P510/2
PHYSICS
Paper 2
July/August, 2023
2 ½ hours

ASSHU ANKOLE JOINT MOCK EXAMINATIONS 2023
Uganda Advanced Certificate of Education
PHYSICS
Paper 2
2 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

- *Attempt five questions including at least one from each section, but not more than one from either sections A or B*

Assume where necessary

- *Acceleration due to gravity, g* = $9.81ms^{-2}$
- *Speed of light in a vacuum C* = $3.0 \times 10^{8}ms^{-1}$
- *Electronic charge e* = $1.6 \times 10^{-19}c$
- *Permeability of free space* μo = $4\pi \times 10^{-7}Hm^{-1}$
- *Permittivity of free space* ϵ_o = $8.85 \times 10^{-12}Fm^{-1}$
- *The constant* $\frac{1}{4\pi\epsilon_o}$ = $9.0 \times 10^{9}F^{-1}m$

SECTION A

1. (a) (i) State characteristics of images formed in a plane mirror. (2 marks)

(ii) Explain two reasons for using prisms rather than plane mirrors in reflecting optical instruments. (2 marks)

(b) Describe how the sextant is used to determine the angle of elevation of a star. (5 marks)

(c) A point object is placed 6cm from a concave mirror of radius of curvature 8 cm. A small rectangular piece of glass of refractive index 1.5 and thickness 3 cm is placed perpendicular to the principal axis between the object and concave mirror. Find the displacement of the image position. (5 marks)

(d)(i) Define the following terms. Dispersive power and refracting Angle of a glass prism. (2 marks)

(ii) Show that the angle of deviation D of light incident onto a small angled prism of refracting angle A and refractive index n is $D = (n-1)A$ (4 marks)

2. (a)(i) Define focal length and radii of curvatures of the surfaces of a convex lens. (2 marks)

(ii) Show that for a convex lens, $\frac{1}{f} = (n-1)\left(\frac{1}{r_1} + \frac{1}{r_2}\right)$, where **f** is the focal length, **n** is the refractive index of glass the lens is made of, $\mathbf{r_1}$, and $\mathbf{r_2}$ are the radii of curvatures of the convex lens surfaces. (5 marks)

(iii) The radii of curvatures of the surfaces of a converging meniscus lens are 16 cm and 18 cm. Find its focal length when it is made of glass of refractive index 1.5 and is placed in water of refractive index $\frac{4}{3}$. (3 marks)

(b) Describe an experiment to determine the focal length of a convex lens by using the displacements method. (5 marks)

(c) Draw the optical parts of an optical spectrometer and state the adjustments made before it is used for any purpose. (5 marks)

SECTION B

3. (a) (i) Define the term Doppler Effect (1 mark)

(ii) An observer moving at a speed of 10 ms^{-1} between two sources of sound **A** and **B** hears beat at 5 s^{-1}. If the frequency of waves produced by source **A** is 515 Hz and the observer is moving towards A, find the frequency of sound produced by B, if the speed of sound in air is 340 ms^{-1}. (5 marks)

(b)(i) Explain using the principle of superposition of waves, the formation of beats. (3 marks)

(ii) The wire of a sonometer of mass per unit length 10^{-3} kgm^{-1} is stretched on two bridges by a load of 40 N. When the wire is

struck at the centre point so that it executes its fundamental vibration and at the same time a turning fork of 264 Hz is sounded and beats are heard and found to have a frequency of 3 Hz. If the load is slightly increased the beat frequency is lowered, calculate the separation of the bridges. (5 marks)

(c) (i) Define the terms fundamental note and overtone as applied to a tube closed at one end. (2 marks)

(ii) Describe an experiment to determine the end correction of a resonance tube. (4 marks)

4. (a)(i) What is meant by interference and diffraction of light waves? (2 marks)

(ii) State the conditions necessary for observing diffraction, and those necessary to produce an interference pattern where the fringes are of the same superaction and of about the same intensity in the Youngs double slit experiment. (4 marks)

(b) Derive the expression for the fringe separation in Young's interference patterns, in terms of the slit separation **a** the distance **D** of the screen from the double slits, and the wave length λ of the light. (5 marks)

(c) In a Young's double slit experiment, light of wavelength 644 mm was used. Initially, the slit separation is 0.20 mm and the distance between the screen and the double slit is 1.00 m. Throughout the experiment, the interference pattern was viewed from the position of the double slit.

(i) What is the angular separation between the neighbouring bright fringes formed on the screen. (3 marks)

(ii) If the screen is then shifted further away from the double slit, what changes, if any, will occur to the interference pattern? (2 marks)

(d)

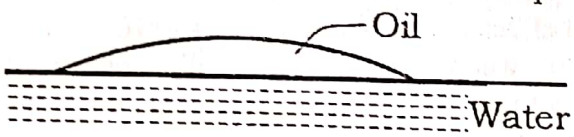

Fig.(i)

The figure (i) above shows a drop of oil of refractive index μ=1.20, floating on the surface of water of refractive index $n_w = 1.33$, and the reflected light is observed from the top.

(i) Explain whether the outer region (which is the thinnest) corresponds to a bright or dark fringe. (2 marks)

(ii) If blue light of wave length 450 nm is incident on the oil drop, estimate the thickness of the oil at the position of the third blue fringe from the outside. (2 marks)

SECTION C

5. (a) (i) Write the expression for the magnetic force **F** on an electron of charge e moving at a velocity $\mathbf{Vms^{-1}}$ at an angle α to a uniform magnetic field of flux density **B**. (1 mark)

(ii) From the expression in a(i) above, deduce the expression for the magnetic force acting on a straight conductor of length *l*, carrying a current **I** in a direction at the angle α to the magnetic field. (3 marks)

(b) Describe an experiment to determine the variation of the magnetic flux density **B** of the magnetic field produced by a straight conductor with the perpendicular distanced from it, by using a small circular coil of many turns and a cathode ray oscilloscope. (6 marks)

(c) A circular coil of 20 turns, and radius 3.2 cm is mounted at the centre of a solenoid of 850 turns per metre, with its axis making an angle of 30° with the axis of the solenoid if the current in the solenoid is 2 A. Calculate the initial torque on the coil when a current of 1.5 A is passed through the coil (5 marks)

(d) What is current sensitivity of a moving coil galvanometer? Explain why in a moving coil galvanometer

(i) the coil is wound around a metallic frame. (1 mark)

(ii) A strong permanent magnet with concave curved poles is used. (1 mark)

6. (a)(i) State the Laws of electromagnetic induction. (2 marks)

ii) Describe an experiment to verify the Lenz's law of electromagnetic induction. (5 marks)

(b) A coil of area **A** is rotated at a frequency f in a uniform magnetic field of flux density **B** about an axis which is perpendicular to the magnetic field.

(i) Derive an expression for the e.m.f generated. (3 marks)

(ii) State the factors that determine the induced e.m.f (2 marks)

(c) What is meant by mutual and self-induction? (2 marks)

(d) Along solenoid of effective cross-sectional area 8×10^{-4} m^2 and, length 0.5 m has 2000 turns wound uniformly on a hollow plastic tube, closely wound over the middle region of this solenoid is a short secondary coil of 600 turns. Calculate;

(i) the magnetic flux density **B** of the field with in the solenoid when a steady current of 5 A flows through it. (2 marks)

(ii) the mutual inductance **M** between the solenoid and secondary coil (2 marks)

(iii) The magnitude of the e.m.f of E induced in the secondary coil at the instant when the primary coil current is increasing at the rate of 12 A s^{-1}. (2 marks)

7. (a) Define the terms reactive of a capacitor and impedance of an A.C circuit. (2 marks)

(b)(i) A sinusoidal alternating voltage $V = V_m \sin 20ft$ is applied across a capacitor of capacitance **C**, deduce the expression of the captative reactance. (4 marks)

ii) Explain when an alternating current apparently flows through the capacitor. (3 marks)

(c) Two identical bulbs **A** and **B** are connected to a coil **L** of negligible resistance as shown in the figure (ii) below.

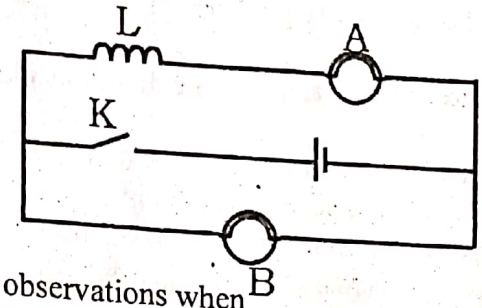

Fig.(ii)

Explain the observations when

(i) switch K in closed. (2 marks)

(ii) switch K is opened (2 marks)

(iii) soft iron rod is inserted in the coil and K is closed. (2 marks)

(d) An air cored coil of inductance 450 Ω is placed in series with a resistor of resistance 450 Ω, and an A.C supply operating at a p.d of 240 V r.ms. and frequency 50 Hz. Find;

(i) the root mean square value of the circuit alternating current (3 marks)

(ii) the p.d across each of the coil and resistor. (2 marks)

.SECTION D

8. (a)(i) Explain why a charged conductor loses charge faster when a pin is attached to it. (3 marks)

ii) Describe an experiment to show that when two insulators are rubbed together, they develop equal and opposite charges (3 marks)

(b)(i) What is an equipotential surface and give two of its properties? (3 marks)

ii) Show that for two points near each other in an electrostatic field the electric field intensity E= Electric potential gradient. (3 marks)

(c)

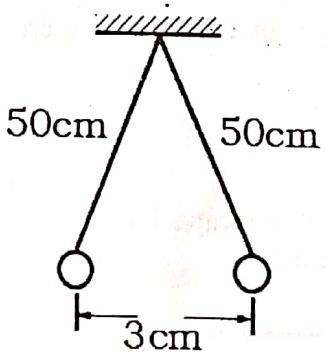

Fig.(iii)

Fig. (iii) above shows two light conducting sphere, each 6 mm diameter and having a mass of 10m g, are suspended from the same

point by insulating fibers 50 cm long. Due to electrostatic repulsion, the spheres are in equilibrium. When 3 cm apart. Find (3 marks)

(i) the force of repulsion between the spheres. (2 marks)

(ii) the charge on each sphere. (3 marks)

(iii) the electric potential of each sphere

(Use the acceleration due to gravity g = $10ms^{-2}$).

9. (a)(i) What is meant by internal resistance of a cell and its electromotive force. (2 marks)

ii) Describe with the aid of circuit diagram how thermoelectric e.m.f can be determined by using a slide wire potentiometer. (5 marks)

(b) In a potentiometer experiment to determine e.m.f and the resistance of a galvanometer, a circuit as shown in fig.(iv) is used. (3 marks)

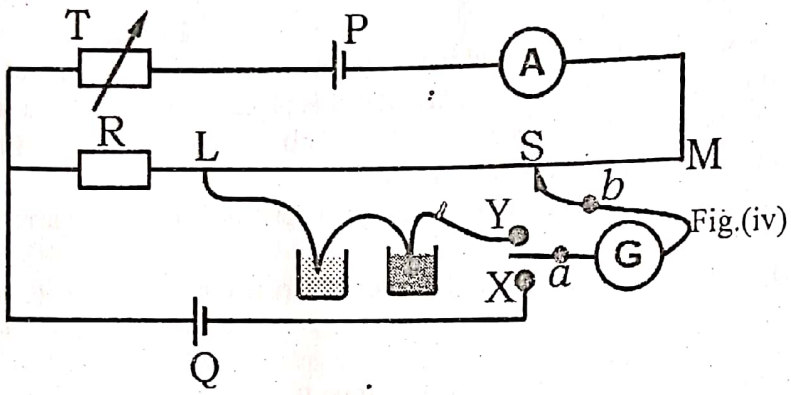

Fig.(iv)

Cell P has e.m.f of 2 V and internal resistance 1.0 Ω while Q has e.m.f 1.5 V and negligible internal resistance LM is a uniform wire of length 1.0 m.

(i) State what purpose rheostat T could serve. (1 mark)

(ii) T is set at 23 Ω. When K is connected to X, the balance point K found 80.0 cm from L while when K is switched to Y, the balance point is 60.0 cm from L. If the ammeter A reads 20 mA, determine the resistance per cm, the resistance R and the thermoelectric e.m.f (8 marks)

(c)(i) Define resistance of a conductor (1 mark)

ii) Explain why the resistance of a metal wire increases when the wire heats up. (3 marks)

10.(a) Define the terms

(i) Dielectric strength. (1 mark)

(ii) Dielectric constant (1 mark)

(b) Describe an experiment to determine capacitance of a capacitor, by using a vibrating read switch circuit. (4 marks)

(c)

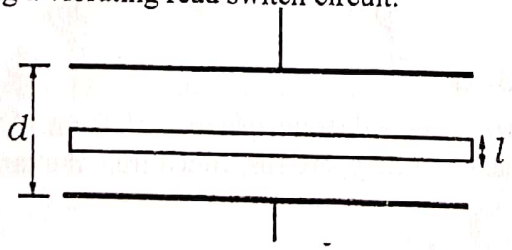

Fig.(v)

A metal plate of thickness l is inserted in the space between the plates of a parallel plate capacitor. The area of each plate is A and the plate separation is d as shown in fig (V) above. Show that the capacitance C of the arrangement is given by $C = \frac{\epsilon_o A}{(d-l)}$, where ϵ_o is the permittivity of free space (3 marks)

(d) Each plate of a parallel plate capacitor has an area of 0.400 m^2 and is separated from each other by 5.00 mm. the capacitor is charged to a p.d of 2.00 kV.

(i) What is the capacitance of the capacitor, and the charge on each plate? (3 marks)

(ii) The charging p.d is then disconnected. A light metal plate of thickness 2.00mm is inserted between the plates of the capacitor and the arrangement is as shown in the figure (V) above. Determine the capacitance of new arrangement and find the work done on the metal plate. Explain whether the metal plate is sucked into or pushed into the space between the plates of the capacitor. (5 marks)

(e) Sketch a graph of current against time during the charging process of the capacitor and explain how it is used to find the charge on the places of the capacitor. (3 marks)

END