P510/2

Physics

Paper 2

July-August 2024

2 ½ Hours

UGANDA MUSLIM TEACHERS' ASSOCIATION

UMTA JOINT MOCK EXAMINATIONS 2024

UGANDA ADVANCED CERTIFICATE OF EDUCATION

Physics

Paper 2

2 Hours 30 Minutes

INSTRUCTIONS TO CANDIDATES:

- *Answer only* **five** *questions, including at least* **one** *question but* ***not*** *more than* **two** *questions from each of the sections* ***A, B, C*** *and* ***D.***
- *Any additional question(s) answered will* ***not*** *be marked.*
- *Mathematical tables and squared paper will be provided where need be.*
- *Non-programmable scientific calculators may be used.*
- *Begin each question on a fresh page of the answer sheets / booklet provided.*

Assume where necessary:

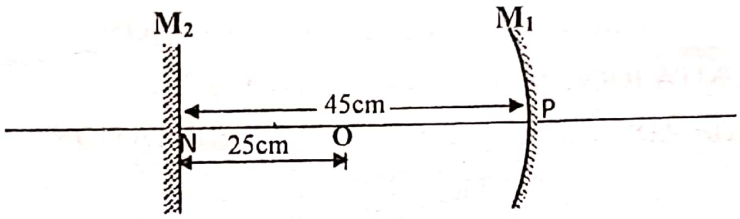
Acceleration due to gravity, g	=	$9.81\ m\,s^{-2}$
Speed of light in Vacuum, c	=	$3.0 \times 10^{8}\ m\,s^{-1}$
Speed of sound in air,	=	$340\ ms^{-1}$
Electronic charge, e	=	$1.6 \times 10^{-19}\ C$
Electronic mass, m_e	=	$9.11 \times 10^{-31}\ kg$
Permeability of free space, μ_o	=	$4.0\pi \times 10^{-7}\ H\,m^{-1}$
Permittivity of free space, ε_0	=	$8.85 \times 10^{-12}\ Fm^{-1}$
The Constant, $\frac{1}{4\pi\varepsilon_o}$	=	$9.0 \times 10^{9}\ F^{-1}\,m$

SECTION A

1. (a) (i) Define focal length and centre of curvature as applied to concave mirrors. (02 marks)

(ii) Show that the radius of curvature, r, of a concave mirror is given by the expression: $r = 2f$, where f is the focal length of the mirror. (03 marks)

(b) A plane mirror, M_2 is placed **30cm** in front and perpendicular to the principal axis of a concave mirror, M_1, whose centre is at **P**, as shown below.



An object **O** placed **25cm** from M_2 produces an image in the hole drilled at pole **P**. If the light rays are reflected first from M_1 and then from M_2,

(i) Draw rays showing the formation of the image. (02 marks)

(ii) Find the focal length of M_1. (04 marks)

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

(ii) Describe an experiment in which the refractive index of a liquid can be determined using an air cell. (05 marks)

(d) Light from a luminous point source on lower face of a rectangular glass block strikes the upper surface and is total internally reflected to form a circle of radius **4.0cm** on lower surface. If the refractive index of the glass block is **1.64**, find the thickness of the glass block. (03 marks)

2. (a) (i) Define focal length as applied in a concave lens. (01 mark)

(ii) Describe an experiment to determine the focal length of a concave lens using a concave mirror. (04 marks)

(b) What is meant by the terms Magnifying power and far point as used in Optics? (02 marks)

(c) A concave lens of focal length **15cm** is arranged coaxially with a convex lens of focal length **20cm**. When an object is placed **60cm** in front of the concave lens, on the side remote from the convex lens, a virtual image is formed **10cm** from the convex lens. Find the separation of the lenses. (04 marks)

(d) (i) Derive an expression for the magnifying power of a Galilean telescope in normal adjustment. (04 marks)

(ii) Explain the limitation of the telescope in **(d)(i)** above. (02 marks)

(e) A far sighted man can read clearly without glasses at distance not less than **75cm**. Find his new near point when he puts on glasses of power **2.5D**. (03 marks)

SECTION B

3. (a) Explain damped oscillations. (02 marks)

(b) (i) What is meant by phase difference and harmonics as applied to wave motion. (02 marks)

(iii) Sketch a graph to show the variation of pressure along a longitudinal wave and explain the shape of the graph. (03 marks)

(c) **Figure 2** shows a source **S** emitting sound of frequency **210Hz** mounted over the open end of the tube when is fitted with a movable piston.

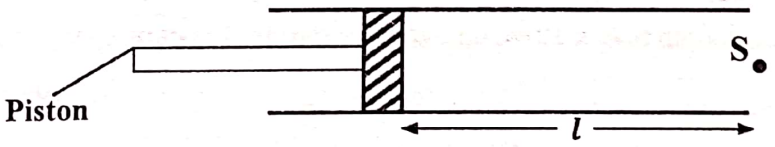


Figure 2

It is found that when the piston is moved slowly along the tube, the sound intensely reaches the first maximum when the length ***l*** between the piston and open end is **41cm** and second maximum intensely occurs when ***l*** is **121cm**.

(i) Explain the observation. (02 marks)

(ii) Calculate the speed of sound in air. (02 marks)

(d) A wire of fixed length and mass **6.5g** is fixed at **two** points and carries an alternating current of frequency **50Hz**. The wire is stretched between the poles of a strong horse shoe magnet such that the wire is set into oscillation,with **two** antinodes. If the tension in the wire is $\mathbf{1.25 \times 10^2}$ $\boldsymbol{N}$, find the length of the wire. (04 marks)

(e) (i) Define beat frequency. (01 mark)

(ii) Describe how an audio oscillator is used to determine the frequency of a tuning fork. (04 marks)

4. (a) (i) State Huygen's principle. (01 mark)

(ii) Use Huygen's principle to show that the angle of incident is equal to the angle of reflection of light. (05 marks)

(b) (i) Define the term diffraction as applied to a light wave. (01 mark)

(ii) Describe an experiment in which the wave length of light can be determined using a diffraction grating and a spectrometer. (06 marks)

(c) (i) What is meant by interference of light waves? (01 mark)

(ii) Explain why a series of bright and dark lines are observed in an air wedge when irradiated normally with a monochromatic light. (03 marks)

(d) **Two** plane glass plates which are in contact at one edge are separated by a piece of metal foil **12.5cm** from that edge. Interference fringes parallel to the line of contact are observed in reflected light of wavelength $\mathbf{5.46 \times 10^{-7}m}$ and are found to be **1.50mm** apart. Find the thickness of the foil. (04 marks)

SECTION C

5. (a) (i) Define magnetic flux density and magnetic moment. (02 marks)

(ii) Explain why diamagnetism is almost independent of temperature. (03 marks)

(b) (i) Describe the structure and mode of operation of a moving coil galvanometer. (05 marks)

(ii) A galvanometer whose sensitivity is **3.5** divisions per **mA** gives a full scale deflection of **30** divisions when connected in series with a battery of **emf 5.0V** and of negligible internal resistance and a resistor of **490Ω**. Calculate the resistance of the galvanometer. (03 marks)

(iii) Explain **two** ways of improving the current sensitivity of a moving coil galvanometer. (02 marks)

(c) The coil of a **dc** motor is mounted in a radial magnetic field of flux density **0.49T.** The coil has **10** turns, each of area **50cm²** and a total resistance of **3.5Ω**. Calculate the;

(i) maximum angular velocity the motor attains when working on a **240V** mains and drawing a current of **0.85A.** (03 marks)

(ii) efficiency of the motor. (02 marks)

6. (a) Define a root mean square value **(r.m.s)** and amplitude of an alternating current. (02 marks)

(b) (i) Describe how a repulsive – iron ammeter is able to measure alternating current. (05 marks)

(ii) Give **one** advantage of the moving iron meter over the moving coilmeter. (01 mark)

(c) What is meant by reactance of an **ac** circuit? (01 mark)

(d) A **240V** supply with frequency of **1kHz** connected in series with a capacitor and an inductor of negligible resistance causes current of **3.0A** to flow through them. Calculate the;

(i) Reactance of the inductor. (02 marks)

(ii) Inductance of the inductor. (02 marks)

(e) (i) Explain why a metal swinging with its plane perpendicular to a uniform magnetic field heats up after some time. (03 marks)

(ii) Describe **one** application of the phenomenon in **e (i)** above. (03 marks)

7. (a) (i) State the laws of electromagnetic induction. (02 marks)

(ii) **Figure 2** shows a copper ring suspended by a thread in a vertical plane.**One** end of a bar magnet is brought horizontally towards the ring.

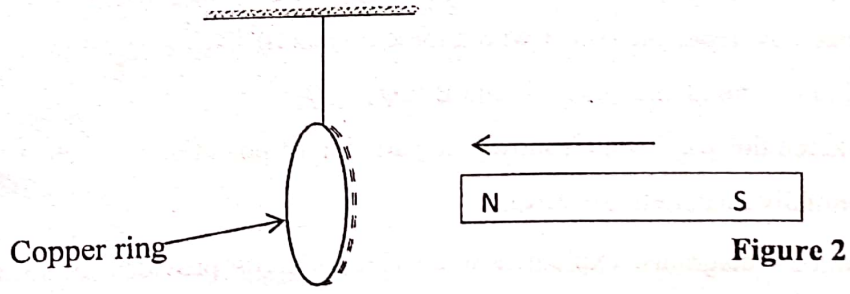


Figure 2

Explain what will be observed. (03 marks)

(b) Show that the magnitude of induced **e.m.f** across the ends of a rod of length l perpendicular to magnetic field of flux density B, moving with velocity, u in a direction inclined at an angle to the magnetic field is given by $E = Blusin\theta$. (04 marks)

(c) At a certain place on the earth, when a metal rod of length **15m** facing East-West is moved northwards at a speed of **200m/s**, an **emf** of **1.2mV** develops between the ends. When the rod is moved at the same speed vertically upwards, an **e.m.f** of **6mV** develops between its tips. Determine the;

(i) angle of dip. (03 marks)

(ii) magnetic flux density of the earth at the place. (02 marks)

(d) (i) Describe the direct method of determining resistance. (05 marks)

(ii) Explain why the method in **d (i)** is called direct method. (01 mark)

SECTION D

8. (a) (i) What is meant by the term electric field intensity? (01 mark)

(ii) Derive the relationship between electric field intensity and electric potential. (03 marks)

(b) (i) State Coulomb's law? (01 mark)

(ii) Explain why electrostatic induction leads to attraction of a neutral conductor. (02 marks)

(c) **Two** identical spheres **A** and **B** carry charges Q_1 and Q_2 respectively. When the spheres are **50cm** apart in a vacuum, they attract each other with a force of $1.08x10^{-1}$**N.** The spheres are connected temporarily using a conducting wire. The spheres now repel each other with a force of $3.2x10^{-2}$**N.**

(i) Find the initial charges on **A** and **B** if $Q_1 > Q_2$ (05 marks)

(ii) Sketch the graph which shows the variation of potential between the charges initially relative to the earth. (02 marks)

(d) With aid of diagrams, explain how an electrophorus provides unlimited supply of charge. (04 marks)

9. (a) (i) Define the terms capacitance and a dielectric as applied to a capacitor. (02 marks)

(ii) Describe how a gold leaf electroscope can be used to compare the magnitude of charges on **two** dielectrics. (04 marks)

(b) In a reed switch experiment, an air spaced capacitor is charged and then discharged through a micro ammeter which reads a steady current, I_1. When a dielectric having the same thickness as the air gap is inserted between the plates of the capacitor so that one third of the volume of the gap is filled with the dielectric, the micro ammeter reads a steady current, I_2. Show that the relative permittivity, ε_r of the dielectric is given by the relation; $\varepsilon_r = \frac{3I_2}{I_1} - 2$ (04 marks)

(c) A capacitor is charged by a **100V d.c** source. When fully charged, it is found to carry charge of $24.0nC$. The capacitor is then connected across an uncharged capacitor of capacitance **6.0nF**. Determine the;

(i) Capacitance of the first capacitor. (02 marks)

(ii) Energy stored in network after the capacitors were joined. (04 marks)

(d) (i) Sketch a graph of charging current against time for a capacitor. (02 marks)

(ii) Explain the graph in **d (i)** above. (02 marks)

10.(a) (i) Define the terms **e.m.f.** and **internal resistance** of a cell. (02 marks)

(ii) A battery of **e.m.f.** E and internal resistance, r, is connected across a variable resistor of resistance, R. Derive an expression for the maximum power delivered by the battery to the resistor. (04 marks)

(b) Describe an experiment determine the internal resistance of a cell accurately using a potentiometer. (05 marks)

(c) In **figure 3** is a circuit diagram, an accumulator, ***D***, of **e.m.f.** 4.0V and internal resistance, **2.0Ω** is connected across a uniform wire ***AB*** of length **100cm** and resistance **8.0Ω**. ***X*** is a cell of **e.m.f. 2.0V** connected across a resistor ***R*** of **5.0Ω.**

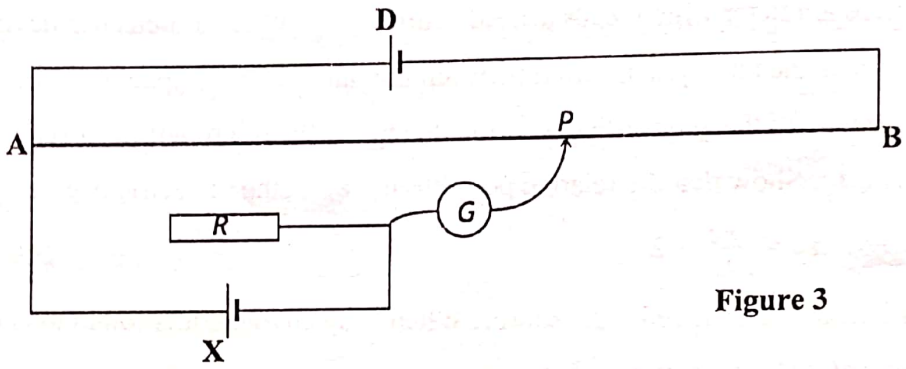


Figure 3

The galvanometer **G** shows no deflection when the sliding contact ***P*** is **45.0cm** from ***A***. Calculate:

(i) the current through resistor ***R***. (04 marks)

(ii) the internal resistance of cell ***X***. (02 marks)

(d) Compare the suitability of using a voltmeter and then a slide wire potentiometer to measure the **p.d.** (03 marks)

END