

## Additional Science Class 01

### General Science

#### Overview

Concept and Application of concept

Physics & Chemistry - 1-3 Questions

- Static- Physical Change, Surface Change, Rainbow, Illusion - 4 Classes
- Cosmic Physics -Black Hole, Theory of relativity, Big Bang - 2 Classes

Biology- 3-5 Questions

**Sources- Booklist-** Class 6-10th Standard NCERTs

#### Waves

- Wave is any disturbance in a medium.
- Circular ripples Known as a wave.
- The wave is defined by a curve.
- Wave-length is a distance after which the wave repeats itself.

#### **Frequency**

- Frequency is a number of occurrence of event per unit time.

#### **Bandwidth**

- The capacity of the network, higher bandwidth reflects more capacity of the network and hence more speed can be expected.
- For e.g Internet networks- 1G (Call), 2G (Call+SMS), 3G (Internet), 4G (Faster Internet ), 5G (Real time communication)

#### **Light**

- Electro-magnetic wave- Electric and Magnetic Field, both are perpendicular to each other.
- Dual nature of light - Particle and Wave.
- Young's double-slit experiment.
- Young in his double-slit experiment deduced the wave nature of light. It helps us in understanding the bending of light, refraction, light as energy carrier etc.
- Light as a particle.
- Einstein in his Photoelectric effect experiment deduced the particle nature of light.
- In this experiment, he found that light of specific frequency was able to eject electron out of the metal surface (Any one of the photons must have collided with electron to eject it out of the metal surface).
- Particle nature of light helps us to understand why light travels in a straight line, phenomenon like reflection etc.
- For this particular experiment, Einstein was awarded the Noble Prize.

#### **Electromagnetic Spectrum**

- Gamma Ray > X ray > Ultraviolet Ray > VIBGYOR > Infrared wave > Miro wave > Radio Wave (In decreasing order of frequency/energy)
- High Energy/Frequency Radiation - Gamma Ray, X-ray, UV Ray (They're having particle nature in them)
- Low Energy/Frequency Radiation - Infrared wave, Miro wave, Radio Wave (They're having wave nature in them)
- Ionising Radiation- Gamma-ray and X-ray

#### **Wave**

#### **Application**

Radio Waves      Radio and T.V Communication, Bluetooth, Submarine Communication

Microwave      Mobile Communication, Micro-wave oven

Infrared      T.V remote

(Carrier of heat from sun, fire or any hot object etc.)

Ultraviolet      It kills bacteria or viruses, synthesises Vitamin-D from our skin.

X-rays      Check Deformation in Bone, Airport or Metro Security Scanner

Gamma Ray      Cancer Therapy

#### Ray Optics

#### **Reflection**

- Reflection is the phenomenon in which the light or sound or heat-waves return to the same medium i.e. the medium remains the same.

#### **Refraction**

- When light travels from one medium to another it changes its path, rarer to denser and vice-versa.
- In refraction, there is no change in the frequency of waves (incoming number=outgoing number) but wavelength and speed change.
- Rarer>Denser Medium - Speed of light reduces, It will move/bend towards the normal.

### **Dispersion**

- White light passes through a prism, it splits into seven individual colours. This happens because different colours have different speeds through any medium.

### **Scattering of Light**

- Intensity/Scattering is inversely proportional to wavelength. For e.g.- Sky appears to be blue (short-wavelength)
- Electrons have a great affinity towards the light. Whenever they come in contact with light, they absorb the same and become excited. In the excited state, they change their orbit by jumping into a higher orbit. After some time they come back to their original orbit and release the absorbed photon (light).

### **Rayleigh scattering**

- It involves the interaction of electromagnetic waves with particles whose size is smaller when compared to the wavelength of electromagnetic waves.
- It is an elastic scattering where the incident and scattered photon share the same frequency.
- The sky appears blue because of Rayleigh scattering.

### **Raman Scattering**

- It is scattering at the atomic or molecular level it happens due to excited electron.
- It is an inelastic scattering.
- It helps us in understanding the structure of the atom, proving the truthfulness of artefacts, etc.
- For this experiment, C.V Raman was awarded the Nobel prize

### **Total Internal Reflection (TIR)**

To occur, the criteria is-

- The light should travel from denser to rarer medium.
- Angle of incidence should be greater than Critical Angle.

### **Optical Fibre**

- Density of core > Clad
- Angle of incidence > Critical Angle.
- Light ray trapped in the core of the fibre.
- On the principle of total internal reflection

### **Optical Illusion**

#### **Mirage**

- It is an optical illusion taking place at hot places, the object appears to be inverted. Reflection and TIR are the responsible phenomena.

#### **Looming**

- Happens in the Colder region.
- The object appears to be suspended in the air.
- The erect object is seen.
- Refraction and TIR is a responsible phenomenon.

#### **Rainbow**

- Dispersion, Refraction and TIR are responsible for this.
- Dispersion- White light entering raindrops, splitting into seven different colours.
- Rainbow in nature is where the outer circle is violet and the inner circle is red. This may happen if more than two total internal reflections are involved.
- It is rarer than a primary rainbow.

#### **Twinkling of stars**

- Light will be reaching to the human eye after multiple refractions through multiple air pockets.
- Because of changing and dynamic atmospheric circulation (moving pocket of cold and warm air). Every second the density of air pocket may change.
- Therefore light may be coming at a deviated angle.
- Line of sight will also be slanted and changing. We cannot locate the exact position of stars. Hence we find stars to be twinkling.
- Far Stars twinkle more than the nearer star.

#### **Why is the sky blue?**

- **Retina** (Screen) - Image is formed. i. Cons- Daylight vision, Colour recognition (Red, Blue, Green- Primary colour) ii. Rod- Dim-light vision.
- Violet, indigo and Blue scattered the most.
- The human eye has more affinity towards blue colour.

#### **Particle suspended**

**Circumstances** | **In Atmosphere** | **Scattered Spectrum** | **Colors of Sky**

1. Normal	Dust particles	V,I,B	Blue as cons are sensitive to blue colour
2. Cyclonic/Storm	Salt	V,I	Violet + Indigo
iii. Heavy Storm	Heavy water Droplets	V	Violet

#### **Sun at Noon**

- Apparent distance travelled by light is less.
- Scattering of every spectrum is negligible.
- Sun/Sky appears white.

#### **Sun at Dusk/Dawn**

- Apparent distance travelled by light is more.
- Scattering of shorter wavelength (Blue) is a lot, because of this, Human eye loose sensitivity to blue colour. Only higher wavelengths (Red, Orange) are able to be recognised by eye.

**The topic for the next class: Wave Optics**

**Additional Science Class 02**

## **Wave Optics**

### **Optical Illusion**

- At dusk and dawn Sun appears to be slightly bigger than normal. We're able to see Sun two minutes before sunrise and two minutes after sunset. This is due to refraction.

### **Mirror**

- Shiny Surface (Front Size) Painted Surface (Back Size), Virtual image is formed- Erect
- Lateral Invasion - Right appears to be left and vice-versa
- Retina (Image in formed inverted). The optical nerve (Brain) interprets the image.

### **Periscope**

- A Periscope consists of two plane mirror strips fixed at 45 degrees to the end of a long narrow tube. They are parallel to each other.

### **Spherical Mirror**

- Concave Mirror (Converging)
- i. Converges parallel beam of light at a single point called the focus.
- ii. Focus is also the point where the image is formed.
- iii. Application: a.If we want to have an image bigger than the object- Shaving mirror, Dentist mirror. b.If we want to focus a parallel beam of light- Torch, Headlights of Vehicle.
- Convex Mirror (Diverging)
- i. Diverges parallel beam of light.
- ii. Application- a.If we want to have the smaller image of the big object-Rearview mirror of vehicles, Surveillance, and Guidance mirror at the Superstore, Sunglasses, Telescopes.

## **Lens**

### **Concave Lens**

- Have similar properties to that of the Convex mirror- Diverging lens.

### **Convex Lens**

- Have similar properties to that of the Concave mirror- Converging lens.

## **Defects of Vision**

### **Myopia/Near Sightedness**

- Due to the elongation of the eyeball, an image is formed in front of the retina, because of which the person is unable to see distant objects clearly.
- Correction: Concave or Diverging Lens

### **Hypermetropia/Far Sightedness**

- Image is formed after the retina
- Correction: Convex Lens

A person may suffer from both Myopia as well as Hypermetropia.

Correction is a bi-focal lens (has both concave and convex lenses in it).

### **Astigmatism**

- Due to the distortion of curvature of the eye, multiple images are formed light focuses on multiple focal points due to the inability of the eye to fix horizontal and vertical lines clearly.

Myopia, Hypermetropia, and Astigmatism and collectively called Refractive errors.

### **Cataract**

- Defect of old age people
- Clouding of the eye lens due to age. Initially, the person is unable to recognize a blue color but when the clouding becomes opaque person may turn blind. The only correction is surgery.

## **Electric Current**

### **Electric Current**

- Flow of charge

### **Ohm's law**

- **Voltage=Current \* Resistance**
- Voltage is the Measurement of the Power Source.
- The higher the voltage more will be the current.
- Resistance is a hindrance or opposition in the flow of current.
- Resistance is directly proportional to the length of the wire and inversely proportional to the cross-sectional area of the wire.
- $R = \rho \cdot l / A$  ;  $\rho$ -property of material
- Property of material-
- i. Conductor- It offers lesser resistance initially with time resistance increases reflected in the heating of the device.
- ii. Insulator-It offers infinite resistance. Current can never pass through it.
- iii. Semi-Conductor- It offers slightly more resistance than the conductor initially, with time resistance offered decreases.

Because of this Semi-conductors have huge applications in the electronics industry.

- iv. SuperConductor- It offers zero resistance. They can offer zero energy loss. Active only at subzero temperature. Silver at nanoscale reflects superconductivity.
- **Series and Parallel Connection.**
- In series same current flows through all the devices.
- At Households parallel connection is preferred in incase of series connection if one of the devices fails then all the devices in the circuit become non-operational.
- **Fuse:** It is a device to protect the costly electronic device from unexpected voltage fluctuations.
- i. Added in series
- ii. Melting point of the wire is low
- iii. Resistance is low.

### **Heating effect of current**

- with time conductor offers resistance which; leads to the heating of the device, here electric energy is getting converted into thermal or heat energy. An alloy of Nickel and Chromium, Nichrome is used to intensify the heating process. This property of the current is utilized in Heater, Geyser, etc.
- Solution refers to Solute (Salt) and Solvent (Water).
- i. Electrolytic- Such solutions allow passage of current. On passage of current, ions are formed. E.g Potable water
- ii. Non-Electrolytic- E.g- Distilled Water, Hence it does not conduct electricity.

### **Chemical effect of current**

- Ions (Charged particles )- + Cation > - Electrode > Cathode , - Anion > + Electrode > Anode
- Electroplating is one of the manifestations of the chemical effect of current.
- Electroplating is the process of accumulation of one metal on the surface of another material.
- For e.g- Imitation Jewellery, Protection of important metals- Galvanisation (Zinc plating on Iron, Zinc Anode, Iron Cathode)

### **Dynamo**

- A device that converts electrical energy into mechanical energy.

### **Motor**

### **Inverter**

- AC vs DC
- AC- Fluctuation, Household appliances-Refrigerator, Air Conditioner, Transmission lines
- DC- Constant, Battery will always give DC, Mobile, Plasma TV, Laptop, E-vehicles, etc
- Inverter-It is a combination of battery and inverter. It converts DC into AC.

## **Magnetic Effect of Current**

- When a current flows through a wire a magnetic field is developed around it.
- When an Iron rod is brought near this magnetic field, it gets magnetized.
- When the current flow is stopped in the wire the magnetic properties of Iron are also gone. This property of the current is harnessed to develop electro-magnets which are used in various electronic devices- telephone receivers, electric bell, etc, such electromagnets are also used in Particle accelerator like the Large Hadron Collider.

## **Electromagnetic Induction- Faraday's law**

- It is the production of voltage or electric current in a changing magnetic field. Applications are wireless charging, eddy current, etc.
- Eddy currents are loops of induced currents in a conductor in a changing magnetic field. These currents are often seen as heat loss but have applications in induction cookware, melting of metals, train braking mechanism.

## **Latent heat**

- Latent heat is the heat absorbed or released by a substance during phase change provided the temperature is constant.
- For E.g- Ice>Water, Boiling Water>Steam
- Ice while melting absorbs some heat keeping temperature @0 degrees C.
- Food gets cooked even after putting off the flame as steam while condensing release 540 calories in food.

## **The topic for the next class: Heat**

Additional Science Class 03

## **Abnormal behavior of Water**

### **Density**

- General rule - Density: Solid>Liquid>Gas
- The density of Ice < Density of Water
- Water does not have a maximum density at 0 degrees celsius.
- Water has a maximum density at 4 degrees celsius (Liquid state).  
An aberration ( $T < = V <$  (molecules come closer)) we find the formation of clusters of a water molecule at this temperature because that volume is minimum and density is maximum.
- Lake and Water bodies freeze in Cold temperatures.
- Because of its abnormal behavior living creatures will survive-the bottom's part has colder temperatures but above it, there is a warmer temperature where living creatures can survive.
- Density = Mass/Volume

### **Cohesive and Adhesive Forces**

- Cohesive Force: It is an intermolecular attractive force between two adjacent portions and two similar sets of molecules of a substance. Forces of attraction between two similar molecules are considered as a cohesive force. E.g- Among water molecules.

- Adhesive force: It is an attractive force between two dissimilar sets of molecules. For eg.- Make-up (Affinity)
- Surface Tension - It is a property of the surface of a liquid to resist an external force caused due to cohesive force. In other words, surface tension is the tendency of a liquid to shrink into the minimum surface area.
- Underwater molecules do not face any surface tension, only the top layer molecule.
- Applications of Surface Tension-
  - i. Water strider is able to walk on the surface of the water.
  - ii. Mosquito eggs able to flow above water.
  - iii. Jaundice (Bile comes out of urine)- Sulphur Test (Bile has less relatively surface tension than urine, so it lower's the overall surface tension and sulfur sinks)
  - iv. Water molecules try to gain a spherical shape. Minimize surface area and hence to reduce the surface tension.
  - v. Capillarity is also one of the manifestations of surface tension.
  - Water molecule = Cohesive force (Binds water molecule together)
  - Water- Towel= Adhesive force (Helps water molecules to rise)
  - vi. Xylem- water moving upwards.
  - vii. Kerosene lamps- Kerosene- Cohesive; Kerosene-Wick- Adhesive

### **Archimedes Principle**

- Any object completely or partially immersed in a fluid is acted upon by an upward or buoyant force whose magnitude is equal to the amount of water displaced by the object.
- Iron nail replaces less water than its weight. The density of Iron nail > Density of Water.
- Ship replaces more water than its weight. The density of Water > Density of Ship.
- Submarine: Ballast tank fill with water (Density increase, it sinks)

### **Matter**

- Anything which has mass and occupying some space.
- Three states of Matter: Solid, Liquid, Gas.
- Plasma is considered the fourth state of matter. (Gas (Heat-Electromagnetic radiations) > Charged, Ionised gas)
- Where Plasma is found- Ionosphere, Fluorescent lamps, Stars, Interstellar Mediums.
- Like Gas, Plasma does not have a definite shape or volume unless enclosed in a container. Unlike gas, Plasma can make structures like beams and filaments under strong magnetic fields.

### **Atom**

- The fundamental unit of matter.
- Nucleus (Neutrons (Zero charges), Protons (Positive charge)), Electrons (Negative Charge, revolve around the nucleus)
- Quarks make up Nucleus.
- Leptons make up Electron.
- Atomic Weight/Mass number = Sum of nucleons
- Atomic Weight= No. of Protons + No. of Neutrons= Atomic Numbers + No. of Neutrons.
- Quarks:
- We have six types of quarks- Up quark (+2/3 charge), Down Quark (-1/3 charge), Strange, Charm, Bottom, and Top.
- How many up and down quarks are required for a proton? Hint= Proton has a positive charge -2 up, 1 down
- Neutrons = 1 up and 2 down
- Isotopes are elements having the same number of protons but a different number of neutrons. In other words, these elements have the same atomic number but different mass numbers.

- E.g-
- i. Hydrogen ( $1H1$ ): Normal water  $H_2O$ , Deuterium ( $1H2$ ):  $D_2O$  Heavy Water, Tritium ( $1H3$ ): Radioactivity.
- ii. Carbon ( $12C6, 13C6, 14C6$ )

### **Nuclear Physics**

- Physics or study at the level of the nucleus will be termed to be nuclear physics.

### **Nuclear physics (Physics at the level of the nucleus)**

- i. Nuclear Fusion (Addition)
- Two small nucleus fuses/merge to form a big nucleus.
- Found in stars, Hydrogen fusion:  $1H1 + 1H1 = 4He2 + \text{Stellar energy} + \text{neutrino}$
- ii. Nuclear Fission (Disintegration)
- When a big nucleus disintegrates into smaller nuclei.
- Radioactivity is one of the manifestations of nuclear fission.

### **Radioactivity**

- Definition: It is the natural emission of high energy radiation of the nucleus from unstable elements or isotopes due to the disintegration of their atomic nuclei.
- i. Alpha decay
- The helium nucleus comes out of the parent nucleus.
- In bigger nuclei like Uranium.
- ii. Beta decay
- Electron comes out of the parent nucleus.
- It generally happens in Isotope like  $6C14$ .
- B+decay ( $p \rightarrow n$ );  $p \rightarrow n + e(+) + \text{neutrino}$  ( $e(+)$ : Positron- antimatter of electron)
- B-decay ( $n \rightarrow p$ );  $n \rightarrow p + e(-) + \text{antineutrino}$  (Antimatter of neutrino)
- iii. Gamma decay
- Gamma rays comes out of parent nucleus.
- Naturally in Barium nucleus.
- After Alpha decay.

### **Neutrino**

- Millions of neutrino are formed every minute.
- Mass-near to zero.
- Chargeless
- They are present everywhere.
- Second most abundant particles in the Universe after light.
- Have lots of information.
- Difficult to Catch.
- Formed during both fission and fusion.

### **Half-life**

- Definition: Radioisotopes decay at a constant rate, the time required by the isotope to decay to its original by half is known as the half-life.
- C-12 (~99%) and C-13 (~1%): Stable, C-14: Unstable
- Every organism has two sets of carbon in them, C-12 stable and C-14 unstable. C-14 decays at a constant rate but the nutrition of the organism compensates for the decay because this C-12 and C-14 ratio in the organism mirrors the environmental level but when the organism is dead this ratio is no longer the same. This difference is exploited to know the age of the fossil.

### **India- Three-stage nuclear program.**

- Pressurized heavy water reactor.
- Fast breeder reactor
- Advance heavy water reactor.
- Uranium- Fertile (99.3%)- Can also be used but with less efficiency. Fissile (0.7%) Can be used in reactors- Efficiency is high.
- Fertile U  $\rightarrow$  (Centrifugation) Fissile U (Costly)
- Slow neutrons will provide more efficiency.
- Heavy Water ( $1H2$ ) is used to slow down the electron.



### **Corrosion vs Galvanisation**

- The decay of metal is known as Corrosion. It is the formation of the oxide layer on the outer surface of the metal.
- In the case of Iron, it is known as Rusting.
- Moisture (Water) + Air (O<sub>2</sub>)

### **Allotropes**

- Some chemical elements are known to exist in two or more different forms because the atoms are bonded together in different manners.
- E.g:
  - i. Carbon- Graphite (Good Conductor of Electricity), Diamond (Hardest material; Naturally formed), Fullerene (High Tensile Strength)
  - Carbon: Non-metal, Bad conductor of Heat, Bad conduction of Electricity, Weak.
  - ii. Phosphorous (Non-metal): Black-P (Good Conductor of Electricity), Red-P, White- P

### **Periodic Table**

- Family of Elements
- Metals and Non-Metals
- Non-metals conducting electricity- In allotropic form (Graphite, Black-P), In natural form- Selenium and Iodine.

### **Disinfectants**

- Chlorine-
  - i. It is used in dark. Efficiency declines in presence of sunlight.
  - ii. There is an odor in chlorinated water.
- It turns skin complexion to dark.
- Ozone-
  - i. Can be used anytime
  - ii. No Odour
  - iii. No impact on skin complexion.

### **Inert Gases- Application**

- Helium (Nonflammable)
- Uses: Lighter than air -Filled in air balloons, Tyres of the airplane. Nitrogen is also used in tires.
- Neon- Advertisement board,
- Argon- Fluorescent lamps
- Kryptons- Surgical lasers
- Xenon- In headlight of vehicles lighthouse. Operation theatre.

### **The topic for the next class: Chemistry**

#### **Additional Science Class 04**

#### **REVISION OF THE PREVIOUS CLASS**

#### **DOUBTS FROM THE PREVIOUS CLASS**

#### **RARE EARTH METALS**

- These are set of 17 elements yttrium(1), scandium(1), lanthanides(15) ( $15+1+1=17$ )
- These all elements are metals hence also called as rare earth metals
- They are not rare as the name suggests, rather they are abundance may be more than the average presence of gold, copper etc in the earth's crust
- They are called rare because it is difficult to extract them in their purest form and also their concentration in ores is very low
- They are generally extracted and traded in the form of oxides hence they are also called as rare earth oxides
- **Applications.**
- Consumer electronics like touch screen
- Computer and network communication, aircraft and submarines, night vision equipment surgical lasers, rechargeable batteries, precision-guided weapons etc
- China is the largest producer of rare earth elements India and Japan have also signed an agreement and in this regard

#### **THE PH SCALE**

- It is a scale to measure acidity or basicity

- 0-7= Acidic; 7= Neutral; 7-14= Basic
- **ACIDS:**
- They are the substances that donate hydrogen ions or protons
- They are the substances that donate hydrogen ions or protons
- They are sour in taste generally
- **Acids are of two types:**
- **Organic acid and Inorganic acid**
- **Organic Acid**
- Organic acids are the acids having Carbon in them, therefore, they are weaker
- In general, organic acids are found naturally
- In general, organic acids are weaker than inorganic acids
- Some common organic acids are= Formic acid, Acetic acid, Citric/Ascorbic acid, Tartaric acid, Malic acid, Tannic acid, Lactic acid, Oxalic acid
- Formic acid is found in ants or bees
- Acetic acid is also known as Vinegar- manufactured in the lab
- Citric acid is in lemon.
- Tartaric acid in Tamarind
- The malic acid in Apple
- The malic acid in Apple
- The tannic acid in tea
- **Inorganic Acids**
- Inorganic acids are manufactured in labs
- Manufactured inorganic acids- Sulphuric acid ( $\text{H}_2\text{SO}_4$ ), Hydrochloric acid ( $\text{HCl}$ ), Nitric acid ( $\text{HNO}_3$ )
- **Bases**
- They are substances that accept hydrogen ions
- It converts red litmus to blue
- It is bitter in taste
- To reduce the acidity of the soil, lime is used
- Acidity in the body is neutralized by antacids (Anti-acids) i.e. bases like baking soda (Sodium bicarbonate), Milk of Magnesia (Magnesium hydroxide).
- Potable water should be basic
- **Salt:**
- Acid and base neutralize each other to give water and salt
- $\text{HCl} + \text{NaOH}$  gives  $\text{NaCl}$  and  $\text{H}_2\text{O}$
- Neuron message transmission in the body takes place in the presence of a salt of Sodium and Potassium
- In sweat, the salt of Sodium, Magnesium, is excreted

### **VISCOSITY**

- It is nothing but the resistance of a fluid to flow
- Honey is more viscous than water
- If temperature increases, the viscosity of liquid decreases (cohesive bond breaks), whereas, the viscosity of gas increases (gas molecules come closer)
- If temperature decreases, the viscosity of blood increases, thereby the heart has to pump more blood, pressure on the heart increases, which might lead to heart failure
- Fever increases the temperature of the body, if the temperature of the blood increases, the viscosity of the blood decreases, thereby the heart has lesser pressure leading to normal conditions

### **ENDOTHERMIC AND EXOTHERMIC REACTIONS**

- **Endothermic:**
- Reactions that need heat to start
- It can never be spontaneous
- Since, such reactions absorb heat, after the reaction, the nearby surrounding becomes cooler
- **Exothermic**
- Reactions that do not require heat to start.
- It can be spontaneous

### **OSMOSIS AND REVERSE OSMOSIS**

- A semi-permeable membrane allows only the passage of solvent (water) and not the solute (salt).

- Osmosis is the movement of a solvent through a semi-permeable membrane from a region of lower concentration to a higher concentration
- **Desalinization plant:**
- **Screening-** To resist bigger impurities like coconut, marine creatures, etc. to enter the setup
- **Filtering-** To clear or filter smaller impurities like hairs, worms, silt, etc
- **Desalinisation-** Through reverse osmosis
- **Chlorination-** Clean water is then reacted with chlorine to make it potable in nature

## HYDROCARBONS

- **Alcohol:**
- Types- Methanol, Ethanol, Propanol, etc
- Only ethanol is a beverage (consumable), whereas, others are toxic in nature
- Alcohol is used as solvents in industries
- Alcohol is used as a spirit in industries
- It is also used in the cosmetics and paint industries.
- It is also used as **Gasohol** (Gasoline+Alcohol)
- Gasohol is also known as Blended fuel
- Its advantages are- Environment friendly, Import of crude oil will decrease, CAD will reduce
- **Chemical explosives:**
- Research and Development Explosive (RDX)
- Tri Nitro Glycerine (TNG).
- Tri Nitro Toluene (TNT).
- Dynamite
- **Extraction of Fuel from crude oil:**
- Gasoline/Petrol- Fuel for cars.
- Naphtha- Making chemicals
- Kerosene- Aircraft fuel
- Diesel oil- Fuel for cars, buses
- Fuel oil- Fuel for ships, power stations
- Residue- Bitumen for roads and roofs
- **Knocking of engine:**
- Unwanted sound in engine reflecting it's poor condition
- Octane number is the measurement of quality of petrol/gasoline
- Cetane number is the measurement of the quality of diesel
- The higher the Octane number implies the better quality of petrol.
- A Higher Cetane number implies a better quality of diesel.
- Better Octane number avoids premature ignition of Petrol (ensures slow-burning), whereas, Better Cetane number avoids delayed ignition of Diesel
- **Aviation turbine Fuel:**
- Kerosene+ more than 2000 chemicals (to avoid corrosion, giving them anti-freezing properties).
- **Natural Gas:**
- Two types- Compressed Natural Gas and Liquefied Natural Gas
- LNG has better fuel efficiency than CNG because the fuel density of LNG is higher than of CNG, but still, LNG is not used in India as storage of LNG requires cryogenic infrastructure
- **LPG and CNG:**
- Liquefied petroleum Gas is mainly Butane, Isobutane, some concentration of Propane along with Ethane is also found
- CNG is 99% Methane
- LPG is an odourless gas and Ethyl mercaptan is added to give odour to sense the leakage.
- CNG is also odourless gas and sulfur is added to give it odor. LPG is heavier than air and in case of leakages, it settles at lower places like parking, godowns, etc
- CNG is lighter than air and in case of leakages it flushes out in the atmosphere
- **Soaps and detergents:**
- They reduce the surface tension of water so that the cleansing properties of water is enhanced
- In the process of rinsing, Micelles carries out dirt with water
- Soap is sodium or Potassium salt of Fatty acid or Carbonic acid, whereas, Detergents are salts of Sodium or Potassium of Sulphonic acid.

- Soaps are not effective in hard water as they interact with the calcium and magnesium salts present in hard water, because of this foam is not formed and the cleansing property is compromised
- On the other hand, detergents do not interact with metallic salts in hard water and hence, are effective in hard water as well
- **Phosphorescence:**
- Some compounds like Calcium Sulphide, etc, absorb some of the visible spectrums in presence of sunlight
- When the sunlight is gone, they emit the absorbed spectrum
- **Florescence:**
- When any substance absorbs light, the electron gets excited and change their orbit.
- In their return journey, they emit radiations of various wavelengths
- This is a comparatively faster process than Phosphorescence
- **Applications-** Argon lamps, Glowsticks
- **Luminescence:**
- Any source that gives the light, for example- Lightbulb, Mobile, ocean, etc.
- **Bioluminescence:**
- Any living source that emits light, for example- firefly, Jellyfishes.
- **Efflorescence:**
- Some salts like washing soda have excess moisture in them
- When such salts are kept in the air, moisture evaporates and salt crystals are left behind.

## **COSMIC PHYSICS**

- **NEWTONS LAW OF GRAVITATION**
- Any object having mass in the universe attract each other by a force of equal magnitude this force is called the force of gravitation
- **ESCAPE VELOCITY**
- It is the minimum velocity required to overcome the gravitational pull of the earth by an object
- For earth escape velocity is 11.2 km/sec
- **Stars:**
- Star is a lump of dust and gas which has its own light
- **Planet:**
- There are 3 criteria to be a planet
- 1) It should revolve around the sun
- 2) It should have enough gravity to attain the spherical or nearly spherical shape
- 3) It should have enough gravity to clear off its surroundings - pluto failed this criterion therefore not recognised as a planet

## **TOPIC FOR THE NEXT CLASS - COSMIC PHYSICS Continued**

### **Additional Science Class 05**

#### **Physics & Chemistry Class 05**

##### **Asteroids**

- They are rocky objects, revolve around the sun, and found between Mars and Jupiter.
- Those asteroids found beyond Jupiter are known as Trojans.
- **Hayabusa 2 of Japan:** They are bringing the clay of an asteroid named Ryugu on the earth.

**Satellites** are rocky objects that revolve around the planets

##### **Comets**

- It is made up nucleus and tails and revolves around the sun.
- There are many gases, dust, and ice in the nucleus.
- They are flammable gases like ammonia, methane.
- Comets are evolved from the Kuiper belt and the Oort cloud.
- When they reach near the Sun, the tail develops, as these gases catch fire.

**Meteoroids:** They are chunks or part of either asteroids or comets. Most of them vanish in the outer atmosphere of the earth.

**Meteors:** They are meteoroids entering the earth's inner atmosphere. They are also called Shooting stars- They show different colors due to the presence of different minerals in them.

**Meteorites:** They are the Meteoroids reaching the earth's surface. They are like big structures on earth like craters, we have the example of Lonar lake in Maharashtra.

##### **Life Cycle of a Small Star**

- The nebula of a star is the womb of a star that consists of dust and hydrogen gas.

- The dimension of the womb can be between 1 to 10 light-years.
- Every phase of a star is for billions of years
- Dust particles have a mass and they try to attract each other by a force of gravitation.
- The stellar energy counters the effect of gravitational force, which leads to the formation of Protostar.
- In Protostar nuclear fusion is just started.
- Nuclear fusion will intensify which gives the Main Sequence Star (Youth stage). Sun is a Main Sequence Star.
- Star burns remaining Hydrogen more quickly, which leads to the expansion of the star, which is called as Red Giant (Mature stage).
- If Hydrogen is almost over, then Helium becomes the fuel.
- Helium, after billions of years, is also almost over.
- Star collapses at Carbon Oxygen core and gives Planetary Nebula (Grave)/Collection of dust and gas, and White Dwarf (Luminous high dense mass)/ Fossil star.
- After billions of years, Planetary Nebula acts as a nebula for a new star.

#### **The life cycle of a Big Star**

- The dimension of a womb will be Greater than 10 light-years.
- The stellar energy counters the effect of gravitational force, which leads to the formation of Protostar.
- In Protostar, nuclear reactions/fusion is just started.
- Nuclear fusion will intensify which gives the Main Sequence Star (Youth).
- Nearly more than 90% of the fuel ( $H_2$ ) is over.
- Star burns remaining Hydrogen more quickly, which leads to the expansion of the star, which is called as Red Super Giant (Mature).
- Hydrogen is then almost over, but then Helium becomes the fuel.
- Helium then reacts with H, He, Be, C, Oxygen, Silicon, Fe (Iron). Helium, after billions of years, is also almost over.
- Star collapses at Iron core which gives Supernova explosion.
- Medium size star gives a Neutron star, whereas, Big size star gives a Blackhole.

#### **Chandrasekhar Limit**

- If the mass of the core of the star is less than 1.44 of the mass of the Sun. Then the star will die as White Dwarf.
- If the mass of the core of the star is less than 3 times the mass of the Sun or greater than 1.44 of the mass of the Sun. Then the star will die as Neutron Star
- If the mass of the core of the star is greater than 3 times the mass of the Sun. Then the Blackhole will be the final stage.

#### **Supernova Explosion**

- It is a big event in the cosmic realm that happens when a star collapses at the iron core.
- The amount of light emitted in the process is equivalent to the amount of light emitted by the Sun for billions of years.
- During the explosion, heavier elements than iron like Uranium, Gold, Silver, etc. are formed.

#### **White Dwarf**

- This is formed when a small star collapses at the Carbon, Oxygen core.
- The collapse is so intense that every electron in each atom reaches the first orbit due to which volume decreases and hence, density increases.
- This state in quantum mechanics is called 'Degenerate Gas'.
- White dwarfs are glowing objects in the universe without any fusion mechanism.

#### **Neutron Star**

- These are formed due to the death of medium stars.
- When a star collapses at the iron core, all electrons in every atom enter the nucleus, where they feed upon the protons to give neutrons.
- Hence, only neutrons are left in the stars and they are called neutron stars.
- These are also called Pulsar because they accelerate any particle entering their magnetic field.

#### **Black Hole**

- A black hole is a massive object in the universe from which even light cannot come out. This is because of the infinite pull of the black hole.
- The gravitation is so much because the entire mass of the black hole is concentrated at a one-dimensional point known as **Singularity**.

- Any object falling in a black hole loses its dimensions and attain one-dimension called the singularity. This process is known as Spaghettification.
- These are dead remains of a big star and they warp or curve space-time infinitely.

**Galaxy:** It is a collection of dust, gas, billions of stars and their solar systems, all bound together by gravity via a black hole.

#### **Kuiper Belt**

- It is an asteroid-like belt that is a remnant of our solar system.
- This looks like a great ring of debris found beyond Neptune.

#### **Heliosphere and Hydrogen Wall**

- Solar winds emanating from the Sun form the shape of a bubble that extends beyond the major planets.
- This bubble is the Heliosphere, which is unable to penetrate an area of hydrogen called the Hydrogen wall.
- This also marks the end of our solar system.

#### **Interstellar**

- It is the part of space (unclaimed) that exists between the stars.
- It is a hard vacuum that consists of the presence of dust, gases, plasma (Ionised gases), and cosmic radiations.

#### **Oort Cloud**

- These are icy objects at the distant edges of the Kuiper Belt.
- This also marks the outermost layer of our solar system.
- The size of the Oort cloud may be bigger than that of the mountains.

**Goldilock Zone:** It is a search for Earth-like planets in outer space.

**Force Carriers: It carries the force.**

Force	Force Carrier	Range	Application
Strong	Gluon	Nucleus (10 to the - 15 meter)	Quarks
Weak	W&Z	Nucleus	Beta-decay radioactivity
Electromagnetic	Photon	Infinite	Electronics light
Gravitation	Graviton	Infinite	Solar system galaxy

**Strong:** It is the strongest force and works within the nucleus. It is responsible for binding the nucleus. It is a Force carrier of Gluon.

**Weak:** It works within the nucleus. It is a Force carrier for electron and neutrino.

**Electromagnetic:** It has an infinite range. It is a Force carrier of Photon.

**Gravitation:** It is the weakest force and has an infinite range. The Force carrier is Graviton (It is imaginary).

#### **Antimatter**

- Antimatter is just the opposite of matter. They resemble matter in every sense but have opposite charge and opposite sub-atomic characteristics.
- Both matter and anti-matter were formed after the big bang. But today anti-matters are rare in-universe.
- When matter and anti-matter interact, they annihilate each other and release a lot of energy. Examples are positron, anti-hydrogen, etc.

**The topic for the next class:** Dark matter, State of matter, Dark energy, the theory of relativity and Higgs Boson, Cosmic Physics (to be continued)

#### **Additional Science Class 06**

#### **COSMIC PHYSICS CONTD...**

- **Universe-** Dark Matter and Visible matter
- Dark matter is that matter which does not interact even with an electromagnetic wave (light)
- 27% is Dark matter and 68% is Dark energy
- Visible matter- neutrinos, stars, and galaxies, heavy elements, and others,
- **Evidence of Dark matter-**
- High galactic orbital velocity than expected
- Gravitational lensing more than expected
- **The states of Matter-**
- 4 states of matter- Solid, Liquid, Gas, and Plasma (super hot and super excited state)
- 5th state of matter- Bose-Einstein condensate (super cool and super unexcited state)
- **Higgs-Boson Theory:**
- The age of the universe is believed to be 13.7 billion years ago
- Cosmic inflation- imaginary but interactive Higgs field appear, quarks and leptons appear (both were chargeless)
- Quarks and leptons interacted with the Higgs field but quarks interacted more and thus gains more mass

- Quarks interacted among themselves and gave protons and neutrons, similarly, the leptons interacted among themselves and gave electrons which led to the formation of the atom
- **Theory of General Relativity:**
- Space-Time Fabric- Einstein considered everything in the universe is lying on time-space
- Any object in the universe having mass and acceleration will warp the space-time fabric
- This curving will create ripples in space-time, which are difficult to observe and are known as Gravitational waves
- **Points to Remember-**
- $E = mc^2$
- Light travels at a constant speed in a vacuum
- No object in the universe can match the speed of light
- Space-time is inter-related, any matter or objects having mass as well as acceleration warps the curves of space-time, heavier the object more will be the warping like blackhole curves or warps space-time infinitely.
- The merging of two black holes or collision of a neutron star with a black hole creates comparatively strong gravitational waves.
- **Some Concepts:**
- **Einstein-Rosen-Bridge (wormhole)-** As a blackhole wraps space-time infinitely they have the potential of bringing two points closer, this way a bridge is created which reduces the physical distance between two points
- **Gravitational Lensing-** light rays due to gravitational interaction are bent inward like a lens near the vicinity of a Galaxy, Blackhole, etc. This phenomenon can allow us to see a very distant star or even a star may appear brighter, this phenomenon is called gravitational lensing
- Any object traveling near to the speed of light or in the vicinity of a stronger gravitational field observes that time has slowed down.
- **Expansion of Universe:**
- Redshift- evidence of the expansion of the universe
- **Evidence of Dark Energy:**
- Mass was formed and with the passage of time More Massive Objects appear in our universe, these masses must have the tendency to attract each other due to gravitation because of that the universe must have collapsed but we have evidence of an expanding universe, which means there must be some hidden force or energy to counter the gravitational attraction. This hidden energy is dark energy.

**Syllabus Concluded**