P510/2
PHYSICS
Paper 2
26 June 2023
2 ½ hours

ENTEBBE JOINT EXAMINATION BUREAU

Uganda Advanced Certificate of Education

PHYSICS

Paper 2

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES:

Answer **FIVE** *questions, taking at least one from each of the Sections* **A, B, C** *and* **D but not more than one question** *should be chosen from either Section* **A** *or* **B**.

Any extra question shall **not** *be assessed.*

Non-programmable scientific electronic calculators may be used.

Assume where necessary

Acceleration due to gravity, g	=	$9.81\ ms^{-2}$
Speed of light in a vacuum, c	=	$3 \times 10^{8}\ ms^{-1}$
Permeability of free space, μ_0	=	$4\pi \times 10^{-7} Hm^{-1}$
Permittivity of free space, ε_0	=	$8.85 \times 10^{-12}\ Fm^{-1}$
The **constant** $\frac{1}{4\pi\varepsilon_0}$	=	$9.0 \times 10^{9}\ mF^{-1}$

SECTION A

1. (a) (i) Define the terms **center of curvature** and **principal focus of a convex mirror.** (02 marks)

(ii) Show that $r = 2f$ for a convex mirror, where r and f are the radius of curvature and focal length of the mirror respectively. (04 marks)

(b) A concave mirror forms a real image whose size is $\frac{2}{5}$ of that of the object. When both the object and screen are moved, the image whose size is $\frac{2}{3}$ of the object is again formed on the screen. If the shift of the object is 30cm, calculate the

(i) focal length of the mirror. (03 marks)
(ii) shift in the screen. (03 marks)

(c) Describe an experiment to determine the focal length of a convex mirror using a plane mirror. (06 marks)

(d) Explain **one** disadvantage of using a convex mirror as a driving mirror. (02 marks)

2. (a) (i) Describe how the focal length of a diverging lens can be determined using a concave mirror. (05 marks)

(ii) A cylindrical tube of length 6 cm has a concave lens of focal length 18 cm fixed on one end and a convex lens on the other. When the tube is used to focus a distant object, the image is formed on the screen placed 36 cm from the tube. Find the focal length of, the convex lens. (03 marks)

(b) (i) Define **magnifying power** of an optical instrument. (01 mark)

(ii) Explain why poles of equal height but different distances from the observer appear to differ in height. (03 marks)

(c) (i) With the help of a labelled diagram, describe how a slide projector works. (05 marks)

(ii) A projector forms an image of area 2 m^2 on a screen placed 6 m from the projection lens. If the area of the object slide is 2cm^2, calculate the focal length of the projection lens. (03 marks)

SECTION B

3. (a) (i) State **three** differences between progressive and stationary waves. *(03 marks)*

(ii) Show that two waves of same frequency and wave length travelling in the opposite direction in the same medium produce a stationary wave, when they meet. *(04 marks)*

(b) A plane progressive wave travelling in the x-direction is represented by the equation $y = 0.36 \sin 7\pi\left[40t - \frac{x}{25}\right]$ where t is in seconds, y and x are in meters. Calculate the

(i) periodic time. *(02 marks)*
(ii) speed of the wave. *(03 marks)*

(c) (i) Define the terms **fundamental note** and **overtone** as applied to a string instrument. *(03 marks)*

(ii) A sonometer wire of length 0.75 m is maintained under a tension of 450 N. The wire is plucked in the middle and then released. If the density of the material of the wire is 8.9×10^3 kgm^{-3} and has a diameter of 1.2 mm, calculate the speed of the resulting transverse wave produced by the sting. *(04 marks)*

(d) State **two** uses of heats. *(02 marks)*

4. (a) Distinguish between **interference** and **diffraction** of light. *(02 marks)*

(b) (i) Explain what is meant by **path-difference** as applied to interference of two wave motions. *(03 marks)*

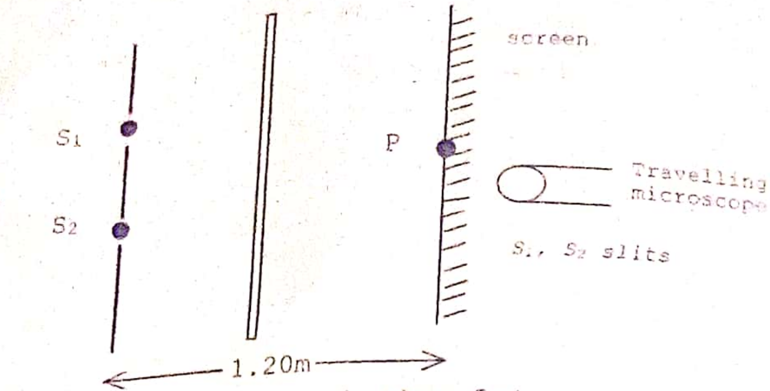
(ii) State the conditions necessary for the effect of interference in options to be observed. *(01 mark)*

(c) (i) Describe an experiment to determine wave length of light using Young's double slit experiment. *(06 marks)*

(ii) In Young's double slit experiment using light of wavelength 600nm, the slit separation is 4×10^{-4}m and the screen is placed 1.20 m from the slits as shown in figure 1.

Turn Over

Fig 1



Find the separation of the fringes observed on the screen. (03 marks)

(d) Explain what is observed at P in (c)(ii) above when white light is used. (03 marks)

(e) (i) What is **polarized light**? (01 mark)

(ii) State **two** uses of polarised light. (01 mark)

SECTION C

5. (a) What is meant by the terms

(i) Current sensitivity (01 mark)
(ii) Magnetic moment of a coil? (01 mark)

(b) (i) Account for the force on a current-carrying conductor placed perpendicular to a magnetic field. (03 marks)

(ii) Show that the torque on a coil-carrying current, I in a uniform magnetic field of flux density B is T=BINACosθ where N is the number of turns of the coil, A is its cross-sectional area and θ is the angle between the plane of the coil and the direction of the magnetic field. (05 marks)

(c) With the aid of a labelled diagram, describe an experiment to determine the magnitude of magnetic field intensity using a hall probe. (04 marks)

(d) A current of 8A is passed along the length of a 2mm by 2mm square sectional wire placed perpendicular to a uniform magnetic field of flux density 1.5×10^{-2}T as shown in figure 2.

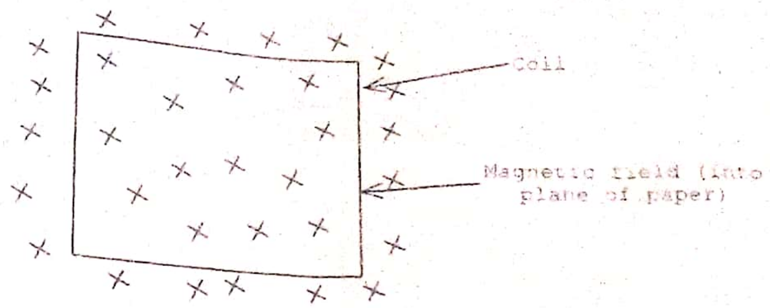


Fig 2

If the electron density of the material of the wire is 1.0×10^{25} per cubic metre, calculate the

(i) force on each electron. *(03 marks)*

(ii) hall voltage between opposite faces. *(03 marks)*

6. (a) State **the laws of electromagnetic induction.** *(02 marks)*

(b) A circular coil of 150 turns and cross-sectional area $0.3m^2$ is placed with its plane perpendicular to a horizontal to a horizontal magnetic field of flux density 1.2×10^{-2} T. The coil is rotated about a vertical axis so that it turns through 70^0 in 2 seconds. Calculate the

(i) initial flux linkage through the coil. *(02 marks)*

(ii) emf induced in the coil *(03 marks)*

(c) (i) Explain how back emf is produced in a coil in an electric motor. *(03 marks)*

(ii) A d.c motor of armature resistance 0.75Ω is connected to a 240V supply. When the motor is running freely, the armature current is 4.0A and makes 400 revolutions per minute. When a load is connected to the motor in the circuit, the armature current increases to 6.0A. Calculate the speed of rotation. *(05 marks)*

(d) With the aid of a diagram, describe how a simple a.c generator works. *(05 marks)*

7. (a) Define the following as applied to a.c circuit.

(i) Root-mean square value of current. *(01 mark)*

(ii) Impendence. *(01 mark)*

(b) An alternating voltage source of V = Vo COs 2πft is connected across an inductor of inductance, *L*.

(i) Derive the expression for the reactance of the inductor. (03 marks)

(ii) Explain the change in current supplied when the source is replaced with one of higher frequency. (02 marks)

(c) Figure 3 shows an inductor of inductance 0.5H and a resistor of resistance 95Ω connected in series across a voltage source of $V = 110 \cos 70\pi t$ volts.

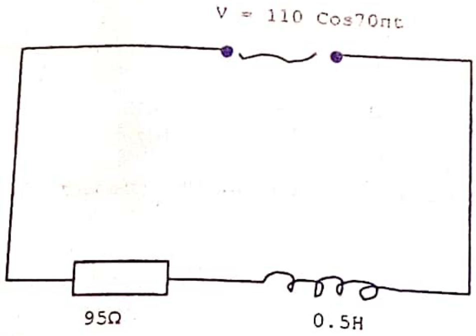


Fig 3

Determine the

(i) r.m.s current supplied. (04 marks)

(ii) power dissipated in the circuit. (02 marks)

(iii) phase angle between the current and the applied voltage. (02 marks)

(d) Describe how a hot wire ammeter works. (05 marks)

SECTION D

8. (a) Define the following terms:

(i) electrical resistivity (01 mark)

(ii) temperature coefficient of resistance. (01 mark)

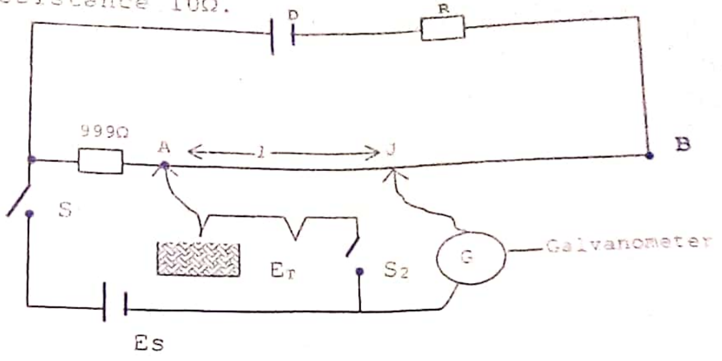
(b) (i) Describe an experiment to determine resistivity of the material of a wire using an ammeter, a metre rule and voltmeter. (06 marks)

(ii) Explain the effect of increasing temperature on resistivity of a semi-conductor. (03 marks)

(c) Explain the principle of a potentiometer. (03 marks)

(d) In figure 4, D is a driver cell of emf 2V and negligible internal resistance. Es is a standard cell of emf 1.0V and AB is a uniform wire of length 100cm and resistance 10Ω.

Fig 4



With S_1 closed and S_2 open, the galvanometer shows no deflection when AJ = 10cm. With S_1 open and S_2 closed, the balance length AJ increases by 50cm. Find the

(i) current flowing through the driver circuit. *(02 marks)*

(ii) value of R. *(02 marks)*

(iii) emf, ET of the thermocouple. *(02 marks)*

9. (a) Define the terms

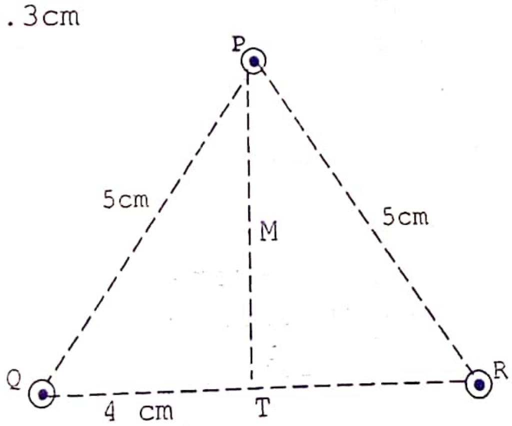
(i) Electric field intensity *(01 mark)*

(ii) Electric potential *(01 mark)*

(b) Derive the relationship between electric field intensity, *E* and electric potential, *V* due to a charge at a point. *(04 marks)*

(c) Charges of +2μc, +4μc and -5μc are placed at the vertices of a triangle *PQR* respectively as shown in figure 5. PQ = PR = 5cm, QT = 4cm, TM = 1.6cm and QM = MR = 4.3cm

Fig 5



Turn Over

Find the
(i) magnitude of electric field intensity at T due to the changes. (05 marks)

(ii) work done in moving a change of $7.5\mu c$ from T to M. (04 marks)

(d) (i) Describe briefly a simple experiment to distinguish between a conductor and an insulator using a gold leaf electroscope. (02 marks)

(ii) State **two** characteristics of an equipotential surface. (02 marks)

10. (a) Define the terms

(i) Dielectric constant (01 mark)
(ii) Farad (01 mark)

(b) Describe an experiment to determine dielectric constant of a material. (05 marks)

(c) A capacitor of capacitance $5\mu f$ is charged to a p.d of 52V with the aid of a battery. The battery is then removed and the capacitor is connected to an uncharged capacitor of capacitance $8\mu f$.

(c) Calculate the
(i) final pd, V across the combination. (03 marks)

(ii) energy stored before and after connecting the two capacities. (04 marks)

(d) (i) Account for the energy charges that in (c)(ii). (01 mark)

(ii) State the energy charges that occur during the charging process in (c). (02 marks)

(e) A parallel plate capacitor consists of two plates each of area A. The plates are separated by a distance in a vacuum. When the capacitor is charged to a pd, V, the charge stored is Q. show that the capacitance of the capacitor is given by

$$C = \frac{\varepsilon_0 A}{d}$$

where ε_0 is the permittivity of free space.

END