GRADE 8

SECOND TERM, 2022/2023 SESSION

PHYSICS

MASTERNOTE

WKS	TOPICS
1	REFLECTION
2	DISPERSION OF WHITE LIGHT
3-4	COLOUR ADDITION AND SUBTRACTION
5	WORK ENERGY AND POWER
6	MID – TERM TEST
7	CALCULATIONS INVOLVING WORKDONE
8-9	SOUND
10	REVISION
11	EXAMINATION

WEEK 1 REFLECTION

Objectives: *By the end of the lesson, the students should be able to:*

i) describe the types of reflection

ii) state the two types of images

iii) explain refraction

iv) list some effects of refraction.

Reflection is the changing in the direction of rays of light due to the obstruction of an opaque object.

Types of reflection

1. Regular reflection
2. Diffused or scattered reflection

   Regular reflection is the reflection from a smooth surface.

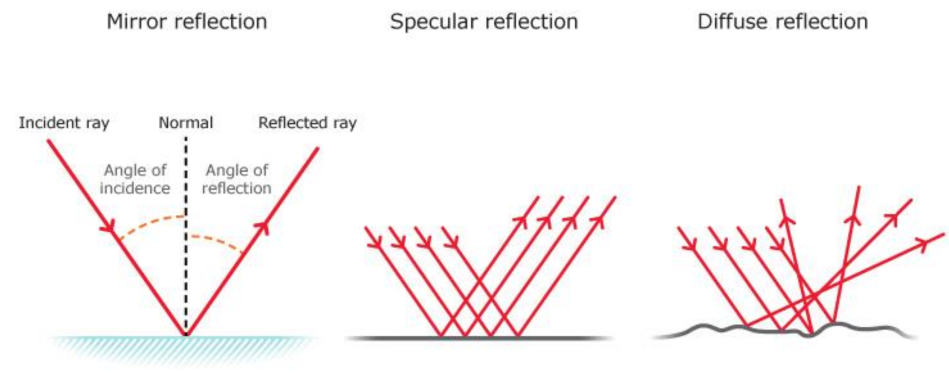
   Scattered reflection is a reflection from a rough surface.

Rays of light is the direction in which light travelled.

Beam is the collection of rays of light.

When light rays hit a surface, they are usually reflected, transmitted or absorbed. When light is reflected from a surface, an image is produced. The way light is reflected from the surface depends on whether the surface is smooth or rough. To properly understand this, we will define some terms.

Incident ray: a light ray that strikes a surface.
Reflected ray: a light ray that is reflected from a surface.
Angle of incidence: the angle between the incident ray and the normal.
Angle of reflection: the angle between the reflected ray and the normal.
Normal: a line perpendicular to the surface where the incident ray strikes.



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Types of reflection

There are two types of reflection:

i) that from a smooth surface which is regular or specular reflection and

ii) that from a rough surface which is scattered or diffuse reflection.

Types of images

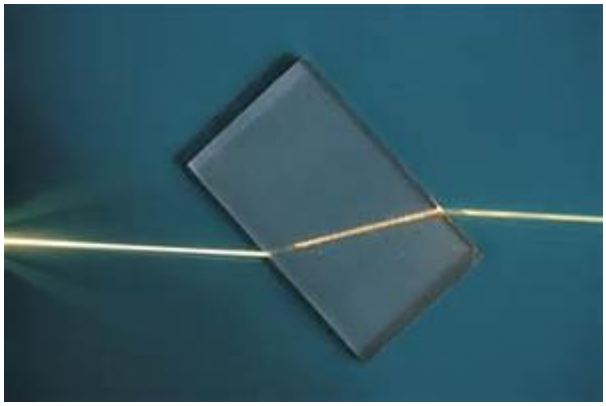
There are two types of images namely:

i) real images: such as those produced on a screen by lenses. The image cannot be collected on a screen.

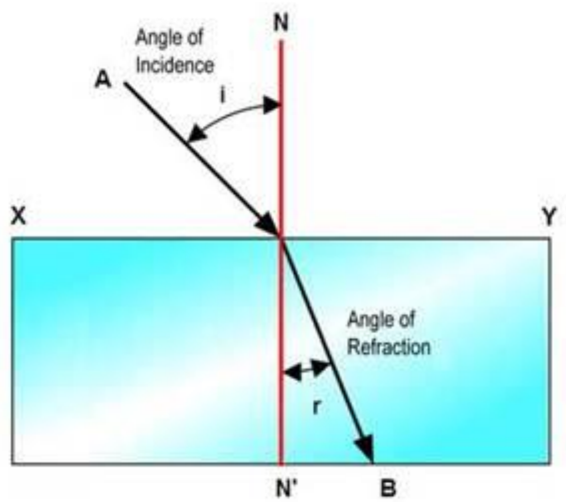
ii) virtual images: are those which cannot be projected on a screen or surface, such as those in a plane mirror. Two plane mirrors may be used together to give a person at the back of a crowd a view of an event. The device is called a periscope. It can also be used to see objects beyond obstacles and in armour cars.

REFRACTION

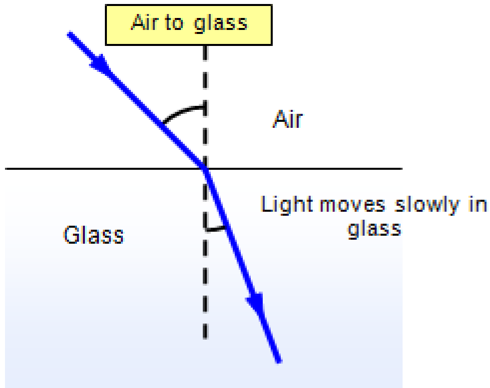
Light is refracted if the incident ray is not 90° to the surface of the transparent material.

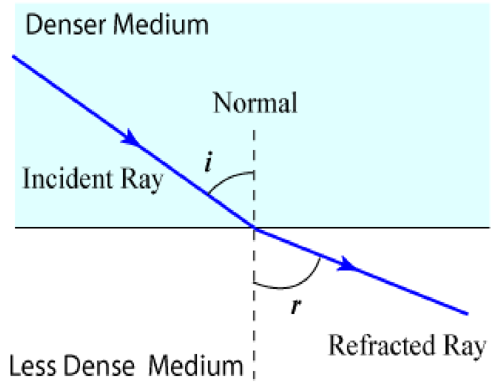


Refraction is the bending of a light ray as it crosses the boundary between two media of different densities, thus causing a change in its direction. The angle the refracted ray makes with the normal is called the angle of refraction.



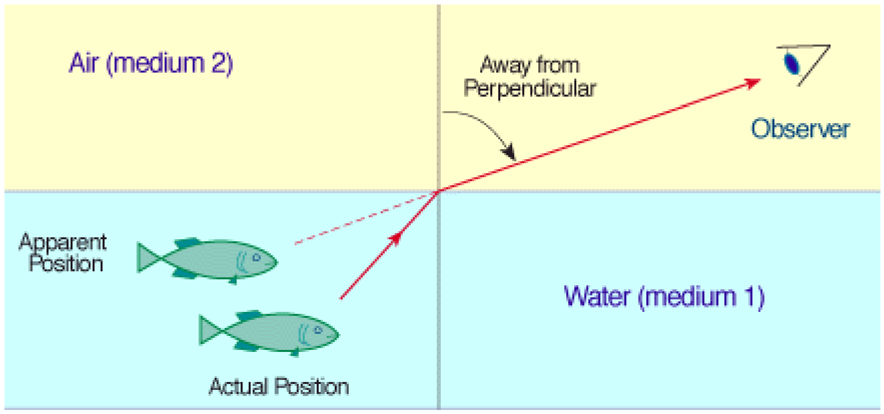
As the light travels from one medium (or substance) to another, it changes speed. If the light slows down when it moves from one medium to the other (that is when it travels from a less dense to a denser medium), the ray bends towards the normal. If the light speeds up as it passes from one medium to the next (that is when it moves from a denser to a less dense medium), the ray bends away from the normal.



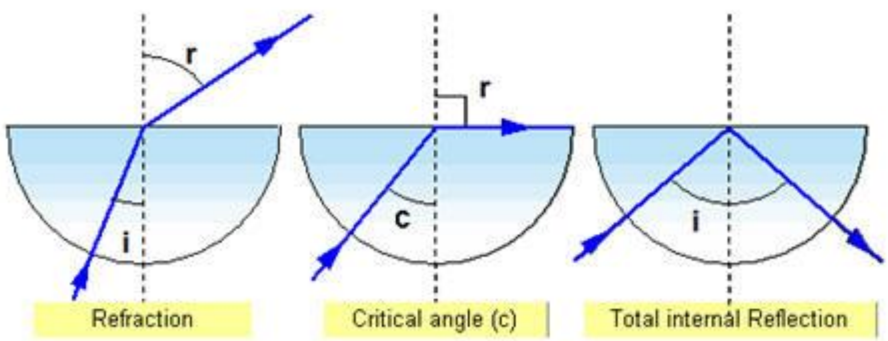


When light rays leave a water surface and enter the air, it speeds up. It also appears to have come from a different direction than that of the path it actually travelled. Refraction of the rays of light makes the bottom of the pool seem closer to the water surface than it really is. It also makes streams and rivers seem shallower than they really are. Thus, someone thinking of wading across a seemingly shallow stretch of water has to put this into consideration. The refracted light from a pencil, spoon or straw in a glass makes it appear bent.

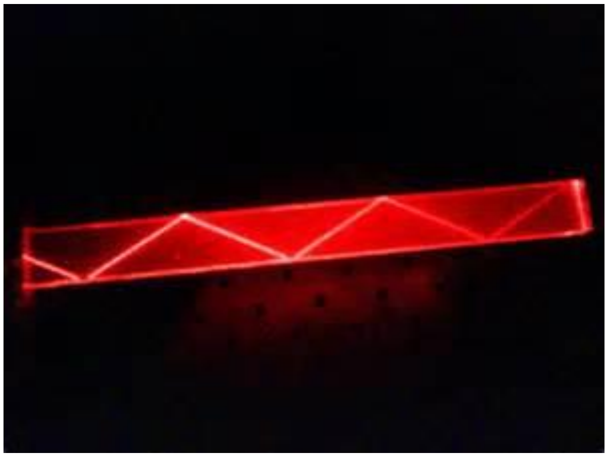
Some of the effects of refraction of light include mirages, the apparent shift in the position of objects immersed in liquids, and the lingering daylight after the sun is below the horizon. A driver looking almost parallel to the road on a hot summer day sees what looks like a puddle of water. The water however disappears as the car approaches. The mirage is as a result of the sun heating the road. The motorist actually sees light from the sky, which looks like light reflected from a puddle.

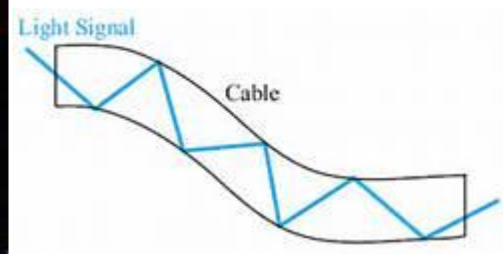


Total Internal Reflection occurs when light passes from a more optically dense medium to a less optically dense medium at an angle so great that there is no refracted ray.The incident angle that causes the refracted ray to lie right along the boundary of the substance is unique to the substance. It is known as the critical angle of the substance. If the angle of incidence is greater than the critical angle, no light leaves; it is all reflected.



This principle is employed in fibre optics. Light enters a long, thin glass rod and is reflected along the glass. Each surface reflection is at an angle greater than the critical angle. The reflection is total, keeping the light within the rod. Light acts in the same way in a thin glass fibre coated with a layer of glass with a lower index of refraction. Such a thin, flexible optical fibre can easily be bent around corners or combined with many other fibres into a cable.





Light passing through optical fibres can be used to transmit information. Information equivalent to 25 000 telephone conversations can be carried by a fibre the thickness of a human hair. This is why they are used to transmit telephone, computer, and video signals within buildings, between cities and even across oceans. Optical fibres are used for more than communications. Two bundles of fibres are used to explore the inside of the human body: one bundle transmits light while the other carries the reflected light back to the doctor.

QUESTIONS

1. Objects that emit light by themselves are called____________
   a. Opaque objects
   b. Luminous objects
   c. Transparent objects
   d. Translucent objects
2. Any object that will not allow light to pass through them are called ________
   a. Opaque objects
   b. Luminous objects
   c. Transparent objects
   d. Transluscent object
3. Any object that allows little light to pass through them is called ____________
   a. Opaque object
   b. Luminous object
   c. Transparent object
   d. Transluscent object
4. Any object that will allow all light to pass through without absorbing any is called __________
   a. Opaque object
   b. Luminous object

c. Transparent object
d. Transluscent object

5. Any object that does not produce light by itself is called _______
   a. Opaque object
   b. Luminous object
   c. Non- luminous object
   d. Transluscent object
6. A region where a force is experienced is called ____________
   a. Gravity
   b. Force
   c. Field
   d. Magnetism
7. The distance through which light travels is called __________
   a. Ray
   b. Beam
   c. Reflection
   d. Refraction
8. A ray that strikes a surface is called_________
   a. Reflected ray
   b. Deflected ray
   c. Incident ray
   d. None of the above
9. There are __________ types of images formed with light
   a. 1
   b. 2
   c. 3
10. State the type of reflection.

THEORY:

1. Differentiate between the two types of images.

2 What is refraction?

3. What is the “critical angle” of incidence?

4. What happens to a ray of light with an angle of incidence greater than the critical angle?

5a) When light is travelling from a denser medium to a less dense medium, it bends _____________ the normal.

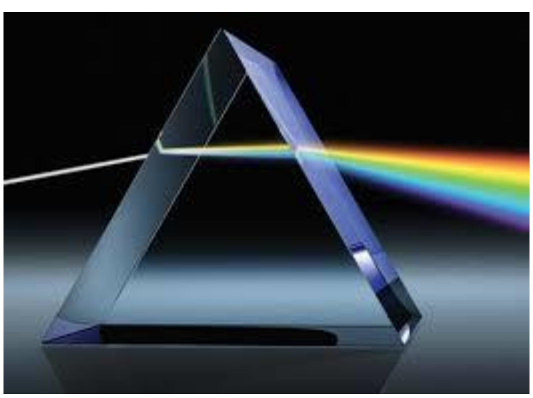
b) When light is travelling from a less dense to a denser medium, it bends _______ the normal.

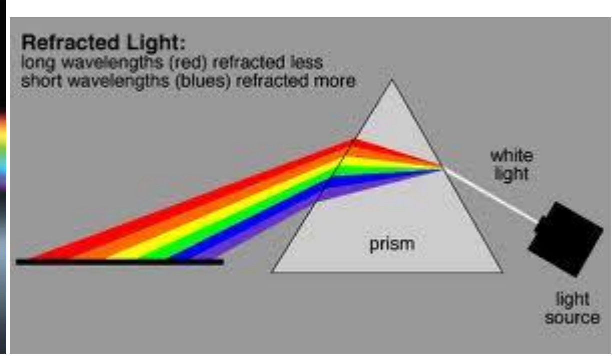
6. State 4 effects of refraction.
7. List some uses of optical fibres.

WEEK 2 DISPERSION OF WHITE LIGHT

Objectives: *By the end of the lesson, the students should be able to:*
i) describe what happens to white light when it passes through a prism
ii) explain the term dispersion
iii) state how the rate of deviation of light from its original direction in air can affect its speed in the new medium it travels in.

Isaac Newton was the first to perform an experiment and observe that white light when passed through a prism, gives an elongated coloured patch of light on a screen placed behind the prism. The coloured pattern is known as the spectrum of white light. The spectrum consists of the Red, Orange, Green, Blue, Indigo, Violet (ROYGBIV).





When another identical prism is placed to intercept the refracted rays, the same arrangement of colours emerge on the screen, but this time, it is found that the colours are more widely separated. If the second prism is inverted, the colours are seen to disappear and only a patch of white light will be seen on the screen. The colours recombined to form white light.

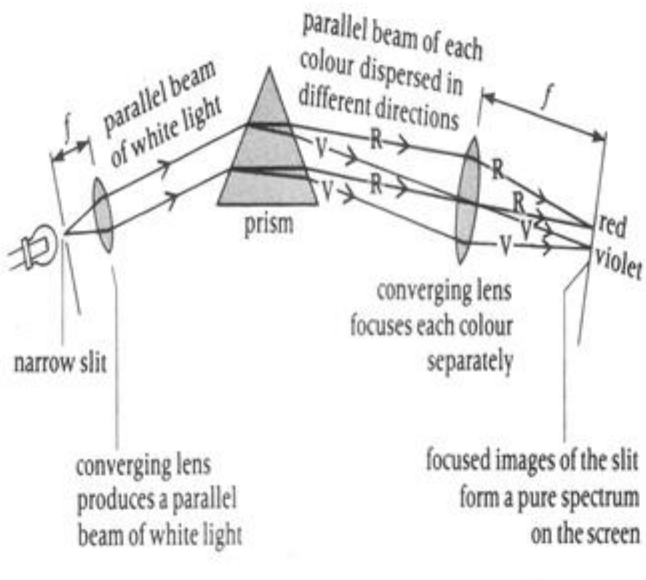
Dispersion is the separation of light into a spectrum by refraction. It is due to the fact that different colours of light travel at different speeds through glass. Light of all wavelengths travels through the vacuum of space at 3.00×10^8m/s. In other media, however, light travels more slowly. Also, waves of different wavelengths travel at different speeds. Thus, the index of refraction of a material depends on the wavelength of the incident light.

In glass and most other materials, red light travels fastest: it has the smallest index of refraction and violet light is the slowest: it has the largest index of refraction. As a result, when white light falls on a prism, red light is bent the least and violet the most. Each colour is therefore refracted in a slightly different direction or angle through glass.

Glass is not the only substance that disperses light. A diamond does not only have one of the highest refractive indices of any material, but also has one of the largest variations in the index. Thus, it disperses light more than most other materials. The intense colours seen when light is dispersed in a diamond is the reason these gems are said to have “fire”.

A rainbow is a spectrum formed when sunlight is dispersed by water droplets in the atmosphere. Sunlight that is incident on a water droplet is refracted. Because of the dispersion, each colour is refracted at a slightly different angle. At the back surface of the droplet, the light undergoes total internal reflection. On the way out of the droplet, the light is once more refracted and dispersed. Although each droplet produces a complete spectrum, an observer will see only a certain wavelength of light from each droplet. The wavelength depends on the relative positions of the sun, droplet and the observer. Because there are millions of droplets in the sky, a complete spectrum is seen. Red light is most intense from droplets that make an angle of 42° with respect to the direction of the sun's rays. Blue light is most intense from those rays making a 40° angle.

A pure spectrum is that in which the colours are clearly separated or distinct from each other. This can be produced by using two converging lenses and a prism.



Producing a pure spectrum of white light

The figure shows an arrangement for producing a pure spectrum.The first converging lens is used to produce a parallel beam of white light. This is done by making the distance from the slit to the lens equal to its focal length.

The second converging lens reverses the effect of the first so that the parallel beam of each separate colour is focused onto a screen.

The combined effect of the two lenses and the prism is to produce a focused image of the slit on the screen in slightly different positions for every colour in the spectrum.

QUESTIONS

1. List the different colours of light in the order of increasing wavelength.

2. A prism bends violet light more than red light. Explain.

3. Which colour of light travels fastest in glass: red, green or blue?

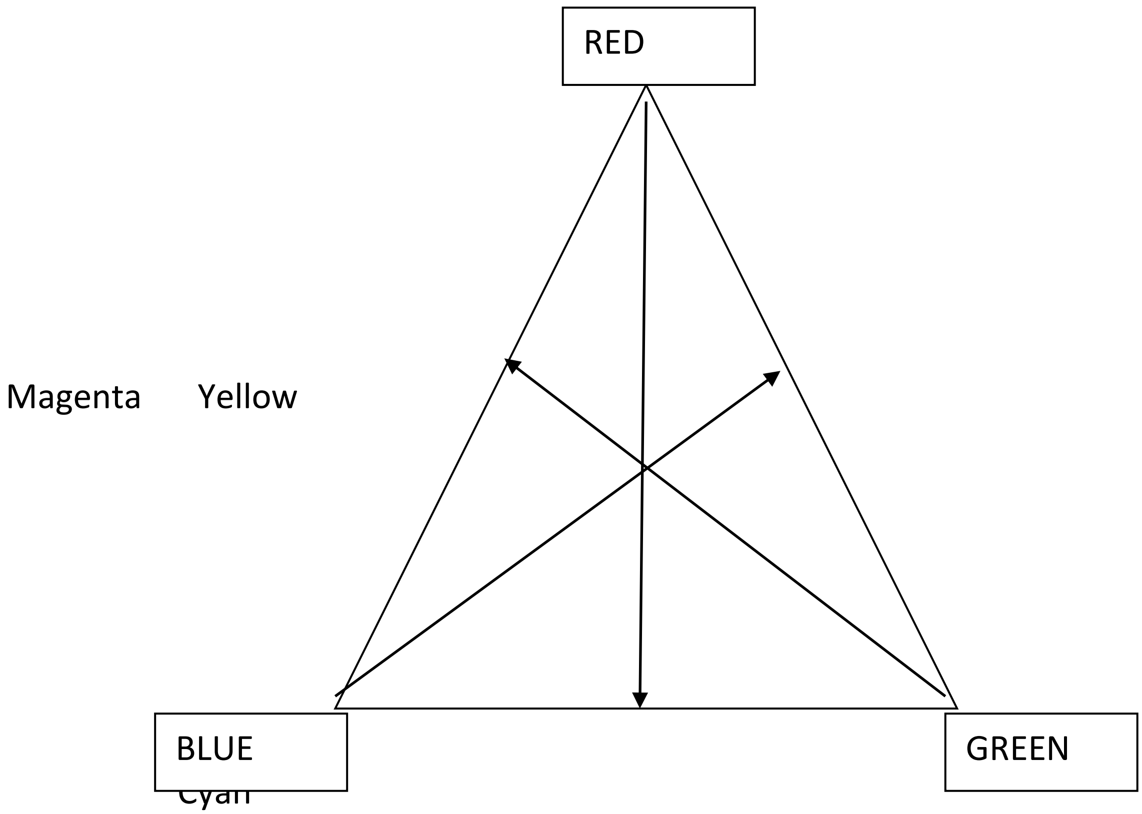
4. Explain what is meant by a pure spectrum of light.

5. Although the light coming from the sun is refracted while passing through Earth's atmosphere, the light is not separated into its spectrum. What does this tell us about the speeds of different colours of light travelling through air?

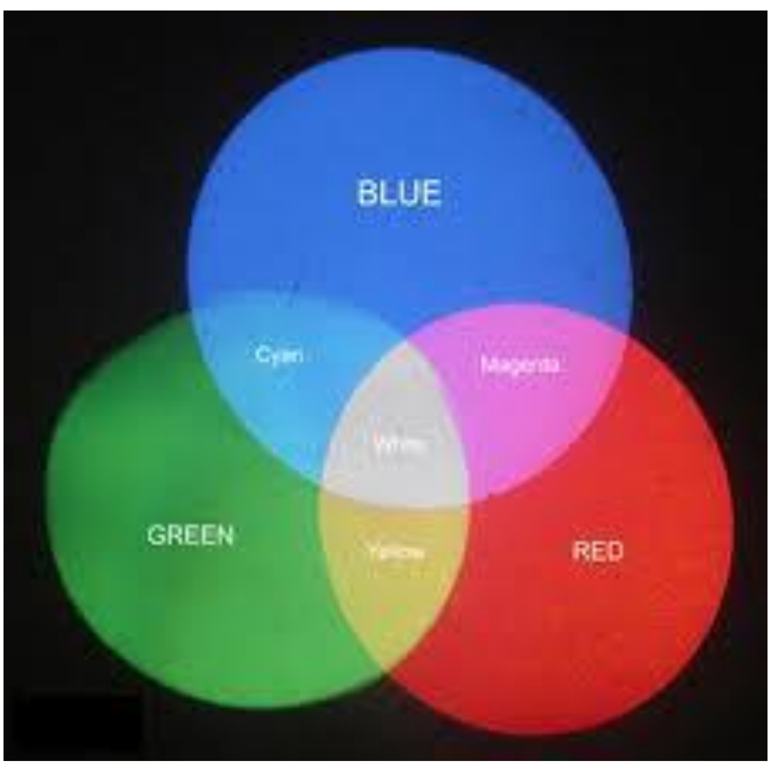
WEEKS3 AND 4 COLOUR ADDITION AND SUBTRACTION

Objectives*: By the end of the lesson, the students should be able to:*
i) identify the primary colours of light
ii) ascertain how secondary and complementary colours are obtained
iii) determine the light that would be reflected, absorbed or transmitted when certain colours of objects are exposed to certain wavelengths of light.

White light can be formed from coloured light in avariety of ways. For example, if correct intensities of red, green and blue light are projected on to a white screen, the screen will appear white. Thus, blue, red and green light added together form white light.This is called the additive colour process. A colour television uses the additive process. It has tiny dot-like sources of red, green and blue light. When all have the correct intensities,the screen appears white. Because of this, red light, green light and blue light are called the **primary colours** of light.



ADDITIVE COLOUR MIXING (LIGHTS)



The primary colours can be mixed by pairs to form three different colours. Red and green light together produce yellow light. Blue and green light produce cyan and red and blue light produce magenta. These three colours, yellow, magenta and cyan are called the **secondary light colours**.

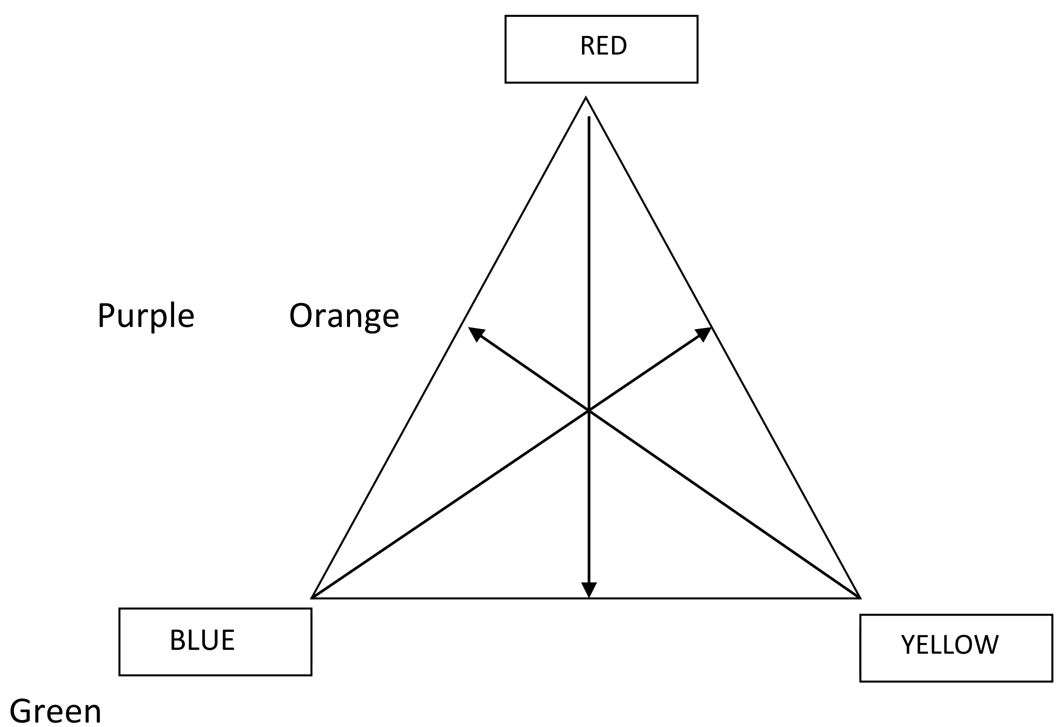
Yellow light consists of red and green lights. If yellow light and blue light are projected onto a white screen with correct intensities, the surface will appear white. Thus, yellow and blue light add to form white light. Yellow light is called the complementary colour to blue light. Yellow light ismade up of two other primary colours. In the same way, cyan and red are **complementary colours** as are magenta and green.

A dye is a molecule that absorbs certain wavelengths of light and transmits or reflects others. A tomato is red because it reflects red light to our eyes. When white light falls on the tomato, dye molecules in the tomato skin absorb the blue and green light and reflect the red. When only blue light falls on the tomato,no light is reflected. The tomato appears black. Black is the absence of reflected light. A white object appears white in daylightbecause it reflects equally all the colours of the spectrum. If a red light is incident on it,it appears red. A black object in daylight absorbs all the colours of the spectrum and reflects none at all. So if it is illuminated in sayblue light, it still appears black. A green leaf appears green in white (or daylight) because it reflects green but absorbs all the colours of white light. The green leaf will appear dark or black if it is illuminated in a dark room by blue light. A red rose flower that appears red in daylight is also red only in red light but appears black in any light which it does not reflect. Thus, if illuminated by a blue light in a dark room, the red flower will appear black. This is because it absorbs all the blue light, leaving no colour to be reflected.

Like a dye, a pigment is a coloured material that absorbs certain colours and transmits or reflects others. A pigment particle is larger than a molecule and can be seen with a microscope. Often a pigment is a finely ground inorganic compound such as titanium(IV) oxide (white), chromium(III) oxide(green), or cadmium sulphide(yellow). They mix to form suspensions instead of solutions.

In summary, if a ray of sunlight strikes the surface of an object, if all the colours are reflected, the object appears white. If all the colours are absorbed, the object appears black. Some objects, however, absorb some colours and reflect some. Healthy grass reflects mainly green and absorbs other colours.
Filtering colours: sheets of coloured plastic or glass can filter the colours in light. They absorb some colours and allow others to pass through. A blue filter allows only blue light to pass through while a red one allows only red light to pass through. Its spectacular use is in the theatre where the stage is bathed with different coloured lights for different effects. Blue is used for night scenes or to generate fear or excitement, while red and yellow are used to make dance routines seem more lively. They are also used in photography to produce images for art exhibitions and advertising campaigns.

The subtractive colour mixing of pigments is summarized below by the diagram.



SUBTRACTIVE COLOUR MIXING (PAINTS)

QUESTIONS

1. What light colour do you add to blue light to obtain white?
2. Name each primary colour and its secondary light colour.

3. What colour will a yellow banana appear when illuminated by a) white light b) green plus red light   c) blue light?
4. You put a piece of red cellophane over one flashlight and a piece of green cellophane over another. You shine the light beams on a white wall. What colour will you see where the two flashlight beams overlap?

WEEK 5   WORK, ENERGY AND POWER

Objectives: *By the end of the lesson, the students should be able to:*
i) differentiate between work, energy and power
hjii) state the mathematical formulae for each
iii) identify and differentiate between the kinds of potential energy
iv) make calculations with the given formulae

Work is defined as the product of force and the perpendicular distance in the direction of the applied force. It is given by W = Force x distance = F x s.
The unit for work is the Joule(J) = newton x metres (Nm) **The work done in a force field**
The weight of a body acts downwards and is due to the force of attraction on the body from the earth's gravitational field. To lift a load through a height h, a pulling force must be applied to overcome the weight of the body. Therefore, work is done against the force of gravity or against the weight of the body. The magnitude of the work done is given by

Work = force x distance

= mg x h = mgh

Where m = mass of the body, g = acceleration due to gravity, and h = height. (g = 10 ms^{-2})For bodiesfalling freely in a force field, the field does work on the body. If a body of mass m, falls through a height h, the work done by gravity on the body is given by w = mgh.**Energy** is the capacity to do work. Work and energy are both measured in Joule. There are many forms of energy. They include: mechanical energy, heat energy, light energy, chemical energy, electrical energy, atomic energy, solar energy etc.

Mechanical energy is classified into two types - potential and kinetic energy. Potential mechanical energy is simply 'stored' energy or the energy possessed by a body by virtue of its position or state. Such stored energy is used to do work when the body moves. A stone resting on top of a table has gravitational potential energy due to its height above the ground level. If the stone has a mass m and the height of the table is h, then the gravitational potential energy is given by E = mgh. E is in Joules, m is in kg,h in metres and g in ms^{-2}. Other examples of potential energy are i) a magnet at rest in a magnetic field(magnetic potential energy)

ii) an electric charge at rest in an electric field (electric potential energy)

iii) chemical potential energy released when wood, petrol, and other fuel sources burn. Iv) a coiled spring when stretched or compressed possesses elastic potential energy.

These are used in daily life. For example, a steam engine uses heat energy to move the coaches, sound energy causes the diaphragm of a microphone to vibrate; the chemical energy in the food we eat causes us to grow and also provides us with muscular energy for our physical activities.

Kinetic energy is the energy possessed by a body by virtue of its motion. Examples of kinetic energy are i) a student running a race

ii) an object falling freely under gravity

iii) electrical charges in motion

iv) a moving bullet or a moving hammer head

The kinetic energy of a bodyin motion is given by K.E. = $\frac{1}{2}mv^2$ where m= mass of the body, v = its velocity,and the unit of K.E. is the Joule. If two bodies in motion have the same mass, the faster body has the greater kinetic energy and if they have the same velocity, the greater mass will have the greater kinetic energy.

Power is the time rate of doing work. If two boys of the same weight climb a flight of steps of the same height, the boy that gets to the top first is said to have the greater power. This is because he has done the work of moving his weight through that height at a shorter time. If the work W joules is donein time t seconds, then the power = $\frac{\text{work done}}{\text{time}} = \frac{\text{energy expended}}{\text{time taken}}$

t

The unit of power is Watts = joule per second. Other commonly used units of power are the kilowatt (KW), the megawatt (MW) and the horsepower (h.p.).

$1kW = 1000\ W = 10^3\ W$

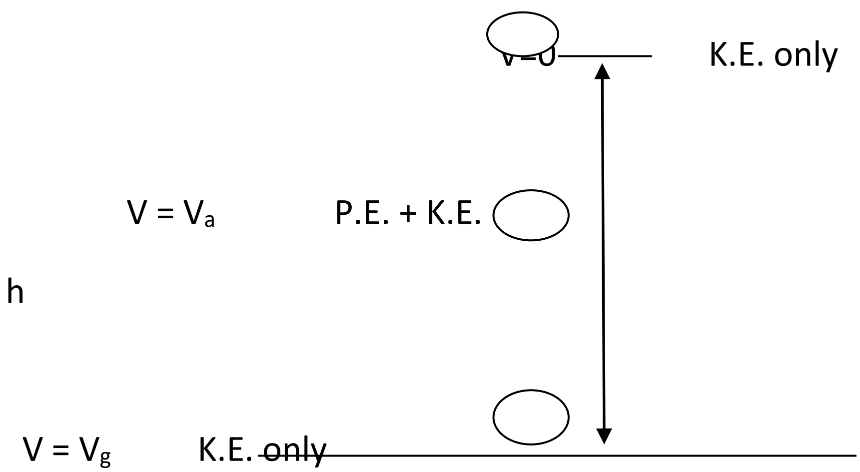
$1MW = 1000\ 000W = 10^6\ W$

$1h.p. = 746\ W.$

Energy conservation and transformation

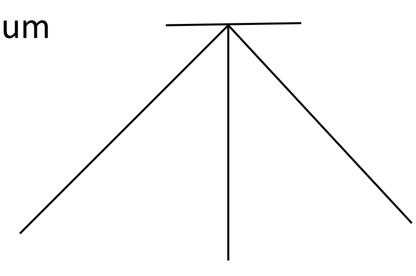
The law of conservation of energy states that in an isolated system, energy cannot be created or destroyed but can be changed from one form to another. Hence, the total amount of energy is always constant. As examples of energy conservation, the kinetic and potential energy of

a) a falling body



At the highest point, the body of mass m, h metres above the ground has energy that is all potential and equal to mgh. At point V = Va, the energy is partly kinetic(since the body has acquired some velocity) and partly potential(since it is at some distance above the ground) but the total energy is also equal to mgh. At V = Vg, the ground or lowest level, the energy is all kinetic. There is no potential energy as the height is zero. The total energy of the body at each of these points totals a constant (mgh). Thus, the total energy is conserved.

b) a simple pendulum



C A B

K.E.=0,P.E.=mghK.E.=1/2mv^2 K.E.=0,P.E.=mgh

At C, the bob is at the lowest position therefore the potential energy of the system is zero but the speed of the pendulum is maximum; thus K.E=maximum. At A and B, the bob is at the greatest height h above C, hence, the total energy is potential and is equal to mgh. At any intermediate point, the energy is partly potential and partly kinetic. At each point, however, the total energy (P.E. + K.E.) is constant and equal to mgh.

World Energy Resources can be classified into two major classes:
i) The Renewable Energy Resources which include solar energy, wind energy, water energy and biomass ii) The non-Renewable Energy Resources which include nuclear energy from radioactive materials and petroleum and natural gas.

QUESTIONS:

1. Mechanical energy can further be subdivided into ______.
   (a) chemical and heat energy
   (b) gravitational and nuclear energy
   (c) kinetic and potential energy
   (d) solar and wind energy

2. Energy is the ______.
   (a) ability to do work
   (b) capacity to work hard
   (c) unit of work
   (d) force of gravity.

3. The unit of energy is the ______.
   (a) Watt
   (b) Joule
   (c) Ampere
   (d) Voltage

4. The following are examples of potential energy **except** ______.
   (a) magnet at rest in a magnetic field
   (b) a coiled spring when stretched or compressed
   (c) a car in motion
   (d) a man waiting for a bus at the bus stop.

5. The formula for potential energy is ______
   (a) $\frac{1}{2}mv^2$
   (b) $\frac{1}{2}pv^2$
   (c) mgh
   (d) mgh/t.
6. A fruit from a tree of mass 2kg is 5m above the ground. What is the P.E. of the fruit above the ground. ($g = 10m/s^2$)
   (a) 37.5J
   (b) 50.0J
   (c) 100.0J
   (d) 120.0J

7. A body falling under gravity will possess _____.
   (a) potential and kinetic energy
   (b) chemical and potential energy
   (c) pivotal and kinetic energy
   (d) none of the above.

8. The energy a body possesses by virtue of its motion is called ______.
   (a) body energy
   (b) magnetic energy
   (c) potential energy
   (d) kinetic energy
9. The following are forms of energy **except**_____.
   (a) heat energy
   (b) solid energy
   (c) light energy
   (d) electrical energy.

10. The energy possessed by a body by virtue of its position is called ______ .
   (a) potential energy
   (b) kinetic energy
   (c) light energy
   (d) heat energy.

WEEK 6 CALCULATIONS INVOLVING WORK DONE

EXAMPLES.

1. A sack loaded with seed and of total mass 100kg falls down from the floor of a lorry 3.0m high. Calculate the work done by gravity on the load.

Solution: W = mgh = 100 x 10 x 3 = 3000 J

2. Find the potential energy of a boy of mass 10kg standing on a building floor 20 metres above the ground level.

Solution: P.E. = mgh = 10 x 10 x 20 = 2000 J

3. A boy of mass 20kg climbs up 10 steps each of height 0.2m in 25 seconds. Calculate the power of the boy.

Solution: Total height climbed = 10 x 0.2m = 2m

Work done = mgh = 20 x 10 x 2 = 400 J

Time taken = 25 seconds

$$\text{Power} = \frac{\text{work done}}{\text{time taken}} = \frac{400}{25} = 16 \text{ Watts.}$$

t

4. An object of mass 5kg is moving at a constant velocity 15m/s. Calculate its kinetic energy. Solution: K.E. $= \frac{1}{2} mv^2$

$$= \frac{1}{2} \times 5 \times 15 \times 15 = 562.5 \text{ J}$$

QUESTIONS

1. A man of mass 50kg ascends a flight of stairs 5m high in 5 seconds. If the acceleration due to gravity is $10m/s^2$, what is the power expended?
2. Differentiate between potential energy and kinetic energy. Give two examples of each.

3. a) If a body of weight 10N is lifted from the floor to a table 2m above the ground, calculate the potential energy gained.
b) What happens to the energy if the body falls off the table and hits the floor?
4. State the law of conservation of energy. How is it illustrated in the swing of a simple pendulum?

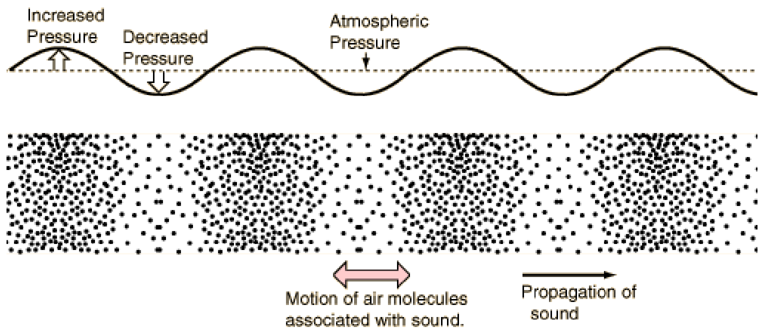
5. At what height above the ground must a body of mass 10kg be situated in order to have potential energy equal in value to the kinetic energy possessed by another body of mass 10 kg moving with a velocity of 10m/s?
6. A ball of mass 8kg falls from rest from a height of 100m. Neglecting air resistance, calculate the total energy after falling a distance of 40m.
7. A boy weighing 350N runs up a flight of stairs consisting of `20 steps each 10cm high in 10 seconds. What is his power?

WEEKS 8 AND 9 SOUND

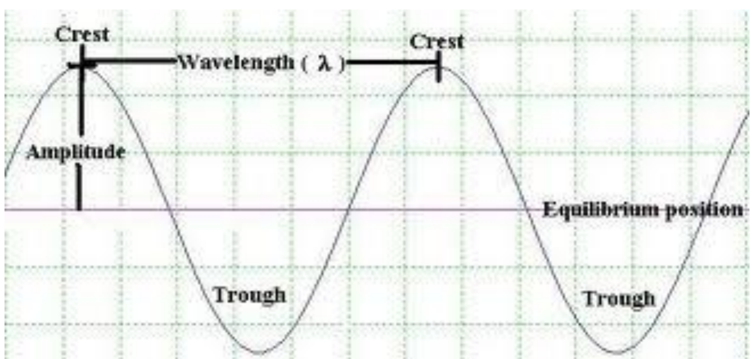
Objectives: *By the end of the lesson, the students should be able to:*
i) explain how sound waves travel
ii) describe the process of sound detection by the ear
iii) relate loudness and amplitude
iv) relate the pitch of a sound to the frequency
v) explain the Doppler shift and state its uses.

Any object makes a sound when it vibrates. A vibration is a movement about a fixed point. This movement may be described as a to-and-fro movement or a backwards and forwards movement.
Sound waves can travel in a gas, a liquid or a solid because they all contain particles. When an object vibrates, it makes the particles next to it vibrate too. For example, when an object vibrates in the air, it pushes on the particles around it.
As the vibrating object moves towards the air particles, it squashes them together. The particles are not compressed but the pressure in the air at that place rises because the particles are closer together. As the object moves away

from the particles next to it, it gives them more space and they spread out and the pressure at that place falls.

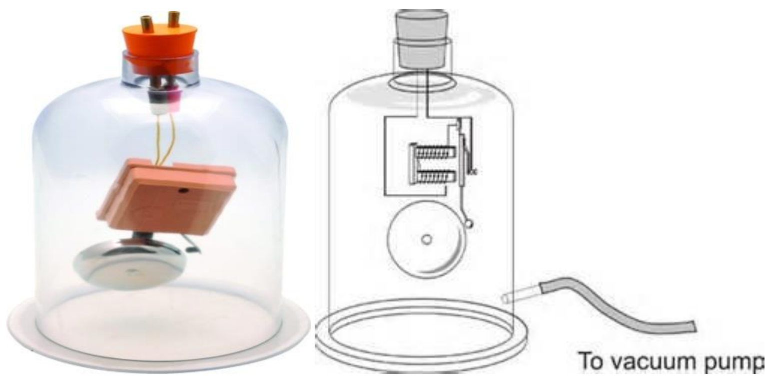


If these changes in pressure are plotted on a graph, they make a waveform similar to that shown below.



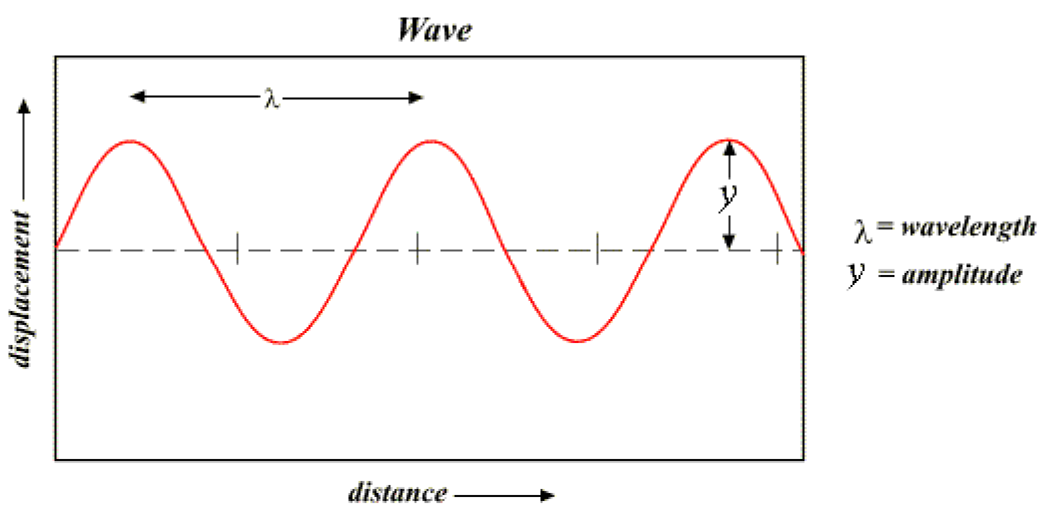
Sound waves are generated and travel in liquids and solids in the same way they do in gases. The particles in liquids and solids are held together by forces of attraction. In a liquid, the particles are further apart than they are in a solid and can move around one another. Sound therefore travels very well through a liquid. It moves faster and further than it does in a gas.
When sound travels through a solid, it moves even faster than when it travels through a liquid because of the close interaction of the particles. However, the sound does not travel so far. **Ingeneral, the velocity of sound is greater in solids and liquids than in gases**.
A humpback whale emits a series of sounds called songs which it uses to communicate with other whales. The sound travels thousands of kilometers through the ocean. A snake detects vibrations in the ground with its lower jaw bone. The bone transmits the vibrations to the snake’s ears and allows the snake to detect the footsteps of its prey.

Sound waves cannot pass through a vacuum because it does not contain any particles. As air is drawn out of the bell jar with a pump, the sound of the bell becomes quieter. When a vacuum is established in the bell jar, the bell cannot be heard though the hammer can be seen striking the bell.



Describing a wave

The**amplitude** of a wave is the height of the crest or the depth of the trough and shows the maximum displacement of the particles from their rest position. The **wavelength** is the distance from the top of one crest to the top of the next crest or from the bottom of one trough to the bottom of the next trough.

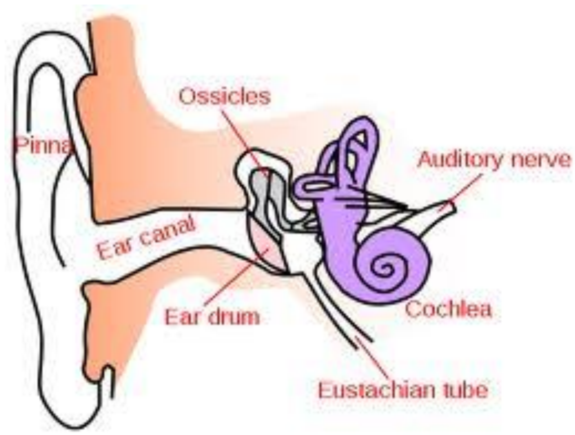


Sound detection

Sound detectors convert sound energy into another form of energy. In a sound detector, a diaphragm vibrates at the frequency of the sound wave. The vibration of the diaphragm is then converted into another form of energy. A microphone is a device that converts sound energy into electrical energy.

The ear is an amazing sound detector. It not only detects sound waves over a very wide range of frequencies but it is also sensitive to an enormous range of waveamplitudes. Human hearing can distinguish many different qualities of sound.

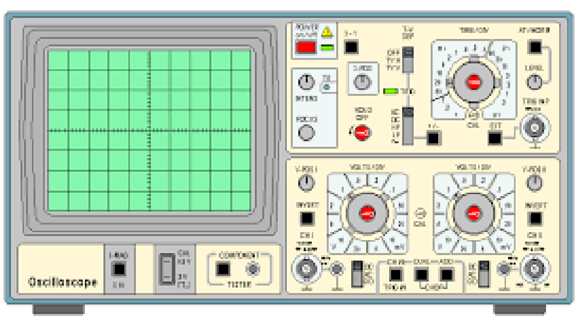
The ear is not equally sensitive to sound of all frequencies. Most people cannot hear sounds with frequencies below 20 Hz or above 20 000 Hz. In general, most people are most sensitive to sound with frequencies between 1000 Hz and 5000 Hz. Older people are less sensitive to frequencies above 10 000 Hz than are young people. By 70 years of age, most people can hear nothing above 8 000 Hz. This loss affects the ability to understand speech.

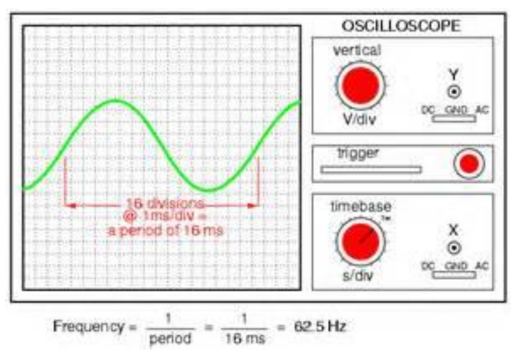


The ear is divided into three parts - the outer, the middle and the inner ear. The outer ear consists of the fleshy, visible part of the ear called the pinna, which collects sound; the auditory canal; and the eardrum. Sound waves cause vibrations in the eardrum. The middle ear consists of three tiny bones in an ear-filled space in the skull. The bones transmit the vibrations of the eardrum to the oval window on the inner ear. The inner ear is filled with a watery liquid. Sound vibrations are transmitted through the liquid into sensitive portions of the spiral-shaped cochlea. In the cochlea, tiny hair cells are vibrated by the waves. Vibrations of these cells stimulate nerve cells that lead to the brain, producing the sensation of sound. *If the sound is very loud when it enters the ear, the vibrations are so strong they damage the fibres and the nerve endings are not stimulated. This can give rise to permanent damage and deafness.*

Over exposure to loud sounds can cause the ear to lose its sensitivity, especially to high frequencies. The longer the exposure, the greater the effect. Short term exposures could clear in a period of hours but long-term exposure could take days or weeks to be recovered from. Long exposure to 100dB or greater sound levels can produce permanent damage. Specifically designed ear muffs and inserts can reduce the sound and its effects to the ear much better than cotton earplugs and special ear inserts. Another source of hearing loss is the result of loud music from stereo headphones on personal radios and tape players. Some doctors have said that an earphone is“like the nozzle of a fire hose stuck down the ear canal”.

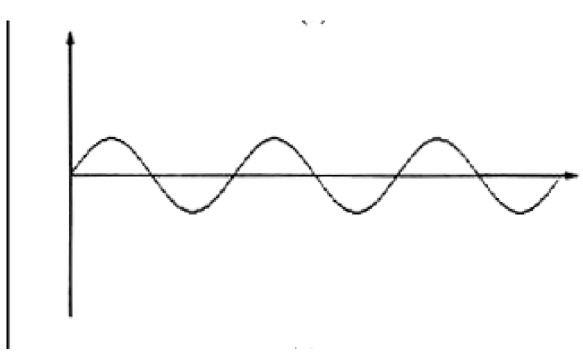
The instrument which allows one to see the waves produced by the sounds is called an oscilloscope. There are two types: the cathode ray oscilloscope (CRO) which is used in some school laboratories and the digital oscilloscope which does the same work as the CRO but only differs in that displays produced on the screen can be stored.

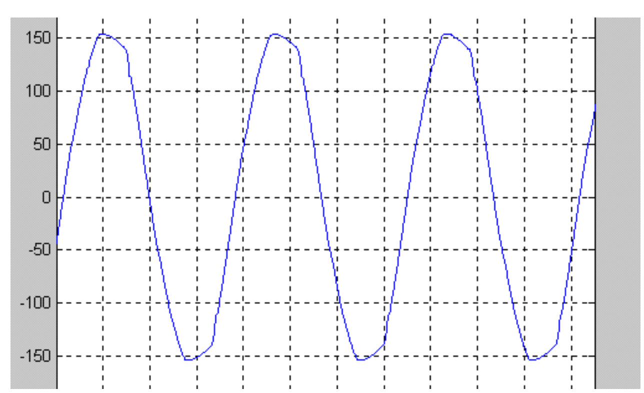




The loudness of a sound

The loudness of a sound is related to the movement of the vibrating object. If an object only moves a short distance from its rest position, it will produce a sound wave with only a small amplitude and the sound that is heard will be a quiet one. If the object’s distance from its rest position is large, it will produce sound waves with a large amplitude and the sound heard is a loud one. The loudness of a sound is measured in decibels.

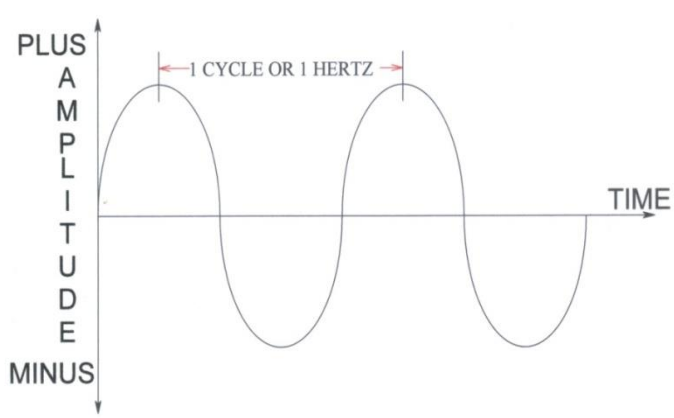




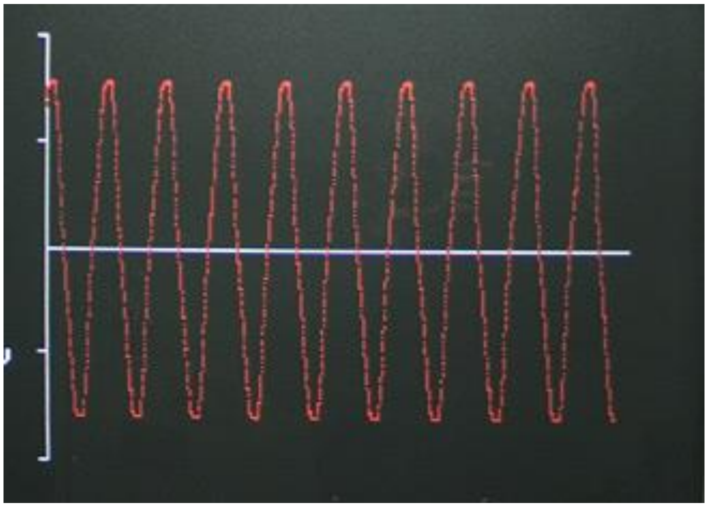
Quiet sound loud sound

Effect of loudness on the ear The vibrating air particles of a very loud sound can produce such a strong pushing and pulling force that the eardrum could have a hole torn in it. Thus, the eardrum is said to be perforated. Its vibration is no longer efficient and the person loses his or her hearing. The eardrum can heal and normal hearing can be restored. When a person is exposed to a very loud sound or a particular note for a long time, there will be a permanent damage to a nerve ending in the cochlea and the person will no longer be able to hear. People who perform in pop groups are at risk of developing this kind of deafness, called nerve deafness. With time, they can't hear a range of notes which they used to play frequently. Also, people who work in noisy surroundings like in airports and metal factories wear ear muffs to protect their ears. It covers their ear and reduces the amount of sound energy entering the ears.
Some people have temporary deafness due to the development of ear wax in the outer ear. It can be removed under the supervision of a nurse. Also, some people have growths of tissue in their middle ear which does not allow the ear bones to move freely. People with this may be prescribed hearing aids.

Pitch of a sound The pitch of the sound an object makes depends on the number of sound waves it produces in a second. The number of waves per second is called the frequency. The frequency of a sound is measured in hertz (Hz). The higher the frequency of the wave, the higher the pitch of the sound.



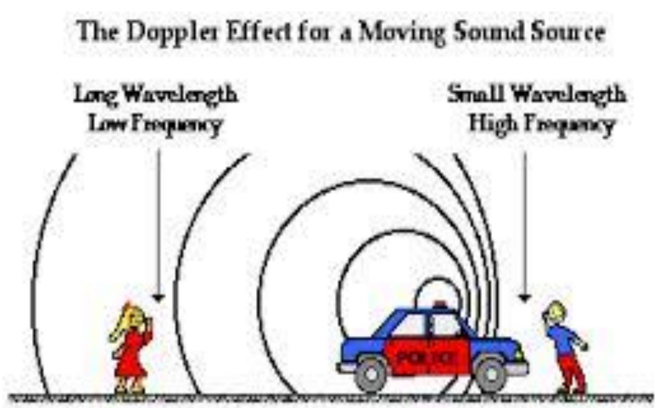
Low-frequency sound (low pitch)


High-frequency sound (high pitch)

It is worthy of note that higher-frequency waves have a shorter wavelength than the lower-frequency waves. Sound waves share this property with light waves. The ear of a young person is sensitive to frequencies in the range of 20Hz - 20 000 Hz (Hertz) but the ability to detect the higher frequencies decreases with age. Some may have a restricted range of hearing due to nerve damage. They may be able to hear some low-pitched or high-pitched sounds.

THE DOPPLER SHIFT

Have you ever noticed the pitch of an ambulance, fire or police siren as the vehicle sped past you? The frequency is higher when the vehicle is moving towards you, then suddenly drops to a lower pitch as the source moves away. This effect is called the Doppler shift.



When the sound source is moving towards you, it emits waves which spread in circles around the location of the source at the time it produced the wave. The

frequency of the sound source does not change, but when the source is moving towards the sound detector, more waves are crowded into the space between them. The wavelength shortens. Because the velocity does not change, the frequency of the detected sound is greater. When the source is moving away from the detector, the wavelength is lengthened and the detected frequency is lower. A Doppler shift also occurs if the detector is moving and the source is stationary. It occurs for all types of waves (mechanical and electromagnetic). It is used by: i) radar detectors to measure the speed of baseballs and automobiles
ii) astronomers to measure the speed and infer the distance of distant galaxies
iii) physicians to detect the velocity of the moving heart wall in a fetus using ultrasound iv) a bat to detect and catch flying insects(when an insect is flying faster than the bat, the reflected frequency is lower but when it is catching up with the insect, the reflected frequency is higher.

RESEARCH:
Briefly describe how the bat and the dolphin receive sound and how these sound receptors influence their hunting and their life styles generally.

EXERCISES
1. How do sound waves travel in solids, liquids and gases?
2. What can be used in the human body to detect sound waves?
3. Why do people put a hand to their ear when they are listening to someone who is whispering?
4. What may happen to the ears of those who wear headphones and turn up the sound?
5. What is the relationship between loudness of a sound wave and its amplitude?
6. How does the pitch of a sound relate to its frequency?
7. What kind of ear damage might be caused by a loud explosion?
8. The following are three frequencies of sound waves: 1800 Hz, 50Hz, 10 000Hz.
A. Which has the highest and which has the lowest pitch?
B. What does Hz stand for?

9. When a ringing bell is placed inside a jar connected to a vacuum pump and the air is removed, no sound is heard. Explain why.

10. Does the Doppler shift occur for only some types of waves or all types of waves?

11. A bat emits short pulses of high frequency sound and detects the echoes.

a) In what way would the echo from large and small insects compare if they were the same distance from the bat?

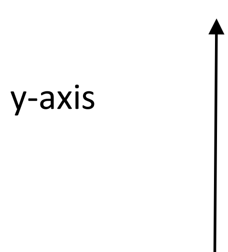
b) In what way would the echo from an insect flying toward the bat differ from that of an insect flying away from the bat?

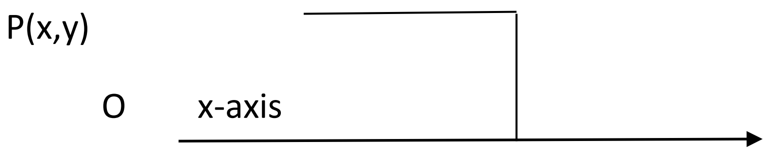
WEEK 10 POSITION, DISTANCE AND DISPLACEMENT

OBJECTIVES : *By the end of the lesson, the students should be able to: i) define each of these terms ii) state the difference between velocity and speed, displacement and distance*

iii) state what information can be obtained from distance-time, velocity-time graphs iv) solve simple problems.

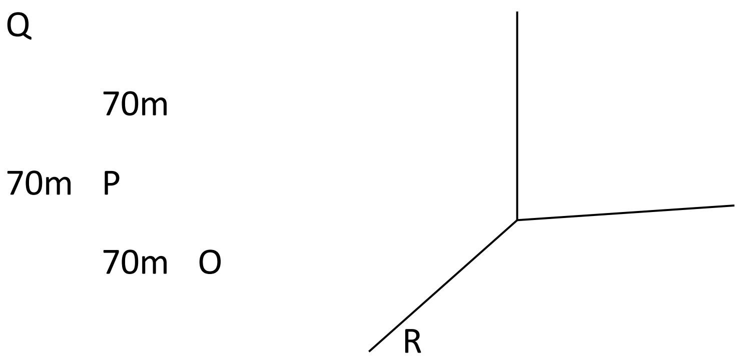
The position of a body is usually defined by means of a frame of reference or a point of reference called the origin. In order to locate the position of a point, it is customary to draw two lines intersecting at an origin O and perpendicular to each other.





The horizontal line going across from left to right of the page is called the x-axis and the vertical line going up the page is called the y-axis. By convention, all points to the right of O are positive, points to the left are negative, points above O are positive while points below O are negative. The position of a point such as P is specified by two quantities or co-ordinates: the x and the y coordinates. If the position P is specified by the coordinates (a,b) it means that the distance of P from O in the x-direction is a and in the y-direction is b. The x-coordinates called the abscissa, the y-coordinate is called the ordinate.

DISTANCE AND DISPLACEMENT



When an object moves, say 70m from a point O to another point P, we say that the **distance** covered by the object is 70m. The distance indicates how far the object has moved. However, knowing the distance alone is not sufficient to tell us where or in what direction the object has moved. Points R and S are also 70m from O, and we cannot tell which point is the final position of the object. In the study of motion, it is necessary to specify the direction in which a body is moving. If it travelled eastward, its final position is at P. If it is northward, the final position is Q and if north-west, the final position is R. Therefore, with the final position specified, the final position of the object is known.

Displacement is thus defined as distance travelled in a specified direction. It requires distance and direction to specify it. The direction of the bodies can be found using a compass. Distance is a scalar quantity (one with only magnitude) while displacement is a vector quantity (with both magnitude and direction).

To further distinguish between the two, imagine a person moving 500m to the east, and then turning around and walking back (west) a distance of 300m. The total distance travelled is 800m but the displacement is only 200m since he is now only 200m from the starting position. If a boy walks 30m eastward and then 40m northward, his displacement is 50m in a northeast direction.

SPEED AND VELOCITY

When describing the motion of a body, we usually note the distance it covers and the time it takes to do so. The rate at which a body covers a distance is called the speed of the body. Thus, it is given by speed = distance/ time v = s/t .This is indeed the average speed over the distance s. The S.I. unit of speed is metres per second (m/s). When a body covers equal distances in equal time intervals, no matter how small the intervals may be, the speed is said to be a uniform speed or constant speed.

Velocity and speed are often used interchangeably. But it is important to differentiate between the two. In speed, no direction is specified, but in velocity, it is necessary to specify direction. Since displacement refers to the distance covered in a specified direction, we define velocity in terms of displacement. Velocity is the rate of change of displacement.

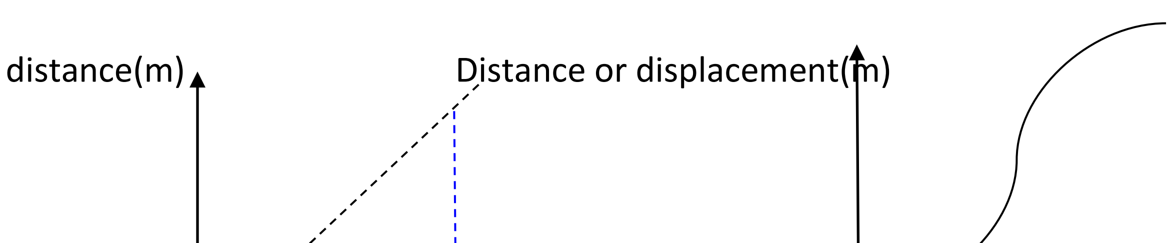
Velocity = displacement/ time

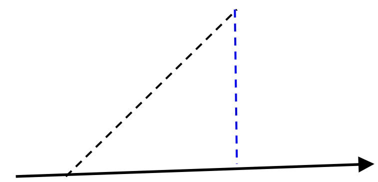
Velocity is said to be uniform or constant when a body moves with equal displacements in equal time intervals. Its unit is metres per second. If the body moves round a circular path at constant speed, then it is said to move with non-uniform velocity, because its direction of motion is constantly changing. Instantaneous velocity is defined as the velocity at any instant in time.

GRAPHS

Distance (or displacement) - time graph

If the measure of the distance covered by a moving object at known time intervals is recorded and the values of distance is plotted on the y-axis and time on the x-axis of the graph, on joining the points, we obtain a distance (or displacement) - time graph.





time(s) time(s)

The slope or gradient of a distance-time graph gives the speed. A displacement - time graph could be linear or curved. For a linear graph, the gradient gives the velocity. For the curve, the gradient of a tangent to a point in the curve gives the instantaneous velocity. The speedometers of moving vehicles indicate instantaneous velocity.

Velocity - time graph This graph is more useful than the other graphs mentioned above because it gives more useful information concerning the motion of objects. The acceleration, retardation, the distance traveled and the average speed can be obtained from the graph.The motion of the objects can form shapes such as square, triangle, trapezium, rectangle or a combination of two or more shapes. Thus, the sum of the areas of the shapes formed corresponds to the distance moved, covered or travelled by the objects.

EXAMPLES:

1. A car travelled a distance of 4km in 40seconds. Find the speed in metre per second(m/s) Solution: 1 km = 1000 m

4km = 4 000m

Since speed = distance/ time = 4000/40 = 100 m/s.

2. A car travels at an average speed of 100 km/h. What distance does it cover in 5 minutes? Solution: 100 km/hr = <u>100 km</u>

60mins

Speed = distance / time

Distance = speed x time

= 100/ 60 x 5 = 8.3 km

QUESTIONS

1. A car starting from rest is accelerated uniformly to a velocity of 100.8 km/h. Convert this to meters per second.

2. A car starting from rest accelerates uniformly and attains a speed of 80m per second in 30 seconds. It maintains this steady speed for another 30 seconds. It then slows down uniformly until it comes to rest in the next 40 seconds. Sketch the velocity- time graph for the motion of this car. Obtain from the graph the uniform acceleration during the first stage of the journey, and the retardation during the last stage of the journey. For how long did the car travel altogether?

3. A motor car accelerates for 10seconds to attain a velocity of 20 m/s. It continues with uniform velocity for a further 20 seconds and then decelerates so that it stops in 20 seconds. Calculate: i) acceleration ii) deceleration iii) the distance travelled.

4. A train moves with a speed of 54 km/hr for one- quarter minute. Find the distance travelled by the train.

5. A particle starts from rest and moves with a constant acceleration of 0.5 m/s^2. Calculate the time taken by the particle to cover a distance of 25m.

6. A body accelerates uniformly from rest at $2m/s^2$. Calculate its velocity after travelling 9 m.

7. A car travels at a uniform velocity of 30m/s for 5 seconds. The brakes are then applied and the car comes to rest with a uniform retardation in a further 8 seconds. Draw a sketch graph of velocity against time. How far does the car travel after the brakes are applied?