P510/2
PHYSICS
Paper 2
2½ HOURS

ASSHU ANKOLE JOINT MOCK EXAMINATIONS 2024

UGANDA ADVANCED CERTIFICATE OF EDUCATION

PHYSICS

Paper 2

2hours 30minutes

INSTRUCTIONS TO CANDIDATES

*Answer **five** questions, including at least **one** from each section, but **not more** than **one** from any of the sections A and B.*

Where necessary assume the following constants:

Acceleration due to gravity	g	=	$9.81 ms^{-2}$
Speed of light in vacuum	c	=	$3.0 \times 10^{8} ms^{-1}$
Speed of sound in air	v	=	$340 ms^{-1}$
Electronic Charge	e	=	$1.6 \times 10^{-19} C$
Electronic mass	m_e	=	$9.1 \times 10^{-31} kg$
Permeability of free space	μ_0	=	$4.0\pi \times 10^{-7} Hm^{-1}$
Permittivity of free space	ε_0	=	8.85×10^{-12} Constant
The Constant	$\frac{1}{4\pi\varepsilon_0}$	=	$9.0 \times 10^{9} F^{-1}m$

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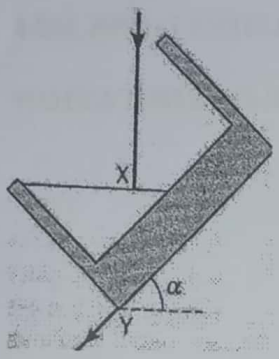
SECTION A

1. (a) Define the term refraction of light. *(1mark)*

   (b) Describe an experiment to determine refractive index of water by critical reflection. *(5marks)*

   (c)



A glass container with thick bottom is half filled with water and a narrow beam of light is shone vertically down into the water. The glass is tilted until an angle α such that the light is refracted along the lower surface of the glass. If the refractive indices of water and glass are 1.33 and 1.5 respectively,

(i) Copy and complete the diagram to show the path of light from when it enters water at X to when it leaves glass at Y. *(1mark)*

(ii) Calculate the critical angle at the glass-air interface. *(2marks)*

(iii) Calculate the value of α. *(3marks)*

(d) Explain carefully why the apparent depth of the water tank changes with position of the observer. *(4marks)*

(e) (i) What is meant by limiting angle of a prism. *(1mark)*

(ii) Calculate the limiting angle of a prism of glass of material of refractive index 1.5. *(3marks)*

2. (a) Define the terms principal axis and focal plane as applied to convex lenses. *(2marks)*

   (b) (i) A convex lens of focal length f forms a real image I of real object O on ascreen. If the distance between the object O and the screen is d, show that for the distance $d \leq 4f$, no image can be formed on the screen. *(5marks)*

   (ii) State another condition apart from that derived in (i) above for which a convex lens cannot form a real image on a screen. *(1mark)*

   (c) Describe an experiment to determine focal length of a concave lens using a concave mirror. *(5marks)*

   (d) An astronomical telescope consisting of an objective lens of focal length 60cm and an eye piece of focal length 3cm is focused on the moon so that the

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final image is formed at minimum distance of distinct vision(25cm) from the eye piece.

(i) Calculate the angular magnification. *(4marks)*

(ii) Assuming that the diameter of the moon subtends an angle of 0.5^o at the objective, find the actual size of the image. *(3marks)*

SECTION B

3. (a) Distinguish between longitudinal and transverse wave motions. *(2marks)*

(b) A progressive simple harmonic wave of frequency $250Hz$ and velocity $30ms^{-1}$ propagates in the positive x direction in a time, t seconds.

(i) Determine the equation of propagation of the progressive wave if its amplitude is 0.03m. *(3marks)*

(ii) The phase difference between two vibrating points on the progressive wave which are 10cm apart. *(2marks)*

(c) Describe an experiment to determine the end collection of a resonance tube using a set of tuning forks. *(5marks)*

(d) The absorption spectrum of a faint galaxy is measured and the wavelength of one of the lines identified as the calcium H line is found to be 478nm. The same line has wavelength of 397nm when measured in the laboratory.

(i) Is the galaxy moving towards or away from the earth? Explain your answer. *(2marks)*

(ii) Calculate the speed of the galaxy relative to the earth. *(3marks)*

(e) Explain why sound is easily heard at night than during the day. *(3marks)*

4. (a) Define the term interference of light and state the conditions for interference pattern to be observed. *(3marks)*

(b) (i) Describe an experiment to observe Newton's rings, and explain how they are formed. *(5marks)*

(ii) In young's double slit experiment, the distance between the center of the interference pattern and the 10^{th} bright fringe on either side is 3.44cm and the distance between the slit and the screen is 2.00cm. If the wave length of the light used is 5.89×10^{-7}m, determine the slit separation. *(4marks)*

(c) (i)What is meant by the terms diffraction and polarization of light. *(2marks)*

(ii) Two Polaroid sheets are placed close together in front of a lamp so that no light passes through them. Describe and explain what happens when one sheet is slowly rotated, the other remaining in the original position. *(2marks)*

(iii) Calculate the polarizing angel for light travelling from water of refractive index 1.33, to glass, of refractive index 1.53. *(3marks)*

(d) Mention any two uses of polarizing devices. *(2marks)*

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SECTION C

5. (a) Define the term magnetic field. *(1marks)*

(b) A stripe of metal 1.2cm wide and $1.5 \times 10^{-3} cm$ thick carries a current of 0.5A along its length, and the metal contains 5×10^{22} free electrons per cm^3. If the stripe is place normal to the magnetic field if flux density 0.5T, a p.d is developed across the foil.

(i) Explain why a p.d is developed across the stripe. *(3marks)*

(ii) Calculate the mean drift velocity of the electrons. *(2marks)*

(iii) Find the value of maximum p.d across the stripe. *(2marks)*

(c) Describe an experiment to show the variation of magnetic flux density at the center of a circular coil with current through it. *(5marks)*

(d) A rectangular coil of 50 turns and dimensions 5cm× 2cm hangs vertically inside a solenoid which carries a current of 4A and has 2000 turns per meter.

(i) Calculate the magnetic flux density of the solenoid. *(2marks)*

(ii) If the plane of the rectangular coil was initially at 60^o to the axis of the solenoid, find the value of current that must be passed through the rectangular coil such that the initial torque on the coil is $3.0 \times 10^{-8} Nm$. *(3marks)*

(e) Explain the orientation of a freely suspended bar magnet at a position in southern hemisphere. *(2marks)*

6. (a) State the laws of electromagnetic induction. *(2marks)*

(b) A circular coil of 150 turns and cross-sectional area $0.3m^2$ is placed with its plane perpendicular to a horizontal magnetic field of flux density $1.2x10^{-2}T$. The coil is rotated about a vertical axis so that it turns through 70^0 in 2s.

Calculate the:

(i) Initial flux linkage through the coil. *(2marks)*

(ii) E.m.f induced in the coil. *(3marks)*

(c) (i) Explain how back e.m.f is produced in a coil in an electric motor. *(2marks)*

(ii) A metal air craft with a wing span of 40m flies with ground speed of $100kmh^{-1}$ in the direction due east at a constant altitude a region where the horizontal component of the earth's field is $1.6 \times 10^{-5} T$ *and* the angle of dip is 71.6^o. Find the potential difference that exists between the wing tips. *(5marks)*

(d) With the aid of a diagram, describe how a simple a.c generator works. *(5marks)*

7. (a) Define the terms *peak* and *root mean square (r.m.s)* value of an alternating voltage. *(2marks)*

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(b) An inductor of inductance, L, is connected across a source of alternating voltage $V = Vo \sin \omega t$.

(i) Derive the relationship between the reactance and the frequency of the supply. *(4marks)*

(ii) Sketch using the same axes the variation of current through the inductor and the voltage across it, with time. *(2marks)*

(iii) Explain the phase difference in the graphs in d(ii) above. *(2marks)*

(c) Describe with the aid of a diagram how a thermal- couple meter measures alternating current. *(4 marks)*

(d) A resistor of 500Ω and a capacitor of capacitance C are connected in series with an ac supply of r.m.s value 15.0v and frequency 50Hz. If the p.d across the resistor has r.m.s value 10.0V, calculate:

(i) p.d across the capacitor. *(2marks)*

(ii) the value of C. *(4marks)*

SECTION D

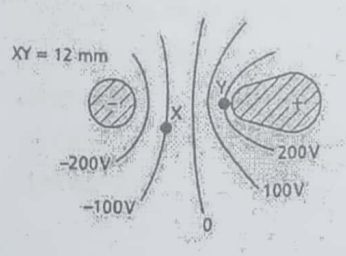
8. (a)Define the terms electric field intensity and electric potential. *(2marks)*

(b) (i) A pin is placed on the cap of a positively charged gold leaf electroscope with its blunt end on the cap. Explain what is observed. *(3marks)*

(ii) Describe an experiment to show that the surface of a pear-shaped conductor is an equipotential surface. *(4marks)*

(iii) Derive an expression for electric field intensity perpendicular to a charged conductor of charge density δ in air. *(3marks)*

(c) The figure shows equipotentials of the electric field between two oppositely charged conductors.



Calculate:

(i) The potential energy of a $+2nC$ point charge at X. *(2marks)*

(ii) The work done to move the $+2nC$ charge from X to Y. *(3marks)*

(d) With the aid of a diagram, describe how an electrophorus provides unlimited supply of electric charge. *(4marks)*

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9. (a) Define dielectric strength of a capacitor and state its units. *(2marks)*

(b) Describe an experiment to determine dielectric constant of a material. *(5marks)*

(c) A parallel air capacitor of area $25cm^2$ and with plate 1mm apart is charged to a potential of 100v. The power supply is then disconnected and the plate moved a further 1mm apart.

(i) Calculate the energy change due to the movement of the capacitor plates. *(5marks)*

(ii) Account for the energy change in (i) above. *(2marks)*

(d) (i) When capacitors are connected in series, the effective capacitance of the combination is less than the capacitance if either capacitor. Explain why? *(3marks)*

(ii) Explain the effect of a dielectric on capacitance of a charged capacitor. *(3marks)*

10. (a) What is meant by the terms electromotive force and terminal p.d of a cell. *(2marks)*

(b) A voltmeter is connected in parallel with a variable resistance R, which is in series with an ammeter and a cell of emf E and internal resistance r. The ammeter and voltmeter readings are noted for several values of R.

(i) Sketch a graph to show the variation of V with I, and use the graph to explain how E and r can be obtained. *(4marks)*

(ii) If in this experiment the ammeter had a resistance of 10Ω and the voltmeter a resistance of 100Ω , R=2Ω , E=2V and r=2Ω, What would be the reading of the ammeter and the voltmeter. *(4marks)*

(c) Explain the principle of a potentiometer. *(3marks)*

(d) A meter bridge is balanced with a piece of aluminum wire of resistance 7.3Ω in the left-hand gap, the sliding contact being 42.6cm from the left end of the bridge wire and the temperature17^oc. If the temperature of the aluminium wire is raised to57^oc, find the new balance length. (Temperature coefficient of resistance of aluminum is3.8×10^{-3} *(5marks)*

(e) Explain why the balance point of the meter bridge should be close to the middle of the bridge wire. *(2marks)*

END

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