P510/2

PHYSICS

PAPER 2

MOCK 2024

AUGUST

3 HRS

MEBU EXAMINATIONS CONSULT

UGANDA ADVANCED CERTIFICATE OF EDUCATION

MOCK EXAMINATIONS 2024

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.
Assume where necessary:
Acceleration due to gravity, g = 9.81 ms^{-2}.
Speed of light in a vacuum, c = 3.0×10^{8} ms^{-1}.
Electron charge, e = 1.6×10^{-19}C.
Electron mass = 9.11×10^{-31}kg.
Plank's constant, h = 6.6×10^{-34}Js.
Permeability of free space = $4.0\pi \times 10\text{-}7Hm^{-1}$.
Permittivity of free space = $8.85 \times 10^{-12}Fm^{-1}$.
The constant $\frac{1}{4\pi\varepsilon_0}$ = $9.0 \times 10^{9}F^{-1}m$.
One electron volt, (eV) = 1.6×10^{-19}J.
Avogadro's number, NA = $6.02 \times 10^{23}mol^{-1}$.
Resistivity of Nichrome wire at 25°C = $1.2 \times 10^{6}\Omega m$.
Specific heat capacity of water = $4.2 \times 10^{3}Jkg^{-1}K^{-1}$.

SECTION A

1. (a) (i) Derive the relationship, $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ for a convex lens, where u is the object distance, v is the image distance and f is the focal length of the lens. (04marks)

(ii) State three possible reasons under which an image of a real object may not be formed by a convex lens on the screen. (03marks)

(b) Describe an experiment to determine the focal length of a convex lens fixed inside a short cylindrical tube. (05marks)

(c) A convex lens of focal length 10cm is arranged coaxially with a concave lens of focal length 18cm.The lens system is used to focus an object placed 24cm from the convex lens on the side remote from the concave lens. The final image is formed on a screen placed 18.6cm from the concave lens. Calculate the;

(i) Separation between the lenses. (05marks)

(ii) Magnification. (03marks)

2. (a) (i) State the laws of refraction of light. (02marks)

(ii) A small object is placed at a distance of 30.0cm from a converging lens of focal length 10.0cm. Calculate the distance from the first lens where a second converging lens of focal length 40.0cm must be placed in order to produce an erect image of the same size as the object. (05marks)

(b) (i) Draw a diagram to show the formation of an image by a compound microscope in normal adjustment and use it to derive an expression for the magnifying power. (06marks)

(ii) A microscope has an objective lens of focal length 10.0cm and eye piece of focal length 20.0cm. If the distance between the objective lens and eye piece is 20cm, calculate the magnifying power of the microscope. (03marks)

(c) What is meant by the following?

(i) Total internal reflection (01mark)

(ii) Critical angle. (01mark)

(d) Briefly explain why an observer sees a spectrum of colors through rain drops when it is raining on a sunny day. (02marks)

SECTION B

3. (a) What is meant by interference pattern as applied to waves? (03marks)

(b) Explain why it is necessary to use a common source when demonstrating interference in light.

(03marks)

(c) In an experiment to determine wavelength of light using Young's method, two slits with a separation of 1.2mm were used. When the screen was placed 18.0cm from the slits, 30 bright fringes occupying a distance 2.5mm were obtained.

(i) Find the wavelength of light used. (04marks)

(ii) List the changes that would be observed if the distance of the screen from the slits was increased. (02marks)

(d)(i) Derive the expression for angular position of nth order principal maximumly produced by transmission diffraction grating. (03 marks)

(ii) Light of two wavelengths, 5.4×10^{-7}m and 5.7×10^{-7}m incident normally on transmission grating with a spacing 2.00×20^{-6}m. Find the angular separation of second order principal maxima. (04 marks)

(iii) Suppose white light is used in (d)(ii) above, describe the positions of the red and violet lights in the order principal maximum relative to central maxima. (01mark)

4. (a) Define the following:

(i) Transverse waves. (01 marks)

(ii) Longitudinal waves. (01 marks)

(b) When a plane wave traverses through a medium, the displacement of the particle is given by $y = 0.01\sin 2\pi (2t-0.01x)$, where y and x are in meters and t in seconds.

Calculate the:

(i) Frequency of the wave. (02marks)

(ii) Wave velocity. (03marks)

(iii) Phase difference at a given instant of time between two particles 50m apart. (02marks)

(c) Describe an experiment to determine the velocity of sound in air by an interference method.

(06marks)

(d) (i) State two applications of Doppler effect. (02marks)

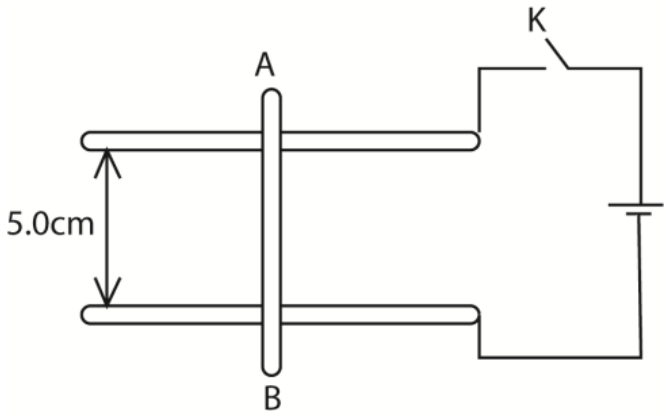
(ii) Derive an expression for frequency, f, of sound as heard by a stationary observer when the source of sound of frequency, f, approaches with uniform speed, p ms^{-1}. (03marks)

SECTION C

5. (a)(i) Write down an expression for the force on a charge, q coulombs moving with velocity, u, at an angle, α, to a uniform magnetic field of flux density B. (01mark)

(ii) Use the expression in (a)(i) above, to deduce the force on a conductor carrying a current in the magnetic field. (03marks)

(b) Figure below shows an aluminium bar AB resting on two horizontal aluminium rails connected to a battery through switch K. A magnetic field of flux density 0.10T acts perpendicularly to the paper.



(i) Explain what happens to AB when switch K is closed.(03marks)

(ii) Calculate the angle to the horizontal to which the rail must be tilted to keep AB stationary if its mass is 5.0g, current in it is 4.0A and the direction of the field remains unchanged. (04marks)

(c)(i) With the aid of a labeled diagram, describe the structure and mode of operation of a moving coil galvanometer. (06marks)

(ii) Discuss the factors which affect the current sensitivity of a moving coil galvanometer. (03marks)

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

(b)(i) With the aid of a diagram, describe how a simple a.c. generator works. (04marks)

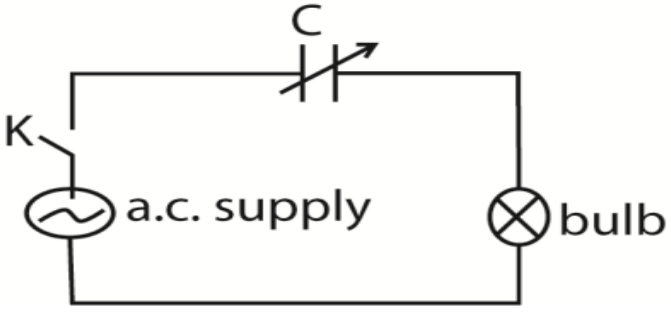
(ii) What are the main energy losses in a practical a.c. generator and how are they minimized? (02marks)

(c) A circular coil having 20 turns each of radius 8.0cm is rotated about its vertical diameter with angular speed of 50 radians per second in a uniform horizontal magnetic field of magnitude 30mT.

(i) Calculate the r.m.s value of the e.m.f. induced in the coil. (03marks)

(ii) If the coil forms a closed loop of resistance 10Ω, how much power is dissipated as heat in it? (02marks)

(d) The figure below shows a capacitor and a bulb connected to a.c supply.



Explain

(i) Why the bulb lights when switch K is closed. (01marks)

(ii) What would happen if the capacitance was reduced? (02marks)

(e) Explain the following observations:

(i) A spark is seen at the switch when the circuit of a current carrying coil is broken. (02marks)

(ii) A magnetized iron bar dropped vertically through a hollow region of a thick cylindrical shell made of copper experiences a retarding force. (02marks)

7. (a) Define the following:

(i) Peak value. (01mark)

(ii) Root mean square (r.m.s) value of alternating current. (01mark)

(b) Derive an equation relating peak value and r.m.s value of alternating current.(03marks)

(c) An electric current flows through a coil of 4Ω immersed in 200kg of water placed in a container. If the temperature of the water rises by 1K per minute, calculate the peak value of current supplied. (03marks)

(d) What is meant by resonance in a circuit? (01mark)

(e) A lamp of resistance 10Ω, a capacitor of capacitance 0.4μF and an inductor of inductance 0.4H are connected in series to an alternating voltage source of 0.01V (r.m.s). The frequency, f, is varied from low to high value while maintaining the amplitude of the applied voltage constant.

(i) Explain how the brightness of the lamp rises. (03marks)

(ii) Calculate the resonance frequency. (03marks)

(iii) Find the voltage across the capacitor. (03marks)

(f) Explain why in an R-C circuit, power is only absorbed by the resistive part of the circuit. (02marks)

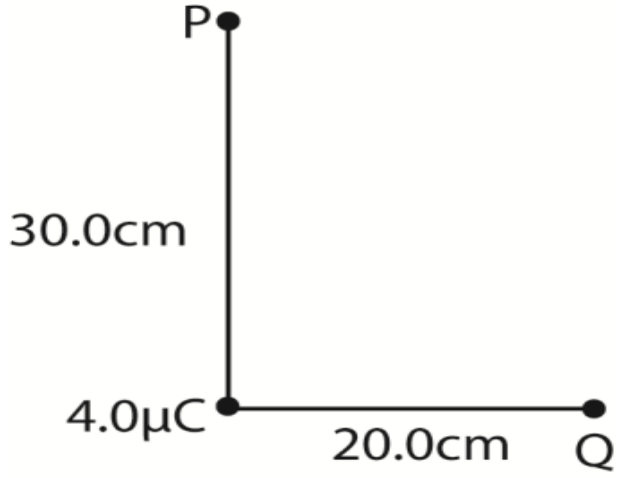
SECTION D

8. (a) State Coulomb's law of electrostatics. (01marks)

(b) (i) Describe how a conductor may be positively charge but remains at zero potential(03marks)

(ii) Explain how the presence of a neutral conductor near a charged conducting sphere may reduce the potential of the sphere. (03 marks)

(c) In the figure below, points P and Q are at a distances 30.0cm and 20.0cm from a point charge of 4.0μC respectively.



Calculate

(i) Electric potential difference between P and Q. (05marks)

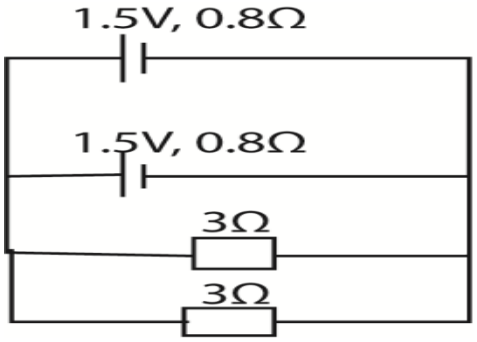
(ii) Energy required to bring a charge of +1.0μC from infinity to Q. (03marks)

(d) Describe with the aid of a diagram, an experiment to show that excess charge resides only on outside of a hollow conductor. (05 marks)

9. (a)(i) Define e.m.f of a battery. (01marks)

(ii) Explain why e.m.f of a battery left standing in a room for long decreases. (02marks)

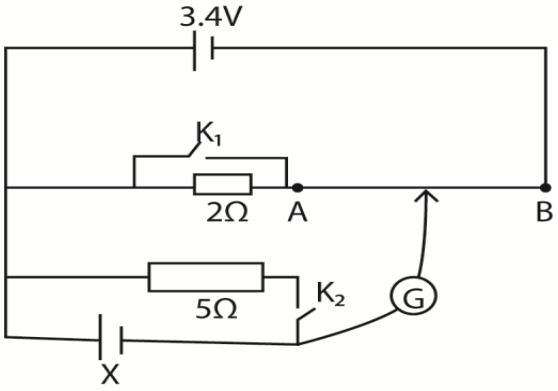
(b) The figure below shows a network of resistors connected to show identical cells of e.m.f 1.5V and internal resistance 0.8Ω.



Calculate the current supplied by the cells. (04marks)

(c) Describe an experiment which can be carried out to determine the resistance of a wire using a potentiometer. (06marks)

(d) The figure below shows a uniform resistance wire AB, 100cm long and resistance 4.0Ω connected with a 2.0Ω resistor through switch K2. When K1 is closed and K2 open, the balance length is 53cm.



Find the

(i) Balance length when K1 and K2 are both open. (04marks)

(ii) Internal resistance of cell X if the balance length is 44.1cm when both K1 and K2 are closed. (03marks)

10. (a)(i) Define a farad. (01mark)

(ii) Describe briefly the energy transformations that take place when charging a capacitor using a dry cell. (02marks)

(b)(i) What is meant by dielectric constant? (02marks)

(ii) A parallel plane capacitor is connected to 100V and then isolated. When a sheet of a dielectric is inserted between the plates, the p.d. decreased to 30V. Calculate the dielectric constant of the dielectric. (03marks)

(c) A 60μF is charged from a 120V supply. It is then connected across the terminals of a 20μF capacitor. Calculate the:

(i) Final p.d across the combination. (03marks)

(ii) Difference in the initial and final energies stored in the capacitor and comment on the difference. (05marks)

(d) Explain the principles of operation of a lightning conductor. (04marks)

END