P510/2
PHYSICS
Paper 2
[redacted]
2½ hrs

Uganda Advanced Certificate of Education

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PHYSICS

Paper 2

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES:

Answer **five** *questions, taking atleast* **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	=	$3.0 \times 10^{8}\ ms^{-1}$.
Electron charge, e	=	$1.6 \times 10^{-19} C$.
Electron mass	=	$9.11 \times 10^{-31} kg$.
Plank's constant, h	=	$6.6 \times 10^{-34} Js$.
Permeability of free space μo	=	$4.0\pi \times 10^{-7} Hm^{-1}$.
Permittivity of free space εo	=	$8.85 \times 10^{-12} Fm^{-1}$.
The constant $\frac{1}{4\pi\varepsilon_0}$	=	$9.0 \times 10^{9} F^{-1} m$.
One electron volt (eV)	=	$1.6 \times 10^{-19} J$.
Avogadro's number N_A	=	$6.02 \times 10^{23} mol^{-1}$.
Resistivity of Nichrome wire at $25^{o}C$	=	$1.2 \times 10^{6} \Omega m$.
Specific heat capacity of water	=	$4.2 \times 10^{3} Jkg^{-1}K^{-1}$.

SECTION A

1. (a) (i) Define the principal focus of a concave lens. (01 mark)

(ii) Draw a ray diagram to show the formation of an image of a finite object by a concave lens. (02 marks)

(iii) Describe the image formed. (01 mark)

(b) An object is placed $60cm$ from a concave lens of focal length $15cm$ and an image is formed on the screen. If the diverging lens is placed half way between the converging lens and the screen the screen has to be moved $5cm$ further to obtain a clear image. Calculate the focal length of the diverging lens. (04 marks)

(c) An object is placed at a distance of $f + a$ from a converging lens of focal length, f. the lens formed an image at a distance $f + b$ from the lens. Show that $f = \sqrt{ab}$. (03 marks)

(d) (i) Define refractive index of a medium. (01 mark)

(ii) An equi – convex lens is placed on a horizontal plane mirror and a pin held vertically above the lens is found to coincide with its image when positioned $20.0cm$ above the lens. When a few drops of liquid is placed between the lens and the mirror, the pin had to be raised $10.0cm$ to obtain coincidence again. If the refractive index of the convex lens is 1.5, find the refractive index of the liquid. (04 marks)

(e) Explain with the aid of a diagram why a thick plane mirror forms multiple images. (04 marks)

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

(ii) Show that the image formed in a plane mirror is as far behind the mirror as the object is infront. (04 marks)

(b) A concave mirror forms an image half the size of the object. The object is then moved towards the mirror until the image size is three quarters that of the object. If the image is moved by a distance of 0.8cm, calculate the;

(i) focal length of the mirror, (03 marks)

(ii) new position of the object. (03 marks)

(c) A ray of light incident at an angle, $\boldsymbol{i}$, on a prism of angle $\boldsymbol{A}$, passes symmetrically through the prism.

(i) Write the expression for the deviation, $\boldsymbol{d}$, of the ray in terms of $\boldsymbol{i}$ and $\boldsymbol{A}$, (01 mark)

(ii) Find the value of $\boldsymbol{d}$ if the angle of the prism is 60^o and the refractive

index of glass is 1.50. (03 marks)

(d) With the aid of a labeled diagram, describe the essential parts of a photographic camera. (04 marks)

SECTION B

3. (a) (i) What is meant by plane polarized light? (01 mark)

(ii) A parallel beam of unpolarised light incident on a transparent medium of refractive index 1.60 is reflected as plane polarized light. Calculate the angle of incidence in air and the angle of refraction in the medium. (03 marks)

(b) (i) What is a diffraction grating? (01 mark)

(ii) Explain the effect of increasing the number of narrow slits in a diffraction grating on the intensity of diffraction fringes. (03 marks)

(c) A parallel beam of monochromatic light of wave length $687nm$ is directed normally on a diffraction grating which has 600 lines per mm. determine the;

(i) number of diffraction images, (03 marks)

(ii) angle of diffraction of the highest order diffraction image. (02 marks)

(d) Distinguish between constructive and destructive interference. (03 marks)

(e) Explain how interference fringes are formed in an air wedge film between two glass slides when mono chromatic light is used. (04 marks)

4. (a) Distinguish between progressive and stationary waves. (03 marks)

(b) Describe an experiment to show that a wire under tension vibrates with more than one frequency. (04 marks)

(c) (i) What is meant by beats? (01 mark)

(ii) Describe how you can determine the frequency of a musical note using beats. (04 marks)

(d) A stretched wire of length $0.90m$, radius $1.5mm$ and density $1400Kgm^{-3}$ is clamped at both ends and plucked in the middle. The fundamental note produced by the wire has the same frequency as the first overtone in a pipe of length $0.30m$ closed at one end. Calculate the tension in the wire.
(Speed of sound in air = $330ms^{-3}$) (04 marks)

(e) (i) State the principle of superposition of waves. (01 mark)

(ii) Explain using the principle of superposition of waves the formation of stationary waves. (03 marks)

SECTION C

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

(b)

The figure above shows two coils, ***A*** which is soft iron cored and ***B*** which is air cored. When switch ***K*** is closed the bulb lights. Explain what would be observed when,

(i) soft iron rods are placed in coil ***B***, (03 marks)

(ii) the a.c source is replaced by d.c source and then switch ***K*** is closed. (04 marks)

(c) (i) A metal disc of radius, ***a*** is placed in a uniform magnetic field of flux density ***B*** with its plane perpendicular to the magnetic field. The disc is rotated with uniform angular frequency, ***f***. derive the expression for the emf induced between the rim and the axle of the disc. (04 marks)

(ii) A circular aluminium disc of radius $30cm$ is mounted inside a long solenoid of 2000 turns per metre, carrying current of $15A$ such that its axis is along the axis of the solenoid. If the disc is rotated about the axis at 40 revolutions per minute, find the emf induced. (05 marks)

(d) (i) What is hysteresis loss? (01 mark)

(ii) How can hysteresis loss be minimized in an a.c transformer? (01 mark)

6. (a) Define;

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

(ii) capacitive reactance. (01 mark)

(b) A sinusoidal alternating voltage $V = 8\,Sin\,120\pi t$ volts is connected across a resistor of 6Ω. Find the mean power dissipated in the resistor. Hence deduce the rms value of the current. (04 marks)

(c) Describe with the aid of a diagram, how a hot iron ammeter works. (05 marks)

(d) A capacitor of capacitance, ***C*** is connected across a source of alternating voltage, $V = V_o\,Sin\,wt$.

(i) Find the current which flows in the circuit. (03 marks)

(ii) Sketch using the same axes the voltage across the capacitor and the current which flows in the circuit with time. (02 marks)

(iii) Explain the phase difference between the voltage and current in (ii) above. (04 marks)

7. (a) Define the terms magnetic flux and magnetic flux density. (02 marks)

(b) Derive an expression for the force per unit length between two long parallel conductors carrying current. (04 marks)

(c) A current of $4.0A$ flows through a long solenoid of 500 turns and length $60.0cm$. Determine the magnitude of the force exerted on a particle of charge $20.0\mu C$ moving at $1500ms^{-1}$ through the centre of the solenoid at an angle of 16^{o} relative to the axis of the solenoid. (04 marks)

(d) Describe how a ballistic galvanometer of unknown charge sensitivity can be used to measure magnetic flux density in a region between the poles of a magnet. (04 marks)

(e) A moving coil galvanometer reads $3mA$ when it is connected in series with a source of emf of negligible internal resistance and a resistor of resistance 200Ω. The galvanometer reads $20\,mA$ when the 200Ω resistor is replaced with the one of resistance 400Ω. Find the;

(i) resistance of the galvanometer, (04 marks)

(ii) e.m.f of the source. (02 marks)

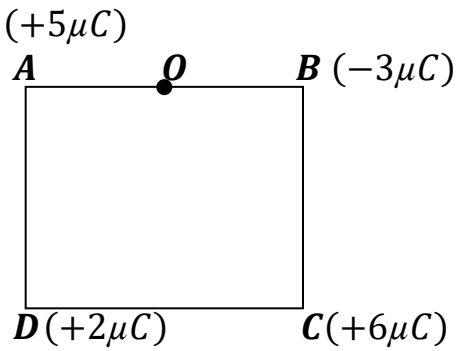
SECTION D

8. (a) State coulomb's law of electrostatics. (01 mark)

(b) (i) Define electric potential. (01 mark)

(ii) Derive the expression for the electric potential at a point a distance, $\boldsymbol{r}$ from an isolated charge of magnitude $\boldsymbol{Q}$ in air. (04 marks)

(c) Charges of magnitude $+5\mu C$, $-3\mu C$, $+6\mu C$ and $+2\mu C$ are placed at the corners $\boldsymbol{A}$, $\boldsymbol{B}$, $\boldsymbol{C}$ and $\boldsymbol{D}$ of a square $\boldsymbol{ABCD}$ of side $1m$ as shown in the figure below.



Calculate the electric field intensity at $\boldsymbol{O}$, the mid point of $\boldsymbol{AB}$. (05 marks)

(d) Explain how a lightening conductor protects a house from lightening. (04 marks)

Turn Over

(e) Describe how the sign of unknown charge on a body can be established using a gold leaf electroscope. (05 marks)

9. (a) What is meant by the terms emf and internal resistance of a cell? (02 marks)

(b) Describe an experiment to determine emf and internal resistance of a cell using an ammeter, arheostat and a voltmeter.. (05 marks)

(c) Three identical cells are connected in series with resistors of 4Ω and 6Ω. A current of $1.5A$ flows in the circuit. When the two resistors are connected in parallel across the three cells in series, the current in the circuit is $2.5A$.

Calculate the;

(i) internal resistance of each cell, (03 marks)

(ii) emf of each cell, (01 mark)

(iii) power dissipated in the 4Ω resistor for the parallel connection. (04 marks)

(d) Explain why a metal wire becomes hot when an electric current flows through it. (03 marks)

(e) What advantages does a potentiometer have over a wheat stone bridge when used to compare two low resistances? (02 marks)

10. (a) Define the following terms;

(i) the farad, (01 mark)

(ii) dielectric constant. (01 mark)

(b) Describe an experiment to show the effect of placing a dielectric between the plates of a charge capacitor on capacitance of a capacitor. (04 marks)

(c) A $3\mu F$ capacitor that can just withstand a p.d of $6000V$ uses a dielectric of constant 5 which breaks down if the electric field strength in it exceeds $5.0 \times 10^{7} Vm^{-1}$. Find the;

(i) thickness of the dielectric, (02 marks)

(ii) effective area of each plate, (02 marks)

(iii) energy per unit volume of the dielectric. (03 marks)

(d) A capacitor of capacitance, C is charged by a battery and then later isolated. When the plates of the capacitor are taken apart, deduce what happens to the potential difference between the plates. (03 marks)

(e) With the aid of a diagram, describe an experiment to show that excess charge resides only on the outside surface of a hollow conductor. (04 marks)

END