P510/2
Physics
Paper 2
2024
2½ hours

MATIGO EXAMINATIONS BOARD

PRE MOCK EXAMINATIONS 2024

Uganda Advanced Certificate of Education

PHYSICS
(Theory)
Paper 2
2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES:

*Answer **five** questions, taking at least **one** from each sections **A, B, C** and D, but not more than one question should be chosen from either A or B.*
*Any additional questions(s) answered will **not** be marked.*
Mathematical tables and graph paper are provided.
Non- programmable scientific calculators may be used
Assume where necessary:

$Acceleration\ due\ to\ gravity, g$	$= 9.81\text{ms}^{-2}$
$Speed\ of\ light\ in\ vacuum, C$	$= 3.0 \times 10^{8}\text{ms}^{-1}$
$Speed\ of\ sound\ in\ air, v$	$= 340\text{ms}^{-1}$
$Electronic\ Charge, e$	$= 1.6 \times 10^{-19}\text{C}$
$Electronic\ mass,$	$= 9.11 \times 10^{-31}\text{kg}$
$Permeability\ of\ free\ space, \mu_0$	$= 4.0\pi \times 10^{-7}\text{H}m^{-1}$
$Permittivity\ of\ free\ space, \varepsilon_0$	$= 8.85 \times 10^{-12}\ \text{F}m^{-1}$
$The\ Constant\ \frac{1}{4\pi\varepsilon_0}$	$= 9.0 \times 10^{9}F^{-1}\text{m}$
$Resistivity\ of\ Nichrome\ wire\ at\ 25°C$	$= 1.2 \times 10^{-6}\Omega m$
$Specific\ heat\ capacity\ of\ water$	$= 4.2 \times 10^{3}Jkg^{-1}K^{-1}$
$Avogadro's\ number, N_A$	$= 6.02 \times 10^{23}\text{mol}^{-1}$
$One\ election\ volt\ (eV)$	$= 1.6 \times 10^{-19}\text{J}$

Turn Over

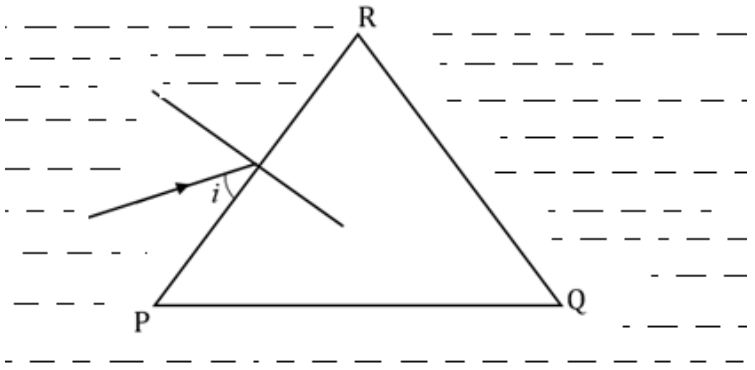
SECTION A

1. (a)(i) Distinguish between **regular** and **irregular reflection** of light. (02 marks)

(ii) Using a ray diagram, explain the formation of the image in a plane mirror. (03 marks)

(b) (i) Derive an expression for the refractive index of a prism in terms of refracting angle, A and the angle of minimum deviation, D. (05 marks)

(ii)



A ray of monochromatic light from a liquid of refractive index 1.3 strikes side PR of the glass prism of refractive index 1.6 at an angle $i = 70°$. Calculate the refracting angle of the prism for which the emergent ray from side RQ grazes the surface of the prism. (04 marks)

(c) (i) State two differences between **reflecting** and **refracting telescopes**. (02 marks)

(ii) Describe with the aid of a ray diagram, how an astronomical telescope forms a final image at the near point. (04 marks)

2. (a) (i) Define the terms **focal point** and **centre of curvature** of a diverging mirror. (02 marks)

(ii) Describe an experiment to determine the focal length of a convex mirror using a converging lens and an illuminated object. (05 marks)

(b) (i) Define spherical and chromatic aberrations. (02 marks)

(ii) Explain the methods of minimizing chromatic and spherical aberration in lenses. (04 marks)

(c) (i) Derive an equation to show the relationship between critical angle, C and the refractive index, n. (03 marks)

(ii) An object is placed on the principal axis of a concave spherical mirror of radius of curvature 20cm at a distance of 30cm. Find the change in image positions when a parallel side slab of glass of thickness 6cm and refractive index 1.5 is introduced between the centre of curvature and the object such that it is perpendicular to the principal axis. (04 marks)

SECTION B

3. (a) (i) Distinguish between **free** and **damped oscillations**. (02 marks)
   (ii) Describe how the amplitude of a forced oscillation builds up to a constant value. (03 marks)
   (b) A cylindrical pipe of length 28cm closed at one end is found to be at resonance when a tuning fork of frequency 864Hz is sounded near the open end. Find the mode of vibration of the air in the pipe and the end correction. [Take the speed of sound in air as $340ms^{-1}$]
   (c) (i) Explain the occurrence of beats in sound. (04 marks)
   (ii) Two tuning forks A and B are sounded together to produce beats of frequency 4Hz. Fork A has a known frequency of 1000Hz. The ends of the tuning fork prongs of A are loaded with a small piece of plasticine and the two notes are sounded again. When the new beat frequency was calculated it was found to have increased. Find the frequency of tuning fork B. (03 marks)
   (d) With the aid of a diagram, describe an experiment to investigate the variation of frequency of a stretched string with length. (05 marks)

4. (a) (i) State Huygyen's principle. (01 mark)
   (b) Monochromatic light propagating in air is incident obliquely onto a plane boundary with a medium of refractive index, n
   (i) Use huygyen's principle to show that the speed v of the light in the medium is given by; $v = \frac{c}{n}$
   Where c is the speed of light in air. (06 marks)
   (ii) If the wave length of the light is 600nm in air, what will it be in a medium of refractive index 1.50?
   (c) (i) What is meant by interference of waves. (01 mark)
   (ii) State the conditions necessary for interference fringes to be observed. (02 marks)
   (iii) Explain the term path difference with reference to interference of two wave motions. (03 marks)
   (d) Two glass slides in contact at one end are separated by a wire of diameter 0.04mm at the other end to form a wedge. Fringes are observed when light of wavelength $5.0 \times 10^{-7}m$ is incident normal to the slides. Find the number of fringes which can be observed. (03 marks)

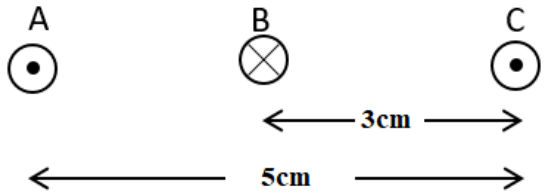
SECTION C

5. (a) (i) Define **magnetic flux density** and state it's SI units. (02 marks)

(ii) A straight conductor of length, *l* having N free electrons each of charge, e is placed perpendicular to a uniform magnetic field of flux density B. When current, I passes through the conductor, each electron experiences a magnetic force. $F_1 = Bev$, where v is the average drift velocity of an electron. Show that the total force experienced by the whole conductor is given by F=BIL. (04 marks)

(b) (i) Describe an experiment for the absolute measurement of current. (06 marks)

(ii) The diagram below shows parallel wires A, B and C each of length 50cm carrying currents of 6A, 5A and 2A respectively. The distance between A and C is 5.0cm while that between B and C is 3.0cm.



Calculate the resultant force exerted on wire B (05 marks)

(c) Explain why a current carrying conductor placed in a uniform magnetic field experiences a force. (03 marks)

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

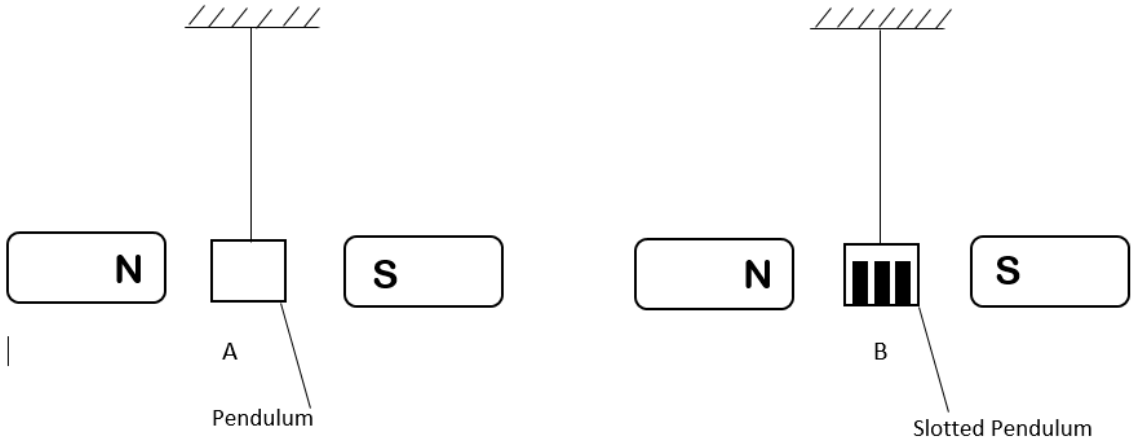
(ii) Describe an experiment to verify Lenz's law of electromagnetism. (05 marks)

(b) (i) A metal disc of radius, a is placed in a uniform magnetic field of flux density B with it's plane perpendicular to the magnetic field. The disc is rotated with uniform angular frequency, f derive the expression for the emf induced between the rim and the axle of the disc. (04 marks)

(ii) A circular aluminium disc of radius 0.3m is mounted inside a long solenoid of 2000 turns and length 2m carrying current of 15A such that its axis is along the axis of the solenoid. If the disc is rotated about the axis at 40 revolutions per minute. Find the emf induced. (05 marks)

(c) (i) What are eddy currents? (01 mark)

(ii) A pendulum made from a conducting material is made to swing freely from a pivot as shown below.



In A, the pendulum comes quickly to rest while in B the pendulum oscillates for some time before stopping. Explain the observation. (03 marks)

7. (a) (i) Why is alternating current referred to as sinusoidal. (01 mark)

(ii) Derive the expression for the average power dissipated in a resistor when a sinusoidal current is passed through. (03 marks)

(b) (i) A current of $I = I_0 \sin 2\pi ft$ is supplied in a circuit containing a capacitor of capacitance, C Derive the expression for the potential difference across the capacitor. (04 marks)

(ii) Draw on the same axes, graphs showing the variation of voltage across the capacitor and the current supplied against time. (02 marks)

(c) (i) Describe how a hot wire ammeter works. (05 marks)

(ii) List the differences in the principle of operation of the ammeter in c (i) above with repulsion type of an ammeter. (02 marks)

(d) A pure inductor of inductance 15mH is connected in series with a resistor of 3.0Ω across an a.c mains of frequency 50Hz. Determine the impedance of the circuit.

(03 marks)

SECTION D

8. (a) (i) What is an **electrophorus**. (01 mark)

(ii) Explain how an electrophorus can be used to provide an enormous charge. (04 marks)

(b) Two light conducting spheres each 6mm diameter having a mass of 10g suspended from the same point by fine insulating fibres 50cm long. Due to electric repulsion. The spheres are in equilibrium 3cm apart. Calculate.

(i) the force of repulsion between the wire. (03 marks)

(ii) the charge in each sphere. (03 marks)

(c) (i) Define **electric potential difference**. (01 mark)

(ii) Derive an equation for potential gradient between two point charges separated by a distance δr. (04 marks)

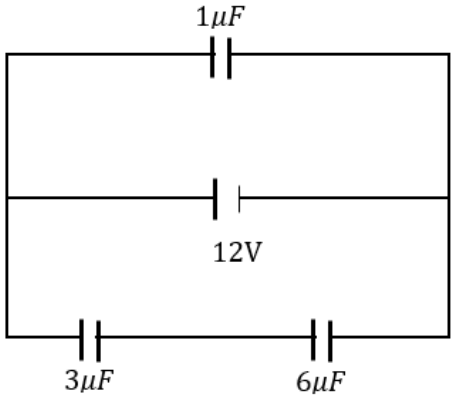
(d) Describe how a lightning conductor works. (04 marks)

9. (a) (i) Define the term **capacitance of a capacitor.** (01 mark)

A sheet of paper 40mm wide and $1.5x10^{-2}$mm thick is between metal foils of the same width and is used to make a $2\mu F$ capacitor. If the permittivity of paper is 2.5 times that of vacuum. What is the length of the paper required? ($\varepsilon_0 = 8.85 \times 10^{-2}$) (03 marks)

(b) Describe an experiment to investigate the variation of capacitance and the dielectric material. (05 marks)

9 (c) A $3\mu F$ capacitor is connected in series with a $6\mu F$ capacitor. The combination is connected to a $1\mu F$ capacitor and a 12V battery as shown below.



Calculate the;

(i) Charge stored by each capacitor. (03 marks)

(ii) P.d across the $6\mu F$ capacitor when fully charged. (03 marks)

(d) Two identical capacitors of capacitance, C are connected in series across a voltage source, V. A dielectric of relative permittivity ε_r is inserted in one of the capacitors and then they are charged fully. The voltage source is now removed and is replaced with an empty identical capacitors with air between its plates. Show that the p.d across the new capacitor will be, (05 marks)

$$V^I = \frac{\varepsilon_r V}{2\varepsilon_r + 1}$$

10. (a) Define the terms **electrical resistivity** and **temperature coefficient** of resistance. (02 marks)

(b) (i) Explain why the temperature coefficient of resistance is positive for metals. (03 marks)

(ii) What are super conductors? (01 mark)

(c) The temperature coefficient of resistance of two conductors P and Q of radii 0.6mm and 0.4mm are $0.0004k^{-1}$ and $0.0003k^{-1}$ respectively. If the ratio of their resistance at 0^0C is 1.5, calculate;

(i) the ratio of the resistances at 100^0C given that they have the same length. (03 marks)

(d) (i) Derive the balance condition for Wheatstone bridge. (04 marks)

(ii) Explain why the Wheatstone bridge is not suitable for measuring very low or very high resistances. (04 marks)

END

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