P510/2
PHYSICS
PAPER 2
July/August 2024
2 1/2 hours

WAKISSHA JOINT MOCK EXAMINATIONS

Uganda Advanced Certificate of Education

PHYSICS

Paper 2

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES:

- *Answer* **five** *questions, taking at least* ***one*** *from each of the sections* **A**, **B**, **C** *and* **D** *but* ***not*** *more than* **one** *question should be chosen from either section* **A** *or* **B**.
- *Any additional question(s) answered will* **not** *be marked.*
- *Non-programmable scientific calculators may be used.*
- *Mathematical tables and squared papers will be provided.*

Assume where necessary;

Acceleration due to gravity, g,	$= 9.81 ms^{-2}$
Speed of sound in air	$= 330 ms^{-1}$
Speed of light in vacuum, c,	$= 3.0 \times 10^{8} ms^{-1}$
Electronic charge, e,	$= 1.6 \times 10^{-19} C$
Electron mass	$= 9.11 \times 10^{-31} kg$
Planck's constant, h,	$= 6.63 \times 10^{-34} Js$
Permeability of free space, μ_o.	$= 4.0\pi \times 10^{-7} Hm^{-1}$
Permittivity of free space, ε_0,	$= 8.85 \times 10^{-12} Fm^{-1}$
The constant $\frac{1}{4\pi\varepsilon_0}$	$= 9 \times 10^{9} F^{-1} m$
One electron volt, (eV)	$= 1.6 \times 10^{-19} J$
Avogadro's number, N_A	$= 6.02 \times 10^{23} mol^{-1}$
Specific heat capacity of water	$= 4200\ Jkg^{-1}K^{-1}$

SECTION A

1. (a) (i) State the **laws of reflection of light** (02 marks)

(ii) Explain with the aid of a ray diagram how a thick plane mirror forms multiple images. (04 marks)

(b) A concave mirror A of focal length 20 cm is placed 50 cm infront of a convex mirror, B of focal length 15 cm. An object is placed on a common axis of A and B at a point 30 cm infront of A.
Find :-

(i) the distance from B of the image formed by reflection, first in A and then in B. (05marks)

(ii) the magnification of the image formed in (b) (i) above. (02 marks)

(c) Describe an experiment to determine the focal length of a convex mirror using a convex lens of known length. (04 marks)

(d) Explain why curved mirrors of small aperture are preferred to those of wider aperture. (03 marks)

2. (a) (i) What is meant by **refraction of light?** (01 mark)

(ii) State the **laws of refraction** (02 marks)

(b) (i) Derive an expression for the focal length of a convex lens in terms of the radii of curvature of its surfaces and its refractive index. (05marks)

(iii) The radii of curvature of a converging meniscus are 25 cm and 20 cm.
Find its focal length if the refractive index of the lens is 1.5. (02 marks)

(c) Describe an experiment to determine the focal length of a thin converging lens mounted inside a short cylindrical tube. (05 marks)

(d) Two lenses of focal length 1.2 cm and 4.0 cm are arranged to form a microscope in normal adjustment. If the object is placed 1.5 cm from the objective lens, find the distance between the two lenses. (03 marks)

(e) State two advantages of a reflecting telescope over a refracting telescope. (02 marks)

SECTION B

3. (a) Define the following:
   (i) Transverse waves. (01 marks)
   (ii) Longitudinal waves. (01 mark)

   (b) When a plane wave traverses a medium, the displacement of the particles is given by, $y = 0.02 \sin 2\pi (3t - 0.02x)$, where y and x are in meters and t is in seconds.
   Calculate the;
   (i) frequency of the wave. (02 marks)
   (ii) wave velocity. (02 marks)
   (iii) phase difference at a given instant of time, between two particles 25 m apart. (02 marks)

   (c) (i) Explain how beats are formed. (03 marks)
   (ii) Explain how beats are used in tuning a musical instrument. (03 marks)

   (d) A car, X, moving at a speed of 30 ms^{-1} towards a stationary observer and another observer in car, Y moving in opposite direction with the same speed as, X, sounds a horn of frequency 280 Hz. Find the frequency of sound heard by the;
   (i) Stationary observer. (03 marks)
   (ii) Observer in car, Y (03 marks)
   (speed of sound in air = 330 ms^{-1})

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

   (b) Monochromatic light propagating in air is incident obliquely on to a plane boundary with a material of refractive index, n.
   (i) Use Huygen's principle to show that the speed, V of light in the material is given by $V = \frac{c}{n}$ where C is the speed of light in air. (04 marks)
   (ii) If the wavelength of light is 600 nm in air, what will it be in a material of refractive index 1.50? (03 marks)

   (c) (i) What is **plane polarized light?** (01 mark)
   (iii) Describe how plane polarized light is produced by reflection. (04 marks)

   (d) A parallel beam of unpolarised light travelling in a liquid of refractive index 1.33 is incident on a glass block of refractive index 1.52 and reflected as plane polarized light.
   Calculate the angle of refraction in the glass block. (04 marks)

   (c) Describe how interference of light can be used to test for the flatness of a surface. (03 marks)

Turn Over

SECTION C

5. (a) Define the following terms; (01 mark)
   (i) Magnetic flux density (01 mark)
   (ii) The tesla

   (b) Two infinitely long straight wires carrying currents, I_1 and I_2 respectively are placed parallel to each other in a vacuum at a distance 'd' meters apart. Derive the expression for the force per meter between the wires. (04 marks)

   (c) (i) Write an expression for magnetic flux density, B, at the centre of a circular coil of N turns, each of radius r and carrying a current, I (01 mark)

   (ii) A wire of length 8.0m is wound into a circular coil of radius 5.0cm. If a current of 2A pass through the coil, find the magnetic flux density at the centre of the coil. (04 marks)

   (d) Describe an experiment to compare the magnetic flux density at the centre of a coil carrying current with the horizontal component of the earth's magnetic flux density. (05 marks)

   (e) An air craft of wing span 20m is moving horizontally from West to East at a velocity of $250ms^{-1}$ in a place where the angle of dip is 40^0. The e.m.f induced across the tips of the wings is $6.0x10^{-3}$ V. Find the magnetic flux density of the earth's field. (04 marks)

6. (a) Define **self and mutual induction.** (02 marks)

   (b) (i) Describe the structure and action of a transformer. (05 marks)
   (ii) Give the causes of power loses in a transformer and sate how each can be minimized. (04 marks)

   (c) A conducting rod 0.6m long, of resistance 0.05Ω and mass 0.04kg falls through a horizontal magnetic field of flux density 0.3T, with its ends sliding smoothly down two thick vertical rails. The top ends of the rails are joined by a wire of negligible resistance.
   (i) Explain why the rod attains steady velocity after a short time. (03 marks)

   (ii) Calculate the steady velocity attained. (03 marks)

   (d) Discuss the factors which determine the maximum e.m.f generated by a dynamo. (03 marks)

7. (a) Define the following as applied to an alternating current circuit;
   (i) Peak value (01 mark)
   (ii) Root mean square value. (01 mark)

   (b) A sinusoidal voltage is applied across a resistor of resistance, R in which an alternating current $I = I_0 \sin 2\pi ft$ flows. Derive an expression for the root mean square value of the alternating current. (04 marks)

(c) A sinusoidal alternating voltage of 20 V(rms) and frequency 80 Hz is applied across a coil of wire of inductance 0.6 H. Calculate the root mean square value of the current which flows through the coil. (03 marks)

(d)

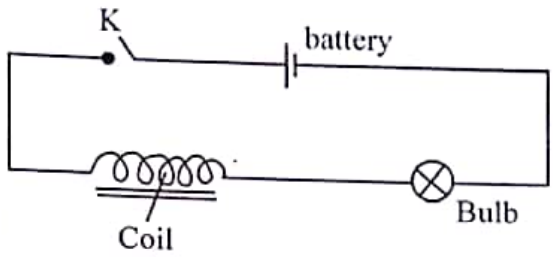

Fig.1

A bulb and coil are connected in series to a battery as shown in the figure 1 above.

(i) State what is observed when switch K is closed and when it is opened. (02 marks)

(ii) Explain your observation in (d)(i) (04 marks)

(e) With the aid of a labeled diagram, describe how a repulsive type of moving iron ammeter works. (05 marks)

SECTION D

8. (a) Define **electric field intensity** and **electric potential at a point.** (02 marks)

(b) A pin is placed on a cap of a positively charged gold leaf electroscope with the blunt end on the cap. Explain what is observed. (03 marks)

(c) With the aid of a diagram, describe the structure and action of a Van der Graff generator. (05 marks)

(d) Two metal plates 40 cm apart are connected to a 6 kV d.c supply. When a small charged sphere of mass 8.0×10^{-3} kg is placed between the plates, it remains stationary. Indicate the forces acting on the sphere and determine the magnitude of the charge on the sphere. (04 marks)

(e) Describe an experiment to show that the potential over the surface of a pear-shaped charged conductor is constant. (04 marks)

(f) Explain briefly why a neutral metal body is attracted to a charged body when brought near it. (02 marks)

Turn Over

9. (a) (i) Define **capacitance of a capacitor.** (01 marks)

(ii) A conducting sphere of diameter 22.0 cm carrying a charge of 8.0×10^{-10} C is maintained at an electric potential of 60 V. Find the permittivity of the surrounding medium. (03 marks)

(b) Describe an experiment to determine the effect of area of overlap on capacitance of a parallel plate capacitor. (04 marks)

(c) The plates of a parallel plate capacitor each of area 2.0 cm^2 are 5 mm apart. The plates are in vacuum and a potential difference of 10 kV is applied across the capacitor.
Find the magnitude of charge on each on each plate. (03 marks)

(d) A capacitor filled with a dielectric of dielectric constant, ε_r, between its plates is charged and then isolated. Show that when the dielectric is removed from the capacitor, the fractional change in voltage across its plates is $\varepsilon_r - 1$ (03 marks)

(e) (i) Define **relative permittivity of an insulting material.** (01 marks)
(ii) Describe how relative permittivity of an insulating material is determined using a ballistic galvanometer. (05 marks)

10. (a) (i) Define **resistance of a conductor.** (01 marks)
(ii) Explain how length and temperature of a conductor affect its resistance. (03 marks)

(b) A 10 V battery is connected across a potential divider of resistance 900 Ω. If a bulb with a filament of resisance150 Ω is connected across one third of the potential divider, determine the amount of electrical energy consumed by the bulb in 5 seconds. (04 marks)

(c) (i) Derive the balance condition when using a meter bridge to measure resistance. (04 marks)
(ii) State two precautions taken to achieve accurate measurement. (02 marks)

(d)

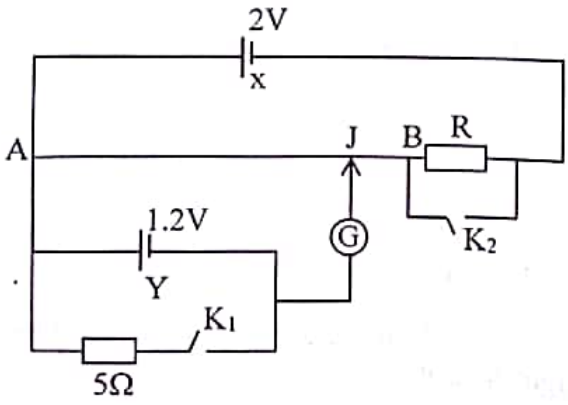

Fig.2

In the circuit in figure 2, AB is a resistance wire of length 100 cm, resistivity 9.0×10^{-6} Ω m and cross sectional area 1.5 mm^2. X is an accumulator of e.m.f 2 V and negligible internal resistance. Y is a cell of e.m.f 1.2 V and internal resistance 1 Ω.

When K_1 and K_2 are both open, the balance length AJ is 75 cm.

(i) Find the value of the resistance, R (04 marks)

(ii) Determine the balance length when K_1 and K_2 are both closed. (02 marks)

END