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)*

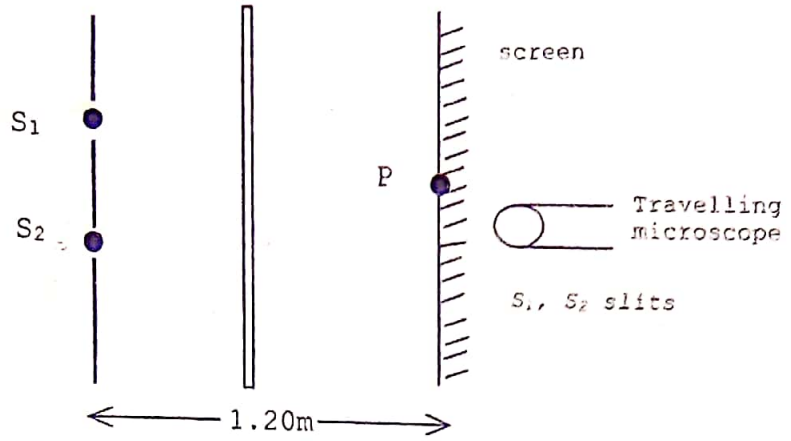
(b) (i) Explain what is meant by **path-difference** as applied to interference of two wave motions. *(03 marks)*

(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.

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 $\tau = BINA\cos\theta$ 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.

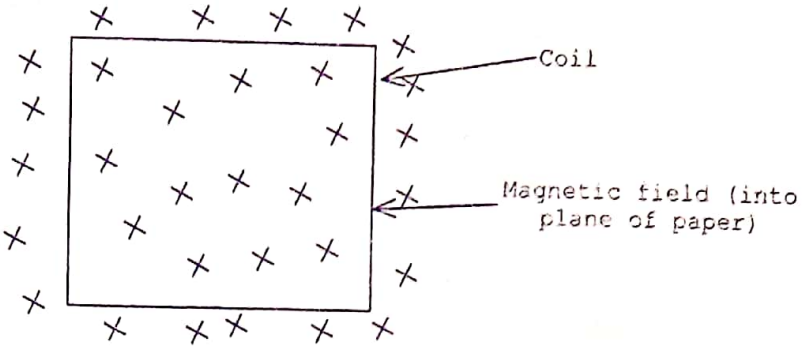


Fig 2

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 $V = Vo\ COs\ 2\pi ft$ 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 Cos70πt volts.

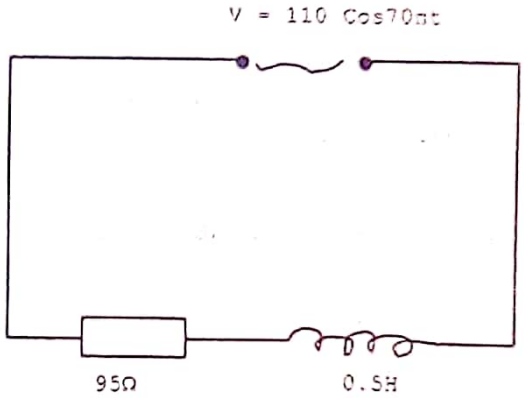


Fig 3

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)*

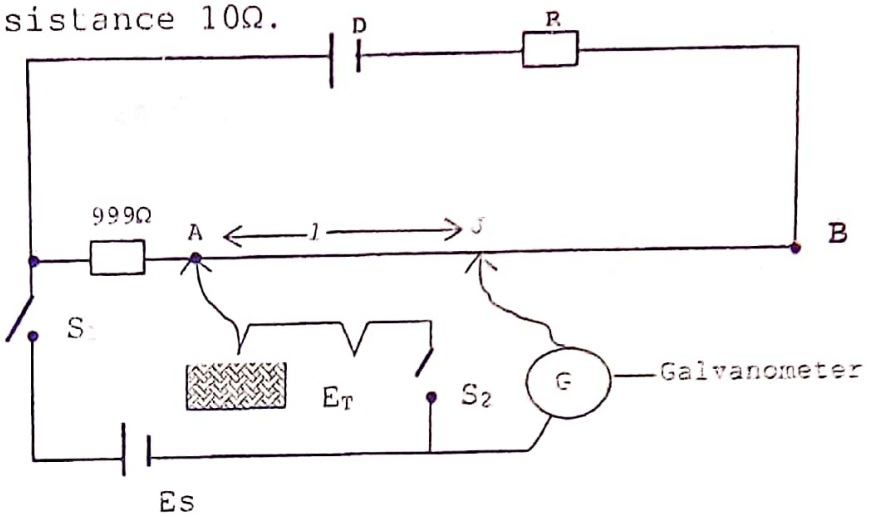
(ii) Explain the effect of increasing temperature on resistivity of a semi-conductor. *(03 marks)*

(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

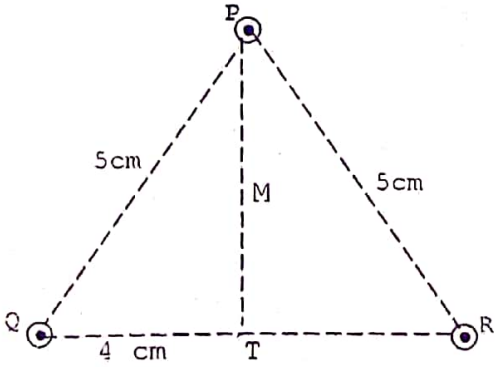
(i) Electric field intensity *(01 mark)*

(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



Find the

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

(ii) work done in moving a change of 7.5μc 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 5μf 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 8μf.

(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