P510/2
PHYSICS
PAPER 2
July/August 2023
$2^1/_2$hours

WAKISSHA JOINT MOCK EXAMINATIONS

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.*
- *Non-programmable scientific calculators may be used.*
- *Mathematical tables and squared papers will be provided.*

Assume where necessary;

Acceleration due to gravity, g,	$= 9.81 ms^{-2}$
Speed of sound in air	$= 330 ms^{-1}$
Speed of light in vacuum, c,	$= 3.0 \times 10^{8} ms^{-1}$
Electronic charge, e,	$= 1.6 \times 10^{-19} C$
Electron mass	$= 9.11 \times 10^{-31} kg$
Planck's constant, h,	$= 6.63 \times 10^{-34} Js$
Permeability of free space, μ_o.	$= 4.0\pi \times 10^{-7} Hm^{-1}$
Permittivity of free space, ε_0,	$= 8.85 \times 10^{-12} Fm^{-1}$
The constant $\frac{1}{4\pi\varepsilon_0}$	$= 9 \times 10^{9} F^{-1} m$
One electron volt, (eV)	$= 1.6 \times 10^{-19} J$
Avogadro's number, N_A	$= 6.02 \times 10^{23} mol^{-1}$
Specific heat capacity of water	$= 4200 Jkg^{-1} k^{-1}$

SECTION A

1. (a) (i) Define **focal length** of a convex lens. (01 mark)

(ii) Show that the effective focal length, f, of two thin convex lenses in contact is given by;

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$$

Where f_1 and f_2 are the focal lengths of the individual lenses. (04 marks)

(iii) A compound lens consists of two lenses in contact having powers of +12.5 D and – 2.5 D. Find the position of the final image of an object placed 15.0 cm from the compound lens. (03 marks)

(b) (i) Define **refractive index** of a medium. (01 mark)

(ii) Describe an experiment to determine the refractive index of a liquid using a biconvex lens and a plane mirror. (05 marks)

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

(d) A compound microscope consists of two converging lenses of focal lengths 1.0 cm and 5.0 cm respectively. An object is placed 1.1 cm from the objective and the microscope is adjusted so that the final image is formed 30 cm from the eye piece. Calculate the:-

(i) Separation of lenses. (02 marks)

(ii) Magnifying power of the lenses. (03 marks)

2. (a) What is meant by the following terms as applied to optics:-

(i) **Refraction.** (01 mark)

(ii) **Critical angle.** (01 mark)

(b) Describe an experiment to determine the critical angle for a water - air boundary. (05 marks)

(c) A scratch is made at the bottom of a thick glass container which is filled with water. The scratch appears displaced by 0.5 cm when viewed from above the water. If the refractive indices of water and glass are 1.33 and 1.50 respectively and the thickness of water is 0.8 cm, determine the thickness of glass. (04 marks)

(d) Derive an expression for the refractive index of a prism in terms of the refracting angle, A, and the angle of minimum deviation, D. (04 marks)

(e) A glass prism of refracting angle, 60^0 and refractive index 1.60 is immersed into a liquid of refractive index 1.33. Calculate the:-

(i) angle of incidence for a ray of light which passes symmetrically through the prism. (03 marks)

(ii) angle of deviation of the ray. (02 marks)

SECTION B

(a) (i) Define the terms; **amplitude, frequency** and **wave length** as applied to wave motion. (03 marks)

(ii) Derive the relation between velocity, wave length and frequency of a wave. (03 marks)

(b) The displacement y of a progressive wave is given as;

$y = 3cos\left(\pi t - \frac{\pi x}{10}\right)$ metres

Determine the:-

(i) velocity of the wave, (03 marks)

(ii) maximum velocity of the particles in the medium. (02 marks)

(c) (i) Define **resonance.** (01 mark)

(ii) Describe an experiment to determine the end correction of a resonance tube. (04 marks)

(d) (i) State **Doppler effect.** (01 mark)

(ii) Derive an expression for the frequency, f^l, of sound as heard by a stationary observer when the source of sound of frequency f, approaches with uniform speed U_S. (03 marks)

4. (a) (i) State **two** conditions necessary for interference patterns to be 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 0.05 cm apart and interference is observed on the screen placed at a distance of 1.0 m from the slits. It is found that the 9^{th} bright fringe is at a distance of 88.4 mm from the second dark fringe from the centre of the fringe pattern. Find the wave length of light used. (05 marks)

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

(ii) A diffraction grating of spacing, d, is illuminated normally with light of wave length, λ. Derive the condition for occurrence of diffraction maxima. (03 marks)

(d) Light of wave length 5.8×10^{-7} m is incident on a diffraction grating of 500 lines per mm.

Find the:-

(i) diffraction angle for the 2^{nd} order image. (03 marks)

(ii) maximum number of images formed. (02 marks)

SECTION C

5. (a) Define **magnetic moment** of a coil. (01 mark)

(b) A circular coil of 20 turns of wire lies in a uniform magnetic field of flux density 0.05 T. The normal to the coil makes an angle of 30^0 with the direction of the magnetic field. If the diameter of the coil is 8 cm and the coil carries a current of 2.0 A, find the:-

(i) magnetic moment of the coil. (02 marks)

(ii) torque on the coil. (03 marks)

(c) (i) State **Lenz's law** of electromagnetic induction. (01 mark)

(ii) With the aid of a diagram describe an experiment to illustrate Lenz's law. (05 marks)

(d) (i) Define **magnetic flux density** and state its unit. (02 marks)

(ii) Show that when the magnetic flux linking a coil changes, the total charge which passes through it depends only on the resistance of the coil and the total flux linking it. (06 marks)

6. (a) (i) Write down the expression for the force on a charge, q coulombs moving with velocity, u, at an angle, θ, to a uniform magnetic field of flux density, B. (01 mark)

(ii) Use the expression in (a) (i) to deduce the force on a conductor carrying a current in a magnetic field. (03 marks)

(b) (i) With the aid of a labelled diagram, describe the structure and mode of operation of a moving coil galvanometer. (06 marks)

(ii) Discuss the factors which affect the current sensitivity of a moving coil galvanometer. (03 marks)

(c) A conducting disc of radius 5.0 cm with the plane perpendicular to a uniform magnetic field of flux density 0.25T, rotates at 15 revolutions per second about an axis through its center and perpendicular to its plane. Calculate the:-

(i) magnetic flux threading the disc. (03 marks)

(ii) e.m.f generated between the center of the disc and its rim. (02 marks)

(d) State any **two** factors which determine the efficiency of a transformer. (02 marks)

(a) Define **root mean square** value of alternating current. (01 mark)

(b) A resistor of 200 Ω is connected across an alternating voltage $V = 40\sin 160\pi t$.

(i) Find the frequency of the alternating voltage. (01 mark)

(ii) Calculate the mean power dissipated in the resistor. (03 marks)

(c) Show that current leads voltage by 90^0 when a sinusoidal voltage is applied across a capacitor. (04 marks)

(d) Describe with the aid of a labelled diagram how a thermocouple meter works. (04 marks)

(e) What is meant by **resonance** in a circuit? (01 mark)

(f) A resistor of resistance 20 Ω, a capacitor of capacitance 0.8 μF and an indicator of inductance 0.8 H are connected in series to an alternating voltage source of 0.02 V (r.m.s).

(i) Calculate the resonant frequency. (03 marks)

(ii) Find the voltage a cross the capacitor. (03 marks)

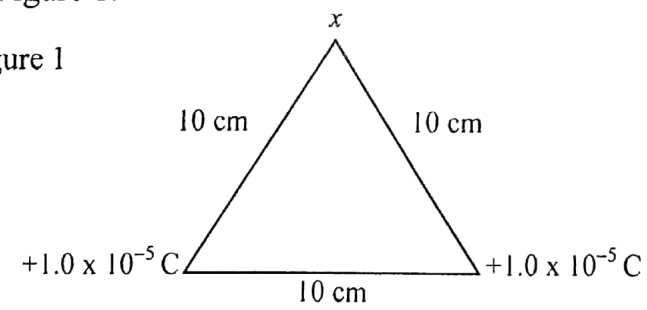
SECTION D

8. (a) (i) Define **electric potential** and **electrical field intensity** at a point. (02 marks)

(iii) Derive an expression for electric potential at a point which is a distance, r, from a point charge Q. (03 marks)

(b) Two charges each of 1.0×10^{-5} C are placed 10 cm apart as shown in Figure 1.

Figure 1



Calculate the:-

(i) Electric field intensity at *x*. (05 marks)

(ii) Electric potential at *x*. (03 marks)

(c) Describe an experiment to show that when two dissimilar dielectrics are rubbed together, they acquire equal but opposite charges. (04 marks)

(d) Describe how a conductor may be positively charged but remains at zero potential. (03 marks)

Turn Over

9. (a) Define the following :-

(i) **capacitance.** (01 mark)

(ii) **dielectric strength.** (01 mark)

(b) Describe an experiment that can be used to show how capacitance of a capacitor depends on the permittivity of a dielectric. (04 marks)

(c) The plates of a parallel plate capacitor are separated by a distance of 0.2 cm in air. If the surface area of each plate is 5.0 cm^2 and a p.d of 6 V is applied a cross the plates, find the magnitude of the charge on each plate. (03 marks)

(d) A 60 μF capacitor is charged from a 120 V supply. It is then connected across the terminals of a 40 μF capacitor.
Calculate the:-

(i) final p.d a cross the combination. (03 marks)

(ii) difference in the initial and final energies stored in the capacitors and comment on the difference. (05 marks)

(e) Explain **corona discharge.** (03 marks)

10. (a) Define the following as applied to a battery:

(i) **Electromotive force.** (01 mark)

(ii) **Internal resistance** (01 mark)

(b) A battery of e.m.f, E, and internal resistance, r, is connected a cross a load of resistance, R. Derive an expression for the maximum power delivered to the load. (04 marks)

(c) (i) Explain why temperature co-efficient of resistance is positive for metals. (03 marks)

(ii) The resistance of an element of an electric fire is 52 Ω at 20^0C. When operating on a 240 V supply, the current flowing through it is 4 A. Calculate the steady temperature reached by the electric fire if the temperature coefficient of resistance of the element is $2.0 \times 10^{-4} K^{-1}$. (05 marks)

(d) Describe with the aid of a diagram, how you would standardize a slide wire potentiometer. (03 marks)

(e) A dry cell gives a balance length of 85.0 cm on a potentiometer wire. When a resistor of resistance 20 Ω is connected a cross the terminals of the cell, a balance length of 80.0 cm is obtained. Find the internal resistance of the cell. (03 marks)

END