P510/2
Physics paper two
July, 2024
$2\frac{1}{2}hours$

INTERNAL MOCK EXAMINATIONS 2024
UGANDA ADVANCED CERTIFICATE OF EDUCATION
PHYSICS PAPER TWO
2hours and 30minutes

INSTRUCTION TO CANDIDATES

- ✓ Attempt **FIVE** questions including **atleast one** from section A, B, C and D **but NOT** more than one question from section A and B.
- ✓ Any additional question answered will not be marked
- ✓ Assume where necessary;

$Speed\ of\ light\ in\ a\ vaccum\ c\ = 3.0x10^{8}ms^{-1}$

$speed\ of\ sound\ in\ air = 340\ ms^{-1}$

$Accerelation\ due\ to\ gravity\ g\ = 9.81ms^{-2}$

$permeability\ of\ free\ space\ \mu_0 = 4.0\pi x10^{-7}Hm^{-1}$

$permitivity\ of\ free\ space\ \varepsilon_0 = 8.85x10^{-12}\ Fm^{-1}$

$The\ constant\ \frac{1}{4\pi\ \varepsilon_0} = 9x10^{9}\ \ F^{-1}m$

SECTION A

1. (a) Define the following as applied in curved mirrors
   (i) Focal point (1 mark)
   (ii) Center of curvature (1 mark)
   (b) A converging mirror forms an erect image three times the size of the object. The mirror id then moved backwards a distance of 18cm away from its initial position. If the radius of curvature of this mirror is 36cm. Find the distance d between the initial and final image positions. (4 mark)
   (c) A diverging lens of focal length 100mm and a converging lens of focal length 150mm are used as a set to view distant objects.
   (i) Show with the aid of a ray diagram how you can view the image of an object at infinity to be formed at the near point distance of the eye. (2 mark)
   (ii) State two limitations of the set up in c (i) to a viewer. (2 mark)
   (iii) Calculate the angular magnification produced. (3 mark)
   (d) (i) State two conditions for a convex lens to form a real image of a real object on the screen (2 marks)
   (ii) Briefly describe an experiment to determine the focal length of a convex lens using newton's relation. (5 marks)

2. (a) Define the following terms:
   (i) Critical angle (1 mark)
   (ii) Limiting angle of glass prism (1 mark)
   (b) (i) Explain with the aid of diagram the action of total reflecting glass prisms in periscopes (2 mark)
   (ii) Give two reasons why the periscope in b (i) may be preferred to a plane mirror periscope. (2 marks)
   (c) Briefly describe an experiment to determine the reflecting angle of a glass prism using the optical pin method (4 marks)
   (d) A diverging lens of focal length 15cm is positioned facing a distant object and is 20cm away from a converging lens of focal length 10cm.
   (i) Find the final image position in the converging lens. (3 mark)
   (ii) State the defects of the image in d(i) and explain how they can be minimized. (3 mark)
   (e) (i) Define the deviation of light (1 mark)
   (ii)

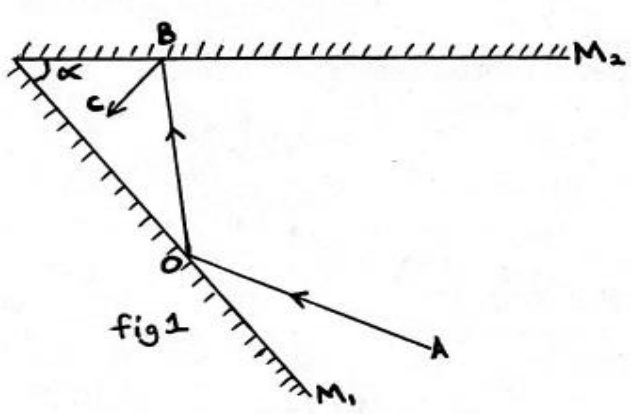

fig 1

A ray of light is incident on plane mirror M_1 inclined to plane mirror M_2 at angle α. If the net deviation of the ray is β, show that $\alpha = \frac{\beta}{2}$ (3 marks)

SECTION B

3. (a) (i) Distinguish between mechanical waves and electromagnetic waves. (2 marks)
   (ii) Define the terms harmonics and overtones (2 marks)
   (b) A uniform wire of length l , cross section area A and density ρ is stretched under tension$T$. The wire is now plucked mid-way its full length and vibrates with a lowest frequency$f$.
   (i) Derive the frequency of the nth harmonic when the wire vibrates in different modes in terms of$n, l, T, \rho \; and \; A$. (4 marks)
   (ii) A wire of cross section area of $3.33x10^{-6}$m^2 and density of 0.6gcm^{-3} is under tension of 20N and resonates when sounding its third harmonic with a tuning fork of frequency 100Hz. Calculate the vibrational length of the wire. (3 marks)
   (c) Describe an experiment to determine the end correction of a closed pipe using several tuning forks of different frequency. (4 marks)
   (d) (i) Define doppler effect (1 marks)
   (ii) A source of sound of frequency f is receding from a stationary observer towards a vertical wall. An observer standing between the source of sound and vertical wall hears beats at a rate of 4.0s^{-1}. If the speed of source of sound 5.0ms^{-1}. Find the value of frequency f (4 mark)
   [Assume speed of sound in air is 340 ms^{-1}]

4. (a) What is meant by;
   (i) Constructive interference (1marks)
   (ii) Division of wave front? (1 marks)
   (b) Describe the experiment to produce interference fringe using young's double slit principle and derive the expression for the fringe width (7 marks)

(c)

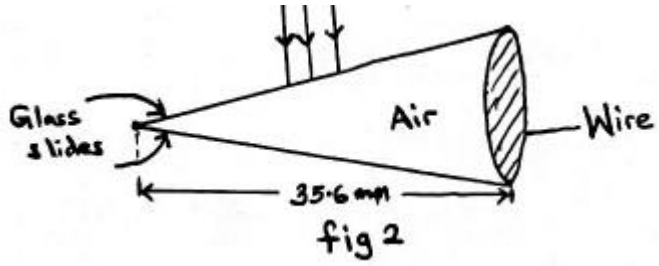

fig 2

Fig.2 shows an air wedge formed by two thin glass slides of length 35.6mm joined at one end and separated at the other end by a wire of diameter D.
When the wedge is illuminated by light of wavelength 589nm, the distance between the seventh and one hundred sixty seventh dark fringe is found to be 26.3nm. Calculate the value of D. (5 marks)

(d) (i) What is meant by polarization of light? (1 marks)
(ii) Describe how polarization of light is used in comparing concentration of sugars (5 marks)

SECTION C

5. (a) (i) State faraday's law of electromagnetic induction. (1 mark)
(ii) Distinguish between mutual and self-induction and state one application for each case. (03 marks)

(b) A lamp rated 30W,0.5A is connected in series with an inductor of self-inductance $0.4H$ and negligible internal resistance and an alternating current source of frequency $50Hz$. If the lamp is operated at full capacity find;
(i) The total impedance of the circuit (04 marks)
(ii) Root mean square value of the applied voltage. (02 marks)

(c) (i) Derive a relation between peak valve and root mean square value of alternating voltage. (3 marks)
(ii) Distinguish between impedance and reactance of an alternating current circuit. (2 marks)
(iii) Sketch on the same axes, the variation of impedance, reactance and resistance with frequency for a series circuit containing a resistor, inductor and capacitor (2 marks)

(d) Describe how the rectifier meter is able to measure alternating current (3 marks)

6. (a) Define these terms as applied in magnetism
(i) Tesla (1 mark)
(ii) Weber (1 mark)

(b) (i) Two parallel wire P and Q separated by 0.04m in air lie on a horizontal wooden flat surface each carrying a current of 10A and 1A respectively as shown in $fig.3$ Wire P is fixed while Q is free and has a mass of $2.04x10^{-6}kg$.

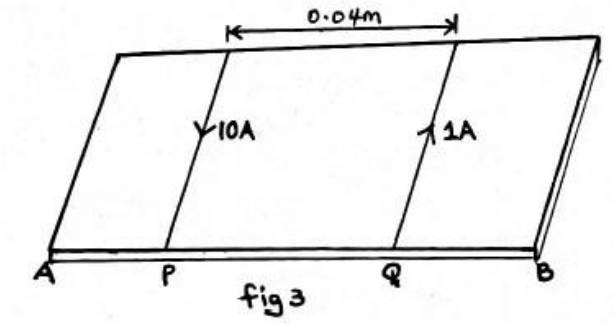

fig 3

Find the angle of inclination when plane AB is raised with end B upwards and A at its original position for wire Q to just be prevented from sliding downwards along BA. (4 marks)

(ii) Explain what would happen to the distance of separation if current in any of the wires P and Q is reversed while plane AB is in horizontal position. (3 marks)

(c) (i) Define the ampere (1 marks)

(ii) Briefly describe an absolute method of measurement of current. (5 marks)

(d) A deflection magnetometer placed at the center of large plane circular coil of 40 turns with its plane in a magnetic meridian deflects through 43^0 and 44^0, when the current of 6A is passed through the coil, on reversing the current through the coil deflection 45^0 and 47^0 were obtained. If the angle of dip is 67^0 and earth's magnetic flux density is $4.0x10^{-5}T$ at the location of the coil, calculate the mean radius r of the coil. (5 marks)

7. (a) (i) State Lenz's law of electromagnetism induction (1 marks)

(ii) Describe an experiment to verify Lenz's law (5 marks)

(iii) Explain how the heating effect of eddy current is applied at industrial scale (3 marks)

(b) A domestic wind fan has a direct current motor of armature residence 2Ω and operated on a 240V main supply. If the motor is 91.7% efficient;

(i) Find the power loss of the D.C motor (4 marks)

(ii) What can be done to reduce on the power loss in b(i) (2 marks)

(c) A plane square coil of 500 turns and cross section area $5.0cm^2$ is positioned with its plane normal to uniform magnetic field of flux density $2.0x10^{-5}T$. The coil is now turned through 90^0 in a time of 10s.

(i) Calculate the magnitude of induced emf in the coil (4 marks)

(ii) Sketch the variation of the induced emf with time (1 marks)

SECTION D

8. (a) (i) State coulombs law of electrostatics (1 marks)
   (ii) Explain the term corona discharge (2 marks)
   (b) Describe an experiment to show that electric charge resides only on the outside surface of a hollow conductor. (3 marks)
   (c) Three-point charges Q_1, Q_2 and Q_3 are placed as shown in figure 4.

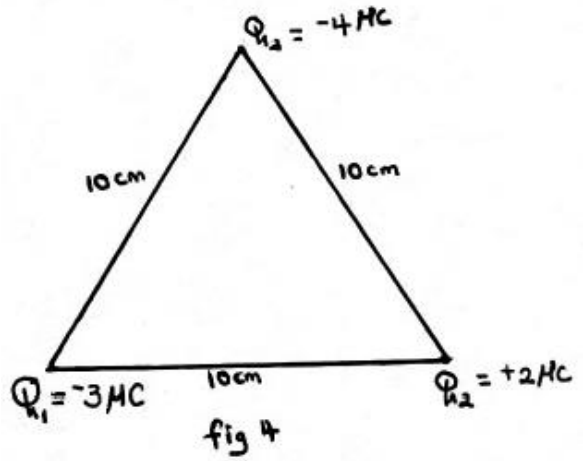

fig 4

   (i) Find the resultant force in charge Q_3 (4 marks)
   (ii) Sketch the electric field pattern of the system of charge in c(i) (2 marks)
   (d) (i) Define the term electrostatic screening and describe how it's done (3 marks)
   (ii) Explain how a conducting body may be positively charged at zero potential (3 marks)
   (iii) Explain why a charged material attracts uncharged body conductor (2 marks)

9. (a) Define the following terms
   (i) Capacitance of capacitor (1 mark)
   (ii) Dielectric constant (1 mark)
   (iii) Dielectric strength (1 mark)
   (b) Describe an experiment to investigate how area of overlap of the capacitor effects capacitance of a parallel plate capacitor. (4 marks)
   (c) Two parallel plate capacitors, one with air as dielectric and the other with mica as a dielectric are identical in all respects. The air capacitor is charged from a 400V supply, isolated and then connected from across a mica capacitor initially uncharged. The potential difference across this parallel combination becomes 50V. Calculate;
   (i) The relative permittivity of mica. (3 marks)
   (ii) The ratio of the energy stored in the parallel combination to the energy stored by the single charged capacitor. (3 marks)
   (iii) Comment and account for the value of the ratio in c(ii) (2 marks)

(d) Two identical capacitors of capacitance C are connected in series across a voltage source of voltage V. A dielectric of relative permittivity ε_r is inserted in one of the capacitors and then both are charged full. The voltage source is now removed and is replaced with an empty identical capacitor with air between its plates. Show that the p.d across the new capacitor will be $V = \frac{\varepsilon_r \, V}{2\varepsilon_r + 1}$ (5 marks)

10. (a) (i) Describe the principle of a slide wire potentiometer. (3 marks)

(ii) Give two advantages of potentiometer circuit over a voltmeter in measurement of P.d. (2 marks)

(b) Using a labelled diagram, describe how a potentiometer slide wire may be used to measure internal resistance of a cell. (5 marks)

(c) In figure 5, S is a standard cell of emf 0.6V. With switch K_1, closed and K_2 open, the balance length PT is 15.1cm. When K_1 is open and K_2 is closed, the balance length becomes 13.4cm and ammeter A reads 0.4A. Calculate the percentage error in the ammeter reading. (4 marks)

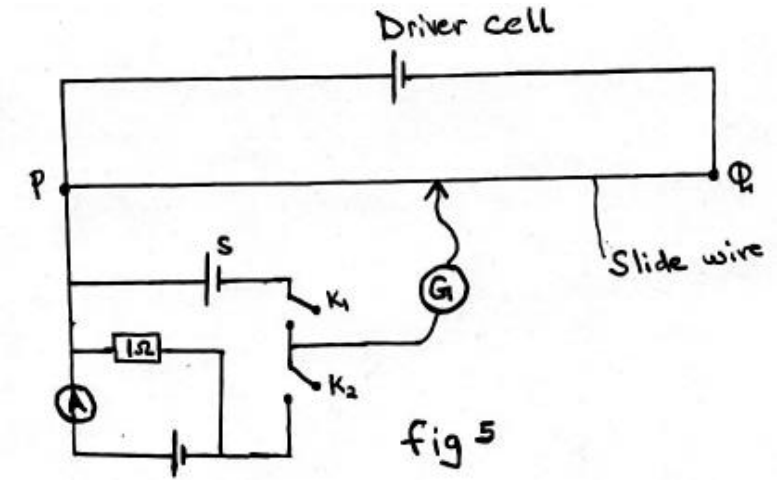

fig 5

(d) (i) Derive the balance condition for a Wheatstone bridge using Kirchhoff's law of circuit network. (4 marks)

(ii) State the reasons why a Wheatstone bridge circuit is not suitable for comparison of either very low or very high resistances (2 marks)

END