510/2
PHYSICS
Paper 2
Nov, 2023
2 Hours

END OF YEAR EXAMINATIONS
Uganda Advanced Certificate of Education
S.5 PHYSICS
Paper 2
2 Hours

INSTRUCTIONS:

- Attempt any **four (04)** questions in this paper, choosing **at least one but not more than two** from each of the sections ***A*** and ***B***.
- Do **not** use a pencil **except** for drawings. Any work done in pencil will **not** be marked.
- Silent non-programmable calculators may be used.
- Where necessary, assume;
  - Acceleration due to gravity g $= 9.81ms^{-2}$.
  - Electronic charge *e* $= 1.6 \text{ x } 10^{-19}C$.
  - Electron mass $= 9.11 \text{ x } 10^{-31}kg$.
  - Density of air $= 1.25kgm^{-3}$.
  - Plank's constant *h* $= 6.6 \text{ x } 10^{-34}Js$.
  - Avogadro's number N_A $= 6.02 \text{ x } 10^{23}mol^{-1}$.
  - Density of water $= 1000kgm^{-3}$.
  - Specific heat capacity of water $= 4200Jkg^{-1}K^{-1}$.
  - Speed of light in air $= 300ms^{-1}$.
  - Speed of light in vacuum *c* $= 3.0 \text{ x } 10^{8}ms^{-1}$.
  - Permeability of free space μ_0 $= 4.0\pi \ x \ 10^{-7}Hm^{-1}$.
  - Permittivity of free space ε_0 $= 8.85 \ x \ 10^{-12}Fm^{-1}$.
  - The electron volt *eV* $= 1.6 \ x \ 10^{-19}J$.
  - The constant $\frac{1}{4\pi\varepsilon_0}$ $= 9.0 \ x \ 10^{9}F^{-1}m$.

SECTION A

1. (a) (i) Distinguish between **a shadow** and **an image** **(02 marks)**

(ii) Using a ray diagram show that the image formed by a plane mirror is as far behind the mirror as its object is in front of the mirror. **(03 marks)**

(b) Derive the mirror formula for a spherical mirror. **(05 marks)**

(c) Describe an experiment to determine the focal length of a convex mirror using a converging lens. **(05 marks)**

(d) A rod, 80cm long, is laid along the principal axis of a diverging mirror of focal length 30 cm. If the nearest end of the rod is 40 cm from the mirror, find the length of the image of the rod **(05 marks)**

2. (a) What is meant by

(i) ***refractive index*** of a medium? **(01 mark)**

(ii) ***total internal reflection*** of light? **(01 mark)**

(b) (i) Explain why a pool of water looks shallower. **(03 marks)**

(ii) Describe an experiment to determine the refractive index of liquid using an air-cell. **(05 marks)**

(c) A ray of light is incident at a small angle if incidence on a prism of small angle, A. If the refractive index of the prism material is n, derive an expression for the deviation produced. **(04 marks)**

(d) A ray of light is incident on a prism of refractive index 1.5 and refracting angle 60^o. The ray emerges from the prism at an angle of 65^o. Find

(i) the angle of incidence **(04 marks)**

(ii) the deviation of the ray **(02 marks)**

3. (a) For a converging lens, what is meant by

(i) **principal axis** **(01 mark)**

(ii) **principal focus** **(01 mark)**

(b) A lens of focal length f forms an image on a screen of an object which is at a distance y from the screen. Derive an expression for the distance y for the image to always be real. **(04 marks)**

(c) Describe an experiment to determine the focal length of a diverging lens with the help of a converging mirror. **(05 marks)**

(d) What is meant by the following?

(i) **Visual angle** **(01 mark)**

(ii) **Angular magnification** of an instrument **(01 mark)**

(e) (i) Draw a ray diagram to illustrate how a Galilean telescope forms a final virtual image 30 cm from the eyepiece. **(02 marks)**

(ii) Derive an expression for the angular magnification of the arrangement in (d) (i). **(03marks)**

(iii) State two advantages of this telescope over a terrestrial telescope. **(02 marks)**

SECTION B

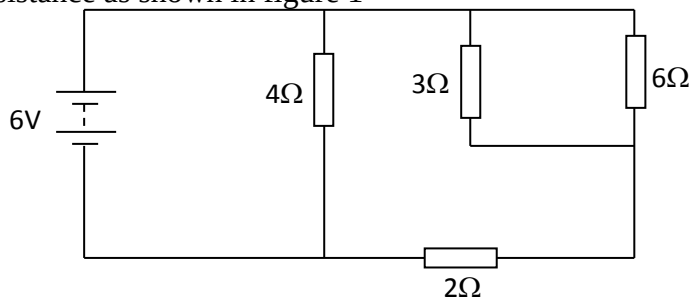
4. (a) (i) State Ohm's law **(01 marks)**

(ii) Give an example of a non-Ohmic conductor and sketch its current-voltage characteristic. **(02 marks)**

(b) (i) Define potential difference. **(01 marks)**

(ii) Derive an expression for the electrical energy dissipated in a resistor of resistance **R**, carrying a current **I** for time **t**. **(03 marks)**

(c) A network of resistors of 2Ω, 3Ω, 4Ω and 6Ω are connected to a 6V d.c supply of negligible internal resistance as shown in figure 1



Calculate the power dissipated in the 6Ω resistor. **(04 marks)**

(d) (i) Define **temperature coefficient of resistance**. **(01 marks)**

(ii) Explain why a conductor heats up when a current flows through it. **(02 marks)**

(e) An electric heater consists of 4.0 m of wire of diameter 0.60 mm. When connected to a 240 V supply, the heater dissipates 2.4 kW and the temperature of the heater is found to be 1020^{o}C. If the resistivity of the material of the wire at 10^{o}C is 10.2 x 10^{-7}Ωm, calculate:

(i) the resistance of the wire at 10^{o}C. **(02 marks)**

(ii) the mean temperature coefficient of resistance of the material of the wire between 10^{o}C and 1020^{o}C. **(04 marks)**

5. (a) (i) Distinguish between an ***electric field*** and an ***electric field line***. **(02 marks)**

(ii) Three point charges of +5μC, – 10μC and + 5μC lie along the + x direction in one straight line and in that respective order, equidistant from one another. Sketch the resultant electric field pattern expected. **(03 marks)**

(b) (i) State Coulomb's law of electrostatics. **(01 mark)**

(ii) The figure 3 shows three point charges each of +1.0μC placed at the vertices A, B and C of an equilateral triangle of side 2 m. A fourth point charge **– q** is placed at D, the mid-point of side BC.

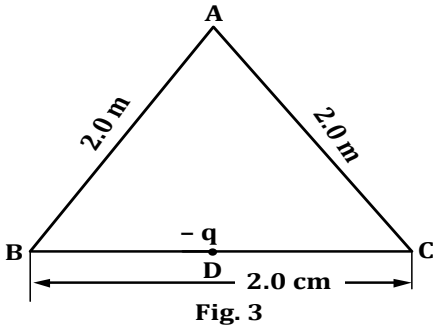


Fig. 3

If the net electric force on the charge at point A is zero. Determine the magnitude of the charge at point D. **(06 marks)**

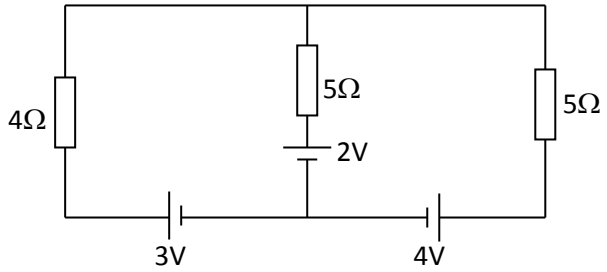
(c) (i) What is meant by the term ***corona discharge***? (03 marks)

(ii) Explain why the metal cap of Gold leaf electroscopes is always smooth and circular. **(03 marks)**

(d) Briefly explain how a gold leaf electroscope works. **(03 marks**

6. (a) (i) State Kirchhoff's circuit laws. **(02 marks)**

(ii) In the circuit shown in figure 5, all the sources have negligible internal resistance.

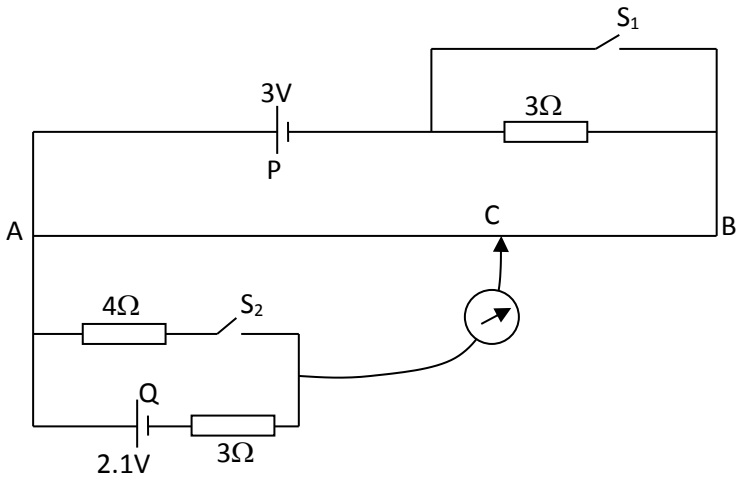


Find the current flowing in the 4Ω resistor. **(04 marks)**

(b) Explain why a potentiometer may be preferred to a voltmeter for measuring emf of a cell. **(02 marks)**

(c) Describe an experiment to measure the emf of a cell using a potentiometer. **(06 marks)**

(d) In the circuit shown in figure 6 the sources P and Q have negligible internal resistance and emfs 3V and 2.1V respectively. The wire AB is uniform and has resistance of 12Ω.



Find the balance length AC when

(i) switch S_1 closed and S_2 open. **(03 marks)**

(ii) switch S_1 open and S_2 closed **(03 marks)**

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