P510/2
PHYSICS
(Theory)
Paper 2
Jul/Aug. 2023
2½ hours

MATIGO MOCK EXAMINATIONS BOARD

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, μ_0	$= 4.0\pi \times 10^{-7}\text{H}m^{-1}$
Permittivity of free space, ε_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) Define the following term as used in refraction of light

(i) Real depth (01 mark)

(ii) Apparent depth (01 mark)

(b) A plane mirror lies at the bottom of a long flat dish containing water, the mirror making an angle of 10° with the horizontal, as shown in the figure below.

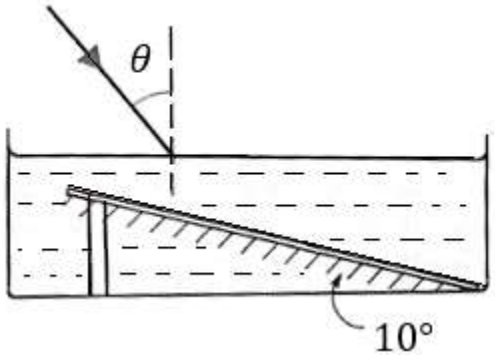

Figure 1

A narrow beam of monochromatic light falls on the surface of the water at an angle of incidence $\boldsymbol{\theta}$. If the relative index of water is $^4/_3$, determine the maximum value of $\boldsymbol{\theta}$ for which light, after reflection from the mirror, wound emerge from the upper surface of the water. (05 marks)

(c) (i) Explain how a blurred image and a caustic surface are formed in a large spherical concave mirror. (03 marks)

(ii) Briefly explain **two** ways how the defect in (c)(i) above can be minimized. (02 marks)

(d) (i) Describe a graphical method for finding the focal length of a concave mirror. (05 marks)

(ii) An object is placed at a distance of $36cm$ from convex mirror. A plane mirror is placed in between so that the two virtual images formed coincide. If the plane mirror is at a distance of $24cm$ from the object, find the radius of curvature of the convex mirror. (03 marks)

2. (a)(i) Define *focal plane* of a convex lens. (01 marks)

(ii) Using a ray diagram of a finite object, derive the formula $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ for a convex lens. (04 marks)

(iii) Show that the linear magnification produced by a thin converging lens is equal to the ratio of image distance to the object distance. (03 marks)

(b) A small finite object is $40cm$ from a concave lens with a focal length of 40cm. a convex lens is placed $55cm$ to the right of the concave lens. If the two lenses are placed coaxially to form a final real inverted image at $37.5cm$ to the right of the convex lens, find the focal length of the converging. (04 marks)

(c) Explain why substances with a high refractive index like diamond, sparkle. (03 marks)

(d) You are provided with a concave mirror, meter rule, optical pin, small quantity of a liquid, clamp and retort stand. Using the apparatus provided describe how you can determine experimentally the refractive index of the liquid provided. (05 marks)

SECTION B

3. (a) (i) What is meant by the term **beat period**. (01 mark)

(ii) Calculate the velocity of sound in a gas in which two waves of length $2m$ and $2.02m$ produce 7 beats in 4 seconds. (03 marks)

(b) (i) State the laws of vibration of a fixed string. (03 marks)

(ii) Describe an experiment to show that the wire under tension vibrates with more than one frequency. (05 marks)

(c) (i) Explain how stationary waves are formed. (03 marks)

(ii) A vibrating tuning fork of frequency $760Hz$ is held above the open end of a closed tube of length $40cm$. If the tube resonates with a tuning fork, determine the mode of vibration and the end correction.
(Velocity of sound in air is $300ms^{-1}$) (05 marks)

4. (a)(i) What are ***coherent*** sources of waves? (01 mark)

(ii) What are the methods of producing coherent source? (04 marks)

(b)(i) Distinguish between plane ***polarized light*** and ***ordinary light***. (02 marks)

(ii) Describe how plane polarized light can be produced. (04 marks)

(iii) State two uses of polarized light. (01 mark)

(c)(i) What is meant by interference pattern as applied to waves. (03 marks)

(ii) Using young's method to determine wavelength of light, two slits of separation 1.4mm was used when the screen was placed 20.0cm from the slits, 20 bright fringes occupying a distance 2.0mm was obtained. Find wavelength of light used. (03 marks)

(d) List **two** changes that would be observed in (c)(ii) if the distance of the screen from the slits was decreased. (02 marks)

SECTION C

5. (a)(i) Define the term ***Ampere***. (01 mark)

(i) Describe how the magnetic flux density at the centre of the coil may be determined using a current balance. (05 marks)

(b)(i) Derive an expression for the magnetic force experienced by a moving charge **e**, in a uniform magnetic field of flux density, **B** at a speed, **v** (03 marks)

(ii) Figure 2, shows a silver ribbon whose cross section is $1.0cm$ by $0.2cm$. The ribbon carries a current of $50A$ from left to right and it lies in a uniform magnetic field of magnitude$1.5T$.
Using a density value of $n = 6.0 \times 10^{28}$ electrons per cubic meter for silver, find the hall potential between the edges of the ribbon. (04 marks)

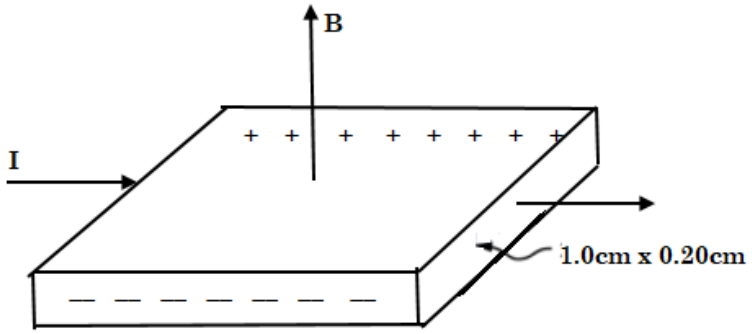

Figure 2

(c)(i) What is *magnetic torque*? (01 marks)

(ii) Name **two** devices, stating their functions whose operations are based on magnetic torque on current carrying conductors. (02 marks)

(d)(i) State any **four** properties of a magnet. (02 marks)

(ii) Sketch the magnetic field pattern due to a local bar magnet in the earth's magnetic field whose south pole is pointing in the geographical north. (02 marks)

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

(ii) Describe an experiment to demonstrate faraday's law of electromagnetic induction. (04 marks)

(b) A coil of 100 turns is wound around the middle of a long solenoid of 250 turns per metre and radius $5.0cm$. A sinusoidal current $I = 5\sqrt{2}\sin 100\pi t$ is passed through the solenoid. Find the emf induced a cross the terminals of the coil.

(c)(i) Distinguish between **mutual** and **self-induction**. (02 marks)

(ii) Two coils A and B are placed in the same horizontal plane near each other as shown in the figure below. P is a rheostat of large value while V is a strong battery.

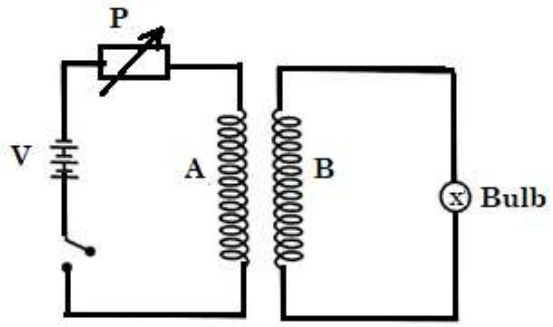

Figure 3

Explain what happens when the resistance, R is varied very fast after closing the switch. (03 marks)

(d)(i) Describe how an $a.c$ transformer works. (05 marks)

7. (a) Define the following terms;

(i) Root mean square value and

(ii) Peak value of alternating current. (2 marks)

(b) Explain why a hot wire ammeter is suitable for measuring alternating current while a moving galvanometer is not. (03 marks)

(c)(i) Define ***resonant frequency***. (01 mark)

(ii) A circuit consists of a capacitor of capacitance $4.0\mu F$ and a resistor of resistance 1200Ω connects to an alternating emf of $120V$ operating at frequency of 50Hz as shown in figure 4 below.

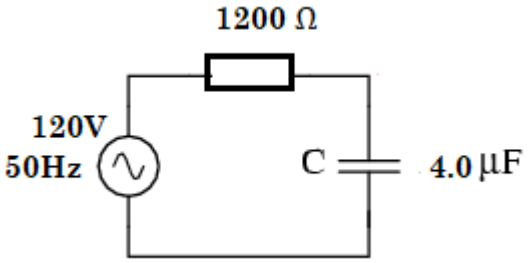

Figure 4

Find;

(i) Current supplied (02 marks)

(ii) Voltage a cross the capacitor. (02 marks)

(iii) Average power supplied. (02 marks)

(d) (i) Explain why a capacitor is referred to as a wattles component. (04 marks)

(ii) Describe the mode of operation of the repulsion type of a moving iron ammeter. (04 marks)

SECTION D

8. (a) Define the terms **electromotive force** and **internal resistance**. (02 marks)

(b) Describe an experiment to determine the resistivity of a specimen wire using a voltmeter and an ammeter. (05 marks)

(c) (i) State **Kirchhoff's laws**. (02 marks)

(ii) In the circuit diagram below four resistors of resistance $1\Omega, 2\Omega, 2\Omega$ *and* 4Ω are connected to two batteries, find the current through 1Ω resistor and power dissipated in the 4Ω resistor.

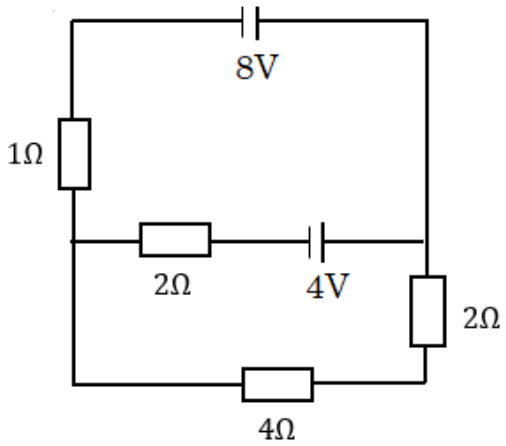

Figure 5

(d) (i) With the aid of a diagram, derive the balance condition of the Wheatstone bridge. (03 marks)

(ii) Explain why a meter bridge cannot be used to measure very low resistances or very high resistances. (02 marks)

9. (a) (i) State **Coulomb's law** of electrostatics. (01 marks)

(ii) Two point charges of $10^{-8}C$ and $-10^{-8}C$ are placed $0.1m$ apart. Calculate electric field intensity at point C. (05 marks)

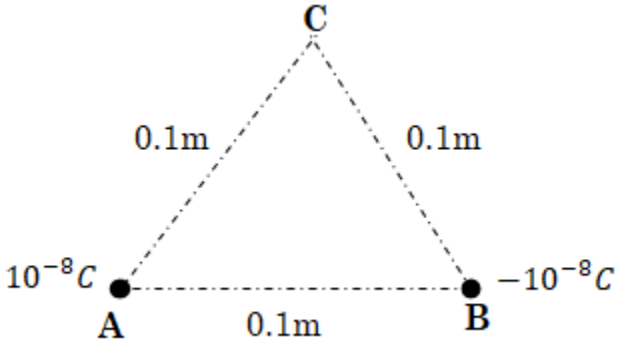

Figure 6

(b)(i) Explain how a conductor can be charged negatively by induction. (03 marks)

(ii) Explain how the presence of a neutral conductor near a negatively charged material can affect the potential of the material. (03 marks)

(c) (i) What is meant by Electrostatic shielding? (02 marks)

(ii) Describe how a Van de Graff generator builds up a large potential. (06 marks)

10. (a) What is meant by **dielectric field strength**? (01 mark)

(b) A parallel plate capacitor is charged to $100V$ and then isolated. When a sheet of a dielectric is inserted between its plates, the p.d decreases to $50V$.

(i) Explain why there is a decrease in potential difference across the plate. (03 marks)

(ii) Calculate the permittivity of sheet of dielectric. (02 marks)

(c) Derive an expression for the energy stored in a capacitor of capacitance, C charged to a voltage, V. (05 marks)

(d)(i) State **two** physical properties desirable in a material to be used as a dielectric in capacitor. (02 marks)

(ii) Mention any two types of dielectric materials. (02 marks)

(e) Describe an experiment to determine capacitance of a capacitor using a reed switch. (05 marks)

END

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