P510/2
PHYSICS
Paper 2
Nov./Dec. 2025
2 ½ hours

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

PHYSICS

Paper 2
(Theory)

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES:

*This paper consists of **four** Sections;* **A, B, C** and **D**.
Answer **five** *questions in all , taking at least* **one** *from each section but* **not** *more than* **one** *question should be chosen from either section* **A** *or* **B**.
*Any additional question(s) answered will **not** be marked.*
*Answers to every question **must** start on a fresh page.*
Graph paper is provided.
Mathematical tables and silent non-programmable scientific calculators may be used.
Assume where necessary:

Acceleration due to gravity, g	$= 9.81\ m\ s^{-2}$
Electron charge, *e*	$= 1.6 \times 10^{-19}\ C$
Electron *mass*, *m*	$= 9.11 \times 10^{-31}\ kg$
Plank's constant, *h*	$= 6.6 \times 10^{-34}\ J\ s$
Speed of light in a vacuum, *c*	$= 3.0 \times 10^{8}\ m\ s^{-1}$
Avogadro's number, N_A	$= 6.02 \times 10^{23}\ mol^{-1}$
Gas Constant, *R*	$= 8.31\ J\ mol^{-1}\ K^{-1}$
Charge to mass ratio, *e/m*	$= 1.8 \times 10^{11}\ C\ Kg^{-1}$
The constant $\frac{1}{4\pi\varepsilon_0}$	$= 9.0 \times 10^{9}\ N\ m^2\ C^{-2}$
Permeability of free space, μ_0	$= 4\pi \times 10^{-7}\ H\ m^{-1}$
Permitivity of free space, ε_0	$= 8.85 \times 10^{-12}\ F\ m^{-1}$

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SECTION A

1. (a) What is meant by the principle focus of a diverging lens? *(01 mark)*

(b) A finite object is placed along the principal axis of a diverging lens at a distance, u, greater than its focal length, f. Using a ray diagram, derive the lens formula:

$$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$$

where v = image distance. *(06 marks)*

(c) A Galilean telescope has an objective lens of focal length 15 cm and eye piece of focal length 5 cm. If the final image of a distant object is formed 30 cm from the eye piece lens, calculate;

(i) the angular magnification of the telescope. *(04 marks)*

(ii) the separation of the lenses. *(02 marks)*

(d) Explain any **one** disadivantage of a Galilean telescope over an astronomical telescope. *(04 marks)*

(e) Explain what is meant by accommodation in relation to the eye. *(03 marks)*

2. (a) (i) State the laws of reflection of light. *(02 marks)*

(ii) With the aid of a diagram, explain how a thick plane mirror can form multiple images of an object placed infront of it. *(03 marks)*

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(b) A ray of light incident on a glass block at point ***X***, emerges out at point ***Y*** and then reflected at point ***P*** as shown in figure **1**.

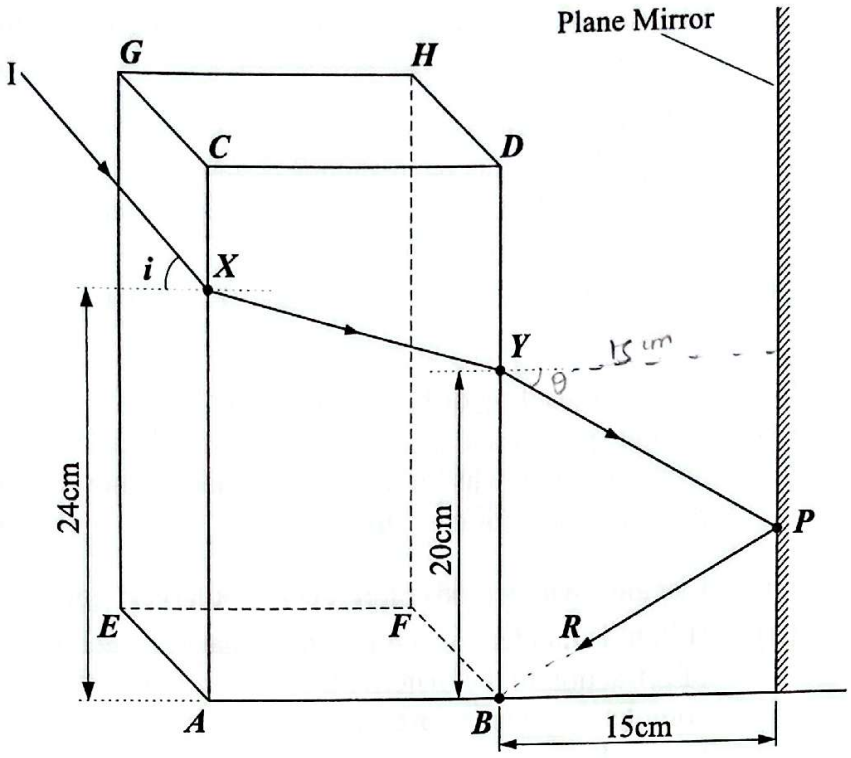

Fig. 1

If the reflected ray ***PR***, passes through point ***B*** and the refractive index of the glass block is 1.52, find;

(i) the value of angle, ***i***. (*03 marks*)

(ii) the width ***AB*** of the glass block. (*03 marks*)

(c) Describe an experiment to measure the focal length, f of a concave mirror. (*05 marks*)

(d) (i) Two thin lenses of focal lenghts, f_1 and f_2 respectively are in contact. Show that the effective focal length, f is given by:

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$$ (*04 marks*)

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SECTION B

3. (a) (i) What is mearnt by interference of waves? (*01 mark*)

(ii) List **two** conditions for the formation of observable interference in light waves. (*02 marks*)

(b) (i) In Young's double slit experiment to demonstrate interference, the spacing of slits is, a, and the distance of the slits from the screen is D. If the wavelength of the light used is λ, derive the expression for the fringe width. (*05 marks*)

(ii) Explain what is observed when the slits in (b) (i) are made wider. (*03 marks*)

(c) (i) What is meant by diffraction of waves? (*01 mark*)

(ii) A loud speaker and a source of light are placed inside a closed house. Explain why an observer outside the house is able to receive sound but not light. (*03 marks*)

(d) (i) List any **two** methods of producing polarised light. (*02 marks*)

(ii) If light is incident on a transparent material such that the angle of refraction in the material is 35.2^0, and the reflected light is completely plane polarised, find the refractive index of the material. (*03 marks*)

4. (a) What is meant by the following;

(i) forced oscillation, (*01 mark*)

(ii) resonance? (*01 mark*)

(b) (i) Describe how a sonometer may be used to determine the frequency of a tuning fork. (*05 marks*)

(ii) Why does a note produced by a vibrating wire differ in quality from that produced by a tuning fork of the same frequency? (*02 marks*)

(c) A person blowing a whistle moves away from a stationary observer towards perpendicular flat wall with a velocity of 1.5 m s^{-1}. If the observer hears 5 beats per second;

(i) explain why the observer hears beats. (*02 marks*)

(ii) find the frequency of the sound from the whistle. (*04 marks*)
(*Speed of sound in air = 336 m s^{-1}*)

(d) Describe how doppler effect may be applied in the measurement of the speed of a star relative to the earth. (*03 marks*)

(e) State what happens to the speed of sound in air if the;

(i) air pressure rises. (*01 mark*)

(ii) temperature rises. (*01 mark*)

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SECTION C

5. (a) Define **magnetic flux density**. *(01 mark)*

(b) (i) Using the Hall probe, describe how magnetic flux density is measured. *(05 marks)*

(ii) A current of 8 A flows through a conductor of length 30.2 cm. If the conductor is placed in magnetic field of flux density 0.3 T at an angle of 56^0 to the direction of the field, calculate the force on the conductor. *(04 marks)*

(c) (i) Define hall effect. *(01 mark)*

(ii) Derive the expression for the hall voltage. *(05 marks)*

(iii) A rectangular conductor of breadth 0.070 mm is placed at right angle to a magnetic field of flux density 2.2 T. If current of 12 A, flowing in it builds up a maximum p.d of 10 μV, calculate the number of charge carriers per atom. *(04 marks)*

6. (a) Define the following as applied to alternating voltage;

(i) root mean square value. *(01 mark)*

(ii) peak value. *(01 mark)*

(b) (i) Show that the reactance X_c of a capacitor of capacitance C is given by:

$$X_c = \frac{1}{2\pi fC}$$

where f is the frequency of the supply source. *(03 marks)*

(ii) If a sinusoidal voltage, V = 240 sin360πt, is connected across a capacitor of capacitance 12 μF, calculate the r.m.s value of the current that flows in the circuit. *(03 marks)*

(c) With the aid of a diagram, describe the mode of operation of a hot wire ammeter. *(05marks)*

(d) (i) Define resonant frequency as applied to alternating current. *(01mark)*

(ii) Explain why the impedance at resonant frequency is purely resistive. *(04 marks)*

(iii) A capacitor of 6 μF, an inductor of 0.8 H, and a resisitor are connected in series to an a.c source. Determine the frequency of current in the circuit at resonance. *(02 marks)*

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7. (a) (i) Define magnetic field. (*01 mark*)

(ii) Describe an experiment to investigate the existence of a magnetic field around a current carrying conductor. (*03 marks*)

(b) A metal bar of width 40 mm is pulled horizontally on a frictionless table with a uniform velocity of 5 mm s^{-1} as shown in figure **2**.

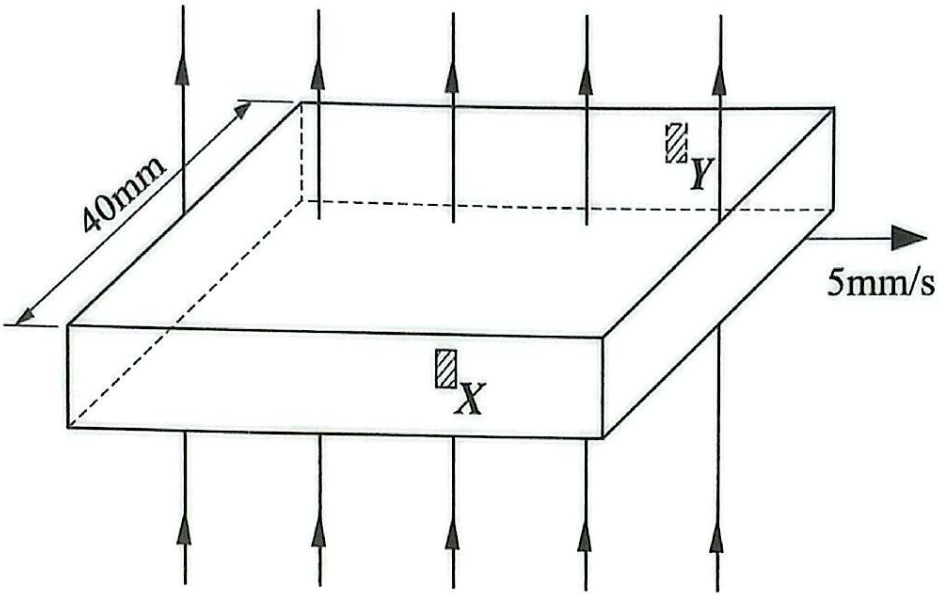

Fig. 2

When a magnetic field of flux density **B**, is applied vertically normal to the bar, a p.d of 6 μV is set across fixed electrical contacts X and Y.

(i) Explain how this potential difference is set up. (*02 marks*)

(ii) Find the flux density **B**, of the magnetic field. (*03 marks*)

(c) With the aid of a labelled diagram, describe the mode of operation of a moving coil loud speaker. (*07 marks*)

(d) (i) Define the magnetic meridian. (*01 mark*)

(ii) A circular coil of 500 turns and mean diameter 6 cm is placed with its plane vertical and parallel to the magnetic meridian, is connected to a ballistic galvanometer. The coil is turned through 180° about the horizontal axis through its centre, a charge of 4.8 μC is induced in it. If the total resistance of the circuit is 9 Ω, find the horizontal component of the earth's magnetic field. (*03 marks*)

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SECTION D

8. (a) Define the following;

(i) resistivity. (*01 mark*)

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

(b) A voltmeter of resistance 1,050 Ω is connected across a carbon lamp filament of resistance 375 Ω at 20 ^{0}C. If the lamp is connected in series with an ammeter and a d.c supply, the readings of the ammeter and the voltmeter are 0.76 A and 150 V respectively when the temperature of the carbon filament is 1,200 ^{0}C. Find;

(i) resistance of the lamp at 1,200 ^{0}C. (*04 marks*)

(ii) the mean temperature coefficient of resistance of carbon between 20 ^{0}C and 1,200 ^{0}C. (*03 marks*)

(c) (i) Describe an experiment to verify Ohm's law. (*04 marks*)

(ii) Sketch the $I-V$ characteristic graph for a thermistor. (*01 mark*)

(iii) Explain the shape of the graph in (c) (ii). (*02 marks*)

(d) Explain why;

(i) a wheat stone bridge is not suitable for measuring small resistances. (*02 marks*)

(ii) the balance point of a metre bridge should be close to the middle of the slide wire. (*02 marks*)

9. (a) Define capacitance of a capacitor. (*01 mark*)

(b) A capacitor of capacitance C, is connected across the terminals of a battery of e.m.f, E.

(i) Draw a graph for time variation of the voltage across the plates of the capacitor during the charging process. (*01 mark*)

(ii) comment on the features on the graph in (b) (i). (*01 mark*)

(iii) Using a graphical method, derive the expression for energy stored in the capacitor in terms of voltage V and capacitance C. (*04 marks*)

(c) A capacitor of capacitance, C is charged to a p.d, V, and then connected across an identical capacitor with a dielectric of constant, ε_r between its plates. Show that the energy stored by the capacitor with a dieelectric is $\frac{\varepsilon_r CV^2}{2(1+\varepsilon_r)^2}$. (*03 marks*)

(d) Describe how the capacitance of a capacitor may be determined using a vibrating reed switch of known frequency, f. (*04 marks*)

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(e) (i) A parallel metal plate capacitor held in air is charged to a p.d of 75 V. When the capacitor is discharged through a ballistic galavanometer, the first throw is 0.6 radians. If a dielectric of constant 2.5 is now placed between the plates to occupy half the area of overlap of the plates and the capacitor is charged to a p.d of 120 V, find the first throw θ, when it is discharged through the same galavanometer. (*04 marks*)

(ii) Explain why water is not used as a dielectric. (*02 marks*)

10. (a) Define the following;

(i) electric field. (*01 mark*)

(ii) electric potential energy. (*01 mark*)

(b) (i) Derive an expression for the electric potential energy of a charge in an electric field. (*05 marks*)

(ii) Points *P* and *Q* lie in an electric field of a positive charge. If *P* is closer to the charge than *Q*, explain how the electric potential energy varies from *Q* to *P*. Assume both points, *P* and *Q* are on the same side of the charge. (*03 marks*)

(c) Charges at points **A**, **B**, **C** and **D** of magnitudes +6 μC, -2 μC, +5 μC and +3 μC respectively are at the corners of a rectangle of diamensions 5 cm × 12 cm placed in a vacuum as shown in figure **3**.

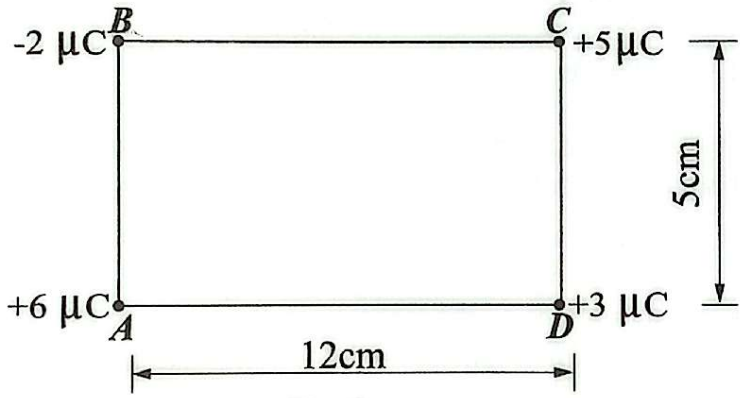

Fig. 3

Calculate the force exerted on the charge at **D**. (*06 marks*)

(d) Explain the variation of electric field intensity on the surface of a charged pear-shaped conductor. (*03 marks*)

(e) State any **two** applications of electrostatics. (*01 mark*)

END

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