P510/2
Physics
JULY/AUGUST 2023
2 ½ hours

UGANDA PRIVATE AND INTEGRATED SCHOOLS ASSOCIATION

UGANDA ADVANCED CERTIFICATE OF EDUCATION

FINAL ASSESSMENT EXAMINATIONS 2023

PHYSICS

PAPER TWO

TIME: 2 HOURS 30 MINUTES

INSTRUCTION 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 **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,*** = $9.81ms^{-2}$
- ***Speed of light in a vacuum, C*** = $3.0x10^{8}ms^{-1}$
- ***Electron charge, e*** = $1.6x10^{-19}C$
- ***Electron mass*** = $9.11x\ 10^{-31}kg$
- ***Plank's constant, h*** = $6.6x10^{-34}Js$
- ***Permeability of free space*** μ_0 = $4.0\pi x10^{-7}\ Hm^{-1}$
- ***Permittivity of free space*** ε_0 = $8.85x10^{-12}\ Fm^{-1}$
- ***The constant*** $\frac{1}{4\pi\varepsilon_0}$ = $9.0x10^{-19}F^{-1}m$
- ***One electron volt (eV)*** = $1.6x10^{-19}J$
- ***A vogadro's number*** N_A = $6.02\ x\ 10^{23}mol^{1}$
- ***Resistivity of Nichrome wire at*** 25^0C = $1.2x10^{-6}\Omega m$
- ***Specific heat capacity of water*** = $4.2x\ 10^{3}Jkg^{-1}\ K^{1}$

SECTION A

1. (a)(I) Define angular magnification of a compound microscope. (1 mark)

(II) Draw a labelled ray diagram to show how two converging lenses can be used to make a compound microscope in normal adjustment. (3 marks)

(b) The focal length of the objective in the microscope is 3.0cm while that of the eye- piece is 6.0 cm. An object of size 2.5 mm is placed 3.5 cm in front of the objective of a compound microscope. The microscope forms a virtual image of the object at the near point of the eye. Find the:

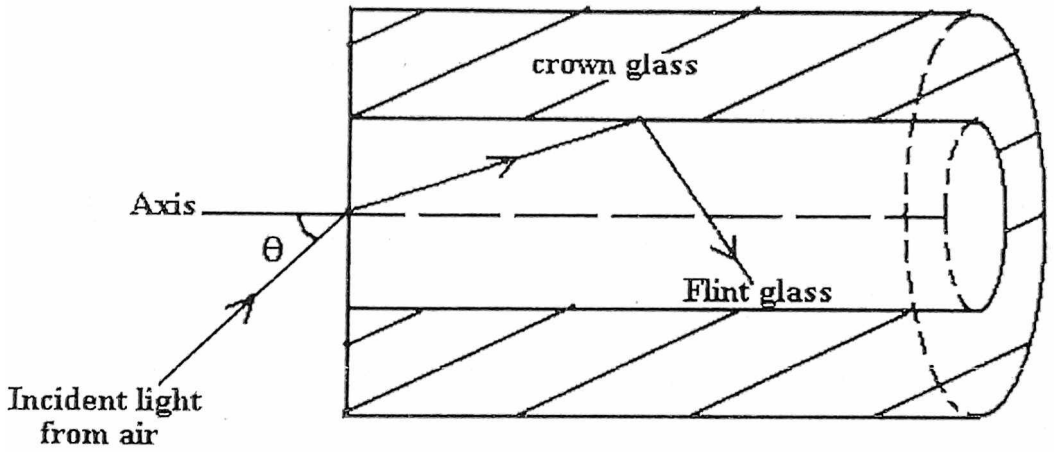
i. Size of the final image. (5 marks)
ii. Position of the eye-ring. (4 marks)

(c) With aid of a labelled diagram, describe the essential part of a slide projector lens. (5 marks)

(d) Explain what is meant by normal adjustment as applied to a microscope. (2marks)

2.(a) (i) What is meant by refraction of light. (1 mark)

(ii) The diagram below shows a cross-section through the diameter of the light pipe with an incident ray of light in its plane.



The refractive indices for flint glass and crown glass are n_1 and n_2 respectively. Show that a ray which enters the pipe is totally reflected at the flint-crown glass provided

$\sin \phi = \sqrt{n_1 - n_2}$

Where ϕ is the maximum angle of incidence at the air – flint glass interface? (5marks)

(b) Describe briefly two uses of glass prisms. (2 marks)

(c) (i) Define the term linear magnification. (1 mark)

(ii) A concave mirror of focal length 15cm forms an erect image that is three times the size of the object. Determine the object and its corresponding image position. (3marks)

(d) Describe an experiment, including a graphical analysis of the results to determine the focal length of a concave mirror using a no parallax method. (4 marks)

(e) A plane mirror is placed at a distance **d** in front of a convex mirror of focal length **f** such that it covers about half of the mirror surface. A pin placed at a distance **L** in front of the plane mirror gives an image in it, which coincides with that of the pin in the convex mirror. With the aid of an illustration, Show that $\mathbf{2df = d^2 - L^2}$. (4 marks)

SECTION B

3.(a) Define the following terms as applied to waves
i) Wavelength (1mark)
ii) Amplitude (1 mark)

(b) The displacement of a particle in a progressive wave is given by $y = 2 \sin 2\pi (0.25x - 100t)$ where x and y are in cm and t in seconds.

Calculate the
i. Wavelength (2 marks)
ii. velocity of the propagation of the wave (2 marks)

(c) State the differences between progressive and stationary waves. (3 marks)

(d) A source of waves generates waves of frequency 500 Hz if the speed of sound in air is 340 ms^{-1} find the:

(i) Wavelength of the waves detected by the observer when the source is moving away from the observer at a speed of 30 ms^{-1}.

(ii) Apparent frequency when the source is moving towards the observer and the observer is moving away at a speed of 20 ms^{-1}. (3 marks)

(e) Describe an experiment to determine the beat frequency of a note. (5 marks)

4.(a) (i) State Huygens' Principle (1 marks)

(ii) Monochromatic light propagating in air is incident obliquely onto a plane boundary with a dielectric material of refractive index n. Use Huygens' Principle to show that the speed V of light in the dielectric is given by V = c/n where c is the speed of light in air. (4marks)

(b).(i)In Young's double slit experiment, the distance between the centre of the interference pattern and the 10^{th} bright fringe on either side is 3.44cm and the distance between the slits and the screen is 2.0 cm. If the wavelength of light used is 5.89×10^{-7}m, determine the slit separation. (3 marks)

(ii) Explain what is meant by an interference pattern as pattern as applied to light waves. (2 marks)

(c)Describe an experiment to measure the wavelength of light using diffraction grating. (6 marks)

(d) Monochromatic light of wavelength 800nm is incident normally on a plane diffraction grating which has 700 lines per mm.

Calculate the:

i. Number of diffraction maxima observed. (2 marks)
ii. Angular position of the first diffraction maximum. (2 marks)

SECTION C

5.(a)(i)Define the terms root mean – square value, peak value of an alternating current. (2 marks)

(ii)Derive the relation between them for a sinusoidal alternating current. (4marks)

(b) A sinusoidal alternating current, $I = I_0 \sin wt$, passes through a pure inductor of inductance, L.

i. Derive an expression for the reactance of the inductor. (4 marks)

ii. Using the same axes, sketch graphs to show the relative phases of the current and voltage across the inductor. (2 marks)

(c) A 240v, 50Hz alternating voltage is applied across a capacitor of capacitance $5\mu F$. Calculate the:

i. Root mean- square value of the current which flows. (2 marks)
ii. Power expended. (2 marks)

(d) Describe how a thermocouple meter works. (4 marks)

6.(a)Define the following

i. magnetic meridian (01 mark)
ii. angle of dip (01 mark)

(b) An air craft is flying horizontally at $1000 kmh^{-1}$ at a point where the earth's magnetic flux density is 2.4×10^{-5} T and the angle of dip is 80^0. If the distance between the wing tips is 60m, calculate the potential difference induced between the wing tips. (04 marks)

(c) Describe with the aid of a diagram an absolute method of determining resistance. (05 marks)

(d)(i) What is meant by the terms self-induction and mutual induction? (2marks)

(ii)Explain the main precautions taken in the construction of an a.c transformer. (03 marks)

(e) A small rectangular coil of 12 turns and dimensions 5cm by 3cm is suspended inside a long solenoid of 1200 turns per metre so that its plane lies along the axis of the solenoid. The coil is connected in series with the solenoid. The coil deflects through 40^0 when a current of 3.0A is passed through the solenoid. Find the torsion constant of the suspension. (04 marks)

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

(b) Describe a method of measuring the magnetic flux density in a region between the poles of a magnet. (06 marks)

(c) A coil of 600 turns and mean area 5.0×10^{-2} m^2 is rotated at a uniform rate of 600 revolutions per minute about an axis perpendicular to a uniform magnetic field of flux density 0.3T. Calculate the maximum value of the e.m.f induced in the coil. (04 marks)

(d) (i)With the aid of a diagram, describe how a simple d.c motor works. (06marks)
(ii) Explain the significance of back e.m.f in the operation of a d.c motor. (02 marks)

SECTION D

8.(a)(i) State coulomb's law of electrostatics. (1 mark)

(ii) Define the terms electric field intensity and electric potential. (2 marks)

(b) Sketch graphs of the variation of electric potential and electric field intensity with distance from the Centre of a charged conducting sphere. (2 marks)

(c)(i) Explain with the aid of a diagram how an insulated metal sphere can be charged by induction using a negatively charged rod. (03 marks)

(ii) Describe how a gold leaf electroscope can be used to detect the presence of charge on a body. (2 marks)

(d) Two metal plates 10cm apart are connected to a 2KV d.c supply. When a small charged sphere of mass 4.0×10^{-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)(i) What is meant by corona discharge. (2 marks)
(ii) Explain how the lightening conductor works. (4 marks)

9.(a)(i) Define temperature coefficient of resistance of a conductor. (01 marks)

(ii) A coil of wire has resistance of 30Ω at 20^0C and 34.5Ω at 60^0C. Calculate its temperature coefficient of resistance. (04marks)

(b) Explain why semi – conductors have negative temperature coefficient of resistance. (03 marks)

(c)(i) Derive the balance condition for a Wheatstone bridge. (4 marks)

(ii)Explain why the Wheatstone bridge is not suitable for measuring very low or very high resistances. (4 marks)

(d)(i) What is meant by the term internal resistance of a cell? (01 marks)

(ii)Describe using a diagram, how you would standardize a potentiometer. (3marks)

10(a) Define capacitance and state its units. (2 marks)

(b) A capacitor is charged is charged by 30V d.c. supply. When the capacitor is fully charged, it is found to carry charge of 5.0μC. calculate

i. Capacitance of the capacitor. (3 marks)
ii. Energy stored in the capacitor. (3 marks)

(c) A parallel plate capacitor is connected across a battery and charged fully. When a dielectric material is now inserted between its plates, the amount of charge stored in the capacitor changes. Explain the change. (4 marks)

(d) A capacitor filled with a dielectric is charged and then discharged through a galvanometer which gives a deflection, θ_1. The dielectric is then withdrawn half way and the capacitor charged to the same voltage and discharged through the galvanometer again. The galvanometer deflection noted is θ_2. Show that the dielectric constant ε_r of the dielectric is given by;

$$\varepsilon_r = \frac{\theta_1}{2\theta_2 - \theta_1}$$

(6 marks)

(e)Explain briefly how a charged capacitor can be fully discharged. (02 marks)

END