P510/2
PHYSICS
Paper 2
(Theory)
Nov./Dec. 2024
2½ hours

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

PHYSICS

Paper 2
(Theory)

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES:

This paper consists of **four** *Sections;* **A**, **B**, **C** *and* **D**.

Answer **five** *questions, including 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.*

Begin answering each question on a fresh page.

Mathematical tables and graph paper will be provided.

Silent non-programmable scientific calculators may be used.

Assume where necessary:

Acceleration due to gravity, g	=	$9.81\ ms^{-2}$
Electron charge, e	=	$1.6 \times 10^{-19}\ C$
Electron mass	=	$9.11 \times 10^{-31}\ kg$
Planck's constant, h	=	$6.6 \times 10^{-34}\ Js$
Speed of light in a vacuum, C	=	$3.0 \times 10^{8}\ ms^{-1}$
Avogadro's number, N_A	=	$6.02 \times 10^{23}\ mol^{-1}$
Gas constant, R	=	$8.31\ Jmol^{-1}K^{-1}$
Charge to mass ratio, e/m	=	$1.8 \times 10^{11}\ Ckg^{-1}$
The constant $\frac{1}{4\pi\varepsilon_0}$	=	$9.0 \times 10^{9}\ mF^{-1}$
Permeability of free space, μ_0	=	$4.0\ \pi \times 10^{-7}\ Hm^{-1}$
Permittivity of free space, ε_0	=	$8.85 \times 10^{-12}\ Fm^{-1}$

Turn Over

SECTION A

1. (a) (i) With the aid of diagrams, differentiate between **regular** and **irregular** reflection. (*03 marks*)

(ii) Show that if two plane mirrors are inclined at an angle, x, then the total deviation of a light ray produced is $2x$ after reflection once on each mirror. (*03 marks*)

(b) Describe an experiment to determine the focal length of a concave mirror using a plane mirror and a pin. (*04 marks*)

(c) (i) Sketch a ray diagram to show how a concave mirror forms a magnified real image of a real object. (*02 marks*)

(ii) A concave mirror of radius of curvature 48 cm produces a real image whose size is three times that of the object. Determine the object position. (*02 marks*)

(d) Describe an experiment to determine the refractive index of a liquid using a concave mirror. (*04 marks*)

(e) Explain the meaning of **a caustic curve**. (*02 marks*)

2. (a) (i) What is meant by **visual angle**? (*01 mark*)

(ii) An observer views a series of electric poles in a straight line. Explain why the pole nearer to the observer appears taller than the rest. (*03 marks*)

(b) (i) With the aid of a ray-diagram, describe how a telescope consisting of a convex lens and a concave lens can be adjusted to form a final image at infinity. (*05 marks*)

(ii) What are the **advantages** and **limitations** of the telescope in (b) (i). (*02 marks*)

(c) (i) Describe how you can modify an astronomical telescope to produce an erect final image at infinity. (*02 marks*)

(ii) Give **two** major **disadvantages** of this modification. (*01 mark*)

(d) The objective of an astronomical telescope in normal adjustment has a diameter of 20 cm and a focal length of 200 cm. The eye-piece has a focal length of 2 cm. Calculate the;

(i) magnifying power of the telescope. (*02 marks*)
(ii) position of the eye-ring. (*02 marks*)
(iii) diameter of the eye-ring. (*02 marks*)

SECTION B

3. (a) (i) What is an **amplitude** of a wave? *(01 mark)*

(ii) What is the difference between **transverse** and **longitudinal** waves? *(01 mark)*

(b) Describe, with the aid of a diagram, an experiment to show how the fundamental frequency varies with tension in a given wire. *(06 marks)*

(c) A glass tube open at the top, is held vertically and filled with water. A tuning fork vibrating at 264 Hz, is held above the tube and water is allowed to flow out slowly. The first resonance occurs when the water level is 31.5 cm from the top while the second resonance occurs when the water level is 96.3 cm from the top.
Find the;

(i) speed of sound in air. *(04 marks)*

(ii) end correction. *(02 marks)*

(d) (i) What are **beats**? *(01 mark)*

(ii) Describe an experiment to determine the frequency of a note using beats. *(05 marks)*

4. (a) With the aid of a diagram, explain what happens when waves move from less dense to dense media. *(03 marks)*

(b) Use Huygens' construction to show that the refractive index, n, of a medium is given by

$$n = \frac{c}{v},$$

where c is the velocity of light in air, and v is the velocity of light in the medium. *(05 marks)*

(c) (i) Explain how interference patterns are formed. *(03 marks)*

(ii) Describe how the wavelength of light may be determined using Young's double slit experiment. *(05 marks)*

(d) A diffraction grating has 500 lines per mm and is illuminated normally with monochromatic light of wave length 589 nm. Find the maximum number of diffraction images obtained. *(04 marks)*

SECTION C

5. (a) Explain the sources of energy loss in a transformer when in use. *(03 marks)*

(b) A machine rated 200 W is operated at 230 V. The resistance of the transmission line from the power station to the machine is 3 Ω.

(i) Calculate the power lost in the cables if transmission is done at 230 V. *(03 marks)*

(ii) Explain how this power can be transmitted to the machine with minimum loss using the same cable. *(03 marks)*

(c) A rectangular coil of N turns, each of area A is rotated at constant angular velocity, ω, with its plane perpendicular to a uniform magnetic field of flux density B. Derive an expression for e.m.f induced in the coil. *(04 marks)*

(d) (i) What is meant by the statement that two coils have a mutual inductance of 1 henry? *(01 mark)*

(ii) The mutual inductance of two coils is 30 henrys. A current of 1.5 A in the primary coil is reduced at a steady rate to zero in a period of 0.002 s. Calculate the e.m.f induced in the secondary coil. *(03 marks)*

(e) (i) Explain what is meant by back e.m.f in a motor. *(02 marks)*

(ii) State **one** advantage of back e.m.f in a motor. *(01 mark)*

6. (a) Define the following:

(i) Magnetic field. *(01 mark)*

(ii) Magnetic saturation. *(01 mark)*

(b) (i) Draw the magnetic field pattern for a bar magnet placed with its north pole facing the earth's north pole. *(01 mark)*

(ii) Describe an experiment to determine the angle of dip at a given place using an earth inductor. *(04 marks)*

(c) (i) Define an **Ampere**. *(01mark)*

(ii) A rectangular metal frame $XVWY$ is pivoted about a horizontal axis XY such that the length PQ is equal to the length YW.

The end VW lies half-way inside the solenoid of n turns per metre. The solenoid is arranged so that its magnetic field of flux density B is perpendicular to VW and the metal frame is connected in series with the solenoid as shown in figure **1**.

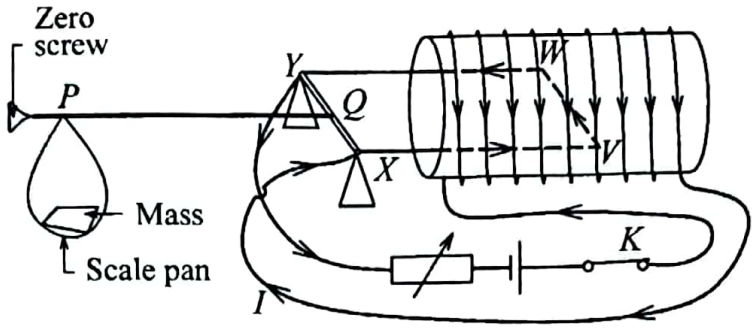

Fig. 1

When switch K is closed, the frame balances when the mass on the pan is m. Show that the current I, flowing is given by

$$I = \sqrt{\frac{mg}{\mu_0 nl}}$$ where l is length of side VW.

(03 marks)

(d) Figure **2** shows two wires P and R carrying currents of 9 A and 5 A out of the paper.

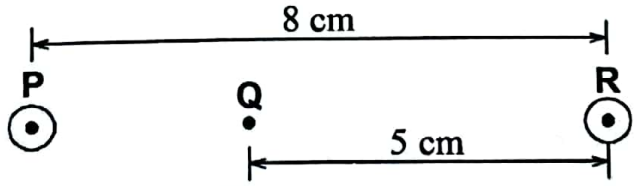

Fig. 2

Find the;

(i) magnetic flux density at point Q. *(04 marks)*

(ii) force per metre acting on wire P. *(03 marks)*

(e) State **four** factors which determine the current sensitivity of a moving coil galvanometer. *(02 marks)*

7. (a) What is meant by the following;

(i) Root mean square value of an alternating current, *(01 mark)*

(ii) Reactance, *(01 mark)*

(iii) Impedence? *(01 mark)*

(b) Show that the average value of power dissipated in a capacitor in a complete cycle is always zero. *(03 marks)*

(c) A capacitor of 20 μF is connected in series with a resistor of 100 Ω across an a.c source of frequency 30 Hz and peak voltage 60 V.
Determine the root mean square value of the current that flows. *(05 marks)*

(d) (i) On the same axes, draw graphs of voltage $V = V_0 \sin \omega t$ and the resulting current against time for a circuit in which the a.c supply is connected across a capacitor. *(02 marks)*

(ii) Explain the values of I when $V = V_0$ and when $V = 0$. *(02 marks)*

(e) Describe the mode of operation of a repulsive type of ammeter. *(05 marks)*

SECTION D

8. (a) What is meant by the following:
(i) Electric field, *(01 mark)*
(ii) Electric flux? *(01 mark)*

(b) Show that the electric field intensity at a distance from a charged plane conductor is independent of the distance from the conductor. *(03 marks)*

(c) (i) Figure **3** shows two oppositely charged long parallel metal plates at a separation of 2 cm with a p.d of 20kV between them.

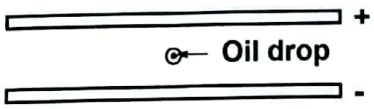

Fig. 3

When a negatively charged oil drop of mass 5.9×10^{-14} kg is introduced in the space between the plates, it remains suspended in space. Estimate the number of electrons in the oil drop. *(04 marks)*

(ii) Explain how a neutral material placed between the plates in figure **3** can be shielded from the electric field. *(03 marks)*

(d) Explain how the presence of a neutral conductor near a negatively charged material affects the potential of the material. *(04 marks)*

(e) Explain why a charged spherical conductor loses charge faster when a pin is placed on it with the sharp point sticking out. *(04 marks)*

9. (a) Define the following:

(i) Temperature coefficient of resistance. *(01 mark)*

(ii) Electrical resistivity. *(01 mark)*

(b) (i) Describe an experiment to measure an unknown resistance using a metre bridge. *(05 marks)*

(ii) Explain why the balance point of a metre bridge should be close to the middle of the slide wire. *(03 marks)*

(c) A piece of wire of length 200 cm and cross-sectional area 0.001 cm^2 has a resistivity of 4.4×10^{-7} Ωm. The ends of the wire are joined together to form a loop. Terminals T_1 and T_2 are fixed across the diameter of the loop and connected to two cells in parallel, each of e.m.f 1.5 V and internal resistance 1 Ω as shown in figure **4**.

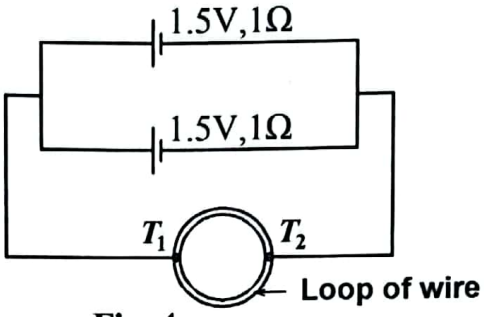

Fig. 4

Find the total current that flows in the circuit. *(06 marks)*

(d) Show that a given source of e.m.f delivers maximum power for a load when the resistance of the load is equal to the internal resistance of the source. *(04 marks)*

10. (a) Define the following:

(i) Dielectric constant. *(01 mark)*

(ii) Dielectric strength. *(01 mark)*

(b) Explain using molecular theory, the effect of a dielectric material on the capacitance of a capacitor. *(05 marks)*

(c) A capacitor of 50 μF is charged fully to a p.d of 45 V. The capacitor is then disconnected and a dielectric material of dielectric constant 2 is inserted between its plates. If it is then connected across an uncharged capacitor of 60 μF, determine the;

(i) p.d across the combination. *(04 marks)*

(ii) change in energy initially stored in both capacitors. *(04 marks)*

(d) (i) Describe how a ballistic galvanometer can be used to compare capacitances of two capacitors. *(04 marks)*

(ii) State any **two** functions of a dielectric material in a capacitor. *(01 mark)*

END