeding is used to create varieties, which are resistant to pathogens and
the yield of the food.
- This method has also been used to increase the protein content of the plant foo
quality of food.
- In India, several varieties of different crop plants have been produced. All thes
production of food.
- Techniques of tissue culture and somatic hybridisation offer vast potential for
to produce new varieties.

TRANSGENIC ANIMALS

- Animals that have had their DNA manipulated to possess and express an extra
transgenic animals.
- Transgenic rats, rabbits, pigs, sheep, cows and fish have been produced, althou
existing transgenic animals are mice.

Normal physiology and development

- Transgenic animals can be specifically designed to allow the study of how ger
affect the normal functions of the body and its development, e.g., study of con
growth such as insulin-like growth factor.

INSIGHT GENERAL STUDIES

•

By introducing genes from other species that alter the formation of this factor
effects that result, information is obtained about the biological role of the facto
Study of disease

•

Many transgenic animals are designed to increase our understanding of how g
development of disease. These are specially made to serve as models for hum
of new treatments for diseases is made possible.

•

Today transgenic models exist for many human diseases such as cancer, cystic
and Alzheimer's disease.
Biological products

•

Medicines required to treat certain human diseases can contain biological proc
often expensive to make.

•

Transgenic animals that produce useful biological products can be created by t
of DNA (or genes) which codes for a particular product such as human protein
antitrypsin) used to treat emphysema.

•

Similar attempts are being made for treatment of phenylketonuria (PKU) and c
• In 1997, the first transgenic cow, Rosie, produced human protein-
enriched milk (2.4 grams per litre).
• The milk contained the human alpha-
lactalbumin and was nutritionally a more balanced product for human
babies than natural cow-milk.
Vaccine safety

•

Transgenic mice are being developed for use in testing the safety of vaccines b

•

Transgenic mice are being used to test the safety of the polio vaccine. If succe
they could replace the use of monkeys to test the safety of batches of the vacci
Chemical safety testing

• This is known as toxicity/safety testing.
•
The procedure is the same as that used for testing toxicity of drugs. Transgeni
genes which make them more sensitive to toxic substances than non-
transgenic animals.
• They are then exposed to the toxic substances and the effects studied.
• Toxicity testing in such animals will allow us to obtain results in less time.
Gene Therapy
•
Gene therapy is the insertion of genes into an individual's cells and tissues to
hereditary diseases.
•
It does so by replacing a defective mutant allele with a functional one or gene
amplification.
•
Viruses that attack their hosts and introduce their genetic material into the hos
cycle are used as vectors to transfer healthy genes or more recently portions o
•
The current interest in the manipulation of microbes, plants, and animals has r
• The first clinical gene therapy was given in 1990 to a 4-
year old girl with adenosine deaminase (ADA) deficiency.
This enzyme is crucial for the immune system to function. The disorder is cau
gene for adenosine deaminase.
•
In some children ADA deficiency can be cured by bone marrow transplantatic
enzyme replacement therapy, in which functional ADA is given to the patient
with both of these approaches that they are not completely curative.
•
As a first step towards gene therapy, lymphocytes from the blood of the patier
the body. A functional ADA cDNA (using a retroviral vector) is then introduc
are subsequently returned to the patient. However, as these cells are not immo
periodic infusion of such genetically engineered lymphocytes. However, if the
cells producing ADA is introduced into cells at early embryonic stages, it coul

INSIGHT GENERAL STUDIES

Molecular Diagnosis

•

Recombinant DNA technology, Polymerase Chain Reaction (PCR) and Enzyn
sorbent Assay

(ELISA) are some of the techniques that serve the purpose of early diagnosis.

•

Presence of a pathogen (bacteria, viruses, etc.) is normally suspected only whe
a disease symptom. By this time the concentration of pathogen is already very

•

PCR is now routinely used to detect HIV in suspected AIDS patients. It is bei
genes in suspected cancer patients too. It is a powerful techqnique to identify r

• ELISA is based on the principle of antigen-
antibody interaction. Infection by pathogen can be detected by the
presence of antigens (proteins, glycoproteins, etc.) or by detecting the antibod
pathogen.

DNA Fingerprinting

•

It is a technique employed by forensic scientists to assist in the identification c
respective DNA profiles.

•

DNA profiles are encrypted sets of numbers that reflect a person's DNA make
person's identifier. It is used in, for example, parental testing and criminal inv

•

99.9% of human DNA sequences are the same in every person, enough of the
one individual from another.

•

DNA fingerprinting involves identifying differences in some specific regions i
repetitive DNA, because in these sequences, a small stretch of DNA is repeate

•

These repetitive DNA are separated from bulk genomic DNA as different peal
centrifugation.

•

The bulk DNA forms a major peak and the other small peaks are referred to as
Cloning

•

Cloning is the production of an exact copy of a cell, any other living part, or a

•

Cloning of an animal was successfully performed for the first time by Ian Wil
Roslin Institute in Edinburgh, Scotland. They cloned successfully a sheep nam

• Dolly was born on 5th July 1996 and was the first mammal to be cloned.

•

During the process of cloning Dolly, a cell was collected from the mammary g
sheep simultaneously, an egg was obtained from a Scottish blackface ewe .The
the egg. Then, the nucleus of the mammary gland cell from the Finn Dorsett sl
of the Scottish blackface ewe whose nucleus had been removed. The egg thus
the Scottish blackface ewe. Development of this egg followed normally and fi
Dolly was given birth by the Scottish blackface ewe, it was found to be absolu
sheep from which the nucleus was taken. Since the nucleus from the egg of the
removed, Dolly did not show any character of the Scottish blackface ewe. Dol
Finn Dorsett sheep and produced several offspring of her own through normal
Dolly died on 14th February 2003 due to a certain lung disease.

•

Since Dolly, several attempts have been made to produce cloned mammals. H
or die soon after birth.

Restriction Enzymes

•

In the year 1963, enzymes responsible for restricting the growth of bacterioph
isolated, restriction endonuclease–Hind II.

•

Besides Hind II, today we know more than 900 restriction enzymes that have b
strains of bacteria each of which recognise different recognition sequences.

•

Restriction enzymes belong to a larger class of enzymes called nucleases. The
and endonucleases.

•

Exonucleases remove nucleotides from the ends of the DNA whereas, endonu
positions within the DNA.

•

Each restriction endonuclease functions by ‘inspecting’ the length of a DNA s
Recombinant DNA technology

Recombinant DNA technology involves several steps in specific sequence suc
of DNA by restriction endonucleases, isolation of a desired DNA fragment, lig
vector, transferring the recombinant DNA into the host, culturing the host cell
extraction of the desired product.

Separation and isolation of DNA fragments

•

The cutting of DNA by restriction endonucleases results in the fragmentes of I

•

These fragments can be separated by a technique known as gel electrophoresis

•

The separated DNA fragments can be visualised only after staining the DNA v
ethidium bromide followed by exposure to UV radiation.

•

The separated bands of DNA are cut out from the agarose gel and extracted fr
known as elution.

•

The DNA fragments purified in this way are used in constructing recombinant
cloning vectors.

HUMAN GENOME PROJECT

• Genetic make-

up of an organism or an individual lies in the DNA sequences. If two individu
their DNA sequences should also be different, at least at some places. These a
finding out the complete DNA sequence of human genome.

•

With the establishment of genetic engineering techniques where it was possibl
piece of DNA and availability of simple and fast techniques for determining D
project of sequencing human genome was launched in the year 1990.

•

Human genome is said to have approximately 3 x 10^9 bp, and if the cost of sec
(the estimated cost in the beginning), the total estimated cost of the project wo
US dollars. Further, if the obtained sequences were to be stored in typed form
the book contained 1000 letters and each book contained 1000 pages, then 33(
to store the information of DNA sequence from a single human cell. The enor
to be generated also necessitated the use of high speed computational devices
and analysis.

Goals of HGP

Some of the important goals of HGP were as follows:

• Identify all the approximately 20,000-25,000 genes in human DNA;

•

Determine the sequences of the 3 billion chemical base pairs that make up hur

• Store this information in databases;Improve tools for data analysis;

• Transfer related technologies to other sectors, such as industries;

•

Address the ethical, legal, and social issues (ELSI) that may arise from the pro

• The Human Genome Project was a 13-
year project coordinated by the U.S. Department of Energy and the
National Institute of Health. The project was completed in 2003.

•

Besides providing clues to understanding human biology, learning about non-
human organisms DNA sequences
can lead to an understanding of their natural capabilities that can be applied to
health care, agriculture, energy production, environmental remediation.

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INSIGHT GENERAL STUDIES

TOPIC

22

ECOLOGY

Introduction

•

Ecology is the branch of science that studies the distribution and abundance of the interactions between organisms and their environment.

•

The environment of an organism includes both its physical habitat, which can abiotic factors like climate and geology, as well as the other organisms which

• The term was coined in 1866 by the German biologist Ernst Haeckel.

Ecosystem

•

An ecosystem is a functional unit of nature this term was first utilized by Tans and biotic components.

•

Abiotic components are inorganic materials- air, water and soil, whereas bioti consumers and decomposers.

•

Each ecosystem has characteristic physical structure resulting from interactior components.

•

Species composition and stratification are the two main structural features of a of nutrition every organism occupies a place in an ecosystem.

•

Productivity, decomposition, energy flow, and nutrient cycling are the four im ecosystem.

•

Primary productivity is the rate of capture of solar energy or biomass producti into two types: gross primary productivity (GPP) and net primary productivity

•

Rate of capture of solar energy or total production of organic matter is called a

- NPP is the remaining biomass or the energy left after utilisation of producers.
- Secondary productivity is the rate of assimilation of food energy by the consu
- In decomposition, complex organic compounds of detritus are converted to ca nutrients by the decomposers.
- Decomposition involves three processes, namely fragmentation of detritus, lea
- Energy flow is unidirectional. First, plants capture solar energy and then, food to decomposers. Organisms of different trophic levels in nature are connected energy relationship forming a food chain.
- The storage and movement of nutrient elements through the various compone nutrient cycling; nutrients are repeatedly used through this process.
- Nutrient cycling is of two types. Gaseous and sedimentary. Atmosphere or hy the gaseous type of cycle (carbon), whereas Earth’s crust is the reservoir for se Products of ecosystem processes are named as ecosystem services, e.g., purifi forests.
- The biotic community is dynamic and undergoes changes with the passage of sequentially ordered and constitute ecological succession. Succession begins v area by pioneers which later pave way for successors and ultimately a stable c climax community remains stable as long as the environment remains unchan

Biodiversity INSIGHT GENERAL STUDIES

•

In our biosphere immense diversity (or heterogeneity) exists not only at the sp
biological organisation ranging from macromolecules within cells to biomes.

•

Biodiversity is the term popularized by the sociobiologist Edward Wilson to d
at all the levels of biological organisation.

• The most important of them are–

(i) Genetic diversity

•

A single species might show high diversity at the genetic level over its distribu

•

The genetic variation shown by the medicinal plant Rauwolfia vomitoria grow
ranges might be in terms of the potency and concentration of the active chemi
produces.

•

India has more than 50,000 genetically different strains of rice, and 1,000 vari

(ii) Species diversity

•

The diversity at the species level. For example, the Western Ghats have a grea
than the Eastern Ghats.

(iii) Ecological diversity

•

At the ecosystem level, India, for instance, with its deserts, rain forests, mangr
estuaries, and alpine meadows has a greater ecosystem diversity than a Scandi

•

It has taken millions of years of evolution, to accumulate this rich diversity in
wealth in less than two centuries if the present rates of species losses continue

•

Biodiversity and its conservation are now vital environmental issues of interna
more people around the world begin to realise the critical importance of biodiv

well- being on this planet.

•

Biodiversity conservation may be in situ as well as ex situ. In in situ conservat
protected in their naturalhabitat so that the entire ecosystem is protected.

•

Recently, 34‘biodiversity hotspots’ in the world have been proposed for intens
these, three (Western Ghats-Sri Lanka,Himalaya and Indo-
Burma) cover India’s rich biodiversity regions.

•

Ourcountry’s in situ conservation efforts are reflected in its 14 biosphereresen
wildlife sanctuaries and many sacredgroves. Ex situ conservation methods inc
threatened species in zoological parks and botanical gardens, in vitro fertilisat
and cryopreservation ofgametes.

Deforestation

• Deforestation is the conversion of forested areas to non-forested ones.

•

At the beginning of the twentieth century, forests covered about 30 per cent of
of the century, it shrunk to 19.4 per cent, whereas the National Forest Policy (
33 per cent forest cover for the plains and 67 per cent for the hills.

•

A number of human activities contribute to it. One of the major reasons is the
land so as to feed the growing human population.

•

Trees are axed for timber, firewood, cattle ranching and for several other purp

•

Slash and burn agriculture, commonly called as Jhum cultivation in the north-
eastern states of India, has also
contributed to deforestation. In slash and burn agriculture, the farmers cut dow
burn the plant remains.

•

The ash is used as a fertiliser and the land is then used for farming or cattle gr
is left for several years so as to allow its recovery. The farmers then move on t
process. In earlier days, when Jhum cultivation was in prevalence, enough tim
gap was given such that the
land recovered from the effect of cultivation. With increasing population, and
recovery phase is done away with, resulting in deforestation.

•

One of the major effects is enhanced carbon dioxide concentration in the atmo
could hold a lot of carbon in their biomass are lost with deforestation.

•

Deforestation also causes loss of biodiversity due to habitat destruction, distur
erosion, and may lead to desertification in extreme cases.

•

Reforestationis the process of restoring a forest that once existed but was remo
the past. Reforestation may occur naturally in a deforested area. However, we
trees with due consideration to biodiversity that earlier existed in that area.

Greenhouse effect and Global warming

•

The term 'Greenhouse effect' has been derived from a phenomenon that occur

•

The greenhouse effect is a naturally occurring phenomenon that is responsible
and atmosphere.

•

Without greenhouse effect the average temperature at surface of Earth would l
18°C rather than the present average of 15°C.

•

In order to understand the greenhouse effect, it is necessary to know the fate o
reaches the outermost atmosphere. Clouds and gases reflect about one-
fourth of the incoming solar radiation,
and absorb some of it but almost half of incoming solar radiation falls on Earth
small proportion is reflected back.

• Earth's surface re-
emits heat in the form of infrared radiation but part of this does not escape into
atmospheric gases (e.g., carbon dioxide, methane, etc.) absorb a major fraction

•

The molecules of these gases radiate heat energy, and a major part of which ag
thus heating it up once again. This cycle is repeated many a times.

• The gases – carbon dioxide and methane –
are commonly known as greenhouse gasses because they are

responsible for the greenhouse effect, maximum produced by U.S.A.

¬ ¬ ¬ ¬ ¬

INSIGHT GENERAL STUDIES

TOPIC

23

MISCELLANEOUS

Carnivorous plants

•

Carnivorous plants are the plants that derive some or most of their nutrients (b
and consuming animals orprotozoans, typically insects and other arthropods.

•

Carnivorous plants appear adapted to grow in places where the soil is thin or p
especially nitrogen, such as acidic bogs and rock outcroppings.

• Charles Darwin wrote Insectivorous Plants, the first well-
known treatise on carnivorous plants, in 1875.

Epiphyte

An epiphyte (or air plants) is a plant that grows upon another plant (such as a t
parasitically or sometimes
upon some other object, derives its moisture and nutrients from the air and rai
accumulating around it.

Parasitic plant

•

A parasitic plant is one that derives some or all of its sustenance from another

•

Parasitic plants have a modified root, the haustorium, that penetrates the host p
the xylem, phloem, or both.e.g. Cuscuta.

Lianas

•

Climbing vines in the rainforests are called lianas. Sunlight hardly reaches the
rainforests.

•

Lianas climb upwards as they need sunlight for survival. Their stems become

• The length of the stems can be 3000 feet.

Strangler Plants

•

Seeds of strangler plants start growing high on other trees. They have air roots
nutrients from the air.

•

Orchids, philodendrons, ferns and bromeliads are the best examples of strangl
grow quickly and start surrounding the host tree.

•

Eventually, due to suffocation, the host tree dies. That is why these plants are
monkeys eat the fruits of these plants and transport the seeds of these plants.

Plants with Prop Roots

•

Plants like mangroves which grow at the river edges have greater risk of flood

•

Several aerial extensions from the trunk grow downwards and support these p

• These prop or stilt roots provide the required stability to these plants.

Plants with Buttress Roots

•

Soil in the rainforests contains maximum nutrients at the surface level. To hav
and support, some tall trees develop buttressed roots.

•

These roots grow from the base of the trunks and try to cover maximum area.

•

Roots growing from the base of the trunk, from the level as high as 15 ft abov

Biofertilizer

•

Biofertilizer is a substance which contains living microorganisms which, whe
or soil, colonizes the rhizosphere or the interior of the plant and promotes gro
availability of primary nutrients to the host plant.

• Examples of
biofertilizers are Rhizobium, Azotobacter, Azospirillum and blue green algae(
Enzymes
• Almost all enzymes are proteins.
•
There are some nucleic acids that behave like enzymes. These are called riboz
•
Enzymes are composed of one or several polypeptide chains. However, there a

non-
protein constituents called cofactors are bound to the the enzyme to make the
active. In these instances, the protein portion of the enzymes is called the apoe

• Catalytic activity is lost when the co-
factor is removed from the enzyme which testifies that they play a crucial
role in the catalytic activity of the enzyme.
Callus
A cluster of undifferentiated plant cells that can, for some species, be induced
Electrophoresis
A technique for separating different types of molecules in a gel (or liquid), io
conducting medium, based on their
differential movement in an applied electrical field.
Hybridization
• Production of offspring, or hybrids, from genetically dissimilar parents.
• The process can be used to produce hybrid plants (by cross-
breeding two different varieties) or hybridomas
(hybrid cells formed by fusing two unlike cells, used in producing monoclona
•
The term is also used to refer to the binding of complementary strands of DN
Library
A set of cloned DNA fragments. A collection of genomic or complementary
organism that have been cloned in a vector and grown in an appropriate host
Vector

The agent (e.g., plasmid or virus) used to carry new DNA into a cell.
Phenotype
Characteristics of an organism which are directly visible is called phenotype.
Genotype
The genetic composition of the organism in which all genes present in the bod
nature of the genes (dominant or recessive) are detected and identified.
Alleles
The characteristic factor (gene) which are represented in the diversified form l
are called alleles of each other.
Apomixis
Apomixis is the naturally occurring ability of some plant species to reproduce
embryo develop without the contribution of male gamete.
Homozygous
If the fact(gene) exhibits the same character specially during the crossbreeding
called homozygous.
Heterozygous
If in the pairs of homozygous factors, both factors (genes) be just opposite to e
dominant and another is recessive then such pair is called heterozygous.
Linkage
When two different characters tie up on the same chromosome then its heredit
proceed along with these characters, which is called linkage.

Polyploidy

Cells are polyploid if they contain more than 2 haploid (n) sets of chromosom
Polyteny
The state where a cell contains polytene chromosome. Polytene chromosome i
composed of thousands of copies of DNA parallel to one another instead of th
chromosome. They are found in the salivary glands of insects.
Necrosis
The localized death of living cells as from infection or the interruption of bloo
Sex chromosomes
Many genes were linked to sexes also, and called as sex-
linked genes. The two sexes (male and female) were found
to have a set of chromosomes which were common, and another set which wa
were different in two sexes were named as sex chromosomes. The remaining s
humans, a normal female has 22 pairs of autosomes and a pair of sex chromos
autosomes and a pair of sex chromosome as XY. In chicken, sex chromosome
Mutation
Mutation is defined as change in the genetic material. A point mutation is a ch
Sickle-
cell anemia is caused due to change of one base in the gene coding for beta-
chain of hemoglobin. Inheritable
mutations can be studied by generating a pedigree of a family. Some mutation
chromosomes (polyploidy) or change in a subset of chromosome number (ane
the mutational basis of genetic disorders. Down's syndrome is due to trisomy
extra copy of chromosome 21 and consequently the total number of chromoso
one X chromosome is missing and the sex chromosome is as XO, and in Kline
These can be easily studied by analysis of Karyotypes.
Sex linked inheritance in man
1.
Red green color blindness: Wilson (1911) detected the specific gene for dalton

2. Hemophilia: This disease is inherited through an X-

linked recessive gene due to which blood lacks the capacity
to coagulate. This disorder is due to sex chromosomal gene mutation.

Out-crossing

This is the practice of mating of animals within the samebreed, but having no
their pedigreeup to 4-
6 generations. The offspring of such a mating is known as anout-
cross. It is the best breeding
method for animals that arebelow average in productivity in milk production,
single outcross often helps to overcome inbreedingdepression.

Cross-breeding

In this method, superior males of one breed are matedwith superior females of
breeding
allows thedesirable qualities of two different breeds to be combined. The prog
be used for commercial production.
Alternatively, they may be subjected to some form of inbreeding andselection
may be superior to the existingbreeds. Many new animal breeds have been dev
is a new breed of sheep developed in Punjab by crossingBikaneri ewes and M

Interspecific hybridisation

In this method, male and female animalsof two different species are mated. In
combinedesirable features of both the parents, and may be of considerableeco

Gene

The word gene was first identified and used by Johanson in 1909. The gene is
on a chromosome that by itself or with other genes determine the characters o

Diffusion

•

Movement by diffusionis passive, and may be from one part of the cell to the
short distances, from the intercellular spaces of the leaf to the outside. No ener

•

In diffusion, molecules move in a random fashion, the net result being substan
higher concentration to regions of lower concentration.

• Diffusion is a slow process and is not dependent on a 'living system'.

•

Diffusion is very important to plants since it the only means for gaseous move
Diffusion rates are affected by the gradient of concentration, the permeability
them, temperature and pressure.

Transpiration

• Transpiration is the evaporative loss of water by plants.

•

It occurs mainly through the stomata in the leaves. Besides the loss of water v
of oxygen and carbon dioxide in the leaf also occurs through pores called ston

•

Stomata are open in the day time and close during the night. The immediate c
of the stomata is a change in the turgidity of the guard cells.

•

The inner wall of each guard cell, towards the pore or stomatalaperture, is thic

•

When turgidity increases within the two guard cells flanking each stomatal ap
walls bulge out and force the inner walls into a crescent shape.

•

The opening of the stoma is also aided due to the orientation of the microfibril
cells.

•

Cellulose microfibrils are oriented radially rather than longitudinally making i

•

When the guard cells lose turgor, due to water loss (or water stress) the elastic
shape, the guard cells become flaccid and the stoma closes.

•

Usually the lower surface of a dorsiventral (often dicotyledonous) leaf has a g
in an isobilateral (often monocotyledonous) leaf they are about equal on both s

•

Transpiration is affected by several external factors: temperature, light, humid

•

Plant factors that affect transpiration include number and distribution of stoma
per cent, water status of the plant, canopy structure etc.

• Transpirationcreates transpiration pull for absorption and transport of plants
• Supplies water for photosynthesis
• Transports minerals from the soil to all parts of the plant
• Cools leaf surfaces, sometimes 10 to 15 degrees, by evaporative cooling
• Maintains the shape and structure of the plants by keeping cells turgid

Respiration

•

Plants unlike animals have no special systems for breathing or gaseous exchar
gaseous exchange by diffusion.

•

Almost all living cells in a plant have their surfaces exposed to air. The breaki
C bonds of complex
organic molecules by oxidation cells leading to the release of a lot of energy is

• Glucose is the favoured substrate for respiration.

•

Fats and proteins can also be broken down to yield energy. The initial stage of
in the cytoplasm.

•

Each glucose molecule is broken through a series of enzyme catalysed reactio
acid. This process is called glycolysis. The fate of the pyruvate depends on the
organism.

•

Under anaerobic conditions either lactic acid fermentation or alcohol fermenta
pathway is an amphibolic pathway as it involves both anabolism and catabolis

•

The respiratory quotient depends upon the type of respiratory substance used (
Photosynthesis

•

Green plants make their own food by photosynthesis. During this process carb

is taken in by leaves through stomata and used for making carbohydrates, prin

•

Photosynthesis takes place only in the green parts of the plants, mainly the lea

•

Within the leaves, the mesophyll cells have a large number of chloroplasts tha

fixation.

•

Within the chloroplasts, the membranes are sites for the light reaction, while t
occurs in the stromatal aperture.

•

Photosynthesis has two stages: the light reaction and the carbon fixing reactio

•

Some tropical plants show a special type of photosynthesis called C4 pathway
of CO2 fixation that takes place in the mesophyll, is a 4-
carbon compound. In the bundle sheath cells the
Calvin pathway is carried out for the synthesis of carbohydrates.
Single cell protein (SCP)

•

Conventional agricultural production of cereals, pulses, vegetables, fruits, etc.
demand of food at the rate at which human and animal population is increasin

•

he shift from grain to meat diets also creates more demand for cereals as it tak
10 Kg of grain to produce
1 Kg of meat by animal farming.

•

More than 25 per cent of human population is suffering from hunger and maln

•

One of the alternate sources of proteins for animal and human nutrition is Sing
are being grown on an industrial scale as source of good protein.

•

Microbes like Spirulina can be grown easily on materials like waste water fror
(containing starch), straw, molasses, animal manure and even sewage, to prod
serve as food rich in protein, minerals, fats, carbohydrate and vitamins.

Biochemical Oxygen Demand (BOD)/Chemical Oxygen Demand (COD)

•

Natural organic detritus and organic waste from waste water treatment plants,
agricultural and urban runoff, acts as a food source for water-borne bacteria.

•

Bacteria decompose these organic materials using dissolved oxygen, thus redu

•

Biochemical oxygen demand (BOD) is a measure of the amount of oxygen tha
decomposing organic matter under aerobic conditions.

•

Biochemical oxygen demand is determined by incubating a sealed sample of v
the loss of oxygen from the beginning to the end of the test. Samples often mu
or the bacteria will deplete all of the oxygen in the bottle before the test is com

•

The main focus of wastewater treatment plants is to reduce the BOD in the eff
waters. Wastewater treatment plants are designed to function as bacteria farm
oxygen and organic waste.

•

The excess bacteria grown in the system are removed as sludge, and this "soli
land.

•

Chemical oxygen demand (COD) does not differentiate between biologically a
matter, and it is a measure of the total quantity of oxygen required to oxidize a
dioxide and water.

•

COD values are always greater than BOD values, but COD measurements can
BOD measurements take five day.

Lymphoid organs

•

These are the organs where origin and/or maturation and proliferation of lymp

- The primary lymphoid organs are bone marrow and thymuswhere immature ly

antigen-
sensitive lymphocytes. After maturation the lymphocytes migrate to secondary
spleen, lymph nodes, tonsils, Peyer's patches of small intestine and appendix.

•
The secondary lymphoid organs provide the sites for interaction of lymphocyt
proliferate to become effector cells. The location of various lymphoid organs i
•
The bone marrow is the main lymphoid organ where all blood cells including
•
The thymus is a lobed organ located near the heart and beneath the breastbone
•
The thymus is quite large at the time of birth but keeps reducing in size with a
attained it reduces to a very small size.
• Both bone-marrow and thymus provide micro-
environments for the development and maturation of Tlymphocytes.
•
The spleen is a large beanshaped organ. It mainly contains lymphocytes and p
the blood by trapping blood-borne microorganisms.
•
Spleen also has a large reservoir of erythrocytes. The lymph nodes are small s
different points along the lymphatic system.
• Lymph nodes serve to trap the micro-
organisms or other antigens, which happen to get into the lymph and
tissue fluid.
•
Antigens trapped in the lymph nodes are responsible for the activation of lymp
cause the immune response.
•
There is lymphoid tissue also located within the lining of the major tracts (resp
tracts) called mucosalassociatedlymphoid tissue(MALT). It constitutes about 5
tissue in human body.
Important Fact About Some Plants

Leafless roots Rootless plant

Plants that are all roots
Smallest angiosperrn
Largest angiosperm / Tallest plant Sequoia sempervirens

Largest bud
Broadest leaf
Longest leaf
Plant with two leaves only Plant with single leaf
Smallest flower
Study of flowers
Bryophyllum and Bigonio
Wolffia (smallest angiosperm) and Utriculoria, (a submerged hydrophyte)
Podostemon (a hydrophyte)
Wolffia
Eucalyptus regnaus with height of more than
(Redwood Tree) is the massive plant which is 14 m. over 111
m tall and more than 24 in girth.
cabbage
Victoria amazonica
Raphio vinifera
Welwitschia (a gymnosperm)
Monophyllea
Wolffia arrhiza
Anthology

INSIGHT GENERAL STUDIES

Some Important ScientiestsAnd Their Contributions
Father of Botany

Father of Taxonomy
Taxonomy — Term
Systematics—Term
Father of lndian taxonomy Biosystematics - Term Taxon Term
Origin of Species
Evolution –Term

Nitrogen fixation :
Theophrastus (He has written Historia Plantanum and the Causes of Plants.)
Carolus Linnaeus.
De-Candolle
C. Linnaeus
Santapau
Camp and Gilly
Adolf-Mayer (for Animals).
Charles Darwin(Author of the book)
Herbert Spencer

- Nitrogen fixation is the natural process, either biological or abiotic, by which r converted into ammonia (NH_3).
- This process is essential for life because fixed nitrogen is required to biosynth of life, e.g., nucleotides for DNA and RNA and amino acids for proteins.
- Nitrogen fixation also refers to other biological conversions of nitrogen, such dioxide.
- Microorganisms that fix nitrogen are bacteria called diazotrophs or Nitrogen f plants, and some animals (termites), have formed associations (symbioses) wi

• Nitrogen fixation also occurs as a result of non-
biological processes. These include lightning, industrially through the Haber-Bosch Process, and combustion.

•
Biological nitrogen fixation was discovered by the Dutch microbiologist Mart

•
Biological nitrogen fixation (BNF) occurs when atmospheric nitrogen is conv
callednitrogenase.The reaction for BNF is:

$N_2 + 8 H^+ + 8 e^” \ ^{23}_{11}\ 2 NH_3 + H_2$

•
Enzymes responsible for nitrogenase action are very susceptible to destruction
bacteria cease production of the enzyme in the presence of oxygen).

• Many nitrogen-
fixing organisms exist only in anaerobic conditions, respiring to draw down o
binding the oxygen with a protein such as Leghemoglobin.

• Microorganisms that fix nitrogen (Diazotrophs) are:
• Cyanobacteria
• Azotobacteraceae
• Rhizobia
• Frankia

Nitrogen fixation by rhizobia

• Rhizobia are soil, Gram-
negative bacteria with the unique ability to establish a N_2-
fixing symbiosis on legume roots and on the stems of some aquatic legumes.

•
During this interaction bacteroids, as rhizobia are called in the symbiotic state
compartments within a specialized organ, the nodule, where they fix N_2.

Rhizobium bacteria in Legume family

• Plants that contribute to nitrogen fixation include the legume family – Fabaceae – with taxa such as clover,
soybeans, alfalfa, lupines, peanuts, and rooibos. They contain symbiotic bacte
nodules in their root systems, producing nitrogen compounds that help the pla
other plants.

•

When the plant dies, the fixed nitrogen is released, making it available to othe
fertilize the soil.

•

The great majority of legumes have this association, but a few genera (e.g., St
traditional and organic farming practices, fields are rotated through various ty
includes one consisting mainly or entirely of clover or buckwheat (family Pol
referred to as "green manure."

Frankia bacteria

• Although by far the majority of nitrogen-
fixing plants are in the legume family Fabaceae, there are a few nonleguminou
with Frankia bacteria.

•

These plants, referred to as "actinorhizal plants", consist of 24genera of wood
among 8 plant families.

Cyanobacteria or Blue Green Algae

• Cyanobacteria also known as blue-green algae, blue-green bacteria, and Cyanophyta, is
a phylum of bacteria that obtain their energy through photosynthesis.

• Cyanobacteria include unicellular and colonial species.

•

Some filamentous colonies show the ability to differentiate into several differe
cells, the normal, photosynthetic cells that are formed under favorable growin
climate-
resistant spores that may form when environmental conditions become harsh;

•

Heterocysts may also form under the appropriate environmental conditions (a

nitrogen isinsufficient. Heterocyst-
forming species are specialized for nitrogen fixation and are able to fix nitrogen gas into ammonia (NH_3),nitrites (NO^{-2}) or nitrates (NO^{-}
^{3}) which can be absorbed by plants and
converted to protein and nucleic acids (atmospheric nitrogen is not bioavailabl

• Rice plantations utilize healthy populations of nitrogen-fixing cyanobacteria (azolla) for use as rice paddy fertilizer .

•

Aquatic cyanobacteria are probably best known for the extensive and highly v both freshwater and the marine environment and can have the appearance of b green paint or scum. The
association of toxicitywith such blooms has frequently led to the closure of rec are observed. Marine bacteriophages are a significantparasite of unicellular ma they infect cells, they lyse them, releasing more phages into the water.

•

Nitrogen fixation by cyanobacteria in coral reefs can fix twice the amount of n around 1.8 kg of nitrogen is fixed per hectare per day.

Azotobacter

•

Azotobacter are ubiquitous in neutral and weakly basic soils, but not acidic so Arctic and Antarctic soils, despite the cold climate, short growing season and soils. In dry soils, Azotobacter can survive in the form of cysts for up to 24 ye

•

Azotobacter are also found in aquatic habitats. Several members are associated the rhizosphere, having certain relationships with the plant. Some strains are a the earthworm Eisenia fetida.

• Azotobacter are free-living nitrogen-fixing bacteria, in contrast to Rhizobium species, they normally fix molecular nitrogen from the atmosphere without symbiotic relations with plants, although some Azotobacter species are associated with plants.

•

Nitrogen fixation is inhibited in the presence of available nitrogen sources, suc
nitrates.

•

Azotobacter range of enzymes needed to perform the nitrogen fixation incluc
an important enzyme nitrogenase. The process of nitrogen fixation requires an
of adenosine triphosphate (ATP).

•

Nitrogen fixation is highly sensitive to the presence of oxygen, and therefore
special defensive mechanism against oxygen, namely a significant intensificat
the concentration of oxygen in the cells.

•

There is also a special protein shethna, which protects nitrogenase and is invol
oxygen. Mutants not producing this protein, are killed by oxygen during nitrog
nitrogen source in the medium. Homocitrate ions play a certain role in the pro
by Azotobacter.

•

They also facilitate the mobility of heavy metals in the soil and thus enhance b
heavy metals, such as cadmium, mercuryand lead.
heavy metals, such as cadmium, mercuryand lead.
trichlorophenol.

• 2,4,6-
trichlorophenol was previously used as an insecticide,fungicide and herbicide
have mutagenic and carcinogenic effects.

•

They are also used in production of alginic acid (E400), which is applied in m
industry as an additive to ice cream, puddings and creams, and in the biosorpti
Bio Diesel

•

Bio Diesel is asubstitute for, or an additive to, diesel fuel that is derived from t
Sunflower, Canola or Jatropha.

•

It is an alternative fuel that can be used in diesel engines and provides power s fuel.

•

Bio Diesel is arenewable domestically produced liquid fuel that can help redu
on foreign oil imports.

•

Recent environmental and economic concerns (Kyoto Protocol) have prompte
biodiesel throughout the world. In 1991, the European Community, (EC) Prop
use of biofuels, including biodiesel.

•

Today, 21 countries worldwide, produce Biodiesel.Some example of the plant

⁂ Castor bean (Ricinus communis)
⁂ Citrullus colocynthis (Tumba)
⁂ Flax
⁂ Jojoba (Simmondsia chinesis)
⁂ Jerusalem artichoke (Helianthus tuberosus L.)Kenaf
⁂ Karanja (Pongamia pinnata)
⁂ Kokum (Garcinia indica)
⁂ Moringa oleiferaMahua (Madhuca indica)
⁂ Neem (Azadirachta indica)
⁂ Simarouba (Simarouba glauca)
⁂ CamelinaCalophyllum inophyllum L

•

Most of the Jatropha oil currently produced in India is used as a substitute for
Diesel Engines and the demand for it is about 15 million tons. It is used as fue
diesel. It is also used for manufacture of Washing Soap. Not much virgin oil (
for manufacture of BioDiesel or for exports.

In Nut-shell:

•
Bio Diesel is the most valuable form of renewable energy that can be used dir
diesel engine.
•
Bio Diesel fuel and can be produced from oilseed plants such as rape seeds, su
Curcas.
• Bio Diesel is environmental friendly and ideal for heavily polluted cities.
• Bio Diesel is as biodegradable as salt
•
Bio Diesel produces 80% less carbon dioxide and 100% less sulfur dioxide em
in cancer risks.
•
Bio Diesel can be used alone or mixed in any ratio with mineral oil diesel fuel
ranges between 5 and 20% (B5 - B20)
• Bio Diesel extends the live of diesel engines
• Bio Diesel is cheaper then mineral oil diesel
• Bio Diesel is conserving natural resources

Biodiesel Scenario In India

• As India is deficient in edible oils, non-edible oil is the main choice for producing biodiesel. According to Indian government policy and Indian technology effects. Some development v with regards to the production of transesterfied non edible oil and its use in bio Institute of Science, Bangalore, Tamilnadu Agriculture University Coimbatore Technology in association with Pan horti consultants. Coimbatore.
•
Generally a Blend of 5% to 20% is used in India (B5 to B20). Indian Oil Corp development work to establish the parameters of the production of tranesterifi use of bio diesel in its R&D center at Faridabad. Research is carried out in Ku for marginally altering the engine parameters to suit the Indian Jatropha seeds transesterification.

Stem cells

•

Stem cells have the remarkable potential to develop into many different cell ty life and growth. In addition, in many tissues they serve as a sort of internal rep without limit to replenish other cells as long as the person or animal is still ali

•

When a stem cell divides, each new cell has the potential either to remain a ste of cell with a more specialized function, such as a muscle cell, a red blood cel

•

Stem cells are distinguished from other cell types by two important characteris cells capable of renewing themselves through cell division, sometimes after lo under certain physiologic or experimental conditions, they can be induced to b specific cells with special functions.

•

In some organs, such as the gut and bone marrow, stem cells regularly divide t damaged tissues. In other organs, however, such as the pancreas and the heart, special conditions.

Nitrosomonas

•

This rare bacteria oxidizes ammonia into nitrite as a metabolic process. Nitros of industrial and sewage waste and in the process of bioremediation. They are cycle by increasing the availability of nitrogen to plants while limiting carbon found in soil, sewage, freshwater, and on building surfaces, especially in pollu levels of nitrogen compounds.

•

The bacteria has power generating membranes, which form long, thin tubes in from the oxidation of ammonia to produce energy. It obtains the carbon it requ via carbon fixation, which converts carbon in a gaseous form into carbon bou

INSIGHT GENERAL STUDIES

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Unlike plants, which fix carbon into sugar through energy gained through the
Nitrosomonas use energy gained through the oxidation of ammonia to fix gase
molecules. Nitrosomonas must consume large amounts of ammonia before cel
process of cell division may take up to several days. This microbe is photopho
or form clumps with other microbes to avoid light.

Bio-Ethanol

• Bio-
ethanol is usually obtained from the conversion of carbon based feedstock, the
the sun using photosynthesis, provided that all minerals required for growth (s
phosphorus) are returned to the land.

•

Ethanol can be produced from a variety of feedstocks such as sugar cane, bag
sorghum, grainsorghum, switchgrass, barley, hemp, kenaf, potatoes, sweetpota
molasses, corn, stover, grain, wheat, straw,c otton, other biomass, as well as m
and harvestings, whichever has the best well-to-wheel assessment.

• An alternative process to produce bio-
ethanol from algae is being developed by the company Algenol. Rather
than grow algae and then harvest and ferment it the algae grow in sunlight and
which is removed without killing the algae. It is claimed the process can produ
compared with 400 gallons for corn production.

Golden Rice

Golden rice is a variety of Oryza sativa rice produced through genetic enginee
carotene,
a precursor of pro-vitamin A in the edible parts of rice.

Golden rice was developed as a fortified food to be used in areas where there i
2005 a new variety calledGolden Rice 2 was announced which produces up to
carotene than the
original variety of golden rice.

Disease caused by polised rice is Beri-Beri.

Endangered Animal Species:

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Red List refers to a specific category of threatened species, and may include c
Red List of Threatened Species uses the term endangered species as a specific
rather than as a general term. .

*
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Extinct: Javan Tiger, Thylacine, Dodo, Passenger Pigeon, Caribbean Monk Se
Elephant Bird,Woolly Mammoth, Dusky Seaside Sparrow

*
** Extinct in the wild: captive individuals survive, but there is no free-living, natural population.

Examples: Hawaiian Crow, Wyoming Toad, Socorro Dove, Red-tailed Black Shark,Scimitar Oryx, Catarina Pupfish

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Critically endangered: faces an extremely high risk of extinction in the immed
Gorilla, Bactrian Camel, Ethiopian Wolf, Saiga, Takhi, Kakapo,Arakan Forest
Rhino, Brazilian Merganser, Axolotl, Leatherback Sea Turtle, Northern White
Philippine Eagle, Brown Spider Monkey, California Condor, Island Fox, Blac

*
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Endangered: faces a very high risk of extinction in the near future. Examples:
Elephant, Giant Panda, Snow Leopard, African Wild Dog, Green Sea Turtle,M
Lion, Philippine Eagle, Markhor, Bornean Orangutan, Grevy's Zebra, Tasman

*
** Vulnerable: faces a high risk of extinction in the medium-term. Examples: African Elephant, Cheetah, Gaur,
Lion, Sloth Bear, Dugong, Polar Bear, Indian Rhinoceros, Komodo Dragon, C
Mandrill, Fossa

*
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Near threatened: may be considered threatened in the near future. Examples: B
billed Duck, Solitary
Eagle, American Bison, Jaguar, Maned Wolf, Tiger Shark, Southern White Rh
Parrot, Striped Hyena, Narwhal.

Grafting

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Grafting is the horticultural technique of binding together different parts of a p
unit that continues to live.

•

It involves grafting a piece of one plant, a one or two year old branch, known
usually of the same species, known as the ‘stock’. The stock has the task of fo
trunk, and the scion will form the crown as of the bonsai tree and the upper tr

•

The fused plant pieces form a new plant although at the same time each retain
type of grafting are:

⁂ Branch grafting
⁂ Bud grafting
⁂ Crown, or rind, grafting and wedge grafting
⁂ Lateral grafting

Some Plant and their edible parts

• Asparagus -

The edible portion is the rapidly emerging stems that arise from the crowns in

• Black Pepper -Fruit.
• Broccoli -

The edible portion is stem tissue, flower buds, and some small leaves.

• Cauliflower - The edible portion is proliferated stem and flower tissue.
• Cinnamon - Bark of the Cinnamomum zeylanicum
• Cloves – flower.

•

Ginger - Ginger was a spice also known as ‘Grains of Paradise’, also called A

part.

• Saffron - The dried aromatic stigmas of plant.

•

Cardamon (aka Cardamom) was a spice made from the whole or ground dried

• Coriander - A Spice made from seeds and leaves.
• Cumin - Dried fruit of a plant .
• Garlic – Bulb , swollen leaves.
• Turmeric - Spice made from a root.
• Mustard - A spice with a pungent flavor, either used as seeds or ground

• Onion -
The edible portion is swollen leaves with a bit of stem. They are bulbs which,

modified stems in which the primary storage tissue is expanded leaf bases. Th
red varieties.

• Potato -
The edible portion is an underground stem that is also a tuber. The “eyes” of tl
buds. Potatoes come in white, yellow, orange, or purple-colored varieties.
• Radish -The edible portion is a root .
Some Common Disease in Human Body by Pollutants

Some common Pollutants Carbon Monoxide
Nitrogenous Oxide
Dust Particles
Lead
Arsenic
Cadmium
Manganese
Nickel
Target Organ/Disease
Central Nervous System Respiratory Disease
Respiratory Disease,Cancer Liver and Kidney Damage Nervous system, skin
Renal, Skeletal, Pulmonary Nervous system, renal system Pulmonary, skin

SOME FACTS INSIGHT GENERAL STUDIES

*** Skin covers 1.85 sq. m of surface and weigh 2.72 kg in human body.

***
Composition of Bones: Organic matter 33.30%, Phosphate of Lime 51.04%, C
of Calcium 2.00%, Phosphate of Magnesium 1.16%, Chloride of Sodium .00%

***
India has 27 lakh HIV patients as per National Aids Control Organisation(NA
women.

*** EEG (Electroencephalography) use to measure brain waves.

***
Lactase and Renin enzymes are found upto the age of 8 years in children for th

*** Smallest bone found in our body Ear (Stapes).

***
Gambusia Affinis is also known as Mousquito fish, it eats larvae of mosquito
control.

MISUSE OF BIOLOGY

Biological techniques are mis-
used by various agencies against the human race. A few examples are:

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Amniocentesis is a biological technique in which amniotic fluid via a needle is
into the uterus and amniotic sac, in order to gain information about the foetus.
cells (amniocytes) at the amniotic membrane and some foetal skin cells. These
stimulated to grow. After few days, the cells are broken to release the chromos
connected and compared with the 23 pairs of normal human chromosomes for
pieces. This technique detects foetal abnormalities by analyzing choromosoma
foetus. This test could reveal the sex of foetus, which has increased the cases o
clear case of misuse of a biological technique.

• Bio-
weapons are developed by using certain biological techniques. These bio-
weapons are antibiotic-resistant

microorganisms with increased infectivity such as Bacillus anthracis, which is
forming bacterium
causing infectious disease known as anthrax. A cloud of anthrax spores, if rele
inhaled by the individuals under attack may act as an agent of effective weapo

DNA Fingerprinting Hyderabad & Diagnostics (CDFD)
National Institute of Delhi Immunology

National Institute of Delhi Plant Genome
Research

National Brain Research Gurgoan Centre
DNA fingerprinting, Diagnostics, Gemone analysis and Bioinformatics.
manufacture of vaccines and immunological reagents,
develop immunological approaches for regulation of
male and female fertility.
Coordinate research of high caliber in basic and applied
plant molecular biology; utilize molecular biology
approaches along with tissue culture and genetic
engineering technology to identify important genes and
manipulate these for generating transgenic plants with
improved agronomic characters and pathogen/stress resistances; for
monitoring important traits;
indentification of genes that are vital for the survival of
the pathogens so that those could be targeted for pathogen combating.
Functioning of the brain at the molecular, cellular, genetic
and behavioural levels to address major neurological disease.

INSIGHT GENERAL STUDIES

National Centre for Cell Pune
Sciences
Rajiv Gandhi Centtre for Thiruvanantha Biotechnology puram

National Agri-Food Mohali, Biotechnology Institute Punjab
Basic research, teaching & training and as a national
repository for cell lines/hybridomas etc.
An international hub of biotechnology helps in
translational cancer research, human molecular genetics,
chemical biology, molecular reproduction, cancer
biology, molecular virology, neurobiology.
To transform agri-food sector into globally rewarding and
sustainable biotechnology-based enterprise through
innovative solutions in primary and secondary agriculture including high-end food processing.

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