

P510/2
PHYSICS
PAPER 2
July/August 2024
2½ 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,	$= 9.81 \text{ ms}^{-2}$
Speed of sound in air	$= 330 \text{ ms}^{-1}$
Speed of light in vacuum, c,	$= 3.0 \times 10^8 \text{ ms}^{-1}$
Electronic charge, e,	$= 1.6 \times 10^{-19} \text{ C}$
Electron mass	$= 9.11 \times 10^{-31} \text{ kg}$
Planck's constant, h,	$= 6.63 \times 10^{-34} \text{ Js}$
Permeability of free space, μ_0 ,	$= 4.0\pi \times 10^{-7} \text{ Hm}^{-1}$
Permittivity of free space, ϵ_0 ,	$= 8.85 \times 10^{-12} \text{ Fm}^{-1}$
The constant $\frac{1}{4\pi\epsilon_0}$	$= 9 \times 10^9 \text{ F}^{-1} \text{ m}$
One electron volt, (eV)	$= 1.6 \times 10^{-19} \text{ J}$
Avogadro's number, N_A	$= 6.02 \times 10^{23} \text{ mol}^{-1}$
Specific heat capacity of water	$= 4200 \text{ J kg}^{-1} \text{ K}^{-1}$

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

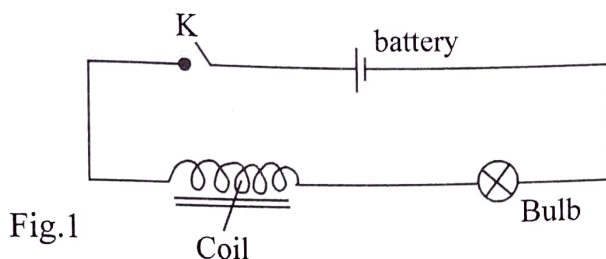
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SECTION C

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° . The e.m.f induced across the tips of the wings is $6.0 \times 10^{-3} \text{ V}$. 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 losses in a transformer and state 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)



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 $8.0 \times 10^{-10} \text{ C}$ 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 $\epsilon_r - 1$ (03 marks)
- (e) (i) Define **relative permittivity of an insulating 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 900Ω . If a bulb with a filament of resistance 150Ω 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)

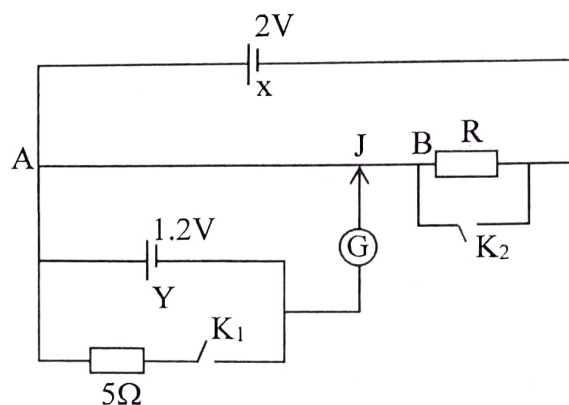


Fig.2

In the circuit in figure 2, AB is a resistance wire of length 100 cm, resistivity $9.0 \times 10^{-6} \Omega \text{ m}$ 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 1Ω .

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