B.P.H.S - Solutions to S.4 Physics Test One-Term One 2019

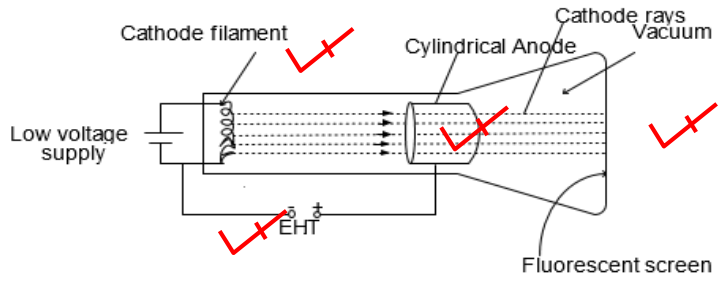
1. (a) What are cathode rays?

These are streams of fast moving electrons. 01

(b) (i) Give two methods of producing electrons

- *Thermionic emission*
- *Photo electric emission* 02

(ii) With the aid of a well labelled diagram, describe how cathode rays are produced.



02

- *When the cathode filament is heated by a low voltage, the electrons are produced by thermionic emission*
- *The emitted electrons are accelerated by E.H.T towards the screen.* 03
- *This stream of fast moving electrons form cathode rays.*

(c) (i) What are x-rays.

These are electromagnetic radiations of short wave length produced when cathode rays are stopped by high density matter. 01

(ii) Give one medical and one industrial use of x-rays

Medical uses of x- rays

- *Used to detect fractures in bones*
- *Used to destroy cancer cell*
- *Used in detection of lung tuber culosis*
- *Used for sterilization of medical equipment's*

Any one (01)

Industrial use of x-rays

- *They are used to locate internal imperfection in welded joints and casting*
- *They are used to detect cracks in metal parts which are invisible*
- *They are used to study structures of crystals*

Any one (01)

(iii) Give two differences between cathode rays and x-rays. 02

- *Cathode rays are negatively charged while x-rays are neutral*
- *Cathode rays can be deflected by both electric and magnetic fields while x-rays cannot be deflected by both electric and magnetic fields.*

(d) (i) Define the term half-life of a radioactive substance. 01

Half-life of a radioactive substance is the time taken for half the number of atoms present in a radioactive substance to decay.

(ii) 16g of a substance X decays to 4g in 2 minutes. Find the half-life of X

$N_0 = 16g$
$N = 2g$
$T_{\frac{1}{2}} = ?$
$t = 2$ minutes
From $N = \frac{No}{2^n}$,

$4 = \frac{16}{2^n}$
$2^n = 4$
$n = 2$

$n = \frac{t}{T_{\frac{1}{2}}}$
$2 = \frac{2}{T_{\frac{1}{2}}}$
$T_{\frac{1}{2}} = 1$minute

02

2. (a) (i) Define the term linear momentum

This is a product of mass and linear velocity of a body. 01

(ii) State the law of conservation of linear momentum.

It states that when two or more bodies collide, their total momentum remains constant provided no external force acts on them. 01

(b) Explain why passengers in a vehicle need to fastened their seat-belts.

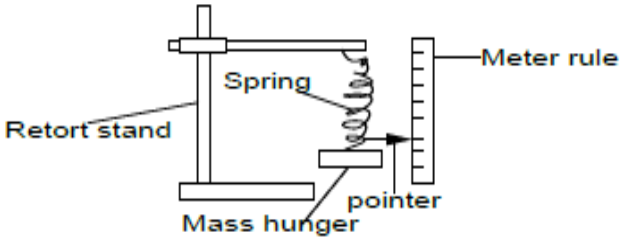
This is done in order to avoid accidents because as the vehicle starts moving, the passengers are thrown backward and when it stops the passengers are thrown forward due to inertia. 03

(c) (i) State Hooke's law.

It states that the extension of an elastic material is directly proportion to the applied force provided the elastic limit is not exceeded 01

(ii) Describe an experiment to verify Hooke's law using a spring.

A spring is damped on a retort stand and a meter rule put besides it as shown below.



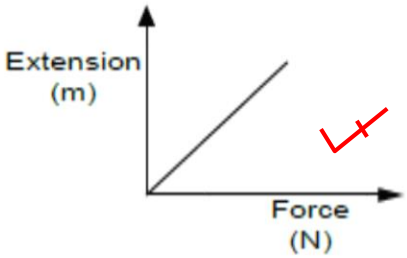
01

- *A pointer is attached at the bottom of the spring and the initial position L_0 of the pointer is noted.*
- *A known mass M is suspended from the spring and new reading L_1 of the pointer is noted.*
- *The extension e, which is equal to $L_1 - L_0$ is obtained.*
- *The procedure is repeated for about five increasing values of the mass.*
- *The values are tabulated as shown below.*

03

Mass(kg)	Force(N)	New position Of pointer	Extension $e = L_1 - L_0$

A graph of extension against force is plotted.



03

A straight line through the origin shows that extension is directly proportional to the force and this verifies Hooke's law

(iii) A spring produces an extension of 6mm when load of 9N is suspended from its free end. What load would cause the same spring to stretch by 16mm

From $\frac{e1}{F1} = \frac{e2}{F2}$

$\frac{6}{9} = \frac{16}{F2}$ 03

$F_2 = 24N$

3. (a) (i) What is meant by the term thermometric property?

This is a physical property of a substance which varies linearly and continuously with temperature.

(ii) Apart from mercury, give one other example of thermometric liquid.

Alcohol

(iii)Give two reasons why mercury is used in thermometers.

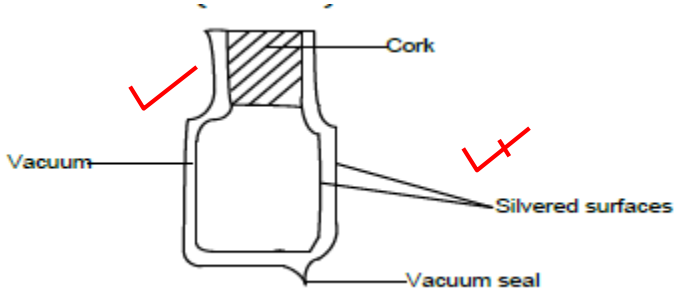
- *It doesn't wet the glass*
- *It is opaque*
- *It expands uniformly*
- *It is a good conductor of heat*

Any two (01)

(b) (i) Distinguish between conduction and convection.

Conduction is the mode of heat transfer in which heat flows through solids from a region of high temperature to a region of low temperature without movement of the material of the medium itself whereas Convection is the mode of heat transfer in which heat flows through fluids from a region of high temperature to a region of low temperature by movement of the fluid itself. 01

(ii) Draw a well labelled diagram of a thermos flask and state the function of each part.



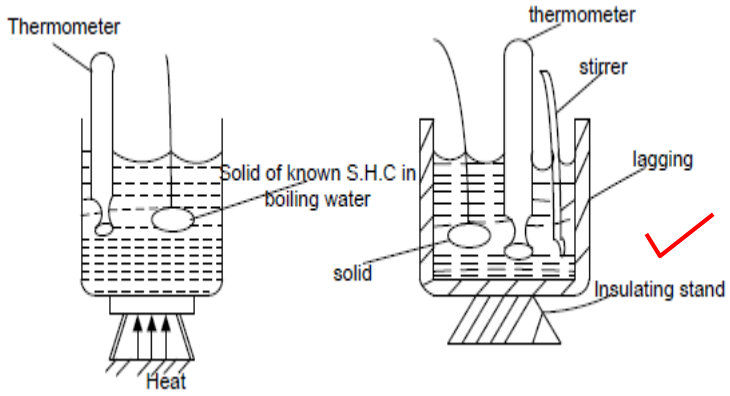
- *The vacuum space minimizes heat loss by conduction and convection.*
- *The silvered glass walls minimize heat loss by radiation.*
- *The cork prevents heat loss by conduction since it is a bad conductor of heat*

03

(i) Define the term specific heat capacity.

This is the amount of heat required to raise the temperature of 1Kg mass of a substance by 1K

(ii) Describe how the specific heat capacity of liquid is determined using the method of mixtures



- *The solid of mass Ms and specific heat capacity C_S in boiling water at temperature θ_1 is transferred to liquid of mass M_L whose specific eat capacityC_L is to be determined in calorimeter of mass M_C and specific heat capacity C_C both at a temperature θ_2.*
- *The mixture is stirred uniformly until final steady temperature θ_3 is obtained*
- *Assuming there is no heat gained by the stirrer and thermometer and no heat is lost to the surrounding.*
- *Heat lost by solid= heat gained by calorimeter +heat gained by liquid*

$$M_S C_S(\theta_1 - \theta_3) = M_L C_L(\theta_2 - \theta_3) + M_c C_c(\theta_2 - \theta_3)$$

$$C_L = \frac{M_S C_S(\theta_1 - \theta_s) - McCc(\theta_2 - \theta_s)}{M_L(\theta_2 - \theta_s)}$$

05

(iii)A copper block of mass 250g is heated to a temperature of 145^0C and then dropped into a copper calorimeter of mass 250g which contains 250g of water at 20^0C. Calculate the maximum temperature attained by the water. (s.h.c of water and copper are 4200JKg^{-1}k^{-1} and 400 JKg^{-1}k^{-1} respectively).

$M_b = 250g = 0.25Kg$

$\theta_1 = 145^0C$

$M_c = 250g = 0.25Kg$

$M_w = 250g = 0.25Kg$

$\theta_2 = 20^0C$

$\theta_3 = ?$

$C_w = 4200JKg^{-1}k^{-1}$

$C_c = 400\ JKg^{-1}k^{-1}$

Assuming no heat is lost to the surrounding,

Heat lost by copper block= heat gained by calorimeter +heat gained by water

$M_b C_c (\theta_1 - \theta_3) = M_c C_c (\theta_3 - \theta_2) + M_w C_w (\theta_3 - \theta_2)$

$0.25 \times 400(145 - \theta_3) = 0.25 \times 400(\theta_3 - 20) + 0.25 \times 4200(\theta_3 - 20)$

$14500 - 100\theta_3 = 100\theta_3 - 2000 + 1050\theta_3 - 21000$

$1250\theta_3 = 37500$

$\theta_3 = 30^0C$

03

4. (a) Define:

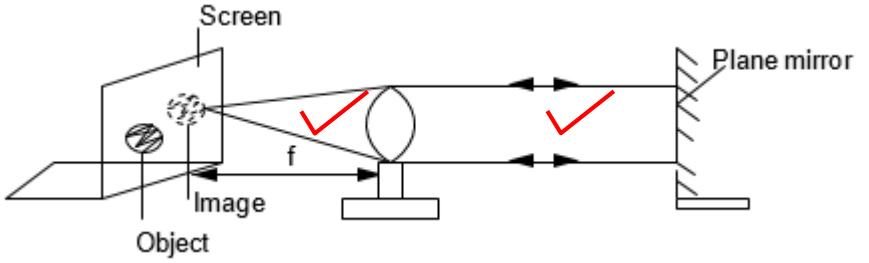
(i) The principal focus of a converging lens.

This is a point on the principal axis to which light rays originally parallel and close to the principal axis converge after refraction at the lens surfaces. 01

(ii) A virtual mage.

This is an image that cannot be formed on the screen. 01

(b) With the aid of a labeled diagram, describe a simple experiment to determine the focal length of a converging lens.



02

- *Place a plane mirror vertically facing a screen with a wire gauze.*
- *Place a converging lens on a lens holder.*
- *Move the lens between the mirror and the screen until a sharp image of the wire gauze is formed on the screen.* 03
- *Measure the distance between the screen and the lens and this is the focal length.*

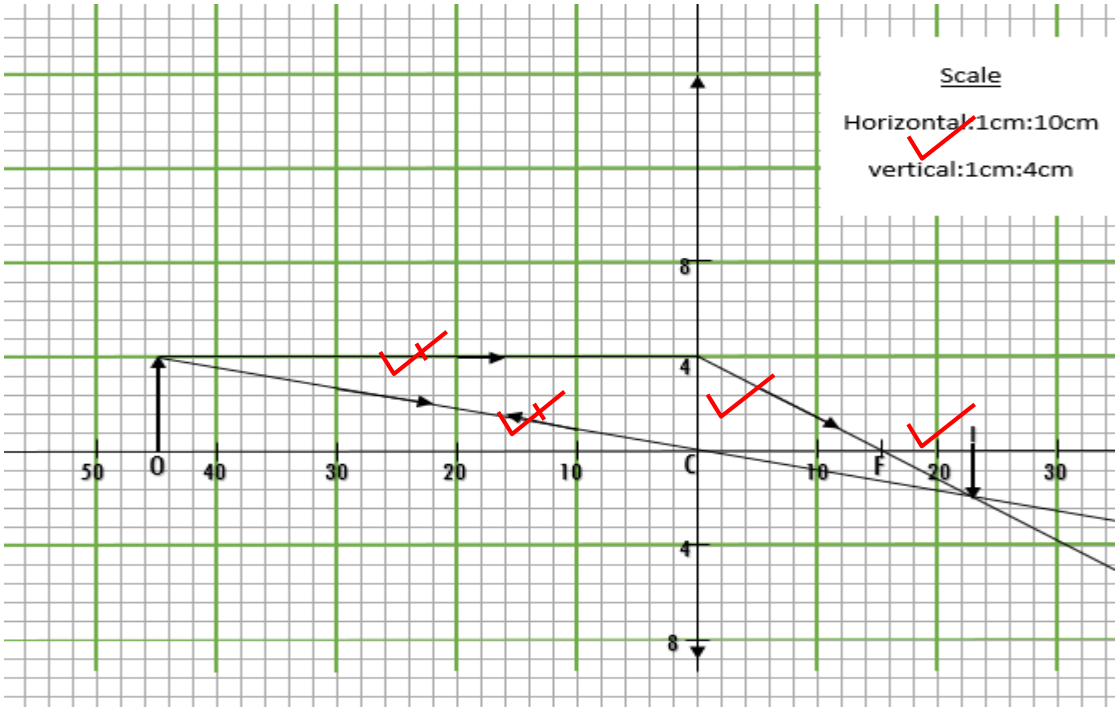
(c) An object of height 4cm is placed perpendicularly on the principal axis at a distance of 45cm from the converging lens of focal length of 15cm. By graphical construction determine:

(i) The position of the image.

$h_0 = 4cm$

u = 45cm

f = 15cm



04

From the graph, v = 22.5cm

(ii) The magnification.

03

Magnification $= \frac{v}{u} = \frac{22.5}{45}$

Magnification = 0.5

(iii) Give two uses of converging lenses.

- *They are used in cameras.*
- *They are used in microscopes*

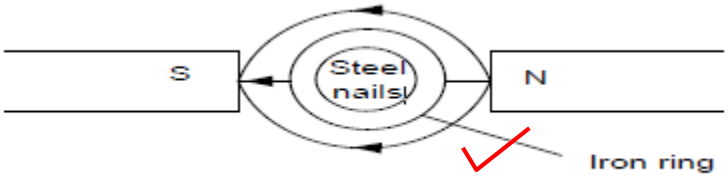
02

5.(a) What is meant by magnetic saturation?

This is when the strength of a magnet cannot be increased beyond a certain limit. 01

(b) With the aid of a diagram, explain what is meant by magnetic shielding.

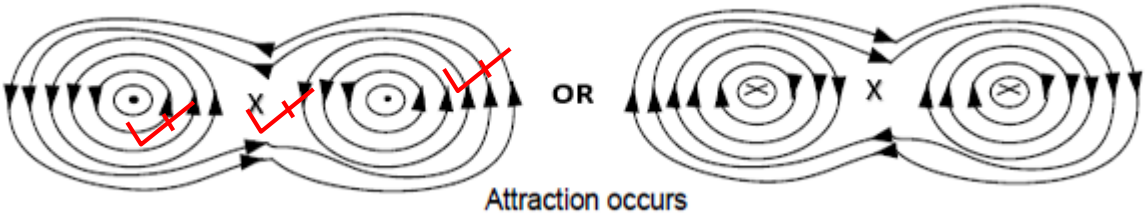
This is the preventing of magnetic field lines from passing through a given area. It is achieved by placing a piece of iron ring in the magnetic field. All the magnetic field lines pass through the part of iron and not in the space inside the ring.



02

(c) Draw a diagram to show the magnetic field patterns resulting from two straight conductors placed vertically near each other carrying a current in:

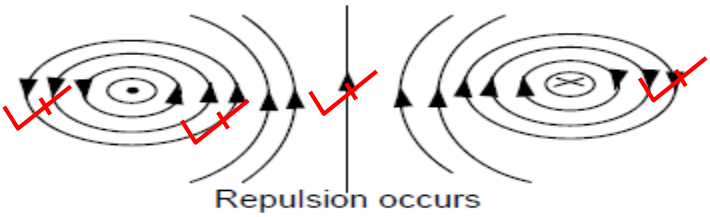
(i) The same direction.



02

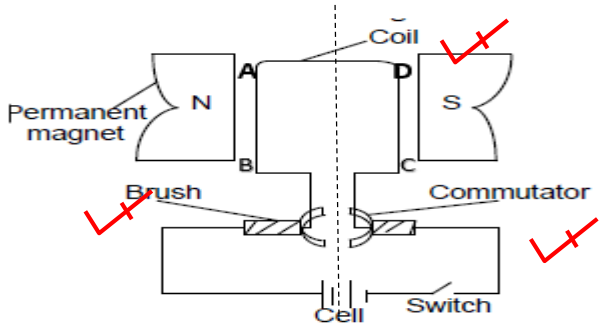
X – neutral point

(ii) Opposite directions.



02

(d) (i) Draw a labeled diagram to show the essential parts of a simple d.c. motor and explain how it works.



02

working

- *When current is switched on, side AB experiences a down ward force and DC an upward force according to Flemings left hand rule.*
- *The two forces form a couple that rotates the coil in an anticlockwise direction.*
- *When the coil reaches the vertical position, the brushes lose contact with the commutators and current stops flowing but the coil continues to rotate due to the momentum gained.*
- *The coil continues to rotate until current is switched off.*

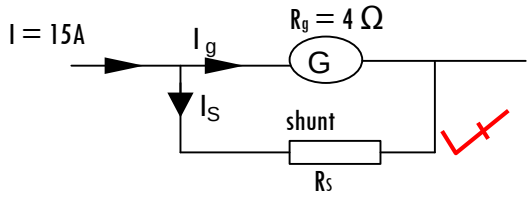
03

Give any two ways in which the power generated by the d.c. motor may be increased.

- *By using strong magnets.*
- *By increasing the strength of electric current*
- *Increasing the number of turns on the armature.*

Any two (02)

(e) A moving coil galvanometer has a coil of resistance 4 Ω and gives a full-scale deflection of 25 mA. Find the value of the resistance required to convert to an ammeter which reads 15A at full-scale deflection.



Current through galvanometer $I_g = 25 \times 10^{3} A$

$= 0.025A$

Current through shunt $I_S = I - 0.025$

$= 15 - 0.025$

$= 14.975A$

From $V = IR$

Sice the galvanometer and the shunt are in parallel,

p.d across the galvanometer = p.d across the shunt

$V_g = V_s$ *02*

$I_g R_g = I_s R_S$

$0.025 \times 4 = 14.975 R_s$

$R_s = 0.0083\Omega$

6. (a) What is meant by a longitudinal wave and a Transverse wave. Give an example each.

A longitudinal wave is one in which the direction of vibration of the particles of the medium is parallel to that of travel of the wave. *01*

Examples include:

Any one($\frac{1}{2}$)

- *Sound waves*
- *Waves due to stretched or compressed springs*

A transverse wave is one in which the direction of vibration of the particles of the medium is perpendicular to that of travel of the wave. *01*

Examples include

- *Water waves*
- *Light waves*
- *Waves due plucked strings*
- *All electromagnetic waves*

Any one($\frac{1}{2}$)

(b) A vibrator in a ripple tank vibrates at $5Hz$. If the distance between 10 successive crests is $37.8cm$, calculate,

(i) The wavelength of the wave.

f = 5Hz
number of wave length, n = 10 -1 = 9λ
9λ = 37.8
λ =4.2cm = 0.042m

03

(ii) the velocity of the wave

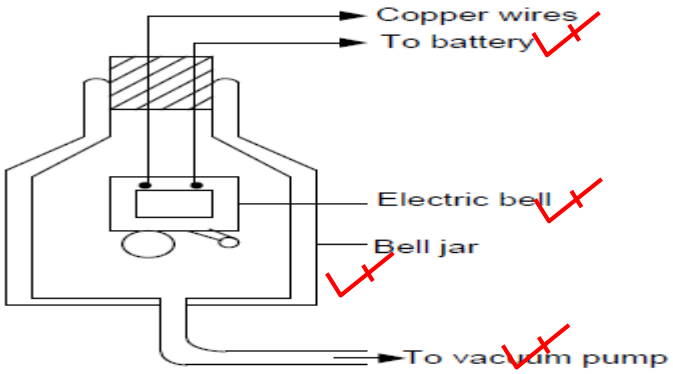
from v = λf,
v = 0.042 x 5
v = 0.21ms^{-1}

03

(c) Explain why open pipes are preferred to closed pipes in producing sound.

Open pipes form complete harmonic series (both odd and even harmonics) compared to closed pipes that produce only odd harmonics and since the quality of sound depends on the number of harmonics, then open pipes produce better quality sound than closed pipes. *02*

(d) Describe a simple experiment to demonstrate that sound waves require a material for their transmission.



02

- *When an electric bell is switched on, a loud sound is heard.*
- *But when the air inside the jar is gradually removed by means of a vacuum pump, the loudness of the sound heard gradually reduces.*
- *When all the air has been completely removed from the jar, no sound is heard even when the bell is still switched on.*
- *This shows that sound waves need a material medium such as air for their transmission.*

03

7. (a) Define the following terms as used in machines.

(i) Mechanical advantage

This is the ratio of load to effort. *01*

(ii) Efficiency

This is the ratio of work output to work input expressed as a percentage *01*

OR it is a ratio of mechanical advantage to velocity ratio expressed as a percentage

(b) (i) Give two reasons why machines are never 100% efficient.

- *Some energy is wasted in overcoming friction.*
- *Some energy is wasted in carrying the moving parts of the machine.* *01*

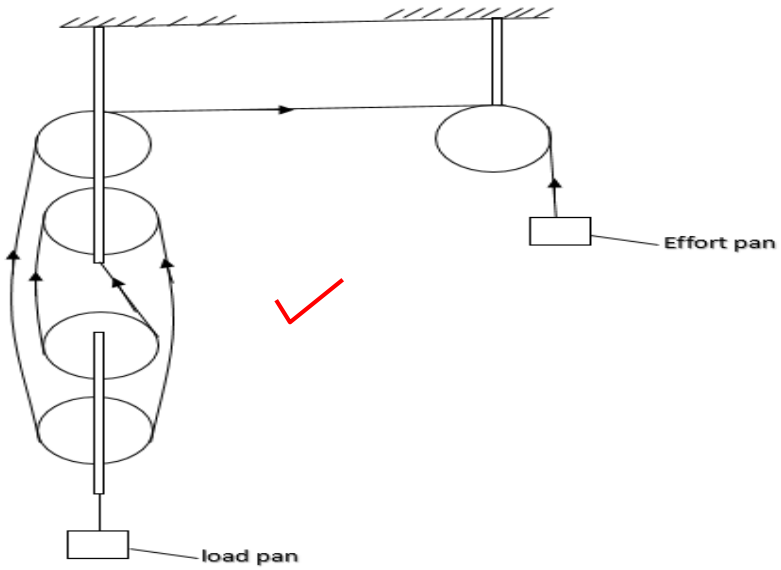
01

(iii) How can one improve on the efficiency of a machine?

- *By using a light string.*
- *By oiling the moving parts to reduce friction*

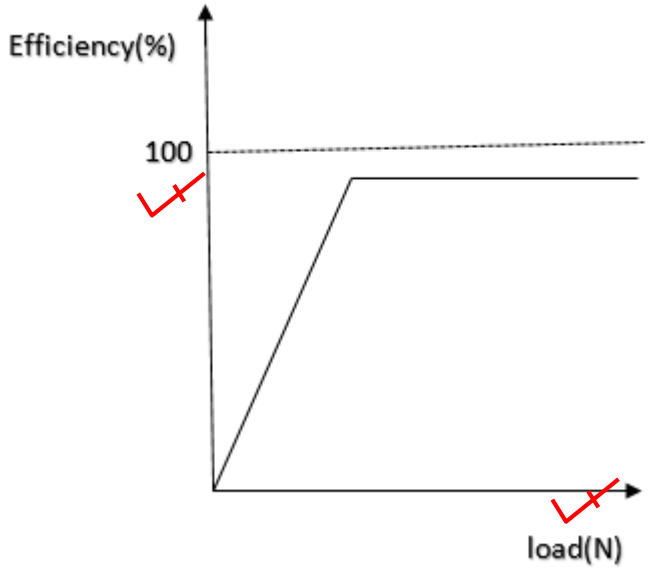
02

(c) Describe an experiment to investigate how the efficiency of a block and tackle pulley system varies with the load it is used to lift.



01

- *The pulleys are set up as shown above.*
- *An initial load is put on the load pan.*
- *Masses are added to the effort pan one at a time until the load just moves slowly with a steady velocity.*
- *The load and the effort are recorded.*
- *The experiment is repeated using various loads and the results are recorded in the table including values of mechanical advantage and efficiency.*
- *A graph of efficiency against load is plotted.*



04

- *The graph shows that efficiency is directly proportional to the applied load.*

(d) A block and tackle pulley system with a velocity ratio of 5 and 60% efficiency is used to lift a load of mass $60kg$ through a vertical height of $2m$

(i) What effort must be exerted?

V.R = 5

Efficiency = 60%

Load = 60 x 10 = 600N

Load distance = 2m

$$\text{From efficiency} = \frac{\text{mechanical advantage}}{\text{velocity ratio}} \times 100\%$$

$$60 = \frac{\text{mechanical advantage}}{5} \times 100$$

Mechanical advantage = 3

02

(ii) How much work is done in lifting the load?

Work done = load x load distance

= 600 x 2 = **1200J**

01

(iii)How much energy is wasted?

$$\text{From efficiency} = \frac{\text{work output}}{\text{work input}} \times 100\%$$

$$60 = \frac{1200}{\text{work input}} \times 100$$

Work input = 2000J

Energy wasted = work input – work output

= 2000 – 1200

= 800J

02

8.(a) What is meant by e.m.f. of a battery?

This is the terminal potential difference across an open circuit.

01

(b) State the use of an earth wire on an electrical device.

It is used to prevent electric shocks

01

(c) State how each of the following factors will affect the resistance of a wire:

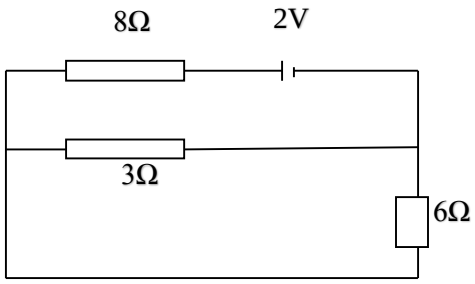
(i) Increasing the length of the wire.

The longer the wire, the higher the resistance. 02

(ii) the cross-sectional area.

The thinner the wire, the higher the resistance and the thicker the wire, the lower the resistance 02

(d) Resistors of 8Ω, 6Ω and 3Ω are connected as shown in figure 1 across a battery of emf 2V and of negligible internal resistance.



Calculate the current through the 8Ω resistor

Total resistance

Considering the 6Ω and the 3Ω resistors

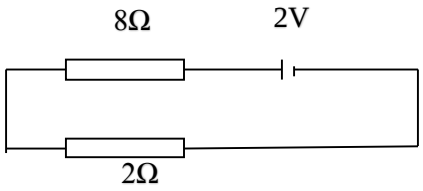
$\frac{1}{R1} = \frac{1}{6} + \frac{1}{3}$

$\frac{1}{R1} = \frac{3+6}{18}$

$9R_1 = 18$

$R_1 = 2\Omega$

The circuit now looks like the one below



In this circuit the 8Ω and the 2Ω are now in series

Therefore, total resistance, R = 8 + 2 = 10Ω

Current through the 8Ω is the total current.

From E= I (r + R)

2 = I (0 + 10)

I = 0.2A 06

(e) A negatively charged cloud passes over a building with a lightning conductor during a thunderstorm. Explain how the building is protected against lightning.

- *When a negatively charged cloud passes over the spikes, it induces positive charges on the spikes.*
- *The positive charge on the spikes together with the negatively charged clouds give an intense electric field that ionizes the air molecules between them.*
- *The positive ions are repelled by the positively charged spikes towards the clouds as space charge which neutralizes the negative charge on the cloud hence reducing its dangerous effect* 04

THE END