UGANDA CERTIFICATE OF EDUCATION 2020

PHYSICS 535/2 MARKING GUIDE

1. (a) State **two** differences between mass and weight. *(02 marks)*

(b) Explain why the variation of weight of a body in two different places on earth's surface can be detected by a sensitive spring balance but not a beam balance. *(04 marks)*

(c) A metal block of mass 20 kg comes to rest in 3 s after sliding through a distance of 9 m along a horizontal floor. Assuming that the block is retarded uniformly, find the;

(i) retardation. *(04 marks)*

(ii) initial kinetic energy. *(04 marks)*

(d) State **two** ways by which friction in (c) above can be reduced. *(02 marks)*

Solution

(a) - Mass is constant while weight varies from place to place**;**

- Mass is a scalar quantity while weight is a vector quantity**;**

- Mass is measured in kg while weight is measured in newtons (N)

- Mass is quantity of matter a body contains while weight is the measure of the gravitational pull of the earth on a body

- Mass is measured using a beam balance while weight is measured using a spring balance

- Mass is a fundamental quantity while weight is a derived quantity ***(First two)***

(b) Measurement by a spring balance depends on the streching of the string by the gravitational force on the body**;** Variation in the gravitional force will therefore cause a difference in the spring balance reading**;** Abeam balance compares the turning effect of the two forces acted upon by the same gravitational force**;**

(c) (i) $v = u + at$**;**

$0 = u + 3a$

$u = -3a$ …… (i)**,**

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

Therefore $9 = -9a + \frac{1}{2}xax3^2$**,** Implying that $a = -2\ ms^{-2}$**;**

(ii) From (i) $u = -3(-2) = 6\ ms^{-1}$**;**

Also $kinetic\ energy = \frac{1}{2}mu^2$**;** $= \frac{1}{2}\ x\ 20\ x\ 6^2$**;** $= 360\ J$**;**

(d) Friction can be reduced by

- Applying oil or grease between surfaces**;**
- Applying rollers**;**
- Applying ball bearing
- Polishing surfaces/smoothening ***(First two)***

2. (a) State **Snell's law** of refraction of light. *(01 mark)*

(b) A ray of red light is incident onto a liquid-air boundary as shown in figure **1**.

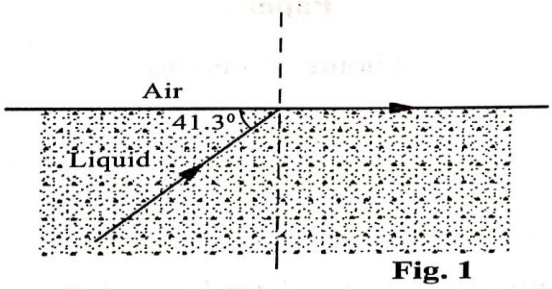


Fig. 1

(i) Find the critical angle for the liquid. *(01 mark)*

(ii) Calculate the refractive index of the liquid. *(02 marks)*

(c) An object 12 cm tall is placed perpendicularly on the principal axis of a convex mirror of a focal length 10 cm. If the object is 16 cm away from the pole of the mirror, find the position and magnification of the image formed by graphical method. *(06 marks)*

(d) (i) What is meant by **dispersion** of light? *(01 mark)*

(ii) A ray of white light is directed towards red (***R***) and blue (***B***) filters arranged as shown in figure **2**.

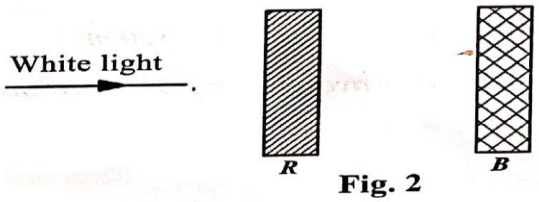


Fig. 2

State the colours between R and B, and after B. *(02 marks)*

(e) State three difference between a lens camera and a human eye (3 marks)

Solution

(a) The ratio of the sine of the angle of incidence to the sine of the angle of refraction for a given pair of media is a constant**;**

(b) (i) Critical angle $c = 90 - 41.3 = 48.7^o$**;**

(ii) $n = \frac{1}{\sin c}$**,** $= \frac{1}{\sin 48.7}$**,** $= 1.33$**;**

(c)

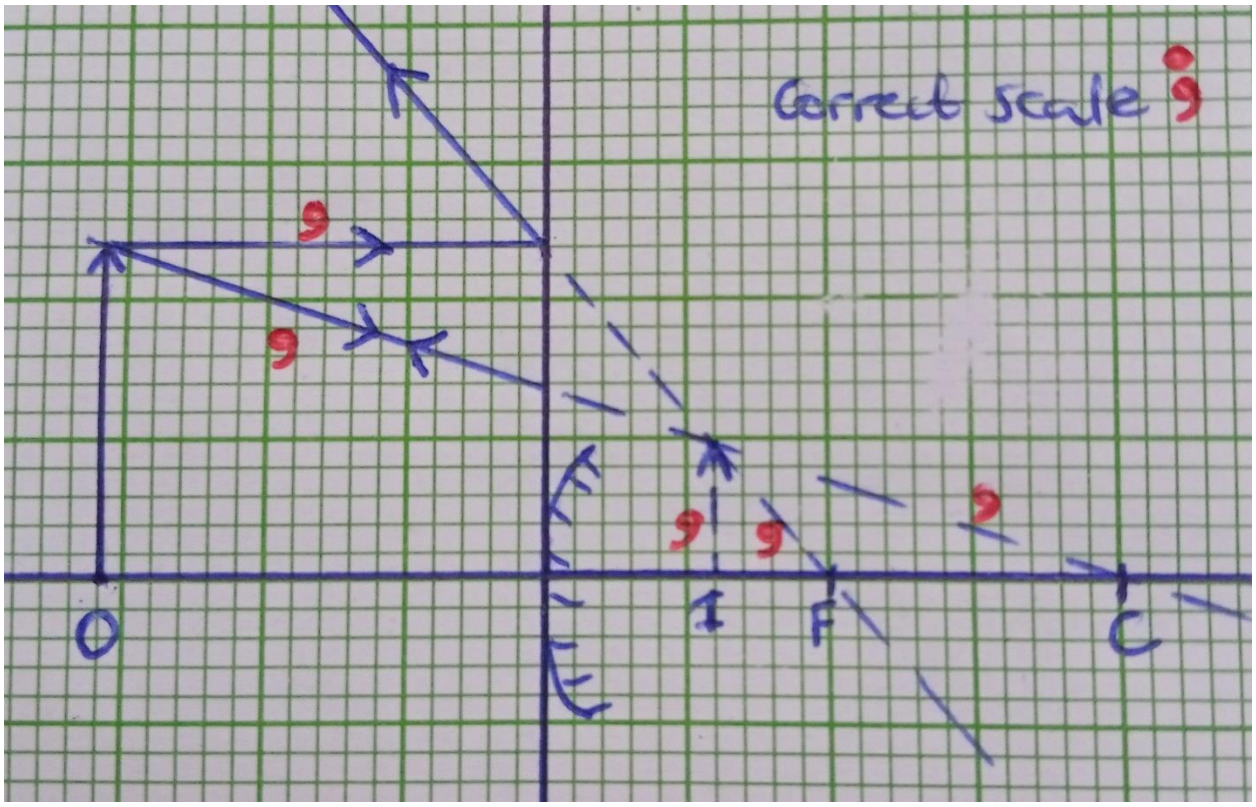


Image distance $= 6.0 \pm 0.2$;

Magnification $\frac{image\ distance}{object\ distance}$, $= \frac{6.0}{16} = 0.375$;

(d) (i) Dispersion is the splitting of white light into its component colours;

(ii) Red colour is seen between R and B;

No colour is seen after the blue filter;

(e) - Focal length of a lens camera is constant and that of the eye is variable;

- Distance between the lens and film is variable for the lens while in the eye distance between the lens and retina is fixed;

- The camera lens is artificial while that of the eye is natural;

- The camera lens is rigid while that of the eye is flexible

- Camera focuses by varying position of the lens while eye focuses by varying shape of the lens ***(First Three)***

3. (a) A capillary tube is dipped into water in a container and another identical capillary tube is also dipped in mercury in a container.

(i) Draw diagrams to show the heights and shapes of each liquid meniscus in the respective tubes. *(02 marks)*

(ii) Use the molecular theory to explain the behaviour in (a) (i). *(02 marks)*

(b) Describe an experiment to demonstrate diffusion in gases. *(04 marks)*

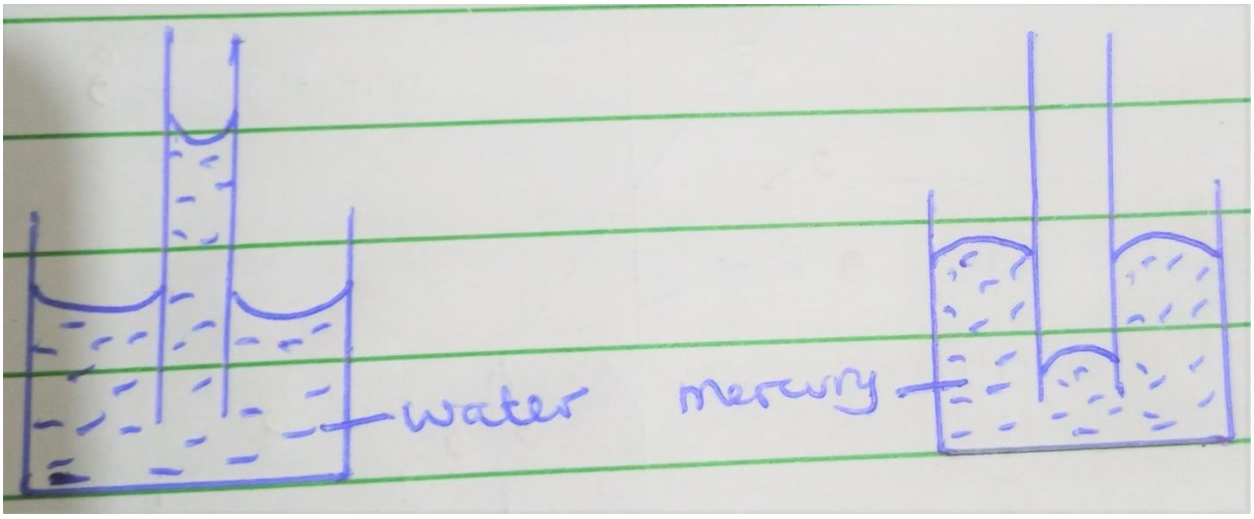
(c) A 10 kg mass of iron at 70 °C is dropped into water in a container. If the mass of water is 20 kg and its temperature is 10 °C before the iron is added, calculate the final temperature of the mixture.
(*Specific heat capacity of water = 4200 $Jkg^{-1}K^{-1}$, Specific heat capacity of iron = 450 $Jkg^{-1}K^{-1}$*) *(04 marks)*

(d) (i) Sketch and describe the shape of a graph of volume against temperature for an ideal gas. *(02 marks)*

(ii) Using your sketch graph in (d) (i), explain the concept of **absolute zero** of temperature. *(02 marks)*

Solution

(a) (i)



(ii) Water shows a rise and a concave curvature in the cappillary tube because the adhesive forces are stronger than its cohesive forcws**;**

Mercury shows a fall and a convex meniscus because cohesive forces are stronger than the adhesive forces**;**

(b) Brown nitrogen gas is collected in a gas jar and sedaled with a cover slip**;** Another jar containing air is inverted and placed on top of the cover slip**;** When the cover slip is removed, a brown colour is seen spreading into the top jar**;** containing air. After some time, the brown colour will uniformly spread and fill the two jars**;** thus demostrating diffusion

Alternatively

Cotton wool is soaked in ammonia chloride solution and then inserted into one open end of an glass tube**;** Another piece of cotton wool is soaked into conc. sulpheric acid and then fitted in the other open end of the glass tube**;** The tube is observed for some time**;**

A white ring is formed almost in the middle of the tube showing that hydron and ammonia diffuses towards each other**;** this demostrates diffusion

(c) $Heat\ lost\ by\ iron\ =\ heat\ gained\ by\ water$

Therefore $10x450(70-\theta) = 20x4200(\theta-10)$**;**

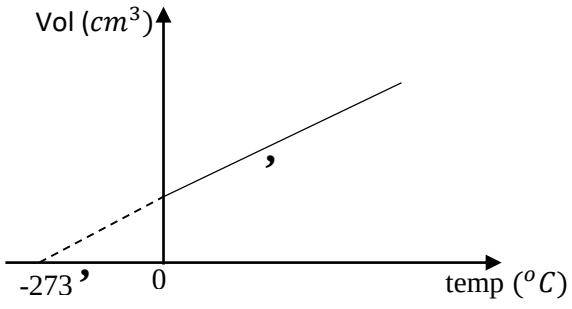
Implying that $4.5(70-\theta)$**;** $= 84(\theta-10)$**;**

So $315-4.5\theta = 840\theta - 840$

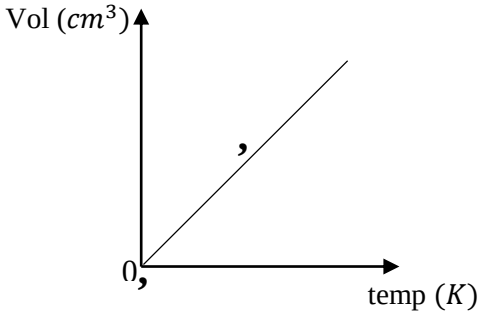
Then $88.5\theta = 1155$

Simplifying gives $\theta = 13.05^{O}C$**;**

(d) (i)



OR



The graph shows that volume of an ideal gas is directly proportional to its temperature**;**

(ii) As the temperature of a gas is reduced, the kinetic energy of the particles reduces**,** and they slow down**,** The particles thereforecome close and the volume reduces. As the temperature reduces further, a point is reached when the particles have zero kinetic energy**,** and theoretical volume is observed. The temperature at which this occures is called the absolute zero temperature**,**

4. (a) Define the following:

(i) Magnetic meridian, *(01 mark)*

(ii) Angle of declination. *(01 mark)*

(b) (i) What is a **magnetic field**? *(01 mark)*

(ii) Sketch the magnetic field pattern around a bar magnet in the earth's field with its north pole facing the geographic south. *(02 marks)*

(c) (i) Using the domain theory, explain the meaning of magnetic saturation. *(02 marks)*

(ii) State **one** disadvantage of magnetising a material by the single touch method. *(01 mark)*

(d) With aid of a diagram, explain how an iron watch between two opposite poles can be kept unmagnetised. *(03 marks)*

(e) (i) What is meant by **rectification**? *(01 mark)*

(ii) With the aid of a circuit diagram, explain how alternating current can be fully rectified using four semiconductor diodes. *(04 marks)*

Solution

(a) (i) Magnetic meridian is the vertical plane containing the magnetic axis of a freely suspended magnet**;**

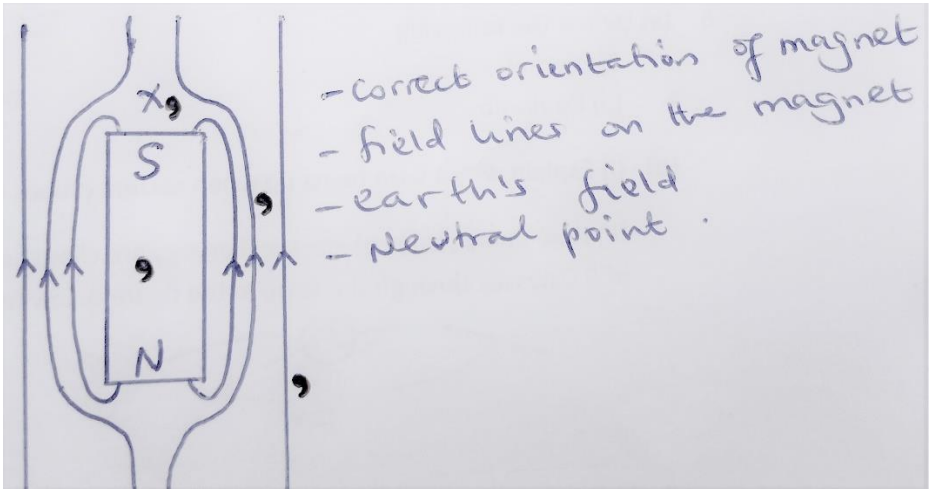
Or It is a plane where a freely suspended magnet sets in the earth's magnetic field

(ii) Angle of declination is the angle between the magnetic meridian and the geographical meridian**;**

Or It is the angle between the magnetic north and the geographic north

(b) (i) Magnetic field is a region around a magnet where magnetic field is felt**;**

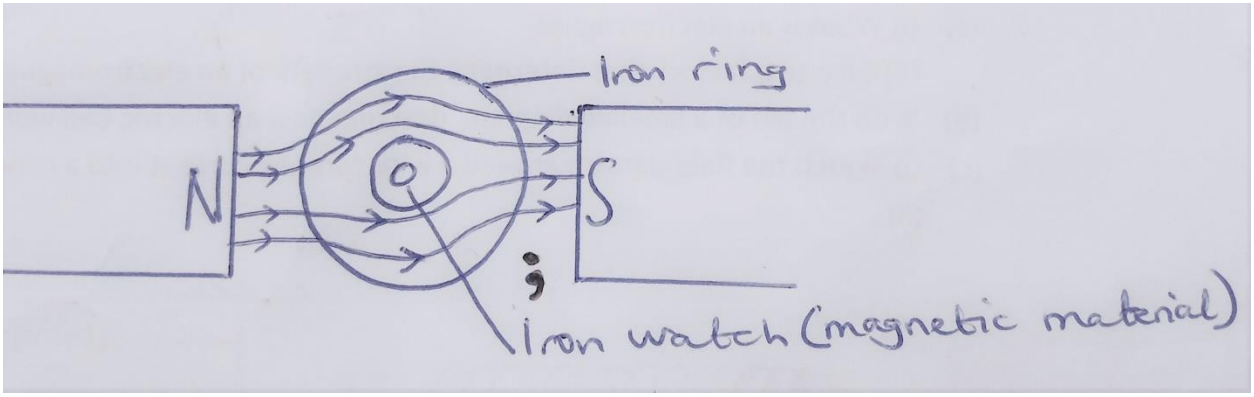
(ii)



(c) (i) Magnetic saturation is a point of maximum strength of a magnet**;** It occurs when all dipoles are perfectly aligned**;** in one direction and the magnetic strength can not be increased further

(ii) It produces a magnet in which one pole is nearer the end of a bar than the other**;** **OR** Produces a weaker magnet **OR** takes long to magnetise

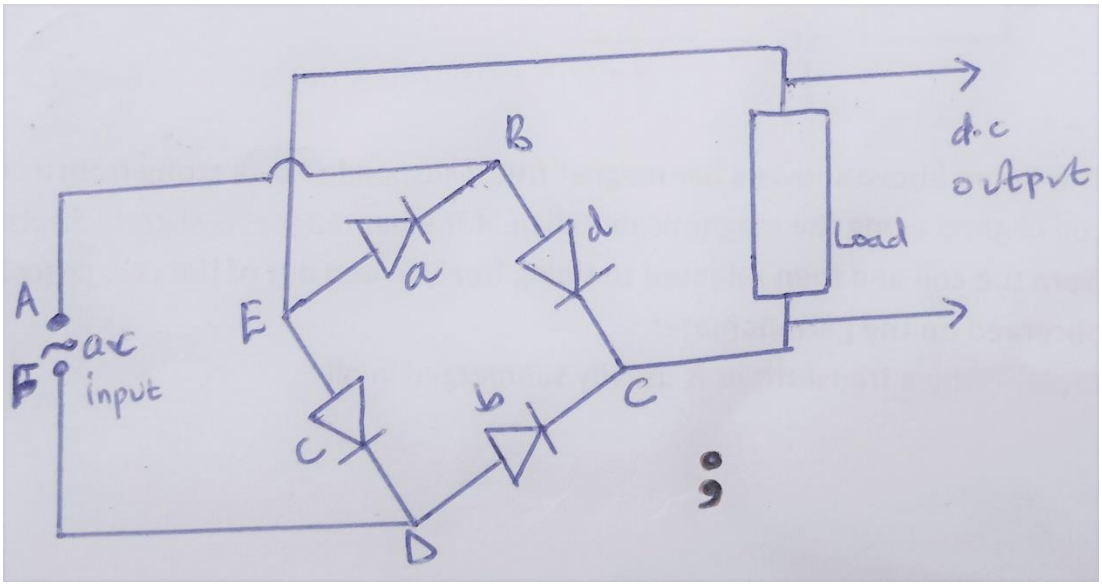
(d)



The iron ring concetrated magnetic field lines to itself**;** hence screening the watch from magnetism**;**

(e) (i) Rectification is the conversion of alternating current to direct current;

(ii)



During the first half cycle when F is positive, diodes b and a conduct. Current fallows the path FDC through the load to EBA;

In the second half cycle when A is positive diodes c and d conduct current and follows the path ABC through the load and then through the path EDF;

In each half cycle current folws through the load in the same diorection;

5. (a) Name the radiations from a radioactive process which;

(i) behaves as electrons. *(01 mark)*

(ii) have the highest penetrating power. *(01 mark)*

(b) What is meant by **nuclear fusion**? *(01 mark)*

(c) Uranium U- 236 undergoes nuclear decay to produce barium, krypton and 2 neutrons according to the following equation.

$$^{236}_{92}U \longrightarrow {}^{144}_{56}Ba + {}^{b}_{a}Kr + 2\,{}^{1}_{0}n + \text{energy}.$$

(i) Find the value of a and b. *(02 marks)*

(ii) State **two** practical applications of nuclear fission. *(02 marks)*

(d) With reference to a cathode ray oscilloscope (CRO);

(i) State the effect of increasing the heating voltage. *(01 mark)*

(ii) State **two** uses of a control grid. *(02 marks)*

(e) An alternating voltage is applied to the Y- plate of a CRO and a section of the waveform produced on the screen is as shown in figure **3**.

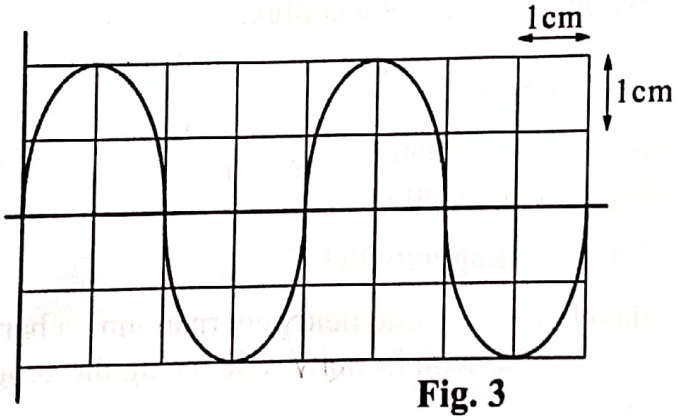


Fig. 3

The time base is set at 0.002 scm^{-1} and Y- gain at 5 V cm^{-1}. Find the

(i) amplitude of the wave. *(02 marks)*

(ii) frequency. *(02 marks)*

(f) State **two** uses of the CRO. *(02 marks)*

Solution

(a) (i) Beta particles**;** (ii) Gamma rays**;**

(b) This is the combining/union/joining of two lighter nuclei to form a heavy nucleus with release of energy**;**

(c) (i) $a + 0 + 56 = 92$ implying that $a = 92 - 56 = 36$**;**

$b + 2 + 144 = 236$ implying that $b = 236 - 146 = 90$**;**

(ii) - Generation of electricity**;**

- Making of atomic or nuclear bomb**;**

(d) (i) Production of more electrons thermionically**;**

(ii) Regulates the number of electrons passing on to the screen**;**

Regulates the brightness of the spot**;**

(e) (i) Amplitude $a = 2\ cm$**,** Therefore $a = 2\ x\ 5$**,** $= 10\ V$**;**

(ii) Frequency, period $T = 4cm$**,** So $T = 4x\ 0.002 = 0.008\ s$**,**

Therefore $f = \frac{1}{T} = \frac{1}{0.008} = 125\ Hz$**;**

(f) - Mesurement of frequency**;**

- Mesurement of voltage**;**
- Mesurement of small time intervals
- Used in Tv screens
- Used in computer monitors
- Measurement of phase difference
- Displying of wave forms ***(First two)***

6. (a) (i) Differentiate between **polarisation** and **local action** as applied to a simple cell. *(02 marks)*

(ii) Describe briefly, how polarisation and local action can be minimised. *(02 marks)*

(iii) State **two** advantages of a lead-acid accumulator over a dry cell. *(02 marks)*

(b) (i) What is meant by **internal resistance** of a cell? *(01 mark)*

(ii) Describe, with the aid of a diagram, a simple experiment to measure the resistance of a resistor. *(04 marks)*

(c) A cell has an e.m.f, E, and internal resistance, r. When resistors of resistances 2 Ω and 5 Ω are connected in turn across the cell, current of 0.5 A and 0.25 A are respectively obtained in the circuit.

Calculate the;

(i) e.m.f, E of the cell. *(03 marks)*

(ii) internal resistance, r, of the cell. *(02 marks)*

Solution

(a) (i) Polarisation is a defect in a cell resulting into formation a layer of hydrogen bubbles on the copper plate weakening current**;**

Local action in a cell is caused by the formation of hydrogen bubbles at the zinc plate**;**

(ii) Polarisation can be minimised byadding a depolisor eg manganese (iv) oxide or pottasium dichromate OR brushing off the bubbles**;**

Local action is minimised by cleaning the zinc plate in sulpheric acid and the rubbing with mercury**;**

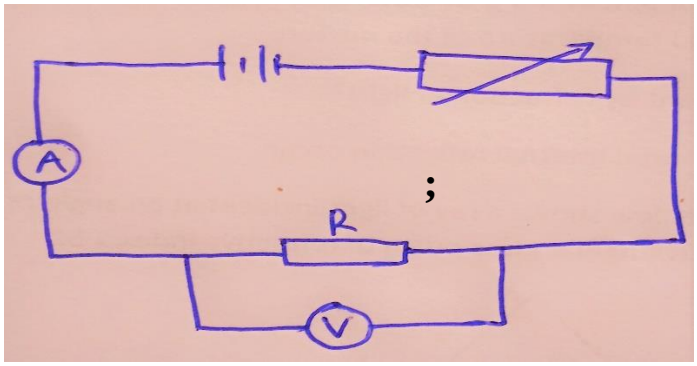
(iii) Lead acid accumulator

- Have a low internal resistance than a dry cell**;**
- Produces a lager current than a dry cell**;**

- Can be recharged unlike a dry cell
- Have a higher voltage than a dry cell ***(First two)***

(b) (i) Internal resistance is the opposition to the flow of current through a cell

(ii)



Connect the circuit as shown. For the position of the rheostat, read the ammeter reading I**,** and voltmeter reading V**,**

Repeat this for various values of I and V by adjusting the rheostat**;**

Plot a graph of V agaist I**,**

Find the slope S of the graph

The slope S = R the value of the resistance of the resistor R**,** is obtained

(c) (i) From $E = I(R + r)$

So $E = 0.5(2 + r) \ldots\ldots\ldots\ldots (i)$**,** And $E = 0.25(5 + r) \ldots\ldots\ldots\ldots (ii)$**,**

Solving the above equations $(i) \div (ii)$

Implies $\frac{0.5(2+r)}{0.25(5+r)} = 1$**,**

Therefore $2(2 + r) = (5 + r)$

Then $4 + 2r = 5 + r$**,**

Giving $r = 1\Omega$

From (i) $E = 0.5(2 + 1) = 0.5x3 = 1.5\,V$**;**

(ii) internal resistance $r = 1\Omega$**;;**

7. (a) State the **principle of moments.** *(01 mark)*

(b) Figure **4** represents a uniform bar ***AB*** of negligible weight pivoted at point ***P***.

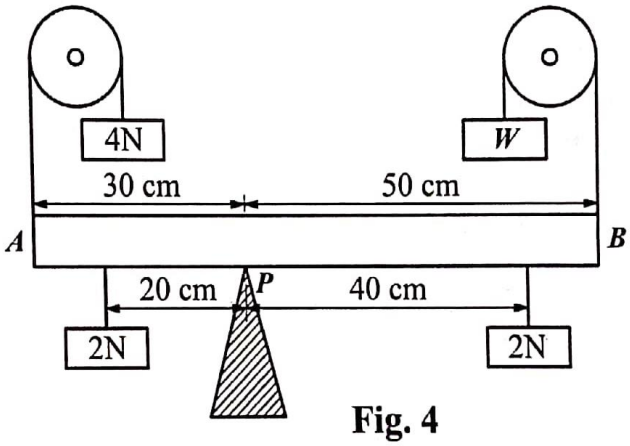


Fig. 4

The bar is in equilibrium under the action of the forces shown. Find the force *W*. *(03 marks)*

(c) An inclined plane of length 4 m is used to raise a load of mass 20 kg through a vertical height 1 m. It is found that an effort of 80 N is needed to move the mass up the slope at a constant speed.

(i) Explain how the 80 N force may be applied. *(01 mark)*

(ii) What is the velocity ratio of the system? *(03 marks)*

(iii) Calculate the efficiency of the system. *(03 marks)*

(d) Given a metre rule, 100 g mass, a piece of thread and a knife edge, describe how they can be used to determine the mass of a banana. *(05 marks)*

Solution

(a) When a body is in equilibruim, the sum of clockwise moment equals the sum of anmticlockwise moment about the same point**;**

(b) From $Sum\ of\ clockwise\ moments\ =\ sum\ of\ anticlockwise\ moments$**;**

Therefore $(2x40) + (3x30) = (2x20) + 50xW$**);**

So $200 \ = \ 40 \ + \ 50W$

This gives $W \ = \ \frac{160}{50} \ = \ 3.2 \ N$**;**

(c) (i) The force of 80 N ia applied by pulling the block along the inclined plane**;**

(through a distance of 4 m)

(ii) $Velocity \ Ratio \ VR = \ \frac{distance \ moved \ by \ the \ effort}{distance \ moved \ by \ the \ load}$**;** $= \ \frac{4}{1}$**;** $= \ 4$**;**

(iii) $Efficiency, \eta = \ \frac{MA}{VR} x100\%$**;**

Therfore $\eta = \ \frac{\frac{200}{80}}{4} x100\%$**;**$= \ 62.5\%$**;**

(d) Place a metre rule on a knife edge and adjust it until it balances**,** note the balance point**,** Hang the banana of unknown mass m at a known distance d_1**,** from the pivot using a thread

Hang a $100 \ g$ mass also using a piece of thread on the other side of the metre rule**,** and adjust it until the metre rule balances**,** again. Measure the distance d_2**,** of its position from the pivot.

For the body to balance, $d_1 xm \ = \ 100x \ d_2$**;**

The mass of the banana m can be calculated from $\boldsymbol{m \ = \ \frac{100x \ d_2}{d_1}}$**;**

8. (a) (i) What are **electromagnetic waves**? *(01 mark)*

(ii) State **three** ways in which electromagnetic waves differ from sound waves. *(03 marks)*

(b) (i) Derive an equation that relates wavelength, frequency and velocity of a wave. *(03 marks)*

(ii) The distance between two successive crests of ripples traveling across water surface is 30 mm. If the waves travel 252 mm in 1.5 s, calculate the frequency of the source producing the ripples. *(03 marks)*

(c) (i) What is meant by **pitch** of a sound wave? *(01 mark)*

(ii) State **two** factors on which frequency of a sound note of a vibrating string depends. *(02 marks)*

(d) Explain why sound is fainter at high mountains than at sea level assuming temperature is constant at both places. *(03 marks)*

Solution

(a) (i) Electromagnetic waves are wavesconsisiting of vibrating/oscillating electric and magnetic fields**;**

(ii)

Electromagnetic waves	Sound waves
- Are transverse - Can pass through a vacuum - Travel at a high speed - Can be polarised - Produced by oscillating electric and magnetic fileds	- Are longitudinal**;** - Cannot pass through vacuum**;** - Travel at a slow speed**;** - Can not be polarised - Produced by oscillating particles

(First three)

(b) (i) Let the number of cycles madee in $1\ s = f$, and time taken to make 1 cycle be T,

But in time T, the distance covered by the cycle is λ,

From $Speed = \frac{distance}{time}$

It implies that $V = \frac{\lambda}{T}$, But $T = \frac{1}{f}$,

Therefore $V = f\lambda$,

(ii) $\lambda = 30mm$, And $Wave\ speed = \frac{252}{1.5}, = 168\ mms^{-1}$,

From $f = \frac{V}{\lambda}$, Therefore $f = \frac{168}{30} = 5.6\ Hz$;

(c) (i) Pitch is the higness or lowness of sound;

Or Pitch is the sharpness or mildness of sound

(ii) - mass per unit length;

- Thickness of the string;

- Tension in the string

- Length of the string ***(first two)***

(d) At the top of a high mountain, air density is low; where the air molecules are further apart compared to the density at sea level.

This implies that the sound energy is not easily transferred or transmitted from one molecule to another; thus sound gets fainter as the air density decreases;