P510/2 PMYSICS Paper 2 Nov. / Dec. 2014 2½ hours



### UGANDA NATIONAL EXAMINATIONS BOARD

# 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 additional question(s) answered will not be marked.

Mathematical tables and squared paper will be provided.

Non-programmable scientific calculators may be used.

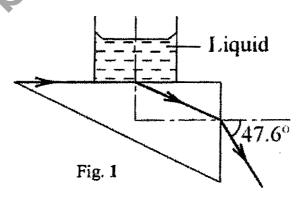
# Assume where necessary:

=	$9.81 \text{ ms}^{-2}$
=	$3.0 \times 10^8  \text{ms}^{-1}$
=	$1.6 \times 10^{-19} \mathrm{C}$
==	$9.11 \times 10^{-31} \mathrm{kg}$
=	$6.6 \times 10^{-34}  \text{Js}$
==	$4.0\pi \times 10^{-7}  \mathrm{Hm}^{-1}$
	$8.85 \times 10^{-12}  \text{Fm}^{-1}$
Accept Accept	$9.0 \times 10^9 \mathrm{F}^{-1} \mathrm{m}$
=	$1.6 \times 10^{-19} \mathrm{J}$
- American Introduction	$6.02 \times 10^{23}  \text{mol}^{-1}$
age-figur accessed	$1.2 \times 10^{-6} \Omega \mathrm{m}$
	$4.2 \times 10^3 \mathrm{Jkg^{-1}K^{-1}}$

#### **SECTION A**

- 1. (a) (i) State the laws of reflection of light. (02 marks)
  - (ii) A ray of light is incident on a plane mirror. The mirror is then turned through an angle  $\alpha$  keeping the direction of the incident ray constant. If the reflected ray turned through an angle  $\beta$ , find the relationship between  $\alpha$  and  $\beta$ . (04 marks)
  - (b) Describe how a sextant is used to determine the angle of elevation of a star. (05 marks)
  - (c) Describe an experiment to determine the refractive index of a small quantity of a liquid using a concave mirror. (05 marks)
  - (d) A plane mirror is placed 10 cm in front of a convex mirror so that it covers about half of the convex mirror surface. A pin placed 20 cm in front of the plane mirror gives an image which coincides with that of the pin in the convex mirror. Find the focal length of the convex mirror.

    (04 marks)
- 2. (a) Define angular magnification of an optical instrument. (01 mark)
  - (b) (i) Describe with the aid of a ray diagram, the operation of a telescope made up of a converging lens and a diverging lens when used in normal adjustment. (05 marks)
    - (ii) State two limitations of this type of telescope. (01 mark)
  - (c) The diagram in Figure 1 shows a path followed by a ray of monochromatic light through a right angled prism of refractive index 1.52. The light emerges in air at an angle of 47.6°.



Find the refractive index of the liquid.

(06 marks)

Spherical aberration. (ii) (02 marks) (e) Explain how chromatic aberration and spherical aberration are minimized in a reflecting telescope. (03 marks)**SECTION B** 3. (a) What is meant by the following as applied to wave motion? (i) Wave length. (01 mark) Wave front. (ii) (01 mark)(b) (i) Define resonance. (01 mark)Describe how velocity of sound in air can be determined using (ii) a resonance tube. (05 marks)Explain how stationary waves are formed. (c) (i) (03 marks)A tuning fork of 760 Hz is sounded near the open end of a (ii) closed pipe of length 40 cm. If air in the tube resonates with the tuning fork, determine the mode of vibration and the end correction. (Velocity of sound in air is 330 ms<sup>-1</sup>) (05 marks) Explain reverberation as applied to sound waves. (d) (i) (02 marks)(ii) Explain how reverberation may be minimised in a large hall. (02 marks)4. (a) State two conditions necessary for interference patterns to be (i) formed. (02 marks)(ii) With the aid of a diagram, describe how interference can be produced by division of wave front. (04 marks) (b) In Young's double slit experiment, the slits are 0.5 mm apart and interference is observed on the screen placed at a distance of 100 cm from the slits. It is found that the 9th bright fringe is at a distance of 8.84 cm from the second dark fringe from the centre of the fringe (05 marks) pattern. Find the wave length of light used.

Explain the following as applied to lenses.

(02 marks)

Chromatic aberration.

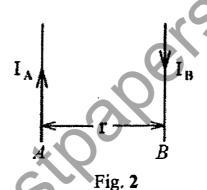
(d)

(i)

- (c) Explain what is observed on the interference fringes in Young's double slit experiment when the monochromatic source of light is replaced by a source of white light. (05 marks)
- (d) Describe how interference fringes are formed in a wedge-shaped film of air. (04 marks)

#### **SECTION C**

- 5. (a) State the laws of electromagnetic induction. (02 marks)
  - (b) Describe a method of measuring the magnetic flux density in the region between the poles of a magnet. (06 marks)
  - (c) Two straight parallel wires A and B carrying steady currents  $I_A$  and  $I_B$  respectively are placed close to each other as shown in Figure 2.



- (i) Sketch the resultant magnetic field pattern. (02 mark.
- (ii) Explain what happens when the currents  $I_A$  and  $I_B$  are steady currents. (04 marks)
- (iii) Find the force per unit length of the wires when  $I_A = 8.0 \text{ A}$ ,  $I_B = 11.0 \text{ A}$  and r = 3.0 cm. (04 marks)
- (d) Explain how eddy currents are produced. (02 marks)
- 6. (a) Write an expression for the force exerted on a straight wire of length, *I* metres carrying a current of *I* amperes, placed at right angles to a uniform magnetic field of flux density *B* teslas.

(01 mark)

- (ii) Explain the origin of the force in (a) (i). (04 marks)
- (b) A rectangular coil of N turns each of length l, and breadth, b, is inclined at an angle θ to a uniform magnetic field of flux density B. Derive an expression for the torque of the coil when a current I is passed through it.

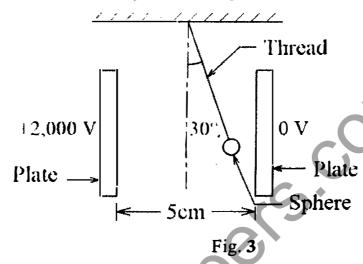
- (c) A single rectangular loop of wire with dimensions 35 cm by 75 cm is arranged such that part of it is inside a region of uniform magnetic field of flux density 0.45 T and part of it is outside the field. The total resistance of the loop is 0.23  $\Omega$ . Calculate the force required to pull the loop from the field at a constant velocity of 3.4 ms<sup>-1</sup> perpendicular to the field.

  (05 marks)
- (d) (i) Define the term magnetic flux. (01 mark)
  - (ii) An electron revolves in a circular orbit of radius  $2.0 \times 10^{-10}$  m at a frequency of  $6.8 \times 10^{15}$  revolutions per second. Calculate the magnetic flux density at the centre of the orbit. (04 marks)
- 7. (a) (i) What is meant by a sinusoidal alternating current? (01 mark)
  - (ii) Define peak value, root mean square (r.m.s) value and frequency of an alternating sinusoidal current. (03 marks)
  - (b) A sinusoidal voltage of r.m.s value 13.2 V is connected across a 50  $\mu$ F capacitor.
    - (i) Find the peak value of the charge on the capacitor. (02 marks)
    - (ii) Sketch using the same axes the graphs of charge Q on the capacitor and current I in the circuit against time. (02 marks)
    - (iii) If the frequency of the alternating current is 49.6 Hz, calculate the r.m.s value of the current through the capacitor. (03 marks)
  - (c) Explain why a capacitor in a circuit blocks the flow of direct currents but allows the flow of alternating current. (04 marks)
  - (d) Describe the structure and mode of operation of the repulsion type moving iron meter. (05 marks)

#### **SECTION D**

- 8. (a) (i) Define the following; electric field intensity and electric potential at a point. (02 marks)
  - (ii) Show that the electric field intensity at a point is equal to the negative potential gradient at that point. (04 marks)
  - (b) (i) Explain with the aid of a diagram, how an insulated metal sphere can be charged by induction using a negatively charged rod. (03 marks)
    - (ii) Describe how a gold leaf electroscope can be used to detect the presence of charge on a body. (02 marks)

- (c) (i) Write down the equation for the electrostatic force between two isolated point charges in a vacuum. (01 mark)
  - (ii) Sketch the electric field lines between two negatively charged spheres carrying unequal charges and use the sketch to explain a neutral point. (02 marks)
- (d) A charged polystyrene sphere of mass 2 g is suspended by a fine nylon thread between two plates 5 cm apart as shown in Figure 3.



When a p.d of 2000 V is applied across the plates, the thread attached to the sphere deflects through an angle of 30°. Calculate the charge on the sphere.

(06 marks)

- 9. (a) Describe an experiment to verify Ohm's law. (04 marks)
  - (b) Derive an expression for the combined resistance of three resistors in parallel. (04 marks)
  - (c) (i) Explain the principle of operation of a slide wire potentiometer. (04 marks)
    - (ii) Two cells A and B connected in series give a balance length of 80.0 cm along a potentiometer wire. When cell B is reversed, the balance length falls to 15.0 cm. If the e.m.f of cell A is 1.5 V, calculate the e.m.f of cell B. (04 marks)
  - (d) A battery of e.m.f. 20.0 V and internal resistance 4.0  $\Omega$  is connected to a resistor of resistance 10.0  $\Omega$ . Calculate the;
    - (i) power generated. (02 marks) (ii) efficiency of the circuit. (02 marks)

- 10. (a) (i) Define capacitance and dielectric constant. (02 marks)
  (ii) State the factors which affect the capacitance of a capacitor.
  (02 marks)
  - (b) A capacitor of capacitance  $C_1$  is charged by a battery of e.m.f,  $V_0$ . The charging battery is then removed and the capacitor is connected to an uncharged capacitor of capacitance  $C_2$ . Show that the loss of energy, E after connection is given by

$$E = \frac{1}{2} \left[ \frac{C_1 C_2}{C_1 + C_2} \right] V_o^2$$
 (05 marks)

- (c) Describe an experiment to measure the capacitance of a capacitor using a ballistic galvanometer. (05 marks)
- (d) A capacitor, X of 5.0  $\mu$ F and another, Y of 8.0  $\mu$ F are connected in series with a 20 V supply.

Calculate the;

- (i) charge on X. (04 marks)
- (ii) potential drop across X. (02 marks)