WEEK ONE

TOPIC: HEAT ENERGY

Heat is a form of energy. Heat is defined as transfer of energy due to temperature difference. It is a measure of quantity of total internal energy of a body.

TEMPERATURE:
It is the property of a body that determines the direction of heat flow when two or more bodies are in contact. Or it is the degree of hotness or coldness of a body that determines the direction of heat flow. It is measured in degree Celsius (^{o}C) or Kelvin (K).

The instrument used in measuring temperature is called thermometer while that of heat is called calorimeter.

TYPES OF THERMOMETER:

There are different types of thermometer with different thermometric substances and thermometric properties.

Thermometric substances are those substances used in the thermometer e.g. Mercury or Alcohol.

Thermometric properties are those physical properties of thermometric substances that enable them to be used in thermometer.

S/N	TYPES OF THERMOMETER	THERMOMETRIC SUBSTANCES	THERMOMETRIC PROPERTIES
1	Liquid in glass thermometer	Mercury or Alcohol	Change in volume due to change in temperature
2a	Gas thermometer	Gas	Change in gas pressure at constant volume.
2b	Constant- Pressure Gas Thermometer	Gas	Change in gas volume at constant pressure.
3	Thermocouple	Two Different Wires	Intensity of current flow due to temperature difference
4	Resistance Thermometer	Resistance Wire	Change in resistance value of a resistor due to change in quantity of heat.

ABSOLUTE SCALE OR KELVIN
The scale is name after an English man known as Lord Kelvin. The scale is based on behavior of idea gases. For an idea gas at constant volume the pressure varies linearly with temperature. The S.I Unit of this scale is called the Kelvin scale which is also the S.I Unit of temperature. The two fixed points for this scale are the triple point of matter at 273.16k and the absolute Zero (O) at OK. The triple point matter is the temperature at which saturated water vapour, pure water and ice coexist in equilibrium. The absolute zero is the temperature at which all possible thermal energy has been transferred from the body. Kelvin scale is also called absolute scale.

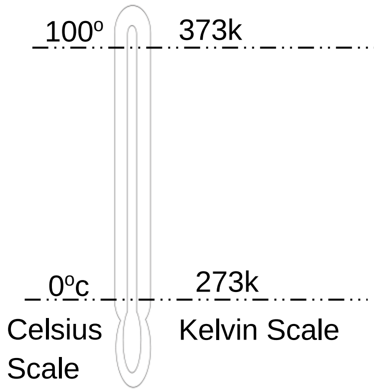
COMPARISM BETWEEN CENTIGRADE (^{O}C)TO KELVIN

To reconcile the centigrade scale to Kelvin scale, the Celsius scale was introduced. If "T" is the temperature on the Kelvin scale andθ is the temperature on the Celsius scale, then,

$0^{0}C=1(k) - 273$

$\Theta^{0}C=T(k) - 273$

$T= 273+\Theta$



The temperature in the Antarctic during mid-winter is found to be 100k. What is the temperature in degree Celsius?

SOLUTION

T= 186K,

Θ = ?

T= =273 +θ

Θ = 186 – 273

= - 87^{0}C.

The lower fixed point of a thermometer is the temperature of a mixture of pure water and the upper fixed point is the temperature of pure steam above water at normal atmospheric pressure.

Temperature is a scalar quantity. The lower fixed point of Celsius scale is 0^{0}C while Kelvin scale is 273k. The upper fixed point of Celsius scale is 100^{o}C and Kelvin is 373k.

The clinical thermometer has a short range i.e. 35^{o}C - 43^{o}C as body temperature.

WEEK TWO

TOPIC: HEAT ENERGY (MEASUREMENT OF HEAT).

HEAT CAPACITY

Heat capacity is defined as the heat required to raise the temperature of the body through 1^oC or 1k.
The unit is joule per Kelvin (J/K). It is given by H = MC.

Where H is the heat capacity,
M is the mass of the body in kilogram (kg)
C is the specific heat capacity in joules per kilogram per Kelvin ($Jkg^{-1}k^{-1}$).

Find the mass of a copper block with heat capacity 50J/K (S.H.C of Copper = 400 $Jkg^{-1}k^{-1}$)

SOLUTION

H = mc
$Cc = 400Jkg^{-1}k^{-1}$)
H = 50 J/K
m=?
50 = 40 x m
M = 50/400 = $^1/_8$ = 0.125kg =125g.

SPECIFIC HEAT CAPACITY

The specific heat capacity of a substance is the defined as the quantity of heat required to raise a unit mass of a body through one degree Celsius or one Kelvin.

Specific heat capacity = $\frac{\text{Heat required}}{\text{Mass x temp. diff.}}$

Mathematically $C = {}^H/_{M\theta} \longrightarrow H = mc\theta$
Where M is mass in kilogram (kg)
Θ is temperature difference in ʅ or k
H is the quantity of heat supplied
C is the specific heat capacity in $ŋkg^{-1}k^{-1}$

CALCULATION

17.6j of heat is supplied a metal of mass 300g that is initial at a temperature of 20^oc. What is the final temperature of the metal? (C_m= 730 Jlkgk).

Solution

H = 17.6kj = 17600j

M = 300g = 0.30kg

$\theta = \theta_2 - \theta_1$

θ_1 = 200C, θ_2 =?

C = 730jkg-1k-1

$H = mc\theta$

$H = mc(\theta_2 - \theta_1)$

$\theta_2 - \theta_1 = H/Mc$

$(\theta_2 - \theta_1) = 17600/(0.3 \times 730)$

$\theta_2 - \theta1 = 80.36$

$\theta_2 - 20 = 80.36$

$\theta_2 = 80.36 + 20$

:-θ_2 = 100.36 = 1000C.

DETERMINATION OF SPECIFIC HEAT CAPACITY

There are two methods of determining specific heat capacity of a body. These are:-
(1) Methods of mixture and (2) Electrical method.

Method of Mixture

This involves heating a body in water to a boiling point and quickly transfer the hot body to a mixture of cold water and copper container (calorimeter) and allow equilibrium temperature to be attained.

At equilibrium we have it that heat lost by hot body = heat gained by water and calorimeter.

i.e
$M_SC_S(\theta_2 - \theta_3) = M_wC_w(\theta_3 - \theta_1) + M_cC_c(\theta_3 - \theta_1)$

$M_c = \frac{(M_wC_w + M_cC_c)(\theta_3 - \theta_1)}{(\theta_2 - \theta_3)}.$

ELECTRICAL METHOD

This method involves supplying heat to a body by electrical means i.e heating a body by the use of electric element or heater.

The heat generated by the heating element is given by i.e. $H = Ivt = V^2t/R$.
The heat absorbed by the body = mcθ.
Heat generated = heat absorbed
1vt = mcθ.
$C = {}^{1vt}/_{M\theta.}$

'I' is current in amperes, V is voltage in volts, t is time in seconds, m is Mass in kilogram,θ is change in temperature in ^{o}C or k and C is specific heat θcapacity in J/kgk.

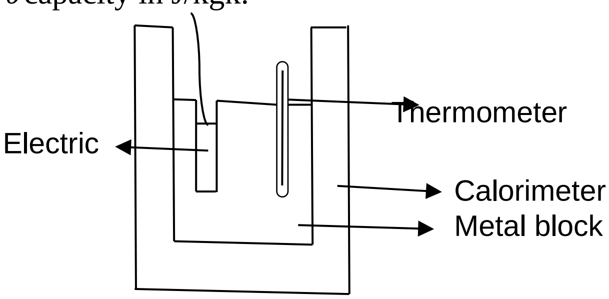


Diagram showing experimental setup for electrical method of finding due specific heat capacity of a solid.

EXAMPLE
In an experiment to determine the specific heat capacity of aluminum, the following readings where obtained.

Mass of aluminum = 0.2kg

Mass of empty calorimeter= 0.1kg
Mass of calorimeter + water = 0.4kg
initial temperature of water = $15.^{0}$C
Final " " " = 55.0^{0}C

S.H.C of copper = 400J1kgk
S.H.C of water = 4200J1kglk
Initial temperature of hot aluminum =291^{0}C
S.H.C of aluminum = ?

SOLUTION

Heat gained = Heat lost

Heat gained = $(M_wC_w + M_cC_c)\theta$

=(0.3x4200+0.1x400)40

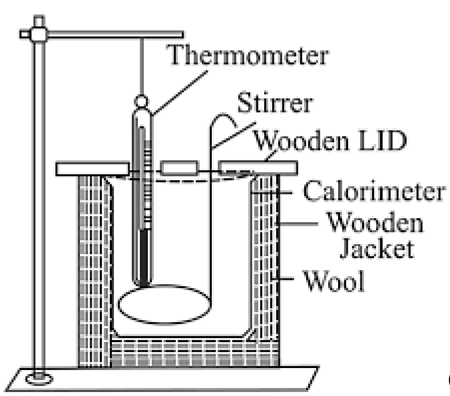
= 52000J

Heat lost $M_AC_A\theta_A$

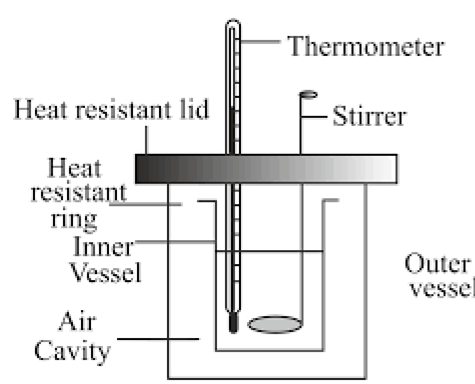
=0.2x (291-55) x C_A = 42.3C_A

47.2C_A = 5200

$C_A = \frac{5200}{47.2}$ = 1102J1kgk



CALORIMETERS



Week3

TOPIC: HEAT ENERGY (LATENT HEAT)

LATENT HEAT:

When a solid (e.g. ice) is continuously heated, its temperature rises steadily until a particular temperature is reached and the solid begins to melt. During the melting process, the temperature of the solid remains steady in spite of the fact that heat is being added to it.

This heat which does not show itself as a rise in temperature of the body but rather remains hidden in the body is known as latent heat.

Therefore, latent heat is the heat that is given out or absorbed during a change of state of a substance without a corresponding change in temperature.

Latent heat of fusion is the heat required to convert substance from solid to liquid.

Latent heat of vaporization is the heat energy required to change a substance from liquid to gaseous state.

Specific latent heat is the quantity of heat required to change a unit mass of a substance to liquid (if solid) or gaseous (if liquid) without change of temperature.

H = ml

Where H is the quantity of heat in joules
m is the mass of the substance in kilograms
l is the specific latent in joules/ kilograms

CALCULATION

If 1.13×10^6J of energy is required to convert 0.5kg of steam to water, calculate the specific latent heat of vaporization of steam.

SOLUTION

$H = 1.13 \times 10^6 J$

$M = 0.5kg$

$L_v = ?$

$H = ML_V$

$L_V = {}^{H}/_{M}$

$L_V = {}^{1.13x106}/_{0.5} = 2.26 \times 10^6$ J/Kg

(2) A 30v electric heater is used to supply a current of 10A for 20minutes to a solid of mass 1kg. The body melts and rises through a temperature of 50^0c at an extra one minute. Determine the latent heat of fusion and specific heat capacity of the solid.

$V = 30_V$

$I = 10A$

$T = 20mins = 1200s$

$Mass = 1kg$

$\Delta\theta = 50^0C$

$C = ?$

$T_2 = \theta$, 1mins =60s

$T_2 = T_1 + T = 1200s$

Solution

(1) Ivt ml

$L_f = Ivt/m$

L_f = 10x30x1200/1 =3.6x105Jkg

(2) $Ivt_2 = ml + mc\,\theta$

10×30×1200 =1×3.6×10+1×c×50

=378000 -360000 =50c

50c =18000

C =18000/50 =360

∴C =360 J/kgk

EVAPORATION, BOILING AND SUBLIMATION

EVAPORATION can be defined as the process whereby a liquid turns spontaneous into vapour below its boiling point. It takes place at all temperatures.

FACTORS AFFECTING EVAPORATION

1. **Temperature**: Increase in temperature increases the rate of evaporation.

2. **Pressure:** The greater the pressure, the slower the rate of evaporation and vice versa.

3. **Wind and dryness of air:** The drier the air (i.e. the less water vapour it contains the faster the evaporation).

4. **Nature of liquid:** Liquids with low boiling points evaporate more rapidly than those with higher boiling points.

5. **Area of liquid exposed:** The greater the surface area, the faster the evaporation.

BOILING

Boiling is defined as the change from liquid to vapour when the saturation vapour pressures is equal to atmospheric pressure or it is the vaporization of the liquid throughout the entire molecule of the liquid. The temperature at which the liquid boils to become vapour is known as saturated temperature and the point is known as boiling point. Boiling point is affected by the following factors, impurities, pressure, mass of liquid, area of the surface exposed etc.

DIFFERENCE BETWEEN BOILING AND EVAPORATION

EVAPORATION	BOILING
1.It occurs at all temperature	It occurs at a particular point
2.It occurs at the surface of the liquid	It occurs at every part of the liquid
3.It causes cooling	It does not cause cooling
4.It is not affected by the mass of the liquid	It is affected by the mass of the liquid
5. It does not depend on the container	It depends on the Container because of their own energy.

SUBLIMATION

This is the process by which solid substance transform to gaseous State without passing through the liquid state e.g. ammonium chloride crystals

RELATIVE HUMIDITY AND DEW POINT

The amount of water vapour present in the atmosphere is called humidity. Relative humidity is the form use to described the amount of water vapour present in the air to the amount of water vapour needed to saturate the same volume of air at the same temperature.

Relative humidity

$$= \frac{\text{Mass of water vapour in a given volume of air}}{\text{Mass of water vapour required to saturate the same volume of air at the same temperature.}}$$

It is measured using hygrometer. It is expressed in percentage.
Relative humidity values are used by meteorologist in whether forecast.

DEW POINT: Dew point is the temperature at which the water vapour present in the air is just sufficient to saturate it.

Another way of defining relative humidity is therefore related to dew point.

$$\text{R. H} = \frac{\text{S.V.P at point}}{\text{S.V.P at air temperature.}} \times 100$$

Dew point is dependent upon prevalent atmospheric conditions like temperature, wind and the amount of water vapour present in the atmosphere.

WEEK 4:

TOPIC: GAS LAWS

KINETIC MOLECULAR THEORY OF GAS

The pressure of a gas enclosed within a container can be explained using kinetic theory of gases. The theory makes the following assumptions.

1. A gas is made up of huge number of molecules, which collide elastically with other molecules and with the walls of the container.

2. The gas molecules are in constant random motion and there are negligible intermolecular forces between the gas molecules.

3. The volume of the molecules of a gas is negligible when compared to the volume of the container.

BAROMETER IN PRACTICAL USE

The barometer is an instrument for measuring atmospheric pressure. There are two types of barometer in practical use. The fortin barometer and the Aneroid barometer

1. **The Fortin Barometer:** This type of barometer is used for measuring atmospheric pressure in the laboratory. It gives a more accurate reading than the simple barometer.

2. **The Aneroid Barometer:** This type of barometer contains no liquid and is therefore more convenient to carry about.

Atmospheric pressure decreases with height. So the aneroid barometer can be used as an altimeter to measure height of a place such an instrument is used in aeroplanes by pilots to know the height of the aeroplanes above sea level.

BOYLE'S LAW

Boyle's law state that the pressure of a fixed amount of gas is inversely proportional to the volume of the gas when the temperature is held constant.

Mathematically, $P \propto {}^{1}/_{V}$
$Pv = k$
Where 'P' and 'V' are pressure and the volume of gas respectively and k is a constant.

Boyle's law equation can be adopted to be
$P_1V_1 = P_2V_2$.
P_1 and V_1 are the pressure and volume of the gas in the initial state and P_2 and V_2 are the pressure and volume of the gas in the final state.

EXAMPLE (1) Air at a pressure of 760mmtlg is contained in a cylinder fitted with piston. The air is compressed by pushing the piston so that the some mass of our now occupies one-fifth of the original volume, without any change in temperature. Calculate the new pressure of the compressed air.

SOLUTION

$P_1 = 760$mmtlg
$V_1 = {}^{1}/_{5} V_1$
$P_2 =?$
$P_1 V_1 = P_2V_2$
$760 \text{ x} V_1 = P_2 \text{ x } \frac{V_1}{5}$
$P_2 = \frac{5 \text{x} 760 \text{x } \cancel{V_1}}{\cancel{V_1}} = 3800$mmtlg

CHARLE'S LAW

Charle's law states that the volume of a fixed mass of gas is directly Proportional to its absolute temperature, provided pressure is kept constant.

MATHEMATICALLY

$V \propto T$
$V = KT$
$K = {}^{V}/_{T}$

V and T are the volume and temperature of the gas respectively.
Charle's law equation can be adopted to be.

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

V_1 and T_1 are the volume and temperature of the gas in the initial state, and
V_2 and T_2 are the volume and temperature of the gas in the final state.

EXAMPLE

A fixed mass of a gas is heated at constant pressure from 10^0C. If its initial volume is $100cm^3$, calculate its volume when the temperature of the gas realize 50^0C.

$T_1 = 10 + 273 = 283K$

$T_2 = 50 + 273K = 323K$

$V_1 = 100cm_3$

$V_2 = ?$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

SOLUTION

$$V_2 = \frac{V_1 T_2}{T_1}$$

$$V_2 = \frac{100x323}{283}$$

$:.\ V_2 114cm^3$

PRESSURE LAW (GAY LUSSAL'S LAW)

Pressure law state that the pressure of a fixed mass of a gas is directly proportional to its absolute temperature provided the volume is kept constant mathematically.

$P \propto T$

$P = KT$

$P^1/T_1 = P^2/T_2.$

$P_1, P_2,$ T_1 and T_2 retain their usual meaning.

Eg: The pressure of a gas at constant volume registered 150cmHg at 0^0C
And 300cmHg at higher temperature, calculate the absolute temperature.

P1 =θ 150cmHg

P2 =300cmHg

T100C = 273K

T2 = ?

P1/ T1 = P2/T2

T2 = P2 T1/ T1

$$T2 = \frac{300 \times 273}{150}$$

:. T2 = 546K

GENERAL GAS LAW

The general gas law is derived from the three laws Boyle's law, Charles's law and pressure law.

Combining the three laws.

$$\frac{PV}{T} = K \text{ (general gas law).}$$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

The temperature of gas of volume $50cm^3$ is 32^0C at a pressure of 300mmHg.
Calculate the temperature when the volume is $80cm^3$ at a pressure of 360mmHg.

SOLUTION

$P_1 = 300mmHg$
$V_1 = 50cm^3$
$T_1 = 32^oC = 305K$
$P_2 = 360mmHg$
$V_2 = 80cm^3$
$T_2 = ?$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$T_2 = P_2V_2T_2/P_1V_1$

$$T_2 = \frac{360 X 80 X 305}{300 X 50} \quad :.\ T_2 = 585.6$$

WEEK 5:

TOPIC: PRODUCTION AND PROPAGATION OF WAVES:

WAVE

A wave is a disturbance in a medium which travels through a medium, transferring energy from one point to another without causing any permanent displacement of the medium itself.

Wave motion is the process of transferring a disturbance (in form of kinetic energy) from one point to another in a medium without any transfer of the particles of the medium.

Not all waves, however, requires a material medium for propagation. There are two types of wave which are, mechanical and electromagnetic waves

MECHANICAL WAVE

These are waves that required material medium for their propagation. Eg. Water waves, sound waves and wave on a rope or string.

ELECTROMAGNETIC WAVES

These are waves that do not required material medium for their propagation e.g. light wave, radio waves, X-rays, gamma –ray etc.

PULSATING SYSTEM

A pulse is a sudden increase in magnitude of a physical quantity, shortly followed by a rapid decrease. We can produce continuous water (wave) ripple or pulse to form a water wave by disturbing the water surface continuous it by throwing in stones a regular intervals. In the laboratory, water waves can be generated or produced and studied in a ripple tank

TERMS USED IN DESCRIBING WAVE.

(i) Amplitude (A): The maximum displacement of particles from their mean or rest position is called the amplitude, A, of the wave. It is measured in meters (m)

(ii) Period (T): This is the time taken by the wave to make one complete cycle or oscillation.
It is measured in seconds (s)

(iii) Frequency (F): The number of cycle or oscillation completed by the wave in one second is called frequency. The S.T Unit of frequency is Hertz (Hz).

IMHZ = 1000000Hz, 1KHz = 1000Hz.

(iv) Wave length (ʎ): The distance along the x – axis between successive crests or troughs is called wave length. It is the distance covered by the wave after one complete cycle. In longitudinal wave, the wave length is the distance between successive compression or rare factor.

(v). Velocity or speed of wave (v): The distance which the wave travels in one second is called the wave speed 'V'. It is measured in meter per second (m/s). If the wave covers "x" meters in "t" seconds, the speed or velocity of the wave is $V = {}^{x}/_{t}$ (m/s).

RELATIONSHIP BETWEEN T, F, λ AND V

From the definition of frequency (f) and period (T), It follows that the twoquantities are related by the equation i.e F = 1/T …….1

The speed "V" wave length,λ, and frequency, "F" are related by the equation.

$V = f\lambda$………..(2)

Combining equation (1) and (2) gives
$V = \lambda/_{T}$………3

EXAMPLE (1) A wave of frequency 400Hz in air has a velocity of 320mls. Find its wavelength, what will be the wavelength when it enters water in which its speed is 100mls.

SOLUTION

$V = F\lambda$. F = 400Hz, V = 320mls
$F = {}^{V}/\lambda$ λ=?
$320 = 400 \times \lambda$
$\lambda = 320/400 = {}^{4}/_{5} = 0.8$m
V = 1600mls
F = 400Hz
λ=?
$\lambda = {}^{V}/_{F} = 100/400 = 4$m

WEEK 6:

TOPIC: TYPES AND PROPERTY OF WAVES

Mechanical wave is a wave that requires material medium for its propagation. It is categories into transverse and longitudinal waves.

TRANSVERSE WAVE

A wave is said to be transverse if the direction of travel of the wave is perpendicular to the direction of the vibrating particles. Examples are water waves, light waves and waves produced in a rope or spring etc.

LONGITUDINAL WAVES

A wave is said to be a longitudinal if the direction of travel of the wave is parallel to the vibration of the medium. Examples are sound waves and waves produced by a stretched string.

DESCRIPTION OF A WAVE EQUATION

We can represent a wave mathematically by the equation Y = Asin ($^{20x}/\lambda$)

Y = Vertical displacement of vibrating Particle.

λ = Wavelength of wave

A = Amplitude of wave

X = horizontal coordinate of the vibrating particle from the origin.

The above equation gives the displacement of any particle at a distance x from the origin. The relationship gives a shape that repeats itself every wavelength. It is a sine wave form. The displacement of the particle t, seconds after is given by

$$Y = A\text{Sin}\,\frac{2\pi}{\lambda}(x - vt)$$

$$Y = A\text{Sin}\left(\frac{2\pi x}{\lambda} - wt\right)$$

$$Y = A\text{Sin}\left(\frac{2\pi x}{\lambda} - 2\pi ft\right)$$

2πf is known as the angular speed.

CALCULATION

A plane progressive wave is represented by the equation $Y = 3Sin(1000\pi t - 0.7x)$ where the symbols have their usual meaning. What is the amplitude, frequency, wavelength and velocity of the wave?

SOLUTION

$$Y = A\sin\left(\frac{2\pi x}{\lambda} - 2\pi ft\right)$$

$$Y = 3\text{Sin}\,(1000\pi t - 0.7x)$$

By method of comparism,

(i) A = 3m

Also, $2\cancel{\pi}ft = 1000\cancel{\pi}t$

2f = 1000

(ii) F = 500Hz

$$\frac{2\pi\cancel{x}}{\lambda} = 0.7\cancel{x}$$

(ii) $\lambda = 2\pi/0.7 = 8.98$m

(iv) V = f λ

=500 x 8.98

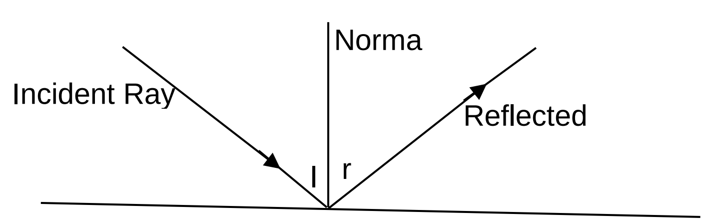
449.2mls.

A plane progressive wave is represented by the equation Y = 2Sin (200ṽt -0.5x)/ λ where the symbol has their usual meaning, what is the frequency of the wave, amplitude, wavelength and speed of the wave?

PROPERTIES OF WAVES

The properties of waves are reflection refraction, interference, diffraction and polarization.

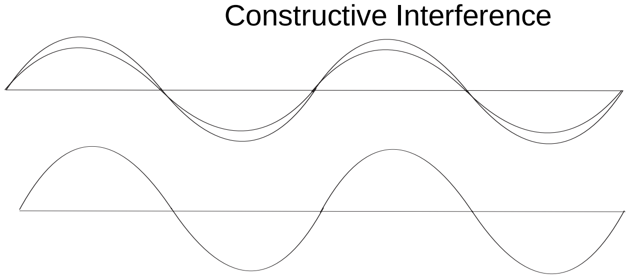
(i) **REFLECTION:** This is the bouncing back or re-propagation of light wave as it strikes a plane surface at an incident angle. Experiment shows that the angle of incidence is equal to angle reflection (r)



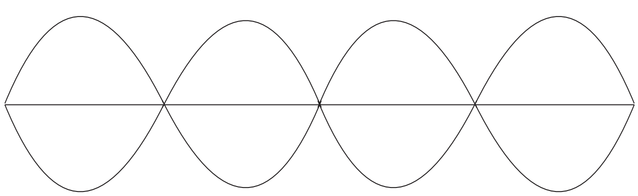
(ii) **INTERFERENCE:** This is the effect produced when two waves having the same frequency, amplitude and wavelength travelling in the same direction in a medium are superposed as they simultaneously pass through a given point. There are two types of interference namely constructive and destructive interference.

When the superposition of the two identical waves result in increased disturbance (i.e. they reinforce each other) it is known as constructive interference. When the resultant effect of the combination of two identical waves results in the annihilation or complete cancellation of the effect of each other (i.e. zero or minimum disturbance): It is called destructive interference. This occurs when path difference between the two identical waves at a point is $\Delta s = n\lambda + {}^{1}/_{2}\lambda$ where n = 0, 1, 2, ….

Constructive Interference

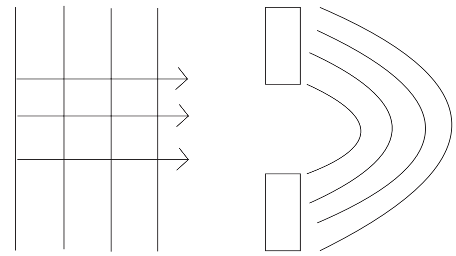


Increased Disturbance



Destructive Interference

(iii) **DIFFRACTION:** Diffraction is the ability of waves to bend around obstacles in their path. It occurs when the wavelength of the wave is longer than the width of the opening size of the obstacles.



(iv) **REFRACTION:** This is the change in the speed and direction of the waves as they cross the boundary between two media of different densities.

(v) **POLARIZATION:** Only transverse waves can be plane polarized. Polarization is a phenomenon whereby a wave that vibrate in one plane is produced.

Polarization occurs with light waves and other electromagnetic waves such as radio waves, x-ray, and infrared radiation but not with sound waves because it is a longitudinal wave.

WEEK 7:

TOPIC: LIGHT WAVE

DEFINITION OF LIGHT

Light is a form of energy called luminous energy and it is reflected outwardly from a source. It can also be defined as energy which causes the sensation of vision. Light is a
form of wave motion which is spread outwardly from a point. It is an electromagnetic
wave with the speed of $3x10^8$mls.

SOURCES AND TRANSMISSION OF LIGHT

There are various sources of light which are categorized into natural and artificial sources,

NATURAL SOURCES

These natural object that generate and emit light by themselves are said to be natural sources, Examples are sun, stars, fire flies.

ARTIFICIAL SOURCES

Those man – made object that generate and emit light on their own are said to be artificial source e.g. candle, electric torch, electric lamp, incandescent lights are lights, Fluorescence etc.

LUMINOUS AND NON-LUMINOUS OBJECT

Luminous objects are these objects that have the ability to generate and emit light on their own. All natural and artificial sources are said to be luminous source of light.

Non-luminous objects are objects that do not generate and emit light on their own but rather are seen by the light they reflect from luminous object. E.g. the sun's rays illuminate the moon and make it to appear luminous in the night, a round sign is seen at night because of the light it reflects from a car head lamp.

Light is transmitted or propagated in a straight line. This is known as rectilinear propagation of light. If large percentage of light passes through an object it falls, on the body is said to be transparent example are glass and water.

When small amount of light passes through on object it falls on the body is said to be translucent e.g. tissue paper, frosted paper and orated paper.

If light does not pass through the object it falls on, the object is said to be opaque e.g. wood, bricks, walls and metal sheet.

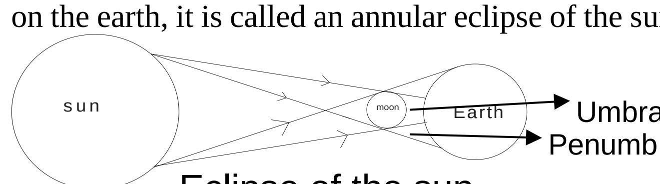
The travelling of light in a straight path is responsible for formation of shadow, eclipse and formation of inverted image in a pin-hole camera.

A shadow produced by a large source of light consists of umbra region (total darkness) and penumbra region (area of partial darkness).

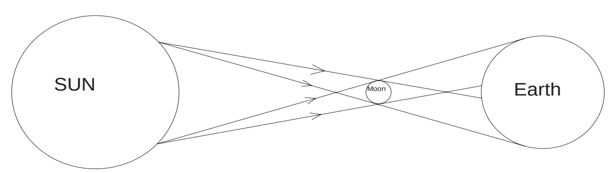
ECLIPSE AND PIN-HOLE CAMERA

An eclipse is formed as a result of shadow cast by one heavenly body to another. While the sun is a luminous object, the moon and the earth are non-luminous. The moon revolves round the earth and the earth also revolves round the sun.

At certain times, during these movements, the three bodies all lie in a straight line.
If the moon is between the sun and the earth, the shadow of the moon will be cast on the earth and this is called eclipse of the sun. But, if no shadow is cast on the earth, it is called an annular eclipse of the sun.

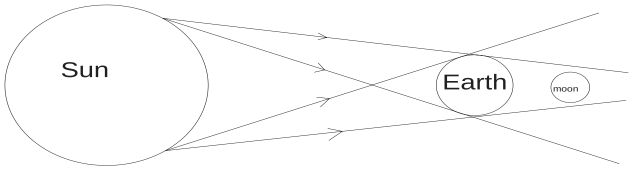


Eclipse of the sun



Annular Eclipse

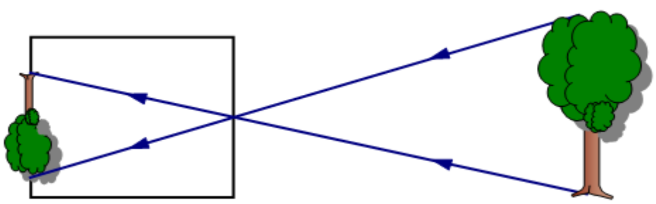
When the sun, the earth and the moon are in line during their movements, the earth being lying between the sun and the moon, the earth being opaque object casts a shadow on the moon and an eclipse of the moon or lunar eclipse occurs.



Eclipse of the Moon

PIN-HOLE CAMERA

The pin-hole camera makes use of the fact that light travels on a straight line. It consists of a light proof – box, one end of which has a small hole made with a pin or needle point.
The opposite end has a screen made of tracing paper or ground glass.
The light from an object in front of the pin-hole camera passes through it and forms an image of it on the screen. If the screen is replaced with a photographic paper or film, a picture of the object can be taken with the pin-hole camera.



Clear upside down (inverted) image with a small pinhole

The image formed by the pin-hold camera is inverted. The image formed on the screen of the pin-hole cameral will be seen more clearly if external light is excluded by covering head with a dark cloth.

From the above diagram.

$$\text{Magnification (m)} = \frac{\text{Size of image}}{\text{Size of object}} = \frac{\text{height of image}}{\text{height of object.}}$$

$$= \frac{\text{Distance of image from pin-hole camera}}{\text{Distance of object from the pin-hole}}$$

$$= \frac{\text{Length of camera}}{\text{Distance of object from pin-hole.}}$$

EXAMPLE: The height of object placed at a distance of 60cm from the pin-hole of pin hole camera is 15cm. If the length of the camera is 10cm, calculate the magnification produced by the camera and the height of the image.

SOLUTION

$$M = \frac{\text{Length of camera}}{\text{Distance of object from pin-hole}} = \frac{10}{60}$$

$$\text{Also, } M = \frac{\text{Length of image}}{\text{Height of object}} = \frac{h}{15}$$

$$10/60 = h/15$$

$$h = \frac{10 \times 15}{60} = 5/2 = 2.5\text{cm}$$

WEEK 8:

TOPIC: REFLECTION OF LIGHT ON PLANE AND CURVED SURFACES

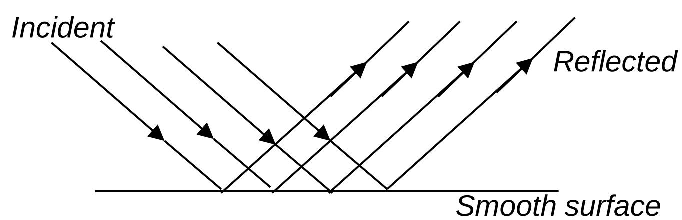
Reflection of light is the bouncing back of light waves when it meet on obstacle along it path of movement.

TYPES OF REFLECTION

There are two types of reflection, these are regular and irregular reflection.

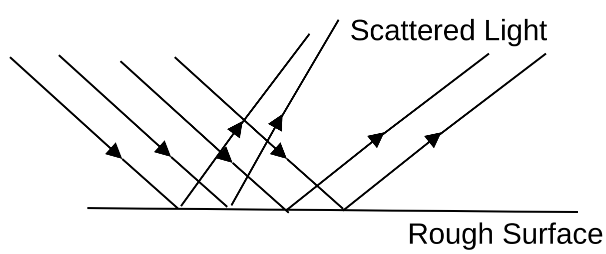
REGULAR REFLECTION

In regular reflection, parallel rays of light incident on a smooth or polished surface are reflected as parallel rays in one direction as shown in the diagram depicted below.



IRREGULAR (DIFFUSED OR SCATTERED) REFLECTION

In diffused or irregular reflection, parallel rays' light incident on a rough or irregular surface are reflected in various directions as shown in the diagram depicted below.



NB Smooth surfaces like mirror produced regular reflection while the page of a book or the table surface or cloth give irregular or scattered reflection.

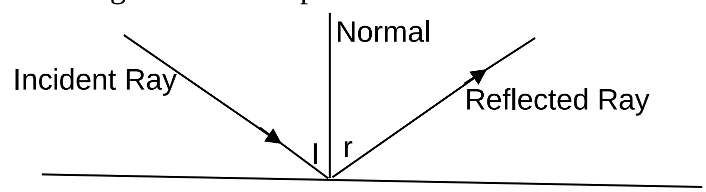
LAWS OF REFLECTION

There are two major laws; which are:-

(i) The first law states that incident ray, the reflected ray and the normal at the point of incident all lie in the same plane.

(ii) The angel of incident (i) is equal to the angel of reflection (r). That is $l^0 = r^0$

The diagram below explains the law.



NATURE AND CHARACHERISTICS OF IMAGES FORMED BY PLANE MIRROR

A virtual image is image that cannot be seen on a screen while a real image is one that can be formed on a screen.

The image formed by a plane mirror has the following characteristics.

(i). Same size as the object

(ii). As far behind the mirror as the object is in front.

(iii) Laterally inverted (i.e. object is perpendicularly opposite its image behind the mirror).

(iv)It is upright and virtual.

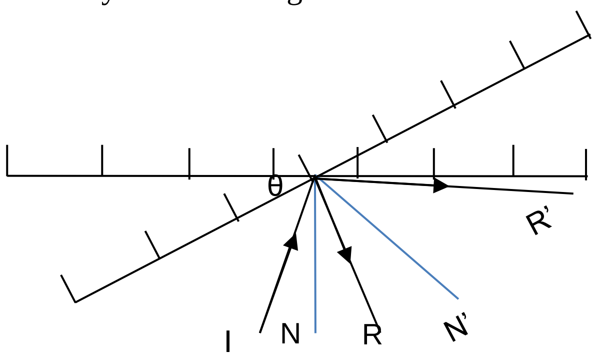
APPLICATION OF PLANE MIRROR

(i) It is used in simple periscope

(ii) It is used in kaleidoscope

EFFECT OF MIRROR ROTATION AND NUMBER OF IMAGESFORMED BY TWO INCLINED PLANE MIRROR.

When a mirror is rotated through an angelθ, the reflected ray rotates through 2Θ.



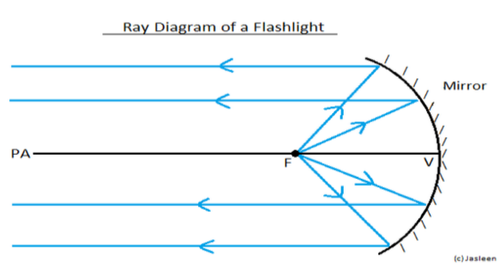
To calculate the number of images formed by two inclined plane mirror, use the formula

I.e. $N = \frac{360}{\theta} - 1$

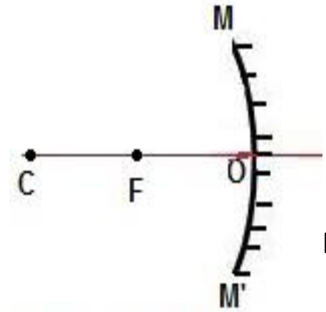
Where N is the number of images formed andθ is the angel between the two plane mirrors.

REFLECTION OF LIGHT ON CURVED SURFACE

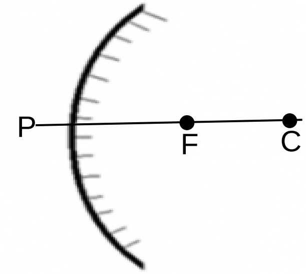
Curved mirrors are spherical mirrors, which are two types of curved mirrors namely the concave mirror and the convex mirror. A curved mirror is produced by coating a glass surface
which is part of the sphere. If the inside surface of the outside surface serves as a reflecting part, the resulting mirror is called a convex or diverging mirror but if the outside surface is coated while the inside surface serves as the reflecting part, the resulting mirror is to as a concave or converging mirror.



Concave Mirror



Concave mirror



Convex Mirror

PARTS OF A SPHERICAL MIRROR

(i) **THE POLE (P):** This is the midpoint or center of the mirror.

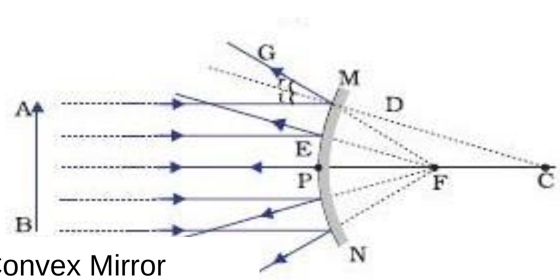
(ii) **THE APERTURE:** This is the width (APB) of the mirror.

(iii)**CENTRE OF CURVATURE (C):** This is the centre of the sphere of which the mirror is part of.

(iv)**THE RADIUS OF CURVATURE(R):** This is the distance CP which is the radius of the sphere of which the mirror is part.

(v) **PRINCIPAL AXIS:** This is an imaginary line drawn in such a way that it joins the pole to the centre of curvature (PC).

(vi)The principal focus (F) of a concave mirror is the point where all rays that are parallel and close to the principle axis converge after reflection while that of a convex mirror is the point where all rays parallel and close to the principle axis appears to diverge after reflection.



Convex Mirror

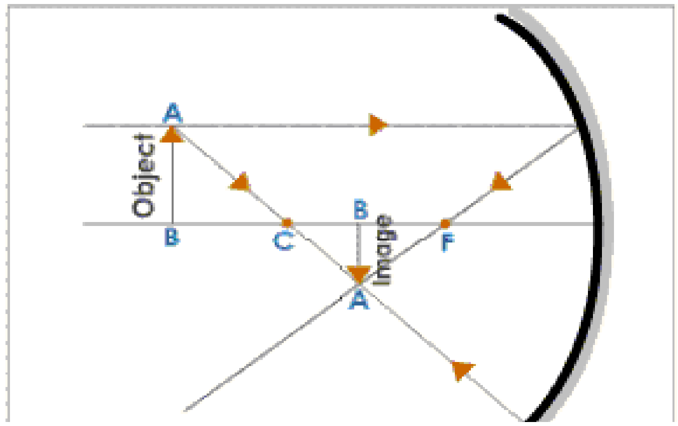
(vii) The focal length is (f) is the distance from the principal focus to the pole and has been found to be half the size of radius of curvature ie $F = {}^{r}/_{2}$

NATURE AND CHARACTERISTIC OF IMAGES FORMED BY SPHERICAL MIRROR.

CONCAVE MIRROR

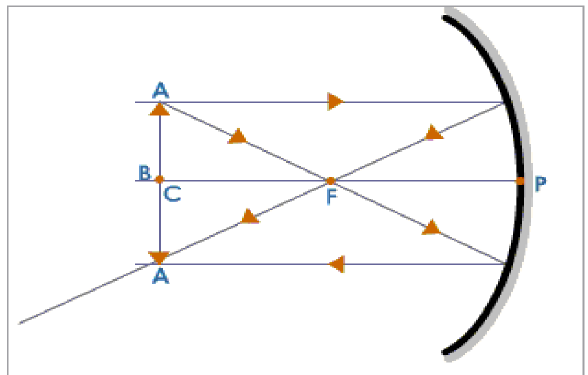
OBJECT BEYOND C.

(i) It is real
(ii) It is inverted
(iii) It is diminished
(iv) It is formed between C and F
(v)



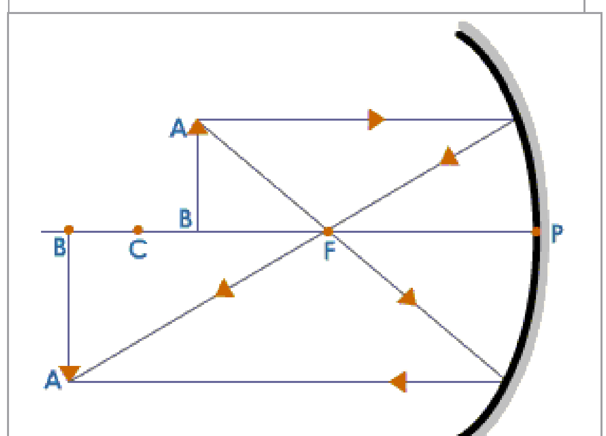
OBJECT AT C

(i) It is real
(ii) It is inverted
(iii) Same height a object
(iv) Same distance as object.



OBJECT IN BETWEEN C AND F

(i) It is real
(ii) It is inverted
(iii) It is magnified
(iv) It is formed beyond C



OBJECT AT F
Image is at infinite.

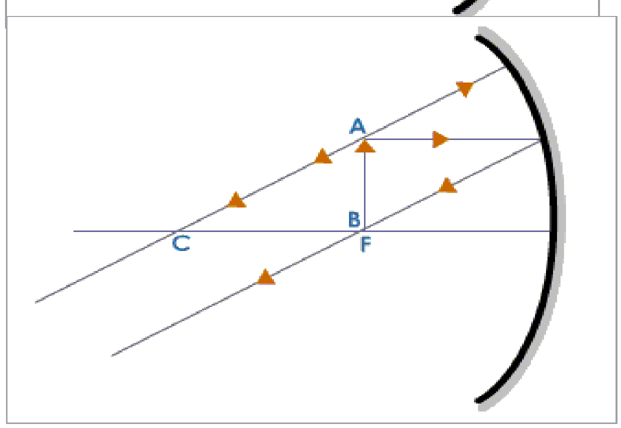
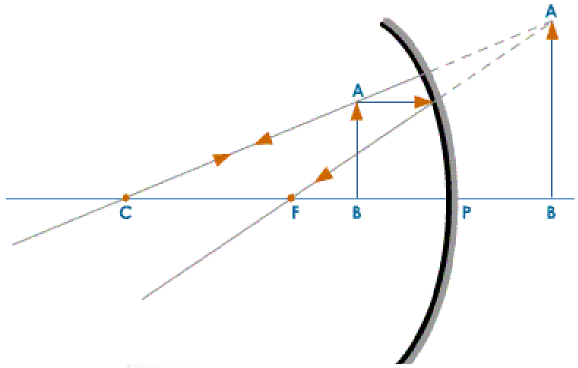


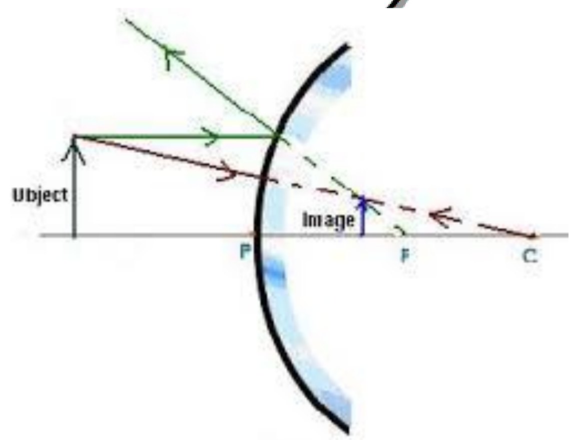
IMAGE BETWEEN F AND P

(i) It is magnified
(ii) It is upright
(iii) It is virtual



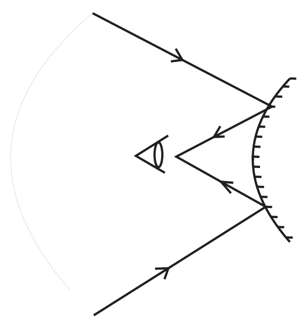
CONVEX MIRROR

(i) It is virtual
(ii) It is diminished
(iii) It is upright



Irrespective of the position of the object, the characteristics and nature of the image formed by a convex mirror remain the same.

NB: Convex mirror is used as a driving mirror because it gives a wider view but gives a false object distance.
Diagram



Parabolic mirror is used in a car head lamp with the position of the point light at the principal focus so that a parallel beam of light is produced by the parabolic mirror.

MIRROR FORMULA

$\frac{1}{F} = \frac{1}{u} + \frac{1}{v}$

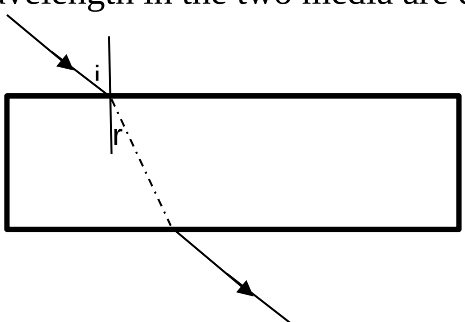
$M = {}^{V}/_{F} - 1$

$M = {}^{V}/_{U}$

WEEK 9/10

TOPIC:
LIGHT WAVE: REFLECTION OF LIGHT

Refraction can be defined as the bending of light rays as it crosses the boundary between two media of different densities, this causing a change in its direction.
The frequency of light in the two media remains the same but its velocities and wavelength in the two media are different.



LAWS OF REFRACTION

There are two laws of refraction, which are

(i) The law states that the incident ray, the refracted ray and the normal at the point of incidence all lie on the same plane.

(ii) The since ratio of angle of incidence to angle of refraction is a constant for a given pair of media. The second law is known as Snell's law i.e. Sin i /sin r = n
The constant 'n' is known as the refractive index of the second medium with respect to the first medium. It is a measure of the bending of light as fit travels from one medium to another.

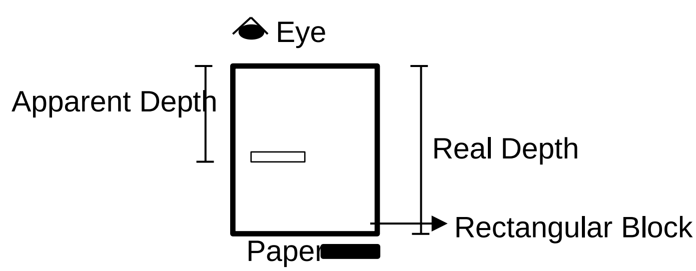
$$N = \frac{\text{velocity of light in medium 1}}{\text{Velocity of light in medium 2}}$$

If the angle of incidence is 28^0 in glass and the angle of refraction in air is 45^0, then the reflective index of air is $_gn_a$ = sin 28/ sin 45 = 0.6623

REAL DEPT AND APPARENT DEPT

The depth of a river or swimming pool appears shallower than it actually is. When a glass of block is placed on top of an object e.g. pin or a mark on a place of paper, the object when viewed from directly above, appears nearer the top. The apparent depth is caused by refraction. Theory shows that the real depth, the apparent depth and the reflective index are related by the formula

$$N = \frac{\text{Real depth}}{\text{Apparent depth}}$$



Effects of Refraction

(i) Swimming pools appears shallower when we look down into it than it actually lies.
(ii) A partially immersed straight stick dipped at an angle into water appears bent at the interface between the air and the water.
(iii) A coin in a bowl, invisible to an observer becomes visible when water is poured into the bowl.
(iv) Mirage.
(v) Total internal reflection.

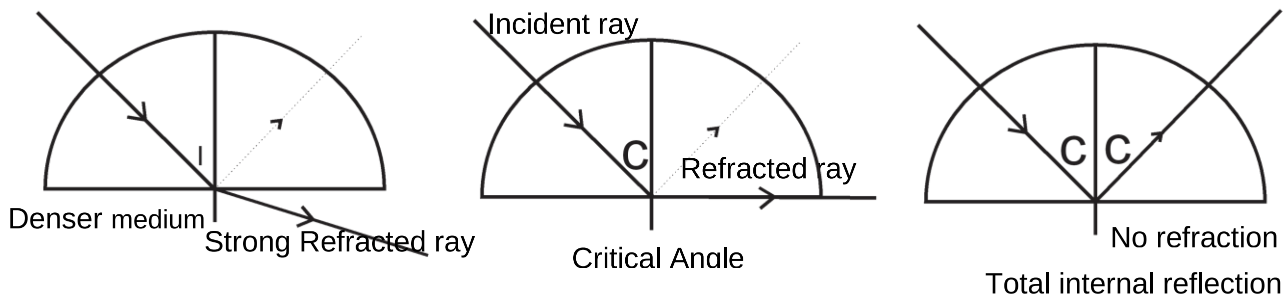
CRITICAL ANGLE AND TOTAL INTERNAL REFLECTION

When light is travelling from optically dense medium to optically less dense medium, a good number of the rays are reflected and small portion of the rays are reflected.

The angle of incidence in the denser medium at which the angle of refraction in the less dense medium is 90^o is called critical angle.

When critical angle in the denser medium is exceeded, the rays will no longer be refracted but reflected internally in the denser medium.

Total internal reflection is the reflection of light rays in a denser medium when light is travelling from a denser medium to a less dense medium when critical angle has been exceeded



CONDITIONS FOR TOTAL INTERNAL REFLECTION

(i) Light must be travelling from denser medium to less dense medium

(ii) Critical angle must be exceeded.

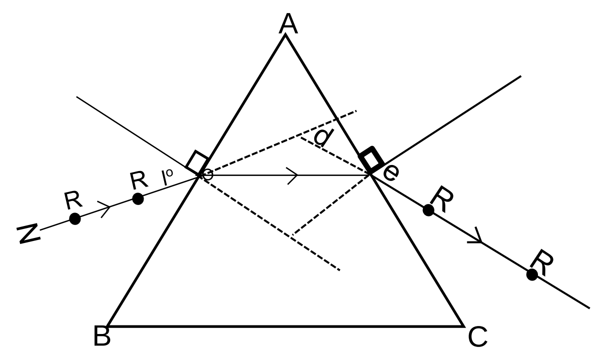
RELATIONSHIP BETWEEN CRITICAL ANGLE AND REFRACTIVE INDEX.

${}_an_g = 1/\mathrm{Sin}C$ for light travelling from air to glass.

MIRAGE

This is a phenomenon that occurs when light is travelling from a dense medium to a less dense medium. At a point, the light rays start travelling from the less dense medium to a denser medium and if it enters the eyes of an observer, the observer seems to have the impression that there is a pool of water in front of him.

REFRACTION: In Triangular Prism



i = Angle of incidence
r = Angle of refraction
e = Emergent angle
d = Angle of deviation
A = Angle of the prism

If we plot a graph of a angle of deviation against angle of incidence, the graph will show that there is an angle of incidence I_m for which the angle of deviation is minimum (d_m) and this is known as angle of minimum deviation.

At minimum deviation.

$$N = \frac{\sin \frac{1}{2} (d_m + A)}{\sin \frac{1}{2}(A)}$$

Graph of deviation against angel of incident.