P510/2
PHYSICS
JULY 2017
2½ h

Uganda Advanced Certificate of Education
PHYSICS MOCK EXAMINATION 2017
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 A or B.
Any additional questions will not be marked.
Non-programmable scientific calculators may be used.

Assume where necessary:

Acceleration due to gravity, g	=	9.81m s^{-2}
Speed of light in a vacuum, c	=	$3.0 \times 10^{8} \text{ m s}^{-1}$
Electron charge e	=	$1.6 \times 10^{-19} \text{ C}$
Permeability of free space, μ_o	=	$4.0\pi \times 10^{-7} \text{ H m}^{-1}$
Permittivity of free space, ε_o	=	$8.85 \times 10^{-12} \text{ F m}^{-1}$
The constant, $\frac{1}{4\pi\varepsilon_o}$	=	$9.0 \times 10^{9} \text{ F}^{-1} \text{ m}$
Velocity of sound in air at 0°C	=	330 m s^{-1}

SECTION A

1.(a) Define **refractive index** of a material. What is the refractive index of a material through which light travels at 2×10^8 m s^{-1}? (02 marks)

(b) Show that the refractive index, *n*, of the material of glass prism is given by

$$n = \frac{\sin\left(\frac{A+D_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$ where *A* is the refractive angle of the prism and D_m is the angle of minimum deviation for light passing through the prism.

(03 marks)

(c) Describe an experiment to determine the refractive index of glass using a triangular prism and optical pin s. (05 marks)

(d) A thin equi-convex lens of glass of refractive index 1.50 whose surfaces have a radius of curvature 24.0 cm is placed on a horizontal plane mirror. When the space between the lens and the mirror is filled with a liquid, a pin held 40.0 cm vertically above the lens is found to coincide with its own image. Calculate the refractive index of the liquid. (05 marks)

(f) In an experiment to determine focal length of a lens, after tabulating results, a student plotted graph of magnification *m* against image distance, *v*.

Explain how the student used the graph to find the focal length of the lens, without calculating the slope. (03 marks)

(g) Explain the advantage of using prisms instead of plane mirrors in periscopes. (02 marks)

2.(a) Define the terms

(i) Power of accommodation. (02 marks)

(ii) angular magnification , as applied to optical instruments. (1mark)

(b) Explain one disadvantage a Galilean telescope has over an astronomical telescope. (02 marks)

(i) Power of accommodation. (01mark)

(c) An astronomical telescope has an objective with a focal length of 100 cm and a diameter of 5 cm. If the eyepiece has a focal length of

20 cm and the telescope is used in normal adjustment, calculate the
(i) Magnifying power (02 marks)
(ii) Diameter of the eye ring (02 marks)
(iii) Separation of the lenses. (0 marks2)

(d) Give two advantages of a prism binoculars as an optical instrument. (02 marks)

(e) (i) Define chromatic aberration. (01 mark)
(ii) Give two properties of lenses used to make an achromatic doublet. (02 marks)

(f) Describe an experiment to determine focal length of a diverging lens using a concave mirror. (05 marks)

SECTION B

3.(a) State the principle of superposition of waves? (01marks)
(b) Distinguish between **Progressive** and **stationary** waves.(03marks)
(c) (i) Describe an experiment to determine the velocity of sound in air by the dust tube method. (06 marks)
(ii) Explain why changes of pressure have no effect on the velocity of sound in air at constant temperature. (03 marks)
(d) (i) What is meant by the terms ***resonance*** and ***fundamental frequency***? (02 marks)
(ii) A steel wire of length 40 cm and diameter 0.025 cm vibrates transversely in unison with a tube, open at both ends and of effective length 60 cm, when each is sounded in its fundamental mode at 27^0C. Find the tension in the wire. (05 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) In Young's double slit experiment, the 4^{th} bright fringe is formed 3.4 mm away from the centre of the fringe system when the wavelength of light used is 6.3×10^{-7} m.
Calculate the distance of the screen from the slits if the separation of the two slits is 0.62 mm (03 marks)
(ii) Explain why light is considered to be a transverse wave, while sound is not. (02 marks)
(c) Two slits X and Y are separated by a distance a and illuminated With light of wavelength λ. Derive the expression for the separation between successive fringes on a screen placed a distance D from the

slit. (05 marks)

(d) Explain with the aid of a diagram, how Newton's rings are formed. (05 marks)

SECTION C

5.(a) Define the following:

(i) Magnetic flux (01 mark)

(ii) Magnetic flux density, (01 mark)

(iii) Angle of dip (01 mark)

(b) (i) A conductor of length l moving with a velocity v cuts through flux at an angle θ to a uniform magnetic field. Derive an expression for the e.m.f induced in it. (04 marks)

(ii) Describe with the aid of a diagram, an absolute method of Measuring resistance.

(c) (i)

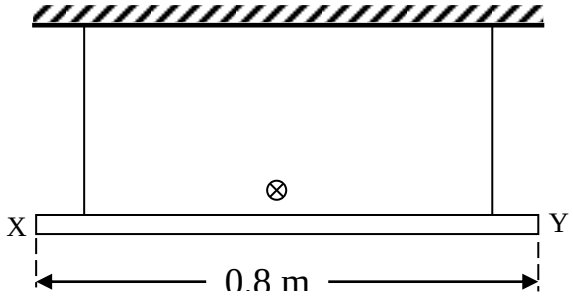

Figure 1

In Figure 1 above, XY is a straight conductor of length 0.8 m and Mass 3.0×10^{-2} kg. The conductor is suspended by a pair of threads in a uniform magnetic field of flux density 4.5×10^{-2} T. Determine the magnitude and direction of the current required to remove the tension in the suspension threads. (04 marks)

(ii) Explain why a wire carrying current in a magnetic field, moves. (03 marks)

6.(a) (i) Define *eddy currents*. (01 mark)

(ii) Explain how eddy currents are put to good use in a car speedometer. (03 marks)

(iii) Explain the effect of eddy currents in a dynamo and how this is overcome. (03 marks)

(b) A copper disc of radius 0.06 m with its plane perpendicular to a uniform magnetic field spins at 900 revolutions per minute about an axis through its centre. A potential difference of 4.5×10^{-5} V. Is shown on a voltmeter connected between the axle and the rim.

Calculate the flux density of the field. (04 marks)

(c) With the aid of a diagram explain how an a.c generator works. (05 marks)

(d) (i) What is *self-induction*? (01 mark)

(ii) Describe an experiment to demonstrate self-induction. (03 marks)

7.(a) (i) Define *reactance of a capacitor*. (01 mark)

(ii) Draw a sketch graph to show the variation of reactance of a capacitor with frequency when the capacitance is constant. (01 mark)

(ii) A capacitor of capacitance $2\,\mu F$ has a current of 1×10^{-3} A (r.m.s) flowing through it. The voltage across the capacitor is 0.156 V. Calculate the frequency of the source. (04 marks)

(b) Explain how alternating current can be converted into fairly steady direct current by use of diodes. (04 marks)

(c) The diagram in **Figure 2** shows a bulb connected to a battery in Series with a capacitor.

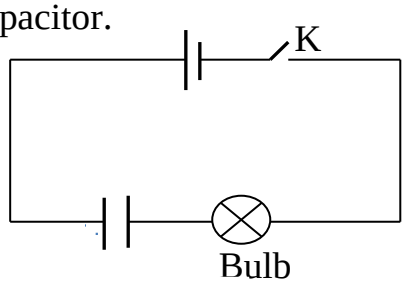

Figure 2

State and *explain* what is observed when

(i) the switch K is closed. (02 marks)

(ii) the battery is replaced with a source of alternating current and the switch closed. (03 marks)

(d) With the aid of labelled diagram explain how a hot wire instrument works. (05 marks)

SECTION D

8.(a) (i) Define the **ohm** and state **Ohm's law**. (02 marks)

(ii) Explain why potential difference between terminals of a battery is not always equal to its e.m.f. (02 marks)

(b) Describe an experiment to determine the resistance of a resistor using a circuit that includes a rheostat. (05 marks)

(c) In a simple metre bridge the resistors A and B have values 5Ω and 3Ω respectively. When A is shunted by a length of wire, the balance point is found to be 0.527 m from A. What is the resistance of the shunt? (03 marks)

If the shunt wire is 0.75 m long and 0.25 mm in diameter, what is the resistivity of the material of the wire? (03 marks)

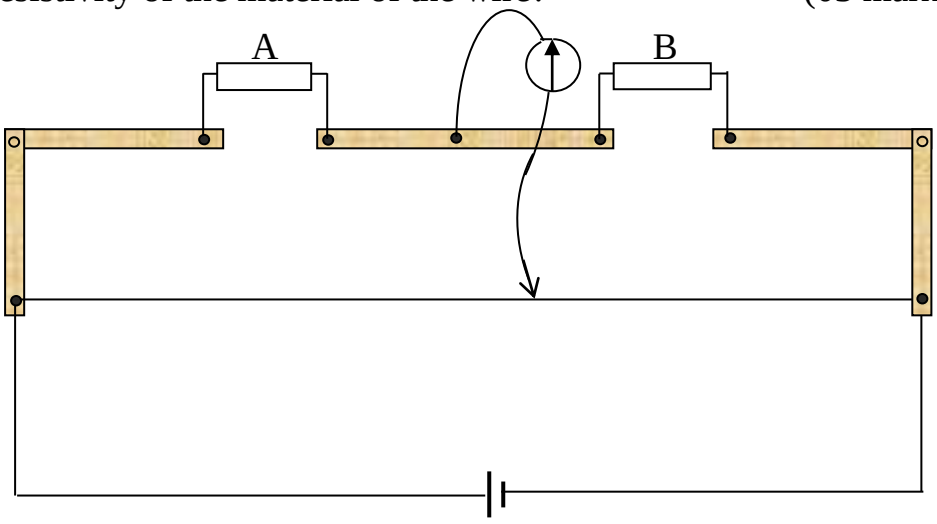

Figure 3

(d) Explain the effect on resistance of a conductor when its cross sectional area is increased. (03 marks)

(e) Why is a Wheatstone bridge unsuitable for comparing two resistances that are very small? (02 marks)

9.(a) (i) Define electric potential (01 mark)

(ii) Derive an expression for the electric potential difference between two points A and B at distances a and b respectively from a single point positive charge, Q. (04 marks)

(b) Explain how you can show that the potential on a pear shaped charged conductor is the same at all points. (03 marks)

(c) Three charges of magnitudes $+ 2.0 \times 10^{-8}$ C, $+ 3.0 \times 10^{-8}$ C and -4.0×10^{-8} C are placed at the vertices A,B and C respectively, of a triangle as shown in figure 4 below.

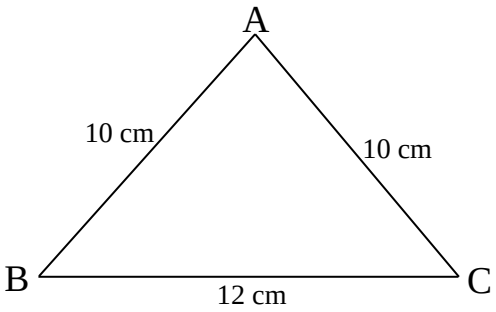

Figure 4

Find

(i) the force exerted on the charge at B. (04 marks)

(ii) Electric potential at a point D half way between B and C. (04 marks)

(d) Describe an experiment to show that equal and opposite charges are produced when a body is electrified by rubbing. (04 marks)

10.(a) (i) Define relative permittivity of a material. (01 mark)

(ii) Describe an experiment to determine relative permittivity of a dielectric using the vibrating reed switch method. (05 marks)

(b) In a vibrating reed experiment, two parallel plates have an area of 0.12 m^2 and are separated by a distance of 2 mm by a dielectric. A battery of 150 V charges and discharges the capacitor at a frequency of 50 Hz and a current of $20\,\mu A$ is produced.

(i) Calculate the relative permittivity of the dielectric. (03 marks)

(ii) What is the new capacitance if the dielectric is half withdrawn from the plates? (02 marks)

(c) Figure 5 below shows a charged capacitor with a dielectric of thickness t between its plates.

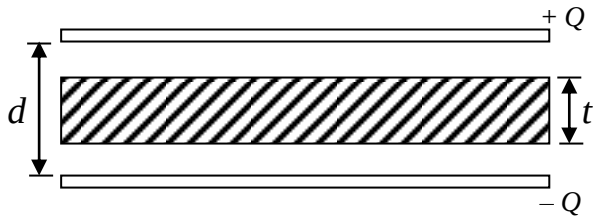

Figure 5

Show that the effective capacitance is given by $C = \dfrac{\varepsilon_0 \varepsilon_r A}{\varepsilon_r (d-t)+t}$

where ε_r *is the dielectric constant of the material*. (05 marks)

(d) (i) Describe and explain what happens when the terminals of a capacitor are connected to a battery of e.m.f. V. (03 marks)

(ii) Hence draw a graph to show the variation of p.d with time across the plates of the capacitor. (01 mark)

END