(ii) Green house effect

(b) List down the effects of the global warming

(c) Suggest possible solutions for global warming

(d) Briefly explain how green house effect occurs in the glass house with plants.

Question 9

(a) Distinguish volcano from earthquake

(b) Give different feature which results from volcanicity

(c) Briefly explain the variation of temperature inside the earth

Question 10

(a) List down different layers of the earth

(b) Briefly explain why the inner core of the earth is solid while the outer core is liquid even though the temperature is higher?

(c) What is the main source of heat energy in the interior of the earth?

APPLICATION OF VECTORS

Question 1

(a) Scalar is a quantity that has only magnitude while vector is a quantity that has both magnitude and direction

(b) **Length** represents the magnitude while the **arrow** points in the direction of the vector

(c) (i) Parallelogram law (iii) Vector polygon
(ii) Triangular law (iv) Resolution of vector

Question 2

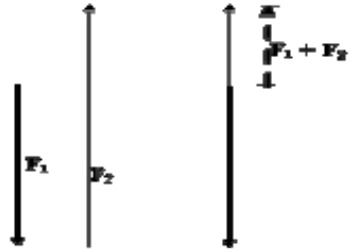
(a) (i) Relative velocity is the velocity of one body with reference to another. For two bodies A and B with velocities V_A and V_B respectively, the velocity of A relative to B is V_A-V_B velocity of B relative to A is V_B- V_A

(ii) Resultant velocity is a single velocity which represents more than one velocities

(iii) Equilibrant force is a force needed to put given forces in equilibrium

(b) Equilibrium of the body is the state of balance of a body under action of forces

(c) Let that F_1 be force due to South and F_2 be forces due North
Scale: 1cm:5N



Steps to follow

1. Choose the scale to suit the values given
2. Using the scale above draw each vector correctly. Figure (a) and (b)
3. Use any of the four methods to find the resultant (vector polygon in this case) i.e. Join the tail of one vector to the head of the other making sure that direction is conserved. Figure (c)
4. The closing line gives the resultant of the vectors given. Measure its length and use scale to translate the length into magnitude.

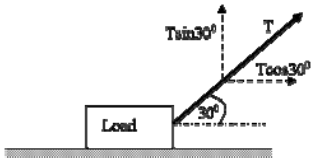
The resultant is 10N to the North.

Question 3

(a) A component of a vector is a magnitude of a vector in the direction of reference frame or interest

(b) Data:

F =200N, m = 25kg, $\theta = 30^0$, F_x=?, F_y=? a =?



(i) Horizontal component F_x=Tcos30
=200cos30
=200(0.866)
=173.2N

Vertical component F_Y = Tsin30
= 200(0.5)
= 100N

(ii) $F = ma$

$a = \frac{F}{m}$

$= \frac{173.2}{25}$

$= 6.93 m/s^2$

Assumptions

1. No friction force acts
2. No vertical motion of the body

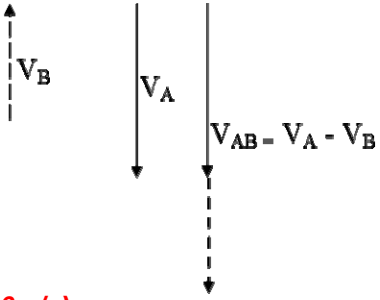
Question 4

(a) (i) Let V_A be velocity of a train (20m/s)

V_B be velocity of a car (-108km/h or -30m/s)

$V_{AB} = V_A - V_B$

Scale:1cm : 5m/s



The resultant is 50m/s to the north

(ii) $V_{AB} = V_A - V_B$

$= V_A + (-V_B)$

$= -30 + (-20)$

$= -50$m/s

(b) Let V_A be velocity of a person (10m/s)

V_B be velocity of a long car (20m/s)

V_C be velocity of the ground (V_C=0m/s)

(i) $V_{AC} = V_A - V_C$

$= (V_A + V_B) - V_C$

$= (20 + 10) - 0$

$= 30$m/s

(ii) $V_{AB} = V_A - V_B$

$= 20 - 10$

GEOPHYSICS

Question 1

(a) List down and explain different layers of the earth

(b) Give brief explanation on the following

(i) Gutenberg discontinuity

(ii) Mohorovicic discontinuity

(c) What are tectonic plates?

Question 2

(a) State the importance of different layers of the earth

(b) Briefly explain what is a volcano and how does it occur

Question 3

(a) List down different types of volcanoes

(b) List down effects of volcanoes

Question 4

(a) How does volcano differ from earthquake?

(b) What are the indicators of the earth quake occurance?

(c) Name the instrument for measuring earth quake and unit in which it is expressed

Question 5

(a) List down precaution against the earth quake hazards

(b) What are the possible hazards of the earth quake?

Question 6

(a) List down different earthquake warning sign

(b) Give the meaning of the following terms

(i) Focus

(ii) Epicentre

(iii) Epicentral distance

(c) Give two units in which earthquake is usually expressed

Question 7

(a) What is meant by atmosphere?

(b) List down different layers of the atmosphere

(c) List down importance of the atmosphere

Question 8

(a) Give the meaning of the following terms

(i) Global warming

(a)Give the meaning of the following terms
(i) Parking orbits
(ii) Speed of escape OR escape velocity
(iii) Gravitational force
(b) What are the causes of ocean tides?
(c) Give different types of ocean tides

Question 8
Match the items in list A against the corresponding one from the list B

List A	List B
(i) The region nearest the earth of which most weather phenomena occur	A. Stratosphere
(ii) The layer in which the ozone layer is found	B. Atmosphere
(iii) The boundary which separates troposphere and stratosphere	C. Ionosphere
(iv) The region found in exosphere where satellites orbit the earth	D. Stratopause
(v) The boundary which separates stratosphere and other layes	E. Magnetosphere
(vi) The outermost region of the atmosphere	F. Troposphere
(vii) The layer which is also known as the upper atmosphere	G. Exosphere
(viii) The collective name given to troposphere and stratosphere	H. Thermosphere
(ix) The layer just above the stratosphere in which most meteors burn while entering the earth's atmosphere	I. Hydrosphere
(x) The layer of gases containing numerous small suspended solid and liquid particles that surrounds the earth.	J. Lithosphere
	K. Mesopause
	L. Mesosphere
	M. Lower atmosphere
	N. Tropopause

Question 9

Question 10

= 10m/s

(iii) $V_{AC} = (V_A + V_B) - V_C$

= (-10 +20)-0

= 10m/s

(c) Let V_M be the velocity of the man

V_I be the velocity of the image

V_R be the velocity of the mirror

V_M= 50m/s, V_I= -50m/s V_R= 0m/s

Velocity of man relative to his image $V_{MI} = V_M - V_I$

= 50 – (-50)

= 100m/s

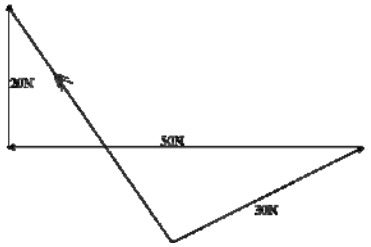
Velocity of man relative to the mirror V_{MR}= 50 – 0

= 50m/s

Question 5

(a) (i) Using Vector polygon method

Hints

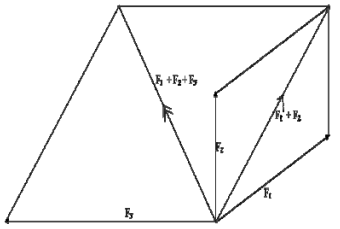


- Select suitable scale say 1cm:5N
- Begin with one known vector say 30N followed by 50N and finally 20N
- The closing line is the resultant, measures its length and determine its magnitude.

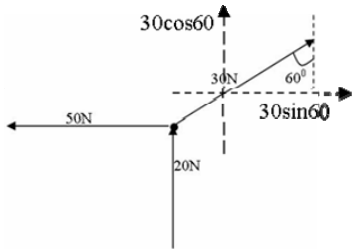
(ii) Using parallelogram law

Hints

- Begin with two known vectors to construct a parallelogram say 30N and 20N
- Draw the diagonal from their common point to mark their resultant
- From the common point, draw the remaining force i.e.50N (horizontally) complete the parallelogram
- Measure the length of the new diagonal to determine the resultant.



(iii) Using resolution method



Hints

- Resolve all the forces that are neither horizontal nor vertical
- Sum all vectors in horizontal direction and vertical direction
- Determine the resultant of the forces by applying Pythagoras theorem

Sum of forces in horizontal direction

F_x = -50 +30sin60

= -50 + 26

= -24N

Sum of forces in vertical direction

F_Y = 20 + 30cos60

= 20 + 15

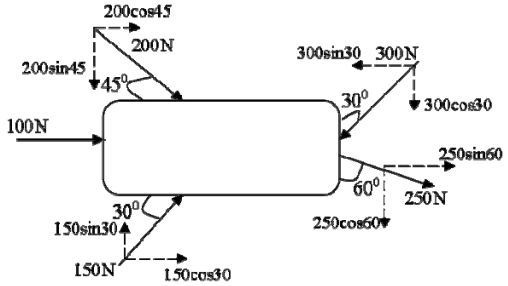
=35N

The resultant F = $\sqrt{(-24)^2+(35)^2}$

=

(iv) Triangle rule is not applicable here!

(b)



Sum of forces in horizontal direction

F_x =100 + 200cos45 – 300sin30 +250sin60 +150cos30

Sum of forces in vertical direction

F_Y = 150sin30 -200sin45 -300cos30 -250cos60

Question 6

(a) (i) Parallelogram law

ELEMENTARY ASTRONOMY

Question 1

(a) Define the terms (i) astronomy (ii) constellation (iii) galaxy

(b) What are the importance of astronomy to our daily life?

(c) Giving examples, explain that it meant by planet

Question 2

(a) What are the uses of constellation?

(b) Explain two of the theories involved in astronomy

(c) What does it mean by the term “solar system”

Question 3

(a) What are the following

(i) Meteorites

(ii) Comets

(iii) asteroids

(b) What is the meaning of the term gravitation

(c) Briefly describe the features and structure of the moon

Question 4

(a) Describe the meaning and the cause of the ocean tides

(b) Name and describe the galaxy to which the solar system belongs

(c) Briefly explain why it is possible for planet satellite to stay in motion about their planets

Question 5

(a) Give the meaning of the following

(i) Zodiacal light

(ii) Morning star

(iii) Evening star

(b) Give the meaning of the following

(ii) Jovial planet

(iii) Terrestrial planet

(iv) Milky way

(c) Briefly explain how astronomy gave rise to the 12 months of the year

Question 6

(a) How are the bodies in the solar system kept in their positions?

(b) What are the satellites?

(c) Give different uses of satellites

Question 7

(b) Amplifier is an electronic device or system that enlarges a given signal

Thermistor is a device whose resistance decreases with increase in temperature

(c) (i) When K is switched on lamp L_2 lights while L_1 does not light

(ii)The resistor 1000Ω controls the current that flow through the base

(iii) When switch K is open the base current is zero and hence collector current becomes zero too and L_2 does not light

"If two vectors are represented by adjacent sides of a parallelogram, their resultant is represented by the diagonal drawn from their common point"

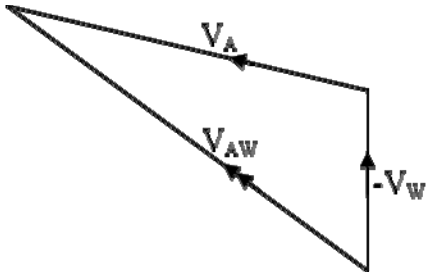
(ii) Triangular law

"If three forces acting at a point are in equilibrium, they can be represented in both magnitude and direction by the three sides of a triangle taken in order"

(b) Let V_A be velocity of aircraft relative to ground

V_w be velocity of wind relative to ground

Using vector polygon,



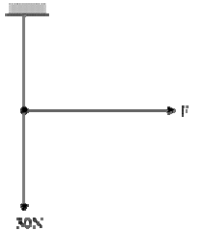
Hint

- $V_{AW}=V_A + (-V_W)$
- *-From V_W reverse the direction to obtain $-V_W$*
- *Use vector polygon for V_{AW}*
- *-The closing line from the tail of $-V_W$ to the head of V_A is the velocity of aircraft relative to wind*

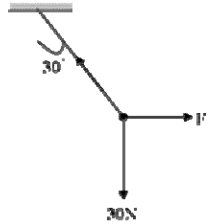
Answer

The velocity of aircraft is 160kph at 68^0

(c)



Before pulling

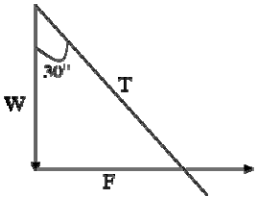


After pulling horizontally

Since the three forces are in equilibrium, we can use triangular law.

Hints:

1. *Choose the scale to be used i.e. 1cm:5N*
2. *Begin by representing a known vector i.e. 30N vertically down ward for weight*
3. *From the end of the line for weight draw a horizontal line to represent direction of the horizontal force applied*
4. *From the tail of the 30N vector measure 300 and draw to represent tension in the string*
5. *The intersection of (3) and (4) maps the third vertex of a triangle*



From the diagram, the horizontal force is ……N and the tension in the string is ,,,,,,,N

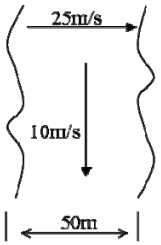
(b) Using resolution method

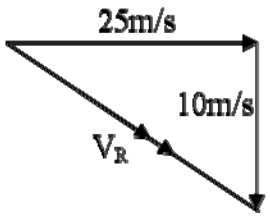
Question 7

Hint

1. *Choose the appropriate scale say 1cm : 4N*
2. *Apply parallelogram law Or vector polygon (vector polygon for my case here)*
3. *Complete the polygon to obtain the length of the diagonal*

(a) (i) By applying vector polygon





The resultant is …….m/s

$$s = ut$$

$$t = \frac{s}{u}$$

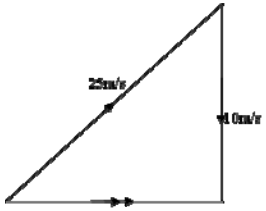
$$= \frac{50}{25}$$

= 2seconds

(ii) If he want to emerge just at the point opposite to him,

$$Tan\ \theta = \frac{10}{25}$$

$$\theta = \tan^{-1}\left(\frac{2}{5}\right)$$

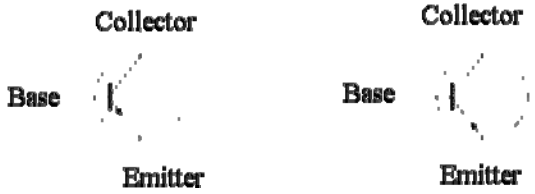


The boat must head at towards upstream

Question 8

(a) A transistor is a three terminal electrical component that can amplify current or voltage. Different types of a transistor are bipolar junction transistor and field effect diode. Bipolar junction diode is further divided into NPN and PNP transistors.

(b)



(c) Common emitter, common base and common collector

Question 9

(a) A transducer is an electrical device which converts one form of energy into electrical energy or viceversa. Examples are microphone, heater, bulb etc

(b) (i) N- type semi conductors possesses electrons as its major carrier. When heated, most of electrons become energetic and move into conduction band and hence it become more conducting

(ii)The hot end become positively charged and cold end become negatively charged.

(c) The ability of diode to conduct in one direction makes it capable of making rectification of alternating current.

Question 10

(a) Different uses of transistor includes

1. Its uses as voltage amplifier
2. Its uses in switching circuits
3. Its use in oscillator circuits

(b) (i) Common emitter because emitter is common to both collector and base

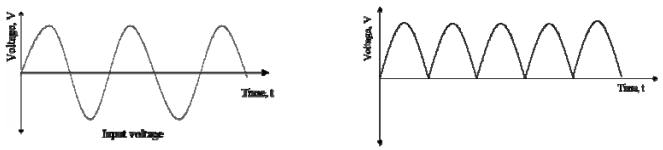
(ii) Capacitor C_1 blocks any direct current in the input signal. Capacitor C_2 blocks direct current so that the output is purely an alternating current.

Question 11

(a) A digital signal is an electronic information that have two values; a low and high only

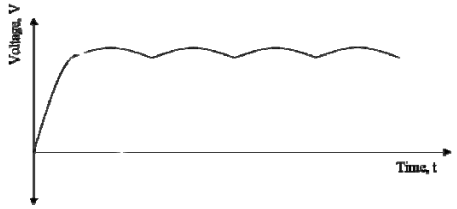
An analogue signal is an electronic information that can have any value between low and high

2. Full wave rectification



Question 7

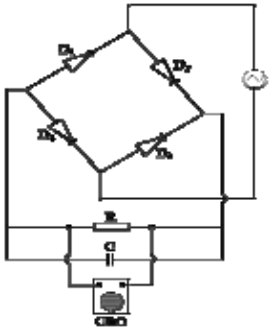
(a) Capacitor help in smoothening of rectified current



(b) Types of diodes

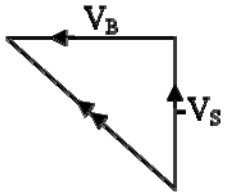
1. Light emitting diode
2. Junction diode
3. zener diode

(c) A full wave rectifier (Rectifier bridge)

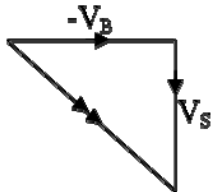


It consists of four diodes arranged as shown in the diagram above. When current of the source is flowing in clockwise direction, it passes through diode D_3 through the resistor, in D_1 back to the source. When it reverses direction it then flows through D_2 to the resistor, D_4 and back to the source. In both cases the current flows in the same direction when flowing in the resistor.

(b) (i) 50kph



(ii) 50kph



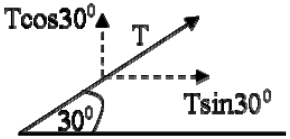
Question 8

(a) (i) Possible

(ii) Not possible, the resultant should never be higher than the sum of the two vectors

(iii) Possible

(b) (i)



Horizontal component = Tcos30

= 800cos30

= 800(0.866)

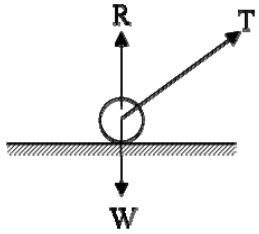
=

Vertical component = Tsin30

= 800(0.5)

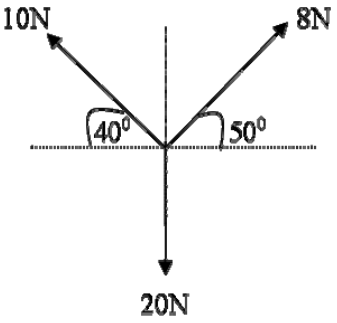
= 400N

(ii) Other forces acting are weight of the tree trunk and reaction force of the weight.



Question 9

(a)



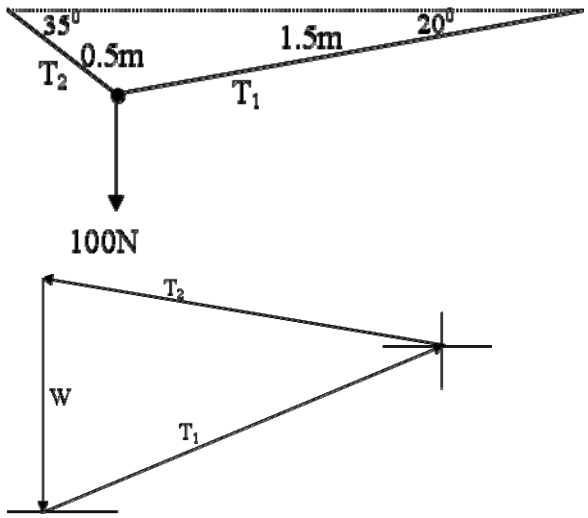
Forces in x- direction

$F_x = 8\cos 50 - 10\cos 40$

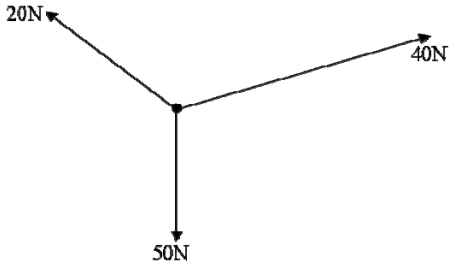
Forces in y – direction

$F_y = 10\sin 40 + 8\sin 50 - 20$

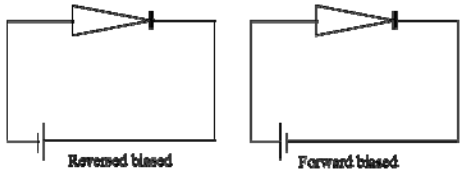
(b)



Question 10



positive terminal of a battery and cathode is connected to a negative terminal of the battery



The reverse biased is the connection in which the diode does not conduct. The anode of the diode is connected to the negative terminal of the batter and the cathode is connected to positive terminal of the cell.

(c) Advantages

1. They are cheap
2. They can be made much smaller and more resistant to damage from impact
3. Do not need heating to energize them
4. Uses small potential voltage to operate

Disadvantages

1. They suffer breakdown if the temperature becomes too high
2. May be permanently damaged when wrongly connected to a battery.

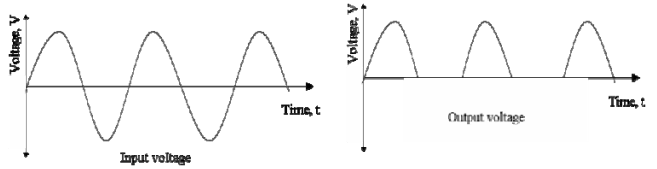
Question 6

(a) The diode in (i) is forward biased while that in (ii) is reverse biased. In forward biased the diode conducts while does not in reverse biased. When switch K is closed, the lamp in (i) will light on while the lamp in (ii) will not light on.

(b) Rectification is the process of converting alternating current into direct current

(c) Two types of rectification are

1. Half wave rectification

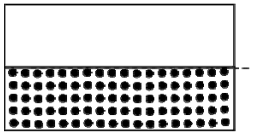


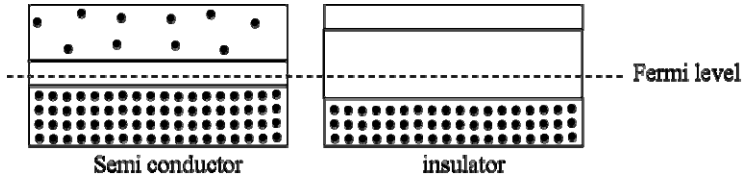
N- type semiconductor is the extrinsic semiconductor in which electrons are major charge career.

Question 4

(a) (i) Fermi level is the maximum region that can be occupied by an electron in the valence band at absolute zero temperature

(ii) Energy levels for conductor, semiconductor and insulators





(b) (i) Dopant is the impurity added to intrinsic semiconductor to improve its conduction. They must be pentavalent or trivalent element such as aluminium, or phosphorus

(ii) Donor impurity is an atom or element that donates and electron to an intrinsic semiconductor to improve its conductivity. It is an atom or element of group V of a periodic table e.g. Phosphorus

(iii) Acceptor impurity is an atom which provides a hole that can be occupied by an electron of an intrinsic atom. It is an atom of a group III of a periodic table e.g. Aluminium.

Question 5

(a) A diode is a device which allows current to flow in only one direction. Different uses of diodes are such as

1. Used in rectifier circuits
2. Used in light emitting components of different devices or circuits e.g calculator display, indicator lamps etc
3. Used as battery eliminator in radio circuits
4. Used as equipment protector against wrong polarity of battery

(b) Forward biased of a diode is the connection that allows conduction of electricity. In this connection, the anode of a diode is connected to

FRICTION FORCE

Question 1

(a) Friction is the force which opposes motion of one body over another

OR

Friction force is the force which opposes relative motion between two bodies in contact.

(b) (i) A shoe sole is not smooth to ensure that there is large friction force between the shoe and the ground. Friction helps in walking

(ii) Threads are provided to the car tyre to increase friction force between the tyre and the ground especially during break application or when making a corner.

(iii) A worn out tyre is smooth and hence would result into slipping which is unfavourable to car motion and when the car makes a corner it can slide and bring danger to both car and the passengers.

(c) (i) Static friction is the friction force between bodies when are not moving relatively over one another.

(ii) Dynamic friction is the friction force between bodies in contact when moving relative to one another. It is also called kinetic friction force

(iii) Limiting friction is the friction force between two bodies in contact when they are about to move relative to one another.

Question 2

(a) Factors which determines the magnitude of friction are

1. Roughness of the surfaces
2. Normal reaction

(b) Laws of friction

1. Friction force depends on the roughness of the surfaces in contact
2. Friction force is directly proportional to the normal reaction between the two surfaces in contact.
3. Friction force does not depend on area of contact between the surfaces.
4. Friction force does not depend on the velocity of the bodies in contact.

(c) Coefficient of friction is the ratio of the friction force to the normal reaction

$$F_f = \mu R$$

$$\mu = \frac{F_f}{R}$$

Question 3

(a) Coefficient of friction ranges between 0 and 1

(b) Advantages of friction force

- Friction force helps in walking
- Friction force helps when igniting or lighting a match box
- Friction force helps when sharpening a knife, spear etc
- Friction force helps in generating heat by rubbing one body against the other
- Friction force helps the tyre to remain on the ground when the car is moving
- Friction force helps to stop the car when brakes are applied.

Disadvantages of friction force

- Friction causes wear and tear to materials e.g. sole of the shoe, machine parts, brakes rubber of the bicycle etc
- Friction force produces undesirable noise in industries
- Friction force causes slowing down of motion of bodies e.g. simple pendulum, falling sphere in liquids etc
- Friction force produces heat which may be dangerous to some cases

(c) Friction force always act in direction opposite to direction of the motion.

Question 4

(a) Data

m =25kg, g = 10m/s^2

$W = mg$

= 25(10)

= 250N

but R = W

$F_f = \mu R$

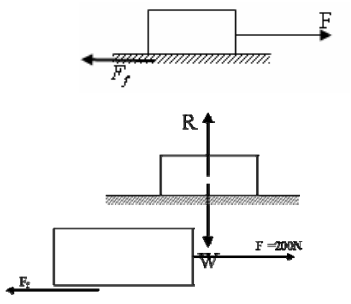
= 0.2(250)

= 50N

F = 200 N – 50 N

= 150N

$F = ma$



ELECTRONICS

Question 1

(a) (i) Electronics is the branch of science dealing with …….

(ii) Energy levels of an atom are region in an atom that can be occupied by electrons

(b) (i) Conductors are materials in which conduction band and valence band overlaps or separated by a very thin forbidden gap OR Conductors are materials that allow heat and electricity to pass through

(ii) Semiconductors are materials with full filled valence band and empty conduction bands separated by narrow forbidden gap. At low temperature they do not conduct electricity but at ordinary temperature they conduct

(iii) Insulators are materials in which valence band is full filled and the conduction band is empty. The two bands are separated by very wide forbidden gap that makes it not conductor even at ordinary temperature.

Question 2

(a) (i) Valence band is the region of lowest energy that is completely filled with electrons

(ii) Conduction band is the region of higher energy level in which electrons responsible for conduction occupies

(iii) Forbidden energy gap is the region between valence band and conduction band which never occupied by electrons

(b) Intrinsic semiconductor is the pure semiconductors in which conduction depends on electrons in conduction band while extrinsic semiconductors is a semiconductor in which conduction depends on the impurity atom introduced into it.

Question 3

(a) Dopping is the special process by which small amount of impurities is introduced into a pure semiconductor. The process results into production of N- type and P- type semiconductors

(b) The conduction of a semiconductor can be improved by

1. Increasing its temperature
2. Doping it with donor or receptor atom

(c) P- type semiconductor is the extrinsic semiconductor in which holes are major charge carrier

2. They are not deflected by magnetic or electric fields
3. They ionize gases
4. They can be diffracted.
5. They readily penetrate the matter
6. They cause fluorescence in certain materials

Question 7

(a) They were called so because at that time they were not identified

(b) Uses of cathode ray oscilloscope

(i) Used to compare frequency of different signals
(ii) Used to measure potential difference
(iii) Used as a clock to measure time interval
(iv) Used to display wave form of different signals.

(c) 1. Cathode ray Oscilloscope 2. Television screen 3. Computer monitor

Question 8

(a) (i) Work function is the minimum energy needed to remove an electron fro the surface of hot metal
(ii) is the positive potential applied to the anode of the cathode ray tube so as to give motion to an electron
(iii) Cathode is the metal that is given negative potential
(iv) Anode is the metal that is given positive potential

(b) Cathode emits electrons or cathode rays

(c) The nature of the metal , temperature of the surface of the metal and the surface area of the metal

Question 9

(a) Requires small energy to eject electron from their surface

(b) Hight melting point and low work function)

(c) A cathode ray tube is evacuated to ensure that generated electrons do not make any impact with anything including air molecules as this would obstract their motion and also ionization to the gas molecules if were there.

Question 10

LIST A	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)
LIST B	J	Y	A	C	G	E	M		F	D

$$a = \frac{F}{m}$$

$$a = \frac{150}{25}$$

$= 6 m/s^2$

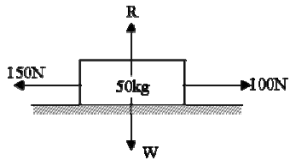
(b) Data

m = 50kg g =10m/s^2, F1=100N, F2=150N, μ =0.15

R = mg
R= 50(10)
=500N

$F_f = \mu R$

= 0.15(500)
= 75N



Net applied force acting = 150 – 100
= 50N

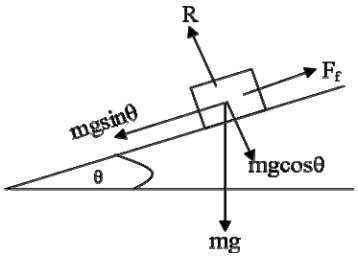
Since net applied force is less than friction force, the block will not move.

Question 5

(a) Methods that reduces friction

(i) Application of lubricants such as oil, grease etc
(ii) Application of ball bearings between moving parts
(iii)Application of rollers
(iv) By smoothening the surfaces in contact

(b) When the block is resting on the wood, the friction force depends on the degree of the roughness and the normal reaction. As the wood is lifted in one side there is a component of the weight of the block which acts down the plane. The magnitude of this components depends on the angle of inclination θ. At a particular value of the angle W$\sin\theta$ becomes equals the friction force $\mu W\cos\theta$ .At this point the block will just begin to move down the wood.



(c) Data: m =2kg, θ = 25^0

$F_f = \mu mg\cos\theta$

Force acting along the plane as the block just begins to slide, $F = mg\sin\theta$ .Hence, for the block just to start moving;

$$\mu mg\cos\theta = mg\sin\theta$$

$$\mu = \tan\theta$$

$$\mu = \tan 25$$

= 0.47

Question 6

(a) Data

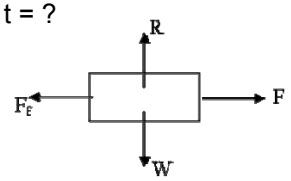
m =50kg, $\mu = 0.3$ F=300N, s = 54m, t = ?

$F_f = \mu R$

$= \mu mg$

=0.3(50)10

=150N



Net force, = applied force – Friction force

Net force = $F - F_f$

= 300 - 150

= 150N

The block can be moved, since the applied force exceeds the friction force

Net force = ma

$$a = \frac{Net\ \ force}{m}$$

$$= \frac{150}{50}$$

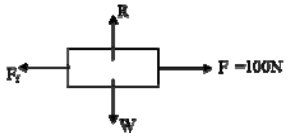
$=3m/s^2$

$$s = ut + \frac{1}{2}at^2$$

$$54 = 0 + \frac{1}{2}(3)t^2$$

$$t^2 = \frac{108}{3}$$

$t = 6$ seconds



(b) Soft X- rays are less penetrating X- rays with long wavelength produced when low voltage is applied to an X- ray tube which is a high evacuated voltage diode valve

Hard X- rays are more penetrating X- rays with short wavelength produced when high voltage is applied to an X- ray tube.

Question 5

(a) (i) Low voltage provides low speed to cathode rays so that low penetrating “soft X- rays” are produced

(ii) High voltage provides high speed to cathode rays so that very penetrating “hard” X- rays are produced

(iii) Tangsten target produces X- rays when hit by fast moving cathode rays

(b) (i) Cathode ray tube are evacuated so that the inside pressure is reduced to zero to enable cathode rays propagates easily. If not evacuated, cathode rays would be deflected away by molecules of air and would not be able to strike the screen properly.

(ii) With gas maintained in CRT, cathode rays would collide with gas molecules and hence deflected. Moreover, with gas maintained the CRT will behave as an open circuit ; with application of large enough potential difference, the gas will ionize and hence conduct producing a spark.

(iii) With gas maintained no image will be formed on the screen since the cathode rays will not reach the screen.

Question 6

(a) During the production of X- rays, there is generation of large amount of heat energy. The anode is therefore made of copper which is a good conductor of heat so that large amount of heat generated is conducted and dissipated to the surrounding.

(b) Uses of X- rays

1. X- rays are used in medicine to inspect teeth and broken or fractured bones etc
2. With great care X- rays can be used to kill cancer cells
3. In industries, X- rays are used to inspect metal casting and welded joints for hidden faults
4. In science, photographs of X- rays diffracted by crystals gives information on how atoms are arranged in difference substance
5. In airports and seaports X- rays are used for non invasive security searches.

(c) Properties of X- rays

1. They affect a photographic plate or film

Question 3

(a) 1.5 cycles takes 0.003 seconds

1 cycle takes = $\frac{0.003}{1.5}$

$= \frac{3 \times 10^{-3}}{1.5}$

= 2 x 10^{-3} seconds (this is period)

Frequency, f = $\frac{1}{T}$

$= \frac{1}{2 \times 10^{-3}}$

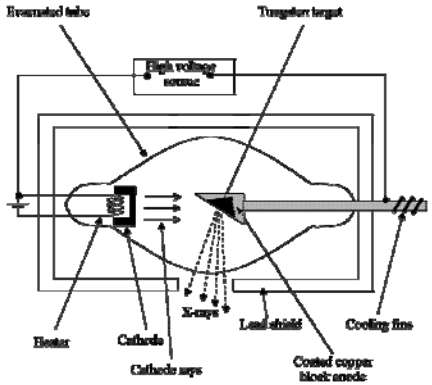
= 500Hz

(b) Cathode rays are particles carrying negative charge while electromagnetic waves are not particles and not charged

(c) Thermionic emission emit electrons. When heat is applied to the metal electrons absorbs thermal energy and if the energy absorbed is sufficiently enough for electrons to break through the surface of metal the electrons leaves.

Question 4

(a) To produce X- rays a tungsten target in evacuated tube is hit by fast moving cathode rays. During this process some kinetic energy of cathode rays are converted into X-radiations and most of the kinetic energy is converted into heat which is conducted away.



(b) Data: F=100N, m =20kg

$F_f = \mu mg$

= 0.15(200)

= 30N

$F_n = F - F_f$

$F_n = 100 - 30$

=70N

$a = \frac{F_n}{m}$

$= \frac{70N}{20kg}$

= 3.5m/s^2

Question 7

Data: m= 20kg, F=300N, $\theta = 30^0$ μ = 0.6

Without considering friction force

$F = 300 - W \sin 30^0$

$= 300 - 20(0.5)$

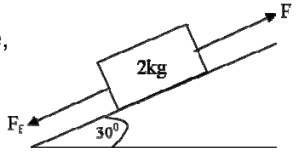
=290N

The net force acts up the plane and hence friction force must act down the plane.

$F_n = F - F_f$

= 290 - F_f

but $F_f = 0.6(200) = 120N$ hence,



F_n = 290 – 120N

= 170N

$a = \frac{F_n}{m}$

$= \frac{170}{20}$

= 8.5m/s^2

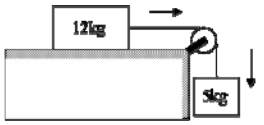
(b) The friction force exerted by the liquid is called **viscosity**

Question 8

$F_f = \mu mg$

$F_f = 0.2(120)$

= 24N



$T - F_f = ma$

T-24 =12a .....(i)

Also

$50 - T = 5a$ ....(ii)

Solving (i) and (ii)

$50 - T = 5a$

$-24 + T = 12a$

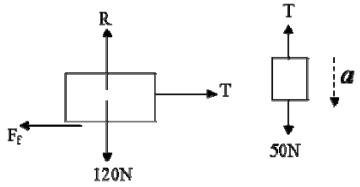
$26 = 17a$

$a = \frac{26}{17}$

=1.5m/s^2

$50 - T = 5(1.5)$

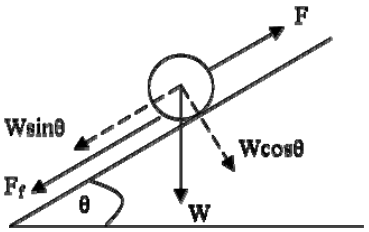
T =42N



Question 9

(a) The component of weight down the plane must overcome friction force

(b) F = F_f + Wsinθ



THERMIONIC EMISSION

Question 1

(a) Thermionic emission is the ejection of an electron from a hot surface of metal. The emitted electron is called thermion

(b) (i) An anode is the metal connected to a positive terminal of a cell or a metal plate with positive potential

(ii) Cathode is the metal rod connected to a negative terminal of the cell or a metal plate with negative potential

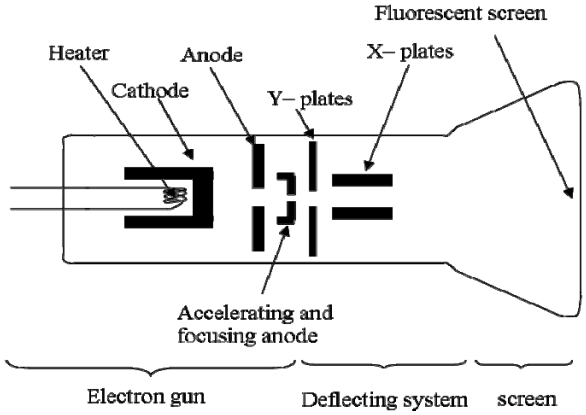
(c) Cathode rays are stream of electrons ejected from a cathode

(d) Properties of cathode rays

- They travel in a straight line
- They are negatively charged
- They are deflected by magnetic and electric fields
- They produce fluorescence on some materials
- They have momentum

Question 2

(a)



(b) Time to and from the aeroplane = $\frac{10mm}{30mm} \times 0.003$

=0.001 seconds

Distance to and from the aeroplane = $0.001 \times 3 \times 10^8$

=3 x 10^{5}m

Distance of the aeroplane = $\frac{3 \times 10^5}{2}$

=1.5 x 10^{5}m

(ii) Half life is 400minutes of the Americum -241 is 400minutes.

Question 10

(a) Kinds of radioactivity
1. Natural radioactivity
2. Artificial radioactivity

(b) To protect a person against radiation effect it should be by
1. Shielding a person with material that can not be penetrated by adiation
2. Keeping smallest possible time of exposure to radiations
3. Shielding the radioactive material by keeping it enclosed in material that does not transmit radiation

(c) 1. Used in nuclear power plants to generate electricity
2. Used in making atomic **bombs**
3. Used in making nuclear weapons

(d) $^{238}_{92}U - 2\alpha \rightarrow {}^{231}_{88}X - 2\beta \rightarrow {}^{230}_{90}Q$

(i) Mass number of Thorium is 230
(ii) Atomic number of Thorium is 90

Question 11

(a)As it penetrates through aluminium foil, the radiation involved is gamma. The 50 count rate remaining constant is probably the background radiation

(b) Uses of radioactivity
(i) Used in sterilization process
(ii) Used as tracers in different process e.g. check blocked kidney
(iii) Used in treatment of cancer
(iv) Used in industries for control of thickness of different industrial products such as iron sheets
(v) Used in pipe oil transportation to check for leaks in pipes

(c) From the graph it shows that the flood occurred about 35 000 years ago

REFLECTION BY A CURVED MIRROR

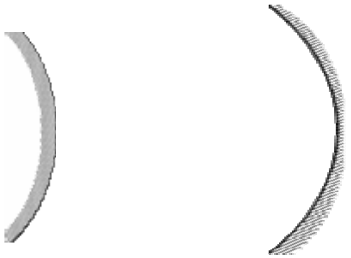
Question 1

(a) (i) Reflection is the bouncing of light ray when it falls on a smooth or shiny surface
(ii) Refraction is the bending of light ray when propagating in media of different densities
(iii) Mirror is the piece of glass painted on one side.

(b) (i) Pole is the midway of the reflecting surface of a curved mirror
(ii) Focal length is the distance between pole and principal focus of a curved mirror.
(iii) Centre of curvature is a centre of a sphere from which a curved mirror is a part
(iv) Principal axis is a line joining centre of curvature and the pole of a curved mirror or lens.

Question 2

(a) (i) Convex mirror is the portion of the spherical glass painted on the inner part. For this mirror, the focal length is negative in real is positive sign convention.

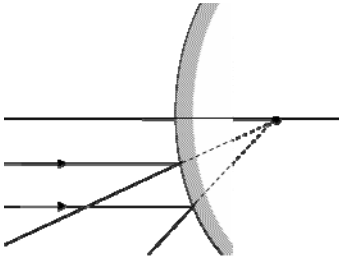


Convex mirror Concave mirror

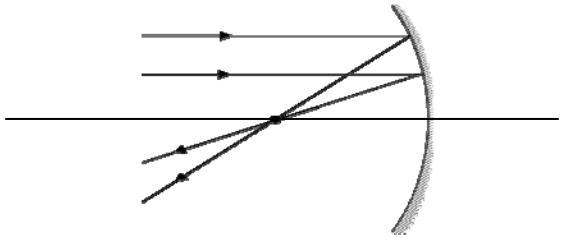
(ii) Concave mirror is the portion of spherical glass which is painted in the outer part. The focal length of this mirror is positive in real is positive sign convention.

(b) Virtual image is an image that can not be formed on a screen. It is formed by apparent intersection of light rays. That is to say it is formed where the light rays does not reach.
Real image is the image that can be formed on the screen. It is formed by real intersection of light rays.

(c)A convex mirror tends to spread out light rays falling on it. After they have been reflected, they tend to diverge the principal focus i.e. they appear to come from the principle focus.

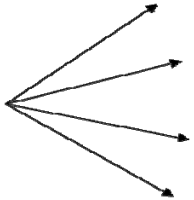


A concave mirror directs rays to the principal focus after reflection. In this case the light rays converge to the principal focus.

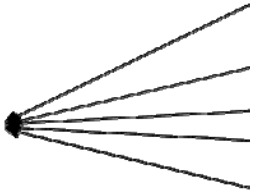


Question 3

(a) Divergent beam is a band of rays coming from one point but going in different directions.



Divergent beam



convergent beam

A convergent beam is the band of light rays coming from different positions but heading to one common point.

(b) A concave mirror forms a virtual image when the object is between principal focus and the pole. At all other points, the concave mirror forms real image.

(c) Data

R=20cm, f =10cm u = 5cm, v=?

$$= \frac{1}{8} \times 4 \times 10^{8}$$

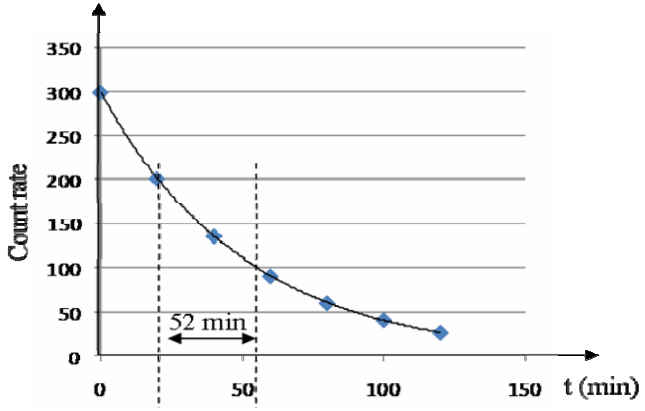
$$= 5 \times 10^{7}$$ gamma rays per second

(b) (i) The count rate of 330/min is called background radiation and is caused by radioactive impurities in the surroundings e.g. building materials, cosmic rays etc

(ii) The table of count rate due to radioactive material

Counts/min	300	201	135	90	60	41	27
Time (min)	0	20	40	60	80	100	120

(iii) The graph of count rate against time

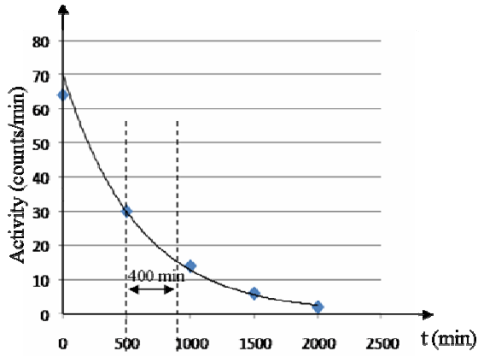


The half life is 52 minutes

Question 9

(a) Activity is the number of disintegration per second

(b) The graph of activity against time for americium -241



Question 7

(a) Nuclear fusion is the process whereby two atoms combine into one with emission of large amount of energy while nuclear fision is the disintegration of an atom into nearly equal atoms with evolution of large amount of energy

(b) Data

N_0 =80 $N = 10$ t =? T =5700

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^{\frac{t}{T}}$$

$$\frac{10}{80} = \left(\frac{1}{2}\right)^{\frac{t}{T}}$$

$$\left(\frac{1}{2}\right)^{3} = \left(\frac{1}{2}\right)^{\frac{t}{5700}}$$

$$3 = \frac{t}{5700}$$

t =17,100 years

It will take 17,100 years.

(c) They wear those badges so that they become aware of the presence of any radiation and hence take necessary steps.

Question 8

(a) Data

N_0 =4 x 10^8 t =24hours $T = 8$days N=?

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^{\frac{t}{T}}$$

$$N = \left(\frac{1}{2}\right)^{\frac{t}{T}} N_0$$

$$= \left(\frac{1}{2}\right)^{\frac{24}{8}} \times 4 \times 10^8$$

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

$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u}$$

$$\frac{1}{v} = \frac{u - f}{fu}$$

$$v = \frac{fu}{u - f}$$

$$= \frac{10(5)}{5 - 10}$$

$$= \frac{-50}{5}$$

=-10cm

The virtual image is formed 10cm behind the mirror

Question 4

(a) 1. A ray parallel to the principal axis is reflected through the principal axis

2. A ray through the principal axis is reflected parallel to the principal axis

3. A ray through the centre of curvature is reflected back through the same path

(b) Data

v = 15cm, f = -20cm u =?

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

$$\frac{1}{u} = \frac{1}{f} - \frac{1}{v}$$

$$= \frac{v - f}{fv}$$

$$\frac{1}{u} = \frac{-15 - (-20)}{300}$$

$$= \frac{5}{300}$$

f = 60cm

Question 5

(a) Magnification is the ratio of the size of an image to the size of an object OR it is the ratio of the image distance to the object distance

(b) (i) Diminished image means the reduced image i.e the size of the image is smaller than the size of the object

(ii) Enlarged image means the image is large than the object

(c) Data

I_0 = 2cm, R=30cm f = 15cm $u = 10$ cm, v =? I_i = ?

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

$$\frac{1}{v}=\frac{1}{f}-\frac{1}{u}$$

$$=\frac{u-f}{fu}$$

$$=\frac{20-30}{15(20)}$$

$$=\frac{-10}{300}$$

$$v=\frac{300}{-10}$$

=-30cm

$$m=\frac{v}{u}$$

$$=\frac{30}{10}$$

= 3

$$m=\frac{Ii}{I_0}$$

$$3=\frac{I_i}{2}$$

I_i =6cm

Question 6

(a) (i) Real is positive sign convention

(ii) New Cartesian sign convention

(b) 1. Rays parallel to principal axis appears to come from principal focus after reflection in the mirror.

2. Rays towards principal focus are reflected parallel to the principal axis

3. Rays through centre of curvature is reflected back through the same path.

(c) Data

v = -15cm f = -5cm, u = ?

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

$$\frac{1}{u}=\frac{1}{f}-\frac{1}{v}$$

$$\frac{1}{u}=\frac{v-f}{fv}$$

$$\frac{1}{u}=\frac{v-f}{fv}$$

$$=\frac{-15-(-5)}{-5(15)}$$

$$=\frac{-10}{-75}$$

$$u=7.5\,\text{cm}$$

Note: Convex mirror forms virtual image at all position of the object.

4. Discharges electroscope rapidly 5. Very small penetrating power of few centimeters of air.	4. Discharges electroscopes slowly 5. Large penetrating power of several meters of air or thin Aluminium foil

(d) Data

(i) C_0 =1200 C =150 t =15hrs $T_{\frac{1}{2}}$ =?

$$\frac{C}{C_0}=\left(\frac{1}{2}\right)^{\frac{t}{T_{\frac{1}{2}}}}$$

$$\frac{150}{1200}=\left(\frac{1}{2}\right)^{\frac{15}{T_{\frac{1}{2}}}}$$

$$\frac{1}{8}=\left(\frac{1}{2}\right)^{\frac{15}{T_{\frac{1}{2}}}}$$

$$2^{-3}=2^{-\left(\frac{15}{T_{\frac{1}{2}}}\right)}$$

$$3=\frac{15}{T_{\frac{1}{2}}}$$

$$T_{\frac{1}{2}}=\frac{15}{3}$$

= 5 hours

The half life is 5 hours

(ii) Data: N_0 =3 x 10^{20} T=25hours N= ?

$$\frac{N}{N_0}=\left(\frac{1}{2}\right)^{\frac{t}{T_{\frac{1}{2}}}}$$

$$N=N_0\left(\frac{1}{2}\right)^{\frac{t}{T_{\frac{1}{2}}}}$$

$$=3\times10^{20}\left(\frac{1}{2}\right)^{\frac{25}{5}}$$

$$=3\times10^{20}\left(\frac{1}{2}\right)^{5}$$

$$=\frac{3\times10^{20}}{32}$$

$$=9.4\times10^{18}\ \text{atoms}$$

- Radioisotopes are used in production of long lasting luminescent paint which can glow in dark
- Radiations from radioactivity can be used in sterilization of surgical instruments.

(b) With emission of β particle, mass number is unchanged but atomic number increases by 1

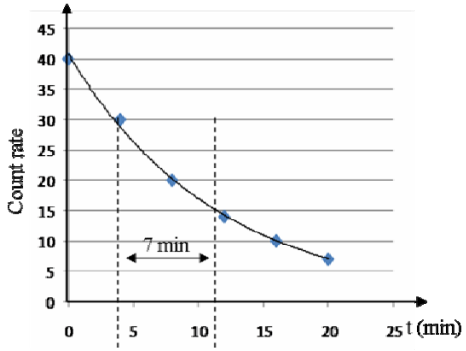
$$^{239}_{92}M - \beta \rightarrow {}^{239}_{92+1}N$$

(i) x =239 y = 93
(ii) N has 93 protons
(iii) Mass number of M is 239 and that of N is 239

Question 5

(a) (i) A is alpha particle B is beta particle , C is beta particle and D is alpha particle
(ii) The elements after A and C radiation are called isotopes

(b) (i)



(ii) The half life is 7 minutes

Question 6

(a) Half life is the time taken for an atom of and element to disintegrate by its half

(b) A is a cell B is γ - rays, C is alpha particle D is beta particle G is anode F is cathode

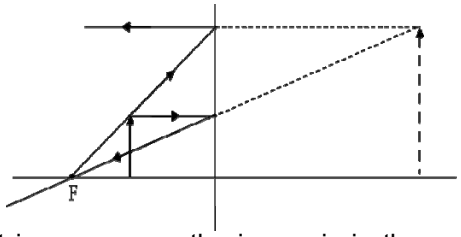
(c)

C- particles	D- particles
1. Is positively charged 2.Hardly deflected by magnetic or electric field 3. Leaves short straight thick tracks in cloud chamber	1. It is negatively charged 2. Easily deflected by magnetic or electric field 3. Leaves irregular, thin tracks in cloud chamber

Question 7

(a) Hints:

- *Select suitable scale for the question e.g 1cm:5cm*
- *Draw the principal axis and mark the position of the lens indicating all necessary measurements such as focal length, principal focus and centre of curvature*
- *Draw a ray parallel to the principal axis; it must pass though F after reflection*
- *Draw a ray through principal focus (beware!) it must proceed parallel to principal axis after reflection by the mirror.*
- *Determine the intersection of the two rays (apparent intersection expected)*



(b) Upright image means the image is in the same orientation as the object.
Inverted image means the image turned upside down

Question 8

(a) Uses of curved mirror

- Convex mirror are used as driving mirror since they give wide range of view though they form diminished image
- Convex mirrors are placed at road junction for seeing around the corner of places like parking lots and supermarkets
- Convex mirror are used for supermarket surveillance
- Concave mirror are used as shaving mirror
- Concave mirrors are used in making reflecting telescopes
- Concave mirror are used in solar cookers.
- Concave mirror are used in making car head lamps or torch to provide parallel beam. For strong parallel beam parabolic mirrors are used.

(b) The image formed by a mirror is always **laterally inverted.** To ensure that the writings are well identified they are printed laterally inverted so that after reflection on the mirror they appear in their normal way.

Question 9

(a) Data

m =2 R=20cm f =10cm , u =?

$$\frac{1}{f}=\frac{1}{v}+\frac{1}{u} \text{ but } m=\frac{v}{u}$$

$$\frac{1}{f}=\frac{1}{-mu}+\frac{1}{u}$$

$$\frac{1}{f}=\frac{1}{u}-\frac{1}{mu}$$

$$\frac{1}{f}=\frac{m-1}{mu}$$

$$u=\frac{f(m-1)}{mu}$$

$$=\frac{10(2-1)}{2}$$

= 5cm

$$v=mu$$

=2(5)

=10cm

(b) Data

u = 10cm f = 6cm v =?

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

$$\frac{1}{v}=\frac{1}{f}-\frac{1}{u}$$

$$\frac{1}{v}=\frac{u-f}{fu}$$

$$v=\frac{fu}{u-f}$$

$$v=\frac{6(10)}{10-6}$$

$$=\frac{60}{4}$$

=15cm

$$m=\frac{v}{u}$$

$$=\frac{15}{10}$$

=1.5

Differences

1. Image formed by a curved mirror is large than the object while in the plane mirror, both the image and object has the same size
2. Image formed by a curved mirror are at different distances to that of the object while for a plane mirror both image and object are at equal distances from the mirror.

Beta particles

- They are negatively charged
- Penetrates more than alpha particles; can pass through several metres of a thin aluminium foil
- Easily deflected by magnetic or electric field
- Affects photographic plates
- Moderate ionization power
- Emitted with nearly velocity of light

Gamma rays

- Have no charge
- Have strong penetrating power
- Have little ionization power
- Can not be deflected by magnetic or electric field
- Affects photographic plates
- They travel at speed of light

(b) Different detectors of radiations

1. Cloud chamber
2. Geiger Muller counter
3. Ionization chamber
4. Spark chamber

(c) Background radiation are radiations which exists even if there is no radioactive element. They are caused by radioactive impurities that are inevitably present.

(d) Different radioactive hazards are such as

- May cause burning of the skin just like a fire
- May cause diseases such as cancer, radiation sickness, leukemia and eye cataracts
- May cause genetic damage that brings defects in children

Question 4

(a) Different uses of radioactivity

- Radioisotopes are used to cure cancerous tumors
- Radioisotopes are used as tracers to follow the path taken by particular substance in the human body.
- In agriculture radioisotopes are used to produce new crop varieties.
- In industry radioisotopes are used to detect cracks or leaks in solid structure
- In industry radioisotopes are used to control thickness of the product e.g. paper, aluminium sheet etc

RADIOACTIVITY

Question 1

(a) Radioactive material is the material which splits out giving out radiations. Examples are uranium, radium and cobalt.

(b) A neutral atom is an atom which has an equal number of protons and electrons

(c) Contents of an atom are proton, neutron and electron

Question 2

(a)(i) Atomic number of an atom is the number of electrons or protons of an atom

(ii) Mass number of an atom is the sum of number of protons or electrons and the number of neutrons of an atom

(iii) Binding energy is the amount of energy needed to completely separate all nucleons of an atom. Nucleons are the contents of the nucleus of an atom i.e. neutrons and protons

(iv) Isotopes are the atoms having the same number of protons but different number of neutrons and hence different mass number. Examples of isotopes are carbon-12 and carbon -14

(b) The subatomic particles of the atom are protons, neutrons and electrons. Protons and neutrons are close packed in the central core of the atom called nucleus

Electrons are outside the nucleus in special positions called energy levels keeping on revolving round the nucleus in their respective orbits. Specific number of electrons are arranged in a given energy level. There are spaces that can not be occupied by electrons; these spaces are called forbidden gaps.

(c) Radiations involved in radioactivity are alpha particles, beta particles and gamma rays.

Question 3

(a) Properties of radiations of radioactivity are as shown below

Alpha particles

- They are positively charged
- Easily absorbed by matter; have very poor penetrating power
- Deflected with difficult by magnetic and electric fields
- Affects photographic plates
- Produce fluorescence
- Have strong ionization power
- Emitted with 10% of velocity of light

Question 10

Data

u =10cm R = 12cm f = - 6cm $v = ?$

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

$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u}$$

$$\frac{1}{v} = \frac{u - f}{fu}$$

$$v = \frac{fu}{u - f}$$

$$= \frac{-6(10)}{10 - (-6)}$$

$$= \frac{-60}{16}$$

= -3.75cm

The object is 3.75cm behind the mirror.

REFRACTION OF LIGHT

Question 1

(a) Refraction is the bending of or change in direction of light when traveling in media of different densities. It is caused by the change in velocity of light in different media.

(b) Laws of refraction.

1st Law" The incident ray and refracted ray are on the opposite sides of the normal at point of incidence and all three are in the same plane

2nd law: When a ray of light passes from one medium to another, the ratio of the sine of angle of incidence to the sine of angle of refraction is constant for two media concerned.

(c) Refractive index is the ratio of the sine of angle of incidence to the sine of angle of refraction **OR** it is the ratio of the velocity of light in air/ vacuum to that in a given media **OR** it is the measure of the ability of a media to cause change in direction of light emerging from another media.

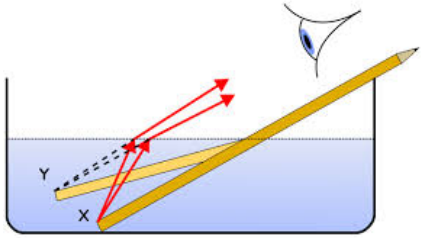
Refractive index = $\frac{\sin i}{\sin r}$

Question 2

(a) (i) Angle of incidence is the angle between the normal and the incident ray

(ii) Angle of refraction is the angle between the normal and the refracted ray

(b) (i) A stick appears bent because, the part of the stick immersed in liquid will apparently be raised up because of refraction of light rays coming from it. When rays coming from the part immersed reached the surface of the liquid are refracted away from the normal forming the image above the actual position of the stick and hence the stick appears bent.



$$75\% = \frac{V_2 I_2}{V_1 I_1}$$

$$0.75 = \left(\frac{V_2}{V_1}\right)\left(\frac{I_2}{I_1}\right) \text{ from } \frac{V_1}{V_2} = \frac{I_2}{I_1} = \frac{N_1}{N_2}$$

$$0.75 = \left(\frac{V_2}{V_1}\right)\left(\frac{N_1}{N_2}\right)$$

$$V_2 = \frac{0.75 V_1 N_2}{N_1}$$

$$= \left(\frac{0.75 \times 250 \times 100}{200}\right)$$

= 93.75V

(c) Loses involved in a transformer

(i) Copper losses caused by heat generated due to the resistance of the primary coil

(ii) Iron losses caused by eddy currents induced in the core of the transformer. This loss is reduced by laminating the iron core

(iii) Hysterisis looses caused by work done in magnetizing and demagnetizing the iron core of the transformer

(iv) Flux leakage caused by poor linkage of magnetic flux between primary and secondary.

(d) Data

V_1 =240V I_1 =1.5A V_2 =24V I_2 =14A

(i) $P_1 = V_1 I_1$

$= 240(1.5)$

=360W

(ii) $P_2 = V_2 I_2$

$= 24(14)$

=336W

(iii) Power wasted = Power input – Power output

= 360 – 336

= 24W

Question 8

(a) Two types of electric generators are 1. Direct current generator 2. Alternating current generator

(b) An alternating current is the current which reverses its direction periodically while direct current is the current which flows in only one direction

(c) Factors that affects electromotive force generated
- (i) Rate of change of magnetic flux
- (ii) Relative directions of the flux and motion of a conductor
- (iii) Number of turns of the coil or length of the conductor in magnetic field
- (iv) The relative speed of a conductor with respect to magnetic field.

Question 9

(a) Electrical energy is transmitted at high voltage to reduce energy loss as heat in transmission cables

(b) Data

V_1 =24V I_1 =2A V_2 =240V

(i) $\frac{N_1}{N_2} = \frac{V_1}{V_2}$

$= \frac{24}{240}$

$= 1:10$

The turn ratio is 1:10

(ii) Power supplied , $= V_1 I_1$

=24(2)

=48W

(iii) $V_1 I_1 = V_2 I_2$

$I_2 = \left(\frac{V_1}{V_2}\right) I_1$

$= \left(\frac{24}{240}\right) 2$

= 0.2A

Question 10

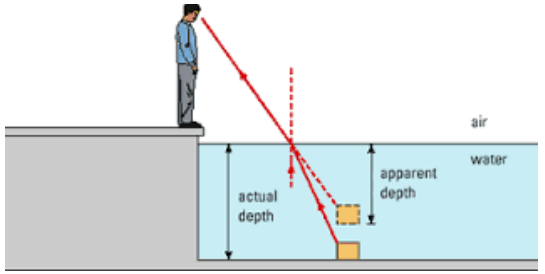
(a) The core of the transformer is laminated so as to minimize energy loss through circulating eddy currents. Eddy currents may overheat the core and the coil

(b) Data

N_1 =200 N_2 =100 V_1 =250V η =75% V_2 =?

$$Efficiency = \frac{Power\ output}{Power\ input} \times 100\%$$

(ii) A light ray coming from the bottom of the pool gets refracted at the surface of the liquid. This refraction causes the image of the bottom to be formed at a relative higher position and hence makes the pool appears shallow.



(iii) Light rays from the writings is refracted on emerging out of the glass into the air. This refraction forms the image of the writings at a position relatively higher than the actual position and hence the writings seem to be uplifted.

(iv) When no water in the vessel, no refraction of the light rays and hence the rays coming from the coin are obstructed by the wall of the vessel in which the coin is contained. On adding water, the light rays coming from the coin gets refracted at the surface and hence forms image of the coin at the higher position where it can be seen.

Question 3

(a) Principle reversibility

" The paths of light rays are reversible"

(b) Critical angle is the incidence angle which produces angle of refraction of 90^0

Total internal reflection is the reflection of light which occurs when light ray propagating from denser media to light media at angle of incidence greater than critical angle.

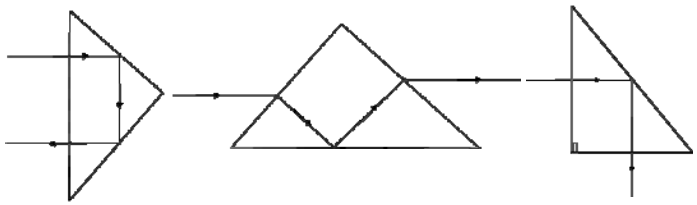
(c) Conditions necessary for total internal reflection are
1. Light must be traveling from optical denser media to light media
2. The angle of incidence must be greater than the critical angle.

Question 4

(a) (i) As angle of incidence is increased, the angle of refraction increases.

(ii) As the angle of incidence is decreased the angle of refraction decreases.

(b)



(c) Refractive index, $\eta = \frac{\sin i}{\sin r}$

$= \frac{\sin 40}{\sin r}$

$\sin r = \frac{\sin 40}{\eta}$

$\sin r = \frac{\sin 40}{1.5}$

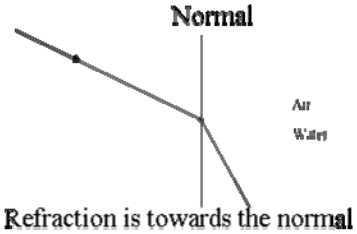
****

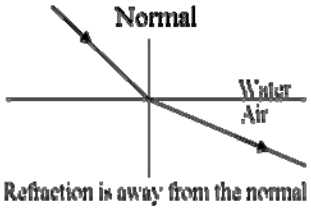
Question 5

(a) (i) Refractive index of water relative to glass is the measure of the ability of water to change direction of light ray traveling from glass to water.

(ii) Refractive index of a glass is the measure of the ability of the glass to cause bending of the light ray coming from air or vacuum into the glass.

(b) (i) away from the normal (ii) towards the normal





(c) Data

Refractive index, η = 1.55, c=?

$\eta = \frac{1}{\sin c}$

$\sin c = \frac{1}{\eta}$

$= \frac{970}{1.5}$

= 646.7Ω

Question 6

(a) A transformer is an electrical device used to raise or to lower the voltage of an alternating current.

(b) Two types of transformers are

1. Step down transformer
2. Step up transformer

(c) A primary circuit is the coil winding in which current enters the transformer

Secondary circuit is the coil in which the current leaves the transformer.

Question 7

(a) (i) A motor is a device which converts electrical energy into mechanical energy

(ii) Electromagnetic induction is the generation of electricity from magnetism or magnetic field

(b) To increase magnetic strength of a coil one should

(i) Increase the number of turns of the coil
(ii) Increase the magnitude of the coil flowing into a coil
(iii) Increasing speed of turn of the coil

(c) Laws of electromagnetic induction

Faraday's law

" Whenever there is a change in the magnetic flux linked with a circuit, an electromotive force is induced, the strength of which is proportional to the rate of change of the flux linked with the circuit."

Lenz's law

"The direction of the induced electromotive force is such that the resulting current always flows in a direction that opposes the change which produce it"

Fleming right hand rule.

"If the first three fingers of the right hand are held at right angles to each other with the forefinger pointing in the direction of the field and the thumb in the direction of the movement, the middle finger points in the direction of the induced current"

(ii) A multiplier is an extra resistor connected in series to a coil of a galvanometer or ammeter so that it can read large potential difference.

(iii) Full scale deflection is the maximum value that an instrument can read.

(b) Data

r =20Ω I = $I_r = 1.5\times10^{-2}$ A I = 10A R=?

$$I_r r = (I - I_r)R$$

$$R = \frac{I_r r}{I - I_r}$$

$$= \frac{1.5\times10^{-2}\times 20}{10 - 1.5\times10^{-2}}$$

$$= \frac{30\times10^{-2}}{1000\times10^{-2} - 1.5\times10^{-2}}$$

$$= \frac{30\times10^{-2}}{998.5\times10^{-2}}$$

= 0.03Ω

(ii) $V = V_r + V_R$

$$V = Ir + IR$$

$$R = \frac{V - Ir}{I}$$

$$= \frac{10 - 20\times1.5\times10^{-2}}{1.5\times10^{-2}}$$

$$= \frac{1000\times10^{-2} - 30\times10^{-2}}{1.5\times10^{-2}}$$

$$= \frac{1000 - 30}{1.5}$$

$$= \frac{1}{1.55}$$

****

Question 6

(a) When light propagates in different media, frequency is unaffected but both wavelength and velocity are changed. For a material of refractive index η then

$$\eta = \frac{speed\ \ of\ \ light\ \ in\ \ vacuum\ \ \ or\ \ air}{speed\ \ \ of\ \ \ light\ \ \ in\ \ a\ \ material}$$

$$\eta = \frac{wavelength\ \ \ in\ \ air\ \ or\ \ vacuum}{wavelength\ \ \ in\ \ a\ \ material}$$

(b) Refractive index = $\frac{true\ \ depth}{Apparent\ \ \ depth}$

$$= \frac{50}{45}$$

=1.1

The refractive index of the material is 1.1

Question 7

(a) Different types of lenses are biconvex lens, biconcave, plano concave, plano convex, diverging meniscus, and converging meniscus.

(i) Principal focus is the point where the refracted rays passes through for a convex lens or diverges in a concave lens

(ii) Focal length is the distance measured from the centre of the lens to principal focus of the lens

(iii)Optical centre of the lens is the centre point of the lens

(b) Data

u =10cm f = 6cm v =?, m = ?

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

$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u}$$

$$\frac{1}{v} = \frac{u - f}{fu}$$

$$v = \frac{fu}{u - f}$$

$$= \frac{6(10)}{10 - 6}$$

=15cm

$$m = \frac{v}{u}$$

$$= \frac{15}{10}$$

=1.5

The image is real 1.5 times the object and is at a distance of 15cm from the lens

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Question 8

(a) Data

$v = -6$ cm, m= 0.6 u =?, f = ?

$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$ but $m = \frac{v}{u}$ hence $u = \frac{v}{m}$

$$\frac{1}{f} = \frac{1}{v} + \frac{m}{v}$$

$$= \frac{-1}{6} + \frac{0.6}{6}$$

$$= \frac{-0.4}{6}$$

$$f = \frac{-6}{0.4}$$

=-15cm

(b) (i) A ray parallel to principal axis is refracted through the principal focus.

(ii) A ray through principal focus is refracted parallel to the principal axis

(iii) A ray through optical centre is unaffected.

(c) Data

Question 3

(a) A solenoid is the coil with negligible diameter compared to its length OR a solenoid is very long coil

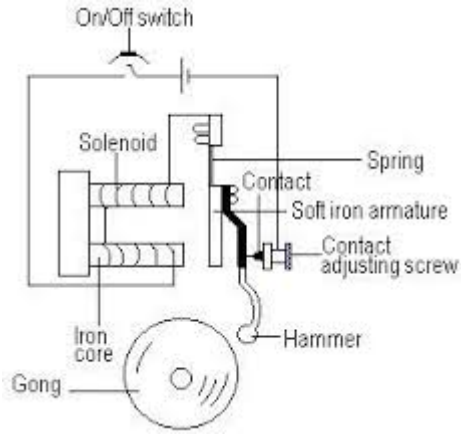
(b) Uses of electromagnets

(i) Used as a crane in metal or iron industries

(ii) Used in manufacturing of relay

(iii) Used in making automatic door lock

(c) Electric bell



Question 4

(a)(i) Self inductance is the generation of electromotive force in a coil as the result of a change in magnetic flux linking the coil

(ii) Mutual inductance is the generation of the electromotive force in one coil as the result of change of flux in the neighbouring coil

(b) The increase of strength of electromagnet can be achieved by

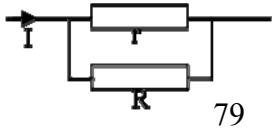
(i) Increasing number of turns of the coil

(ii) Increasing the magnitude of the current flowing

(c) Sensitivity of the galvanometer is its ability to detect very small current.

Question 5

(a) (i) A shunt is an extra resistor connected parallel to the coil of the galvanometer or ammeter so that it can read large currents



ELECTROMAGNETISM

Question 1

(a) (i) Electromagnet is the kind of a magnet generated from electric current

(ii) Electromagnetism is the magnetic effect produced by current flowing in a conductor

(iii) Magnetic field is the region where magnetic effect can be experienced.

(b) (i) Right hand grip rule

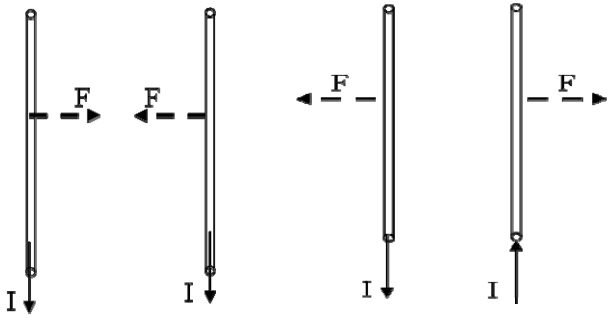
" Imagine the wire carrying the current is gripped by the right hand with the thumb pointing in the direction of the current the fingers will curl around the wire pointing in the direction of the magnetic field.

(ii) Maxwell cork screw rule.

" The direction of the magnetic lines of forces round a current carrying conductor is that in which a right handed cork screw would be turned in order to advance it in the direction of the current.

Question 2

(a) (i) When the currents are flowing in the same direction, the conductors will experience attractive forces



(ii) When the currents are flowing in different direction, the conductors will experience repulsive force

(b) Fleming left hand rule (Motor rule)

" If the left hand is held with the first three fingers mutually at right angle to each other with the forefinger in the direction of the field, the middle finger in the direction of the current then the force on the conductor is in the direction of the thumb.

$m = 4 \quad f = -20\,\text{cm} \quad u = ?$

$\frac{1}{f} = -\frac{1}{v} + \frac{1}{u}$ but $v = mu$

$\frac{1}{f} = -\frac{1}{mu} + \frac{1}{u}$

$\frac{1}{f} = \frac{m-1}{mu}$

$\frac{1}{20} = \frac{4-1}{4u}$

$u = \frac{20(3)}{4}$

=25cm

The object is at 25cm from the lens

$m = \frac{v}{u}$

$u = \frac{v}{m}$

$= \frac{15}{0.6}$

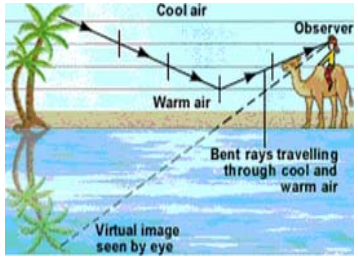
= 25cm

The object is at 25cm from the lens

Question 9

(a) Mirage is an optical illusion caused by total internal reflection of the light in the atmosphere.

(b) (i) During hot weather, the earth is hotter than the surrounding air. The temperature decreases as one moves higher. The density increases as one goes up. The light ray propagating from the sky continuously suffer refraction and at a particular layer the light ray suffers total internal reflection resulting into formation of the image of the sky which appears as a pool of water to the viewer which is called the mirage.



(ii) In the cold deserts the land is colder than the surrounding air. Temperature increases as you go higher and hence the density of air decreases as you go higher. A light ray from the object suffers refraction as it goes higher. At a particular layer the light suffers total internal reflection forming the image at a position above the ground. This image forms a mirage.

(c) Optical fibre is a thin rod of high quality glass designed to guide the light along its length by total internal reflection. Light rays enter the optical fibre and internally reflected from the sides of the fibre each

time they hit the glass boundary at the edge of the fibre. The fibre must be very thin so that the critical angle is reasonably large otherwise would be very small such that the light would not all be totally internally reflected and some would be lost through the sides of the fibre.

Optical fibres are used in

(i) Telecommunication to carry telephone calls at vast distances without loss of intensity and without interference.

(ii) Endoscope used by doctors to view inside a patients body e.g. inside the stomach. Industrial endoscopes are used for inspecting machine parts e.g. jet engine

(iii) Light guides in medical and other applications where bright light needs to be focused on target with a clear line of sight.

Question 10

(a) Uses of lens

(i) Used in optical instruments such as microscope, camera, telescope etc

(ii) Used in the eye for focusing of objects

(iii) Used in microscope to effect magnification of the objects

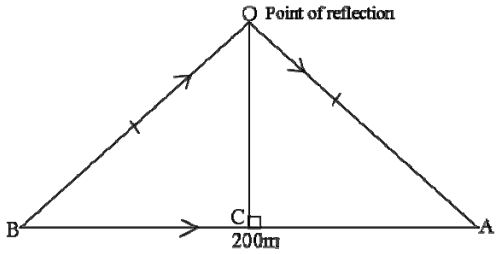
(iv) Used in spectacles to correct eye defects e.g. long sightness, short sightness etc.

(b) (i) AC does not emerge into the air at C because the angle of incidence is large than critical angle and it is propagating into denser medium and hence it suffers total internal reflection

(ii) The ray DE refract away because angle of incident is less than critical angle and hence no total internal reflection occurs.

(ii) Beat is the regular rising and falling in sound heard when the sound sources of nearly equal frequencies are sounded together.

(b)



(i) Velocity of sound traveling from B to A

$$v = \frac{s}{t}$$

$$= \frac{200}{0.6}$$

=333.3m/s

(ii) Time for sound to travel from B to A through O

T = 0.6 + 0.25

= 0.85s

Distance BOA = Velocity x time

$$= 333.3 \times 0.85$$

=283m

Distance BO= $\frac{BOA}{2}$

$$= \frac{283}{2}$$

=141.5m

Using Pythagorus theorem

$$\overline{OC}^2 = \overline{OA}^2 - \overline{BC}^2$$

$$= \sqrt{141.5^2 - 100^2}$$

$$= \sqrt{10022.25}$$

=100m

$$f = \frac{v}{4f}$$

$$= \frac{340}{4(400)}$$

= 0.2m

(ii) $l + c = \frac{\lambda}{2}$ but c=0

$$l = \frac{v}{2f}$$

$$f = \frac{v}{2l}$$

$$= \frac{340}{2(0.2)}$$

Question 9

(a)(i) A fundamental note is the frequency of a note from a string vibrating in one loop or air column vibrating in one segment

(ii) Overtone is the frequency of a note from a string vibrating in more than one segments.

(b) Data

f_1 =249Hz f_2 =256Hz f = ?

$$f = |f_1 - f_2|$$

$$= |249 - 256|$$

=7 H z

(c) Uses of electromagnetic waves

(i) Useful in tracking speed of different bodies in the universe

(ii) Useful in telecommunication e.g. TV and radio broadcasting

(iii) Useful in scientific investigation of crystalline lattice of materials

(iv) Useful in hospitals to different diagnosis e.g. Ultrasound technology

(v) Useful in heating e.g. microwave

(vi) Useful in remote sensing e.g. TV remote control

Question 10

(a) (i) Ultrasound is the sound of frequency higher than 20kHz

OPTICAL INSTRUMENTS

Question 1

(a) Optical instrument is the instrument that uses lens , prism or and mirror which help the human eye to view a small or distant object more clearly

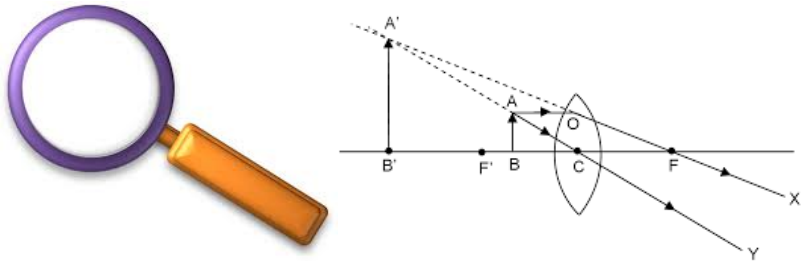
(b) Common optical instruments are such as lens camera, simple microscope, compound microscope, telescope, binocular and project

(c) The eye is treated as an optical instrument since it uses lens in the production of image to the retina.

Question 2

(a) A simple microscope is the convex lens used to magnify objects when viewed while a compound microscope is the optical devices that uses two convex lenses to make magnification of objects when viewed

(b) A simple microscope principle of operation



Question 3

(a) A simple microscope is an optical instrument which uses only one lens in making magnification of the since of the object to be viewed while a compound microscope uses two lenses the object and the eye piece.

(b) Least distance of distinct vision is the smallest image distance at which the eye can observe object without strain.

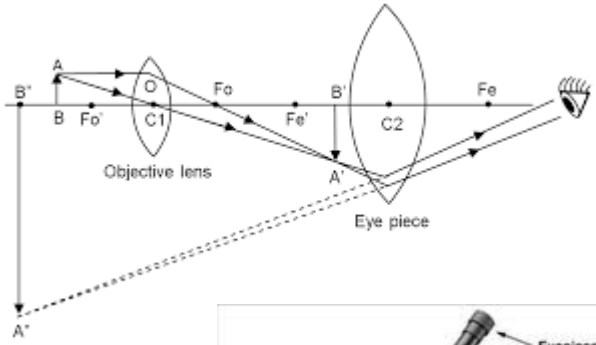
(c) Linear magnification = $1 + \frac{25}{f}$ where f is the focal length of the lens

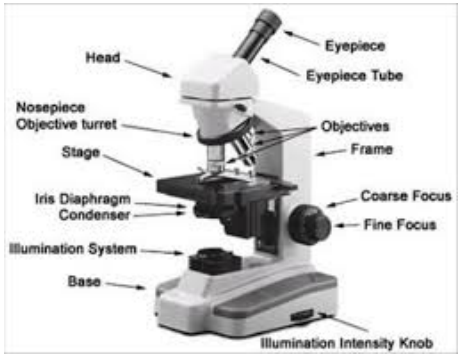
Question 4

(a) A compound microscope

(b) A compound microscope consists of two lenses, the objective lens and eye piece. The objective lens is of ***very short focal length***

compared to the eye piece. The image of an object placed before the objective lens at distance large than focal length forms at a point less than the focal length of the eye piece. The image formed by the objective lens is real, magnified but inverted. The eye piece then acts as the magnifying glass to the image formed by the objective lens. When the final image is at the near point (LDDV) the magnification is the greatest.





(c) Uses of microscope

1. Used in hospitals to make different sample analysis
2. Used in schools and colleges to study microorganisms
3.

(d) The objective lens is of short focal length than eye piece while in the telescope the objective lens is of longer focal length that the eye piece.

$= 2\sqrt{\frac{9}{18}}$

=…….m

Question 8

(a) Data

(i) $l = 20\text{cm}$ m =1.2g T=120N

$$f_0 = \frac{1}{2l}\sqrt{\frac{T}{\mu}} \text{ but } \mu = \frac{m}{l}$$

$$f_0 = \frac{1}{2l}\sqrt{\frac{Tl}{m}}$$

$$f_0 = \frac{1}{2(0.2)}\sqrt{\frac{120(0.2)}{1.2\times10^{-3}}}$$

$$f_0 = \frac{1}{0.4}\sqrt{\frac{24}{1.2}\times10^{3}}$$

$$= 4\times10^{-1}\left(\sqrt{2\times10^{4}}\right)$$

$$= 4\times10^{-1}\left(\sqrt{2}\right)\times10^{2}$$

=…….Hz

For the second harmonic, $f = 2f_0$

(ii) for the third harmonic; $f = 3f_0$

$$f = 3f_0$$

(b) Data

f_0 =400Hz, f_1 =?

(i) $l + c = \frac{\lambda}{4}$ but c=0

$$4l = \lambda \text{ but } \lambda = \frac{v}{f}$$

$$4l = \frac{v}{f}$$

(ii) The temperature affects the velocity of sound. Since the pitch is dependent on frequency therefore the change in frequency affects the pitch of the sound

(iii) Waves from different sources have different waveforms and hence their quality is different.

(b) Data

Speed of light in air, c = 3.0 x 10^8m/s Refractive index, $\eta = \frac{3}{4}$, speed of light in water , v = ?

Refractive index, $\eta = \frac{c}{v}$

$$\frac{3}{4} = \frac{3\times10^8}{v}$$

$$v = \frac{4\times3\times10^8}{3}$$

= 4 x 10^8m/s

(c) Data

l_1 =2m μ_1 =9g/cm μ_2 =18g/cm l_2 =?

$$f = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$$

$$f\alpha\frac{1}{l\sqrt{\mu}}$$

$f_1\alpha\frac{1}{l_1\sqrt{\mu_1}}$ and $f_2\alpha\frac{1}{l_2\sqrt{\mu_2}}$ hence

$$\frac{f_1}{f_2} = \frac{l_2\sqrt{\mu_2}}{l_1\sqrt{\mu_1}}$$

$$\frac{f_1}{f_2} = \left(\frac{l_2}{l_1}\right)\sqrt{\frac{\mu_2}{\mu_1}}$$

$l_2 = \frac{f_1 l_1}{f_2}\sqrt{\frac{\mu_1}{\mu_2}}$ (since in unison $f_1 = f_2$

Question 5

(a) 1. Refracting astronomical telescope 2. Reflecting astronomical telescope.

(b) Uses of telescope

1.
2.
3.

(c) A telescope is the optical instrument used to view distant objects , it employs lenses or curved mirror while a periscope is the device used to view obstructed objects.Periscope employs plane mirrors or triangular prism.

Question 6

(a) ..
(b) …
(c) …

Question 7

(a) …
(b) …..
(c) ……
(d) ……

Question 8

(a) The human eye
(b) Accomodation is the ability to change the focal length of the lens by the eye.
(c) Comparison of the eye and the camera

Similarities

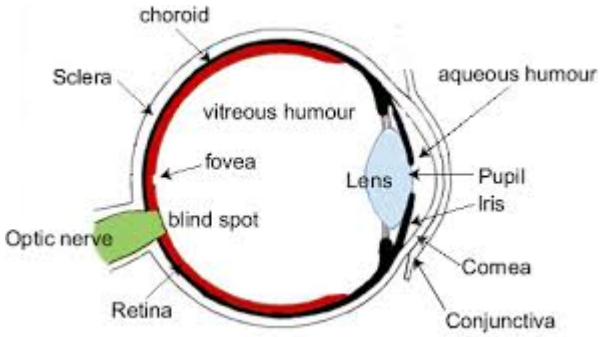
1. Both have biconvex lens
2. Both have dark interior to make it light proof and prevent the reflection of stray rays of light

3. Both have screen on which image is formed
4. Both have mechanism for control of light entering

Differences

1. The eye lens has variable focal length whereas camera lens has fixed focal length
2. The image distance is fixed for the eye but can be varied for the case of camera
3. The eye lid remains open continuously to allow light to pass while the shutter of the camera opens to allow one photograph to be taken at a time.

(d) A telescope is the optical instrument for viewing distant object. It consists of two lens; the objective lens which have **long focal length** and the eye piece which have **short focal length**. The objective lens forms a real, inverted diminished image of the distant object at the focal point of the eyepiece. This image serves as the object to the eye piece. The eye piece forms a virtual, erect , magnified image at the infinity. The final image is therefore inverted.



Question 9

(a) *Short sightness:* It is the eye defect for which a person can see only near objects. Distance objects are focused in front of the retina and hence a person can not see distant objects. It is caused by the eyeball being too long.It is corrected by putting on concave lens

Longsightness: It is the eye defect for which a person can see only distant objects. Near objects are focused beyond the retina and hence can not be seen. It is caused by eyeball being short or the lens is not powerful enough to focus the near object.It can be corrected by putting on convex lens

Astigmatism:

(b) Binocular vision

$s = vt$

=1500(0.1)

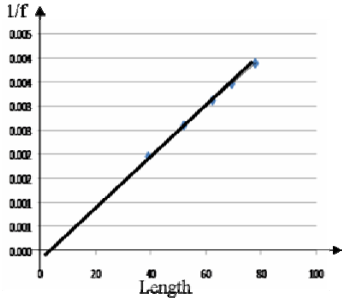
=150m

(ii) Depth of the shoal = $\frac{s}{2}$

$= \frac{150}{2}$

=75m

(c)



Question 6

(a) (i) A house built next to a motor way can overcome noise pollution by using fences or walls to shield the house. Also building using material that absorbs sound (acoustic materials)

(ii) Closing doors and windows.

(b) Discos played at high frequency may be destructive to ear cochlea and hence bringing hearing problems in later life of a teenager.

(c) Data

(i) $\lambda_1 = 1500$m $\lambda_2 = 247$m $f_1 = 200$kHz

(i) $v = \lambda_1 f_1$

$= 1500 \times 200 \times 10^3$

$= 3 \times 10^8$ m/s

(ii) $f = \frac{v}{\lambda}$

$= \frac{3 \times 10^8}{24}$

$= 1.25 \times 10^7$ Hz

Question 7

(a) (i) When a vibrating tuning fork is held against a top of a table a table is put in oscillation at its natural frequency i.e it resonate hence increasing the amplitude of oscillation therefore more louder.

Intensity of sound is the energy per second per unit area carried by the wave

Loudness is the sensation that a person has towards the sound. Loudness depends on the amplitude; the greater the amplitude the greater is the loudness

(b) As the engine speeds up to a certain frequency the windows or seats on the buy may start to rattle if such frequency of the engine equals to natural frequency of the windows and seats. At this stage, windows or seats are put in resonance at their natural frequency and hence vibrates.

Question 4

(a) Factors determining frequency of a note from a vibrating string are

1. Length of a string
2. Mass per unit length of a string
3. Tension in the string

(b) (i) Crest is the highest point in the wave

(ii) Trough is the lowest point of the wave

(iii) Node is the point of no displacement of the stationery or standing wave

(iv) Antinode is the point of maximum displacement of the standing wave

(c) On a hot day, the temperature inside the room is less than the temperature outside. Guitar taken from outside to inside the cold room suffers change in temperature. Because of the contraction caused by lowering in its temperature the length of the string of the guitar is shortened and therefore it gives a different note and hence need to be retuned.

(i) The frequency of the note produced by a string is dependent on its length. As it has been shortened because of contraction, the frequency of the note it produces will be different and hence need to be retuned.

(ii) To retune the guitar the string has to be loosened to reduce tension . This will bring the guitar in tune again.

Question 5

(a) Different uses of sound are

(i) Used in communication between people

(ii) Used to alert a person e.g. horn from the car

(iii) Used in measurement of distance e.g. depth of the sea

(iv) Used in entertainment e.g. choir

(b) Data

t =0.1s v =1500m/s s =?

(c) For an object to be seen by the eye it has to be focused on the retina. In the given diagram, the image of a distant object is formed in front of the retina and hence can not be seen clearly.

Question 10

List A	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)
List B										

COLOURS AND DISPERSION

Question 1

(a) Primary colours are the colours that can not be formed by mixing any other colours. Examples of primary colours are red, blue and green. Secondary colours are the colours formed by mixing up some primary colours. Examples of secondary colours are yellow, magenta and cyan (peacock blue0

(b) Pigments or paints refers to colouring materials that a body contains. The colour of the object is because of pigments. Pigments are used to make dyes, paints and colour ink.

(c) Mixing colours by addition is the process whereby a new coloured light is formed by combination of different coloured lights. Example, yellow is obtained by mixing red and green lights. Mixing colours by subtraction is the process whereby different paints or pigments are mixed together. In this process, most of the colours are removed or absorbed from the total mixture . Pigments acts as a filter that subtracts one or more colours from the visible spectrum. The primary pigments are yellow, magenta and peacock blue (cyan). The secondary pigments are blue, green and red

Cyan + Magenta = Blue
(Green + Blue) + (Red + Blue)
Magenta + Yellow = Red
(Red + Blue) + (Green + Red)
Yellow + Cyan = Green
(Red + Green) + (Green + Blue0

(d) Complementary colours are two colours which when added together they form white light

Question 2

(a) Blue shirt reflects only blue and absorbs other colours including red; green reflects only green light absorbing other colours hence both shirt and spots appear black

(b) An objects reflects the colour of its own and absorbs the rest. A blue colour therefore absorbs all other colours reflecting only blue colour. For this case, a blue colour absorbs the red light and hence no colur is reflected and hence the blue colour will appear black

(c) Colour filter are the bodies that transmits colours of their own and absorbs unlike ones.

WAVE MOTION

Question 1

(a) Electromagnetic waves are the waves which does not need medium for its propagation
Mechanical waves are the waves that needs medium for its propagation

(b) Characteristics of waves are
(i) Reflection
(ii) Refraction
(iii) Diffraction
(iv) Interference

(c) Data…….

Question 2

(a) (i) Amplitude is the maximum displacement of the medium particles from their rest mean position
(ii) Phase is the stage of oscillation reached by a particle of a medium of a wave
(iii) Frequency is the number of oscillations or vibration made in one second
(iv) Wave front……

(b) Data

$\lambda = 0.7$m s= 840m t= 2.5s v = ? f = ?

(i) $v = \frac{s}{t}$

$= \frac{840}{0.5}$

=1680m/s

(ii) $f = \frac{v}{\lambda}$

$= \frac{1680}{0.7}$

=2400m/s

Question 3

(a) Quality of sound is the characteristic of sound which distinguishes two sounds of the same frequency from different sources

$$R = \rho \frac{l}{A}$$

$$\rho = \frac{RA}{l}$$

$$= \frac{2.2 \times 5 \times 10^{-7}}{2}$$

$$= 5.5 \times 10^{-7}\ \Omega m$$

$R \alpha\ l$ since $\frac{\rho}{A}$ is constant

$$\frac{R_1}{R_2} = \frac{l_1}{l_2}$$

$$l_2 = \left(\frac{l_1}{l_2}\right) R_2$$

$$= \left(\frac{2.2}{1}\right) 2$$

=4.4m

Question 3

(a) Dispersion of colour is the process whereby white light is spilted into its component colours

(b) When a beam of light is directed to the triangular prism it is spilted into its component colours of the visible spectrum. The splitting is accompanied by deviation

(c) Spectrum is the arrangement of colours in order of their wavelength or frequency.

Question 4

(a) Red, Orange, Yellow, Green, Blue, Indigo and Violet

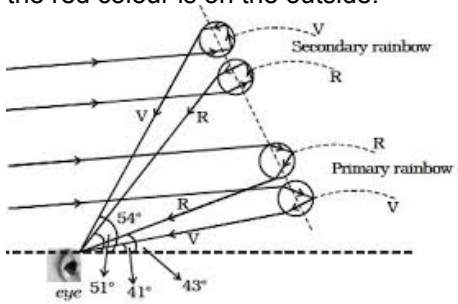
(b) Angle of deviation is the angle through which the light ray turns after being refracted by the sides of a triangular prism

(c) A – violet B – Indigo C- Blue D- Green E – Yellow F- Orange and G- Red

Question 5

(a) Rainbow is an arc formed out of a spectral band of colours resulting from light being refracted and reflected by rain drops in the atmosphere.

(b) A primary rainbow occurs when light suffers one total internal reflection in the water droplets. The primary rainbow has violet colour on the inside of the bow while the red colour is on the outside.



The secondary rainbow occurs when light has undergone two total internal reflection in the water droplets. In this case, the violet colour is on the outside of the bow and the red colour is on the inside. The secondary rainbow is much fainter than the primary rainbow.

(c) Colour is the property of light that reaches our eyes. A particular colour has a specific wavelength and frequency. A pigment is the colouring material of the substance. Pigments changes the colour of an object. They are used to make paints or dyes.

Question 6

(a) White light is composed of different colours which have different wavelengths. When a light falls on a glass prism the speed of the colour components changes making them move in different directions thereby dispersed.

(b) Light spectrum is the arrangement of components of light into espective components while dispersion of colour is the splitting of white light into its component colours.

(c) (i) A – red, B – Blue C – Green D – black
(ii) Black (iii) Secondary paints (iii) complementary paints

Question 7

(a) When light falls on a triangular prism it is dispersed as well as deviated. The dispersion results into colour components of light which are violet, indigo, blue, green, yellow, orange and red with violet always towards the base.

(b) (i) It will appear black flag with green strips
(ii) it will appear as red flag with green strips
(iii) the bus will appear red.

(c) A magenta filter will transmit red light which on reaching the yellow filter it is also transmitted. Hence, red light is transmitted in this case. The order of filters has no effect on final product.

Question 8

(a) Pure colour spectrum is the arrangement of colours in order of their frequencies or wavelengths in which the colours does not overlap (are well separated from one another) while impure colour spectrum have colours which overlaps (colours are not well separated)

(b) (i) The actress will appear in black
(ii) The actress will appear in green
(iii) The actress will appear in green

Question 9

(a) Red colour is bright and very visibale, red colour is least affected by fog, rain,haze, dust etc

(b)

Colour of illumination	Colour of sea	Colour of ship	Appearance (result)
White	Green	Yellow	Yellow ship on green sea
Green	Green	Green	Green ship on green sea
Blue	Black	Black	Black ship on black sea
Red	Black	Red	Red ship on black sea.

$E_2 = P_2 t$

=2000 x 2 x 3600

=14,400,000J

$E_3 = P_3 t$

=1000 x 10 x 60

=600,000J

Total energy E= 2,160,000 +14,400,000 +600,000

=17,160,000 J

3600000 = 1kWH

17,160,000 = x

$$x = \frac{17160000}{3600000}$$

= 4.8 units

Cost = 4.8 x 300

=1440/ Tshs.

Question 11

(a) Three wires involved in household installation are live(red or brown), neutral(black or yellow) and earth (green or yellow with green strips)

(b) Data

p.d = 240V, P= 1000W, m = 3kg θ_1=5^{0}C θ_2 =80^{0}C c =4200J/KgK

$Q = mc(\theta_2 - \theta_1)$ but $Q = Pt$

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

$$t = \frac{mc(\theta_2 - \theta_2)}{P}$$

$$= \frac{3 \times 4200(80 - 5)}{1000}$$

$$= \frac{12600(75)}{1000}$$

$$= \frac{945000}{1000}$$

=945seconds

(c) Data

l_1=2m A= $5 \times 10^{-7} m$ R_1 =2.2Ω R_1 =1Ω ρ =? l_2 =?

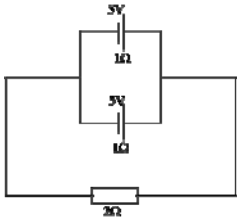
$= 9 \times 1.6 \times 10^{-19}$

$= 1.44 \times 10^{-18}$ J

Question 9

(a) Local action is the production of bubbles of hydrogen on zinc plate because of the impurities contained in it.
Polarization is the production of the hydrogen layer at the copper plate of the simple cell

(b) For internal resistance,



$$\frac{1}{r} = \frac{1}{r_1} + \frac{1}{r_2}$$

$$\frac{1}{r} = \frac{1}{1} + \frac{1}{1}$$

$$= 2$$

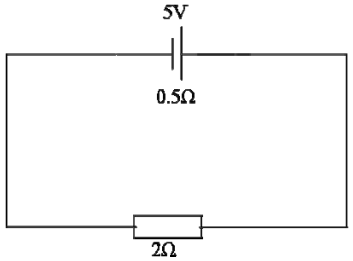
$$r = 0.5\ \Omega$$

$$E = Ir + IR$$

$$I = \frac{E}{r + R}$$

$$I = \frac{5}{0.5 + 2}$$

$$I = 2A$$



(c) Yes. This is because when in parallel the equivalent internal resistance of the two cells is much smaller than the internal resistance of the individual cell and hence the current delivered will be high for parallel combination than for an individual cell.

Question 10

(a) Kilowatthour (kWH) is the amount of the electrical energy consumed in one hour at a rate of 1000 joules per second

(b) Data

P.d =240V, P_1=100V t_1 = 6hrs (21600s) P_2= 2000W t_2 =2hrs (7200s) P_3=1000W t_3 =10min (600s), unit cost =300/= per unit

$E_1 = P_1 t$

=100 x 6 x 3600

=2,160,000J

Question 10

(a) (i) Primary colours: Red, Blue and Green
(ii) Secondary colours: Yellow, Magenta and peacock blue (cyan)
(iii) Complementary colours" Yellow and Blue, Magenta and Green, Cyan and Red

(b) (i) The screen will appear red
(ii) The screen will appear black since the green light transmitted by green glass is absorbed by red glass.

THERMAL EXPANSION

Question 1

(a) Thermal expansion is the fractional changes in the length of a material per temperature rise in centigrade of Kelvin

(b) Thermal energy is the form of energy that flows owing to temperature difference while temperature is the degree of hotness of the body

(c) Different sources of heat energy are such as Bunsen burner, electrical heater, charcoal burner, stove, sun etc

Question 2

(a) Quantity of heat is the amount of heat contained in a body

(b) Comparison of quantity of heat and temperature

Quantity of heat	Temperature
1. It is the form of energy 2. It is measured in Joule 3. It flows from high temperature to low temperature region 4. It is not measured using thermometer	(i) It express how hot or cold a body is (ii) It is measured in Kelvin, centigrade or Farenheit (iii) Can not be transferred or does not flow (iv) It is measured using thermometer

Uses of thermal energy

(i) used to dry grains or washed clothes

(ii) It is used in cooking or boiling

(iii) It used in some experiments for different investigation

(iv) It is used to keep bodies of a living organism warm during cold weather

Question 3

(a) Linear expansivity of a material is a fractional change in length of the material per temperature change in centigrade or Kelvin

(b) The atoms making up a solid material are in continuous vibrational motion . When heat is applied the amplitude of their vibration increases resulting in the increase in dimension of or elongation of the material

(c) Factors determining linear expansion of a material

1. Initial length of the material
2. Change in temperature
3. Nature of the material

$$R_1 \alpha \rho \frac{l_1}{d_1^2} \text{ .....(1)}$$

$$R_2 \alpha \rho \frac{l_1}{d_2^2} \text{ .....(2)}$$

Dividing (1) by (2)

$$\frac{R_1}{R_2} = \left(\frac{l_1}{l_2}\right)\left(\frac{d_2}{d_1}\right)^2$$

$$l_2 = \frac{R_2}{R_1}\left(\frac{d_2}{d_1}\right)^2 l_1$$

$$= \frac{5}{1.05}\left(\frac{0.5d}{d}\right)\times 1$$

$$= \frac{5\times 0.5}{1.05}$$

=

Question 8

(a) Fuse is an electric safety wire which melts when excess of rated current is passed through it. The melting of this wire cuts off the current and hence providing safety to an electrical appliance.
A circuit breaker is a special switch which cuts off current whenever there is electrical short.

(b) A primary cell is the source of electric current that produces electricity at the expense of the chemicals used to make it; they are non reversible and once chemicals are used up the cell become useless
Secondary cell is the source of electric current that produces current by reversible process; they can be recharged once used up. They are sometimes called storage cells or accumulator

(c) Data

e.m.f = 9V Q= 1.6 x 10^{-19}C, W= ?

$$E.m.f = \frac{W}{Q}$$

$$W = EQ$$

(c) Electricity is transmitted over long distance at high voltage so as to have small current flowing in a transmitting wires. This reduces loss of electrical energy as heat generated in the wire.

Question 6

(a) Resistivity of a material is the resistance of a conductor made of a material one metre long and area of cross sectional one square metre.
Conductivity is the reciprocal of resistivity, it the measure of the ability of the material to conduct electricity

(b) (i) When S is closed both 4 Ω and 2 Ω are connected in parallel, some current flows through 4 Ω and hence current through A_2 falls
(ii) When S is open the 4Ω resistor is disconnected and current flows through 8 Ω only and therefore reading in A_2 is the same as that in A_1

Question 7

(a) Data

l_1 =2m $d_1 = 5\times10^{-4}$ m R_1 =3Ω l_2 =3m $d_2 = 6\times10^{-4}$ m R=?

$$R = R_1 + R_2$$

$$R = \rho\frac{l_1}{\pi d_1^2} + \rho\frac{l_2}{\pi d_2^2}$$

$$R = \frac{\rho}{\pi}\left(\frac{l_1}{d_1^2} + \frac{l_3}{d_2^2}\right) \text{ but } \rho = \frac{\pi R_1 d_1^2}{l_1}$$

$$R = \frac{\pi R_1 d_1^2}{\pi l_1}\left(\frac{l_1}{d_1^2} + \frac{l_2}{d_2^2}\right)$$

$$= \frac{R_1 d_1^2}{l_1}\left(\frac{l_1}{d_1^2} + \frac{l_2}{d_2^2}\right)$$

$$= \frac{3\left(5\times10^{-4}\right)^2}{2}\left(\frac{2}{\left(5\times10^{-4}\right)^2} + \frac{3}{\left(6\times10^{-4}\right)^2}\right)$$

=

(b) Data

l_1 =1m R_1 =1.05Ω d_1 =d d_2 =0.5d R_2 =5Ω l_2 =?

Question 4

(a) When the bottle is warmed, it expands thereby giving increase in the diameter of the bottle's mouth and hence the stopper easily removed.

(b) Riverts are used to hold metals together. When hammered at high temperature, the riverts will hold the metals firmly when cooled since they will contract on cooling

(c) Data

l_o =30m, α =2 x 10^{-5}/K, θ_0 =30^{0}C, θ_1 = -5^{0}C, Δl =?

$$\Delta l = l_0\alpha(\theta_1 - \theta_0)$$

=30(2 x 10^{-4})(-5 - 30)
=2.1 x 10^{-1}m

Question 5

(a) When the temperature is increased from 20^{0}C to 50^{0}C A expands more than B. The result of this unequal expansion is the bending of the strip towards the least expanding metal

(b) Data

d_0 =1.5m θ_0 =10^{0}C d_2 =1.51cm α = 1.1 x 10^{-5}/K θ_1 =?

For copper

$$\Delta l = l_0\alpha(\theta_1 - \theta_0)$$

$$1.51 - 1.50 = 1.5(1.1\times10^{-5})(\theta_1 - 10)$$

$$0.01 = 1.65\times10^{-5}(\theta_1 - 10)$$

$$\frac{0.01}{1.65\times10^{-5}} = \theta_1 - 10$$

$$\theta_1 = 10 + \frac{1\times10^{-2}}{1.65\times10^{-5}}$$

$$= 10 + \frac{1}{1.65}\times10^3$$

=10+606
=616^{0}C

Question 6

(a) (i) A rail line is made of an iron . When a temperature raises the iron expands and contracts when the temperature falls. To allow for expansion when the rail expands or contracts an expansion gap is left between the two rails. If this gap is not left, the railway would bend due to expansion a situation which is dangerous to the train.

(ii) A glass tumbler is made of thick glass. When hot liquid is poured in the glass material inside expands. The glass is poor conductor of heat and hence the inner part and the outer part are at different temperatures. The inner part expands more than the outer side resulting into the breaking of the tumbler OR else when a glass tumbler is half filled with hot substance would lead into unequal expansion and hence breaking.

(b) Data. $l_0 = 0.1\text{m}$ $\theta_0 = 15^0 C$, $\frac{\Delta l}{l_0}$ =0.15% θ_1 =100^{0}C α =?

$$\Delta l = l_0 \alpha (\theta_1 - \theta_0)$$

$$\alpha = \frac{\Delta l}{l_0(\theta_1 - \theta_0)}$$

$$= \frac{\Delta l}{l_0}\left(\frac{1}{\theta_1 - \theta_0}\right)$$

$$\alpha = 1.5\times10^{-3}\left(\frac{1}{100-15}\right)$$

$$= \frac{1.5\times10^{-3}}{85}$$

= 1.8 x 10^{-5}/K

Question 7

(a) Linear expansion is the change in length of a material resulting from change in temperature while linear expansivity is the fractional change in length of the material per temperature rise in Kelvin or centigrade

(b) Data

$l_c = 0.6\text{m}$, θ_0 =0^{0}C, θ_1 =100^{0}C α_c =1.68 x 10^{-5}K, α_F = 1.09 x 10^{-5}/K

For copper

$$l_1 - l_c = \alpha_c l_c (\theta_1 - \theta_0)$$

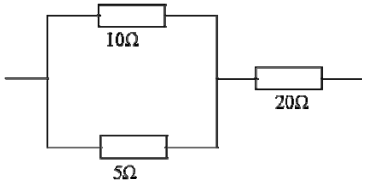
$$l_1 = l_c + \alpha_c l_c (\theta_1 - \theta_0)$$

$$l_1 = l_c + \alpha_c l_c (100 - 0)$$

$$l_1 = l_c + \alpha_c l_c (100)$$

For iron

Current through 10 Ohm resistor



$$I = \frac{V}{R}$$

$$= \frac{10}{10}$$

=1A

Current through 20Ω = 1A + 2A

= 3A

Question 5

(a) Data

I = 2A t= 8s Q=?

$$Q = It$$

= 2(8)

=16C

(b) Data

l_1 =1.2m d_1 =6.4 x 10^{-4}m R_1 =2.4Ω l_2 =3.2 x 10^{-4}m R_2 =?

$$R = \rho\frac{l}{A} \text{ but } A\alpha\, d^2$$

$$R\alpha\rho\frac{l}{d^2}$$

$$\frac{R_2}{R_1} = \left(\frac{l_2}{l_1}\right)\left(\frac{d_1}{d_2}\right)^2$$

$$R_2 = \left(\frac{l_2}{l_1}\right)\left(\frac{d_1}{d_2}\right)^2 R_1$$

$$= \left(\frac{0.8}{1.2}\right)\left(\frac{6.4\times10^{-4}}{3.2\times10^{-4}}\right)^2 2.4$$

$$= \left(\frac{2}{3}\right)(2)^2(2.4)$$

= 2 x 4 x 0.8

= 6.4 Ohms

$$\frac{1}{R_T}=\frac{1}{8}+\frac{1}{X}$$

$$\frac{1}{R_T}=\frac{X+8}{8X}$$

$$\frac{1}{3}=\frac{X+8}{8X}$$

8X=3X +24

8X-3X=24

5X=24

$$X=\frac{24}{5}$$

=4.8 Ω

Question 4

(a) Ohm's law " The potential difference of a metallic conductor is proportional to the current flowing provided the temperature is kept constant"

(b) Factors affecting resistance of a conductor

Temperature: When the temperature of the metallic conductor is increased its resistance also increases. This increase is caused by the increase in vibration of the atoms of the metal which causes high opposition to the electrons flowing in the conductor.

Length of the conductor: The resistance of the metallic conductor is proportional to the length of the conductor. When the length of the conductor is increased its resistance also increases.

Cross section area of a conductor: The resistance of the conductor is inversely proportional to the cross sectional area. That is to say, if the cross sectional area of the metallic conductor is made high, its resistances is lowered.

Nature of the conductor: Different materials has different resistance even if they are identical in all other factors i.e. temperature area and length.

(c) Data

R_1= 10Ω R_2= 5Ω R_3= 5Ω

Potential difference across parallel resistors R_1 and R_2

V = IR

=(5)(2)

=10V

$$l_2=l_F+\alpha_F l_F(100)$$

Difference in length at 0^0C= l_c-l_F

Difference in length at 100^0C = l_1-l_2

$$l_c-l_F=l_1-l_2$$

$$l_c-l_F=l_c+\alpha_c l_c(100)\text{-}l_F+\alpha_F l_F(100)$$

$$0=\alpha_c l_c(100)\text{-}\alpha_F l_F(100)$$

$$\alpha_c l_c(100)=\alpha_F l_F(100)$$

$$l_c=\frac{\alpha_F l_F}{\alpha_F}$$

$$=\left(\frac{1.09\times10^{-5}}{1.68\times10^{-5}}\right)0.6$$

= 0.39m

Question 8

(a) (i) Lining of the telephone or electrical cables

(ii) Railway lining

(iii) Fitting wheels to rims

(iv) Thermostat in controlling temperature

(v) Holding metals firmly together using riverts

(b) An anomalous expansion of water refers to the abnormal expansion of water occurring between 0^0C and 4^0C the range in which water contracts as temperature increases and expands as temperature decreases

(c) During cold weather, water at the surface freezes at 0^0C changing into ice. Cooling from 4^0C to 0^0C water expands, its density decreases and hence the ice floats over water which is at temperature much higher than 0^0C. This behavior makes the water body be covered by ice at the top and water at temperature higher than 0^0C below enabling aquatic animals to take their life in a normal way.

(d) Real expansivity of a liquid is the fractional change in volume of liquid per temperature rise when in an inexpansible vessel while apparent expansivity is the fractional change in volume of liquid per temperature rise when in expansible vessel

Question 9

(a) (i) Areal expansivity is the fractional change in area of a material per temperature rise.

(ii) Cubical expansivity is the fractional change in volume of a material per temperature rise

(iii) Absolute expansivity is the actual fractional change in the size of the material per temperature rise

(b) When heated , water expands and hence its volume increases. Assuming that the evaporation does not take place, the mass of water remain constant and hence the density is reduced.

(c) Data

V_0 =1000cm^3, θ_0 =15^{0}C θ= 90^{0}C α_g =9 x 10^{-6}/K

α_v =4.7 x 10^{-4}/K

$$V - V_0 = \alpha_v V_0(\theta_1 - \theta_0)$$

$$V = V_0 + \alpha_v V_0(\theta_1 - \theta_0)$$

$$= 1000 + 4.7 \times 10^{-4}(1000)(90 - 15)$$

$$= 1000 + 4.7 \times 10^{-1}(75)$$

=1000+7.05

=1007.05cm^3

New volume of the liquid is 1007.05cm^3

For the glass vessel

$V = V_0 + \gamma V_0(\theta_1 - \theta_0)$ but $\gamma = 3\alpha_g$

$$V = V_0 + 3\alpha V_0(\theta_1 - \theta_0)$$

$$= 1000 + 3(9 \times 10^{-6})(1000)(90 - 15)$$

=1000 +27 x10^{-6}(1000)(75)

=1000 +405 x 10^{-3}

=1000 +0.405

=1000.405 cm^3

The new volume of the vessel is 1000.405cm^3

The volume expelled = Volume of liquid – Volume of vessel

V=1007.05 – 1000.405

=6.645cm^3

Question 10

(a) Boyle's law: The volume of a fixed mass of a gas is inversely proportional to its pressure provided temperature is kept constant

CURRENT ELECTRICITY

Question 1

(a) Potential difference is the workdone or energy needed to move a charge across a resistor.

Electromotive force is the energy or workdone needed to move a charge across a circuit.

(b) The source of electromotive force is the energy change in the electrical cell or battery or any source of electric current.

(c) Different sources of e.m.f are such as dry cell, battery, electrical generator, solar panel, accumulator etc.

Question 2

(a) External resistance is the opposition to flow of charge offered by all electrical components in the circuit except the cell

Internal resistance is the opposition to the flow of charge offered by a cell itself.

(b)

Quantity	Measuring instrument
Electromotive force	Voltmeter
Potential difference	Voltmeter
Current	Ammeter
Resistance	Multimeter

(c) Data

e.m.f =3V, p.d =2.5V

The potential difference recorded is less than electromotive force because of potential drop across a cell which is caused by internal resistance.

Question 3

(a) Two safety devices against electrical circuit faults are circuit breaker and fuse.

(b) Data

R_1=3Ω R_2=3 Ω R_3= X

For R_1 and R_2 in series

$R = R_1 + R_2$

= 5 + 3

= 8 Ω

For R and Rx in parallel

Question 5

(a) At night the earth looses heat by radiation into the outer space. On cloudy nights the clouds reflects some heat back to the earth. More heat is therefore lost on clear nights and the earth becomes colder. This lowering of temperature cools the air and hence frost forms.

(b) For a substance to boil more energy is needed to overcome the attractive forces between molecules. Once the attractive forces are overcomed the molecules escapes into the air. This is the change in state. The extra energy is not needed to reach boiling point.

(c) When the outside is cold, the cold glass cools the air close to its surface to below the dew point. This forms condensation on the windows.

$$P_1V_1 = P_2V_2$$

Charles law: The volume of a fixed mass of a gas is directly proportional to its absolute temperature provided the pressure is kept constant

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

Pressure law: The pressure of a fixed mass of a gas at constant volume is directly proportional to its absolute temperature.

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

(b) Data

P_1 = 1atm, T_1=27^{0}C (300K) V_1=100cm^3 P_2=3atm V_2 =35cm^3 T_2=?

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

$$T_2 = \left(\frac{P_2}{P_1}\right)\left(\frac{V_2}{V_1}\right)T_1$$

$$= \left(\frac{3}{1}\right)\left(\frac{35}{100}\right)300$$

= 315K

The raise in temperature, T= $T_2 - T_1$

= 315 -300

=15K

TRANSFER OF THERMAL ENERGY

Question 1

(a) Heat is transferred from one point to another by conduction, convection and radiation

Conduction is the mode of heat transfer in solid material. It is effected by bombardment or collision of particles of the material resulting from the increase in kinetic energy which causes increase in amplitude and frequency of vibration of the particles of the substance. In metals the presence of free electrons also helps in making conduction of heat.

Convection is the mode of heat transfer in fluids. The molecules at high temperature absorbs heat, expands and becomes less denser. This causes the molecule to become buoyant and hence moved upward being replaced by denser cold molecules which also absorbs thermal energy and becomes buoyant. These actions results into currents of molecules upward for less denser and downward for denser molecules. This process ceases when the fluid has become uniform in temperature.

Radiation is the mode of heat transfer in empty space. Heat energy is transferred in the form of electromagnetic wave called radiant energy. Radiant energy is converted into heat energy when it falls on a substance. It is by this mode that heat from the sun reaches the earth's surface..

(b) The heat energy from the sun reaches the earth by radiation. This is because, somewhere between the earth and the sun exists the vacuum which if not by radiation the heat energy would not transfer through to the surface of the earth.

(c) Good conductors: Iron vessel. Copper vessels and Aluminium vessels

Bad conductors: Glass material, plastic material, wood

Question 2

(a) Factors contributing to the conductions of metals are

1. Vibrational motion of the metal atoms or molecules
2. Existence of free electrons that can transfer thermal energy

(b) A carpet helps in keeping the house warm by preventing heat transfer from one region to another. This is because the carpet is made of insulating material. In this case the heat present in the house remains constant.

Unsaturated vapor refers to the amount of water vapour present in the air for which the rate of vapourization is greater than rate of condensation

(d) Vapour pressure is the pressure exerted by air consisting vapor.

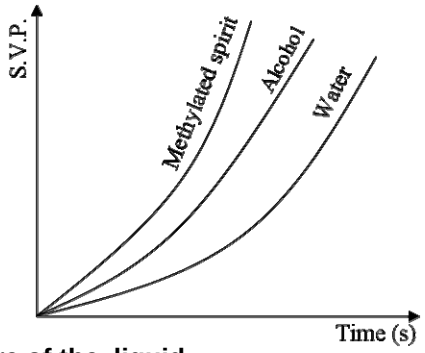
Question 3

(a) Absolute humidity is the mass of water vapor present un the unit volume of air while relative humidity is the ratio of the amount of water vapour present in the unit volume of air to the amount of water vapor required to saturate it at the same temperature.

(b) Factors affecting saturated vapour pressure are

1. Temperature

The rise in temperature increases the vaporur pressure.



2. Nature of the liquid

Different liquids has different saturated vapor at the same temperature.

3. Purity of the liquid.

(c) Dew is the deposition of water drops resulting from condensed water vapor

Dew point is the temperature at which air must be cooled to become saturated.

Question 4

(a) Snow

(b) Llll

VAPOUR AND HUMIDITY

Question 1

(a)(i) Vapour is the amount of substance molecules leaving the surface of the liquid

(ii) Evaporation is a process whereby liquid changes into vapour taking place at the surface of the liquid usually at all temperatures without boiling.

(iii) Boiling is the process whereby liquid changes into vapour at constant temperature.

(b) (i) Moisture refers to the amount of water vapour in the air. Moisture in the air reduces rate of evaporation.

(ii) Wind is the movement of air molecules from one region to another. The wind increases the rate of evaporation

(iii) Temperature facilitates evaporation by giving more energy to the surface molecules. Hence , increase in temperature increases rate of evaporation

(iv)The surface area of the material exposed more molecules to the environment and hence it increases the evaporation.

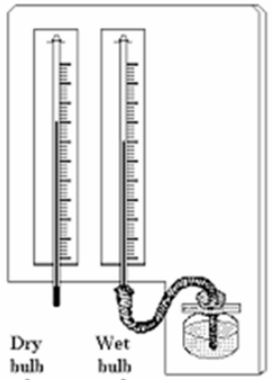
Question 2

(a) (i) Humidity is the measure of the amount of water vapour actually present in the atmosphere

(ii) Relative humidity is the ratio of the saturated vapour pressure at dew point per saturated vapour pressure at room temperature. It is expressed in percentage

Alternatively

Relative humidity is the ratio of the amount of water vapor actually present in a unit volume of air to the amount of water vapor required to saturate that air at same temperature.



Wet and dry bulb Hygrometer

(b) Humidity of air is measured using hygrometer

(c) Saturated vapour is the amount of water molecules present in the air that limit the air from accepting further water molecules.

Question 3

(a) (i) Two thin blankets placed together traps air between them; air is an insulator preventing loss of heat and hence keeps warm. One thick blanket traps no air and hence would relatively be warmer than the two thin blankets

(ii) When fur of the coat are worn are inside, the trapped air helps in insulating the body and hence warmer than when fur are outside

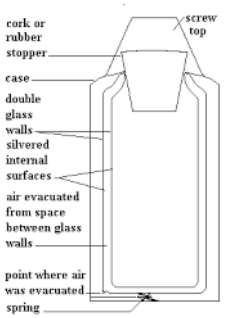
(iii) When worn under clothes, the string vest traps air which is an insulating material; the trapped air prevents heat loss from the body. When worn by themselves air is kept circulating and not trapped and hence there is heat loss from the body which makes it not so much warm.

(b) Radiation ; convection and conduction.

Question 4

(a)(i) Bright and shiny clothes are good reflectors of heat, hence the fire fighter put such clothes so that no heat is absorbed and hence protecting them against high amount of heat

(ii) Black clothes are good absorbers of heat and hence black clothes are preferred in cold weather because they absorb the little available heat to keep the body warm. White clothes are good reflectors hence not preferred



(iii) The silvered surface prevent heat transfer by radiation and hence enable the flask to keep substance at its temperature.

(b) A vacuum flask

Question 5

(a) (i) An iron is a good conductor of heat and has small specific heat capacity therefore requires small quantity of heat to raise its temperature

(ii) Stadium seats are exposed to various weather conditions, however they have to remain at constant temperature all the time. Being a bad conductor with high specific heat capacity plastic material remains nearly at the same temperature whether it is during hot weather or cold weather.

(b) Factors affecting rate of conduction of heat are

(i) Length of the material

(ii) Temperature difference

(iii) Cross section area of the material

(iv) Nature of the material or thermal conductivity.

Question 6

(a) A material is made up of small particles, atoms or molecules. For metallic materials there are also free electrons that move from one place to another in the material. These free electrons increases the conductivity of the material besides the conduction effected by collision of atoms or molecules. When one end of a material is subjected to high temperature, atoms at that end absorbs heat energy and their amplitude of vibration and frequency of collision with adjacent atoms increases. It is this collision which effects the transfer of thermal energy from one atom to another.

(b) Thermopile is the device capable of detecting radiant energy. When radiant energy falls on thermopile, it is absorbed and converted into electrical energy. The current flowing is proportional to the amount of radiant energy absorbed

(c) (i) Bright polished surfaces are poor radiator of heat, they do not lose heat by radiation. Hence, the base of the iron is polished shiny.

(ii) Silvery surfaces are poor radiator and hence tea pot with silvery surfaces loses almost no heat and hence keeps hot water hot for some time.

Question 7

(a) To ensure that no heat is lost from our homes, the following ways are used

- Putting a ceiling board
- Putting carpet on the floor
- The use of curtains on the doors and windows.
- Constructing a wall cavity filled with insulator

(b) Uses of good conductor materials

- Used to make cooking vessels
- Used to make cooling system of different machines e.g Heat sink of a computer, X- ray producing machine etc
- Aluminium is used to make engine block of the motor car.

Question 8

(a) A refrigerator absorbs heat from substance and rejects it to the surrounding. The back of the refrigerator is made black to ensure that heat absorbed from the substances is radiated to the surrounding.

(b) Convection is the process of heat transfer in fluids. Molecules at high temperature region absorbs heat becomes buoyant and raises

= 680,000J

(b) Q= ml_v

= 0.5 x 2,300,000

=1,150,000J

(c) Q= ml_v

= 0.1 x 2,300,000

= 230,000J

Question 10

(a) QR is horizontal because in that time range heat is supplied but not sensed by thermometer because it used to change the state of matter.

RS is the cooling process

(b) A refrigerator is the device which lowers the temperature of the substance to temperature below surrounding temperature.

(c) Data

$m = 0.4$kg θ_1 =20^{0}C θ_f =-10^{0}C P= ?

Heat to change from 20^{0}C to 0^{0}C

$Q_1 = mc(20-0)$

=0.4 x 4200 x 20

=0.8 x 4200

=3,360J

At 0^{0}C (change of state)

$Q_2 = ml_f$

=0.4 x 340,000

=136,000J

Heat to change from 0^{0}C to -10^{0}C

$Q_3 = mc(0-(-10)$

=0.4 x 2100 x 10

= 8400J

Total heat extracted,

Q = Q_1 + Q_2 + Q_3

=3,360 + 136,000 + 8,400

=147,760J

Power = $\frac{Heat\ extracted}{time\ taken}$

$= \frac{147,760}{4 \times 3600}$

$= \frac{147760}{14400}$

=10.3W

(b) Salt is an impurity to water, when ice forms the salt makes it melt at temperature lower than 0^0C. Impurity reduces the melting point

(c) Sqeezing results into increasing pressure. Increase in pressure reduces melting point and hence makes the ice melt at lower temperature.

Question 7

(a) Differences between boiling and evaporation are

- Boiling occurs at a specific temperature and pressure while evaporation occurs at all temperatures
- Boiling takes places quickly while evaporation takes place slowly
- Boiling takes place throughout the liquid while evaporation takes place at the surface only
- Boiling is not accompanied by cooling while evaporation is accompanied by cooling

(b) Factors affecting evaporation are temperature, surface area , humidity and nature of the liquid.

Question 8

(a) Pressure and impurities

(b) Increase in pressure increases boiling point while decrease in pressure reduces boiling point

(c) Data

$m_1 = 0.5$kg time, t = 5min(300s) Power,P=32,000J/min l_f =?

$$P = \frac{Q}{t} \text{ but Q = } ml_f$$

$$P = \frac{ml_f}{t}$$

$$l_f = \frac{Pt}{m}$$

$$= \frac{32000 \times 5}{0.5}$$

= 320,000J/kg

Question 9

Data

(a) Q = ml_f

=2 x 340,000

up to the region of low temperature. These molecules are replaced by cold molecules which are relatively denser. This movement of hot molecules and cold molecules results into convection currents.

(c) For a man standing close to fire is separated from fire by air in between. Air is a fluid and hence convection will take place between the man and the fire.

Question 9

(a) Cooking vessels are good conductors of heat and most have low specific heat capacity. When heated they come hot easily. The wood is a poor conductor and has very high thermal conductivity , they don't get hot very easily and therefore are used to make handles of cooking vessel to make it easy to move the vessel from heat whenever needed to do so.

(b) (i) Absorber is the material which takes in all heat energy falling on it

(ii) Emitter is the material which gives out heat energy

(iii) Reflector is the material that bounces heat energy that falls on it.

Question 10

(a) Heat loss by conduction and convection is controlled by fitting the insulating material in the mouth of the flask. To minimize heat loss by radiation the walls of the flask are silvered to make them shinny. The vacuum between double walls of the flask also reduces heat loss by convection and conduction. The flask itself is made from glass which is bad conductor to reduce heat loss by conduction.

(b) (i) Aluminium is light and good conductor and hence it is efficient in conducting heat

(ii) It has large fins to increase the surface area to effect dissipation of large amount of heat.

(iii) Black surfaces are good radiator of heat and hence by making it black it radiates more heat and hence facilitating rejecting heat to the surrounding.

MEASUREMENT OF THERMAL ENERGY

Question 1

(a) Specific heat capacity is the amount of heat energy needed to change the temperature of a unit mass of a substance through 1^0C or 1K

(b) Low high capacity material is preferred. This is because it will take only small amount of heat to warm

(c) Data

$m = 5$kg change in temperature, $\theta = 20^0$C Q= 2000J c= ?

$Q = mc\theta$

= 5c (20)

2000 = 100c

$$c = \frac{2000}{100}$$

=20J/kg K

Question 2

(a) Heat capacity is the amount of heat needed to change the temperature of a given mass of a substance through 1^0C or 1K
Temperature is the degree of hotness or coldness of the body measured on a chosen scale.

(b) 1. Mass of a substance 2. Specific heat capacity

(c) $m_1 = m_x$ $m_2 = m_y$ $c_1 = 2c$ $c_2 = c$ $\theta_i = 20^0$C $\theta_f = 10^0$C

$m_x : m_y$ =?

For substance X

$Q = m_1 c_1 (20 - 10)$

$Q = m_1 c(10)$

$Q = 10 m_x c$ .....(i)

For substance Y

$Q = m_2 c_2 (20 - 10)$

$Q = m_y 2c(10)$

$Q = 20 m_y c$ .....(ii)

Equating (i) with (ii)

$10 m_x c = 20 m_y c$

$Q_4 = ml_f$

=2(336,000)

=372,000J

Heat needed to change ice into water at 0^0C

$Q_6 = Q_3 + Q_4$

Let θ be final temperature of water, hence

Heat gained by water = Heat lost by steam

$m_2 c(\theta = 0) + = m_1 c(100 - \theta)$

Question 5

(a) Factors that may affect change of state are pressure and impurities

(b) Salt is an impurity to the water, it raises the boiling point of water and hence makes the potato cooks faster

(c) Data

$m = 2$kg specific heat capacity of ice = 2100J/kgK ,Q =?

Heat needed to change temperature from -5^0C to 0^0C

$Q_1 = mc(0 - (-5))$

= 2(2100)(5)

=4200 x 5

= 21000J

At 0^0C (change of state)

$Q_2 = ml_f$

=2 x 336000

=672000J

Change from 0^0C to 5^0C

$Q = mc(5 - 0)$

= 2 x 4200 x 5

=42000J

Total heat needed Q= $Q_1 + Q_2 + Q_3$

= 21,000 + 672,000 + 420,000

= 1,093,000

Question 6

(a) Latent heat is the amount of heat needed to changes the state of a substance at constant temperature while specific latent heat is the amount of heat energy needed to change the state of a unit mass of a substance at constant temperature

$Q_2 = ml_f$

=5 x336,000

=1,680,000J

From 0^0C to 25^0C

$Q_3 = mc(\theta_f - 0)$

=5 x4200 (25 – 0)

=21000 X 25

=525000

$Q=Q_1 + Q_2 + Q_3$

=1,680,000 + + 525,000

=

(c) Steam at 1000C contains latent heat beside the heat quantity owing to its temperature. In this case, steam has more energy that water at the same temperature and hence more dangerous.

Question 4

(a) Impurities added to a substances lowers the melting point. This explains why salt is always added to the roads in cold countries to make ice melt at lower temperatures.

(b) Data

$m_1 = 5$kg $\theta_1 = 130^0$C $m_2 = 2$kg $\theta_2 = -5$kg s.h.c of steam = 2000J/kgK

Heat lost by steam to change from 130^0C to 100^0C

$Q_1 = mc(130 - 100))$

=5( ) (30)

=

Heat rejected during change of state (condensation)

$Q_2 = ml_v$

=5 (2,300,000)

=11,500,000J

Heat rejected for steam to change from 130^0C to water at 100^0C

$Q_5 = Q_1 + Q_2$

Heat gained for ice to change from -5^0C to 0^0C

$Q_3 = mc(0 - (-5))$

=2( ) (5)

=

Heat gained at change of state (Ice to water)

$\frac{m_x}{m_y} = \frac{20c}{10c}$

=2

The ratio $m_x:m_y$ = 2:1

Question 3

(a) Quantity of heat is the amount of heat contained in the body

(b) Data

m_1 =4g (0.004kg), m = 1200g (1.2kg) $\theta_i = 16^0$C $\theta_f = 26^0$C

$Q = mc(\theta_f - \theta_i)$

$\frac{Q}{m} = 4200(26 - 16)$

= 4200(10)

= 42000 J/kg

=42kJ/kg

(c) Data

Q= 38000J m = 2kg $\theta_i = 40^0$C $\theta_f = 90^0$C c= ?

$Q = mc(\theta_f - \theta_i)$

$38000 = 2c(90 - 40)$

$38000 = 100c$

$c = \frac{38000}{100}$

=380J/kgK

Question 4

(a) The sand is hotter than sea (water) because of its low specific heat capacity compared to water . It may also be because of difference in mass; sea is the large body containing large mass while sand is not. This two factors contributes to why the sand is hotter than sea.

(b) Data

$m_1 = 2$kg $\theta_1 = 100^0$C $c_1 = 130$J/kgK $m_2 = 0.3$kg $\theta_2 = 0^0$C

$m_3 = m$ $\theta_3 = 0^0$C $\theta = 16^0$C

Heat quantity of lead,Q = $m_1 c_1 \theta$

=2(130)(100)

=26000J

Heat lost by lead , $Q_1 = m_1c_1(\theta_1 - \theta)$

$= 2(130)(100-16)$

$= 260(84)$

=21840J

Heat gained by water

$Q_2 = m_2c_2(\theta - \theta_2)$

$= 0.3(4200)(16-0)$

=1260(16)

=20160J

Heat gained by the vessel

$Q_3 = m_3c_3(\theta - \theta_3)$

$Q_2 = m_2c_2(16-0)$

Heat loss by lead = Heat gained by vessel and water

21840 =20160 + $16m_2c_2$

$16m_2c_2 = 21840 - 20160$

$m_2c_2 = \frac{21840-20160}{16}$

$= \frac{1680}{16}$

=105J/K

Question 5

(a) A calorimeter

CHANGE OF STATE

Question 1

(a) Matter is anything that occupies space and has mass

(b) States of matter are solid, liquid and gas

(c) Heat energy

Question 2

(a) When water is mixed with ice at -5^{0}C, heat flows from water to ice; the temperature of ice will change from -5^{0}C to 0^{0}C.Some of the ice will be melted into water. If water contain sufficient amount of heat may cause all the ice to melt

(b) Latent heat is the amount of heat energy needed to change the state of a substance while heat capacity is the amount of energy needed to change the temperature of a substance through 1K or 1^{0}C

(c) Data

Mass, m = 200g (0.5kg) specific latent heat of vapourization l_v = 2,300kJ

$Q = ml_v$

= 0.2 x 2,300,000

= 460,000J

Question 3

(a) (i) Melting point is the temperature at which substance changes its state from solid to liquid or vice versa

(ii) Boiling point is the temperature at which substance changes from liquid state to gas or vice versa.

(iii) Regelation is the phenomenon whereby a substance melts under pressure and refreezing when the pressure is reduced. The phenomenon is common to substances that expands on freezing such as water.

(b) Data

$m = 5$kg, θ_0 = -10^{0}C, θ_f =25^{0}C, Q =? s.h.c of ice = 2100J/kgK

From -10^{0}C to 0^{0}C (ice)

$Q_1 = mc(\theta_1 - \theta_0)$

=5 ( )(0-(-10))

=5( ) (10)

=

At 0^{0}C (change of state)

$5040 - 84\theta = 420\theta - 8400$

$5040 + 8400 = (420 + 84)\theta$

$13440 = 504\theta$

$$\theta = \frac{13440}{504}$$

$= 26.7^0C$

Question 9

(a) The statement mean that 400joules of heat are needed to raise the temperature of 1kg of a substance through 1K temperature

(b) Nature of a substance

(c) Data

m = 5kg $\theta_1 = 5^0C$ $\theta_2 = 1^0C$ $c = 50J/kgK$ Q =?

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

$$Q = 5(50)(5-1)$$

$=1000J$

Question 10

(a) A has low specific heat capacity and hence it needs small amount of heat to raise it temperature and also when cooling it cools very easily

(b) Data

$Q = 10000J$ $m = 2kg$ $\theta = 10^0C$ $c = ?$

$$Q = mc\theta$$

$$10000 = 2c(10)$$

$$c = \frac{10000}{20}$$

$= 500J/kgK$

(b) Total gain in potential energy $= nmgh$

$=200m(10)(0.8)$

$=1600m$

Heat gained by lead shot $= mc\theta$

$=11.2mc$

Heat gained = loss in potential energy

$$11.2mc = 1600m$$

$$c = \frac{1600}{11.2}$$

$=143J/kgK$

(c) Data

$m_1 = 40g$ (0.04kg) $\theta_1 = 280K$ $c_1 = 420J/kgK$ $m_2 = 11g$ (0.011kg)

$\theta_2 = 293K$ $\theta = 314K$ c_2 =?

Heat lost by metal, $Q_1 = m_1c_1(\theta_1 - \theta)$

$= Q_1 = 0.04(420)(380 - 314)$

$=16.8(66)$

Heat gained by liquid $= Q_2 = m_2c_2(\theta - \theta_2)$

$$Q_2 = 0.011c_2(314 - 293)$$

$$= 0.011(21)c_2$$

$=0.231c_2$

Heat gain by liquid = Heat lost by metal

$1108.8 = 0.231c_2$

$$c_2 = \frac{1108.8}{0.231}$$

$= 4800J/kgK$

Question 6

(a) Heat capacity is affected by 1. Mass of a substance 2. Specific heat capacity

(b) Data

$m_1 = 1g$ (0.001kg) $\theta_1 = 40^0C$ $c_1 = 4200J/kgK$ $m_2 = 0.5kg$ $\theta_2 = 18^0C$

θ = ? $c_2 = 880J/kgK$

Heat lost by water, $Q_1 = m_1c_1(\theta_1 - \theta)$

$= 0.001(4200)(40 - \theta)$

$= 4.2(40-\theta)$

Heat gained by aluminium pan $Q_2 = m_2c_2(\theta-\theta_2)$

$Q_2 = 0.5(880)(\theta-18)$

$= 440(\theta-18)$

Heat loss by water = Heat gaine by Aluminium pan

$4.2(40-\theta) = 440(\theta-18)$

$168 - 4.2\theta = 440\theta - 7920$

$168 + 7920 = 440\theta + 4.2\theta$

$8088 = 444.2\theta$

$\theta = \frac{8088}{444.2}$

$=18.2^0$C

Question 7

(a) Specific heat capacity is the constant for a given material, hence half the amount will have the same specific heat capacity

(b) Data

$m_1 = 4$ kg $\theta_1 = 20^0$C $m_2 = 3$ kg $\theta_2 = 60^0$C θ =?

Heat lost by hot water, $Q_2 = m_2c_2(\theta - \theta_2)$

$= 3c(60-\theta)$

Heat gained by cold water $Q_1 = m_1c_1(\theta-\theta_1)$

$= 4c(\theta-20)$

Heat lost by hot water = Heat gain by cold water

$3c(60-\theta) = 4c(\theta-20)$

$180 - 3\theta = 4\theta - 20$

$200 = 7\theta$

$\theta = \frac{200}{7}$

$=28.6^0$C

Assumption: No heat lost to the surrounding

Question 8

(a)Law of conservation of energy: Energy can neither be created nor destroyed, but can be transformed.

(b) Data

$m_1 = 90$g (0.09kg) $c_1 = 4200$J/kgK $\theta_1 = 97^0$C $m_2 = 120$g(0.12kg)

$\theta_2 = 17^0$C $\theta = 55^0$C c_2 =? $m_3 = 50$g (0.05kg) $\theta_3 = 17^0$C $c_3 = 380$J/kgK

Heat lost by hot water $Q_1 = m_1c_1(\theta_1-\theta)$

$= 0.09(4200)(97-55)$

$=378(42)$

$= 15876$

Heat gain by brine $Q_2 = m_2c_2(\theta-\theta_2)$

$= 0.12c(55-17)$

$= 0.12c(38)$

$= 4.56c$

Heat gain by a calorimeter $Q_3 = m_3c_3(\theta-\theta_3)$

$= 0.05(380)(55-17)$

$=19(38)$

$= 722$

Heat lost by water= Heat gain by calorimeter + heat gain by brine

$Q_1 = Q_2 + Q_3$

$15876 = 4.56c + 722$

$4.56c = 15876 - 722$

$=15154$

$c = \frac{15154}{4.56}$

$=3323$J/kgK

(c) Data

$m_1 = 20$g (0.02kg) $c_1 = 4200$J/kgK $\theta_1 = 60^0$C $m_2 = 100$g(0.10kg)

$\theta_2 = 20^0$C θ =? $c_2 = 4200$J/kgK

Heat lost by hot water $Q_1 = m_1c_1(\theta_1-\theta)$

$Q_1 = 0.02(4200)(60-\theta)$

$=84(60-\theta)$

Heat lost by cold water $Q_2 = m_2c_2(\theta-\theta_2)$

$= 0.1(4200)(\theta-20)$

$=420(\theta-20)$

Heat lost = Heat gain

$84(60-\theta) = 420(\theta-20)$