P510/2

PHYSICS

Paper 2

July 2024

2 ½ HOURS

ACEITEKA JOINT MOCK EXAMINAIONS 2024

Uganda Advanced Certificate of Education

PHYSICS

Paper 2

2 hours 30 Minutes

INSTRUCTIONS TO CANDIDATES:

- *Answer **five** questions including at least **one** from each section **A, B, C** and **D** but **not** more than **one** question from each of the **sections A** and **B.***
- *Non-programmable scientific electronic 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* = $1.6 \times 10^{-19} C$
  - *Permeability of free space,* μ_0 = $4.0\pi \times 10^{-7} Hm^{-1}$
  - *Permittivity of free space,* ϵ_0 = $8.85 \times 10^{-12} Fm^{-1}$
  - *The constant* $\frac{1}{4}\pi\epsilon_0$ = $9.0 \times 10^{9} mF^{-1}$

SECTION A

1. (a) Define the following terms as applied to optical instruments

(i) Visual angle **(1mk)**

(ii) angular magnification **(1mk)**

(b) Explain using a diagram why the furthest pole in line with others of equal height looks shorter **(3mks)**

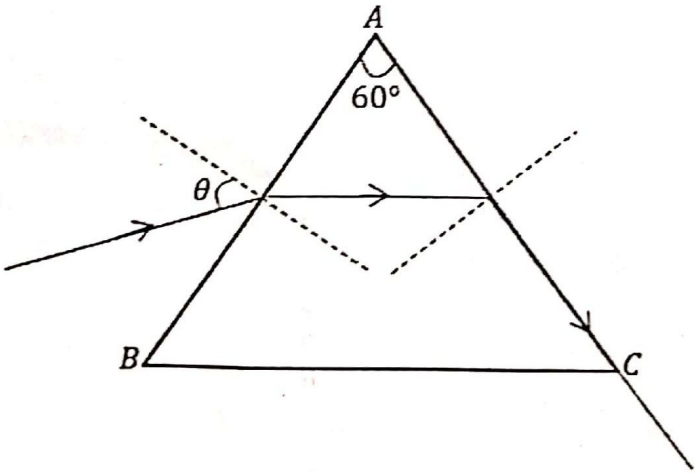
(c) (i) With the aid of a labelled diagram, describe the essential parts of a photographic camera **(5mks)**

(ii) Outline any two differences between a lens camera and a pin hole camera **(2mks)**

(d) Show that the effective focal length, F of a thin converging lens and a thin diverging lens in contact is given by; $-\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2}$ where f_1 and f_2 are the focal lengths of the individual lenses respectively **(4mks)**

(e) A converging lens, L_1 of focal length 10cm is placed at a distance, y in front of a diverging lens of focal length 20cm. An illuminated object is placed 20cm in front of L_1 and the final image by L_2 is formed by 20cm on the principal axis of L_2. Calculate distance, y **(4mks)**

2 (a) The figure shows a ray of monochromatic light incident on a triangular glass prism at an angle of incidence θ. Light just emerges from the face AB of the prism. The speed of light in the prism is $2.0 \times 10^8 ms^{-1}$.



(i). Calculate the refractive index of glass **(2mks)**

(ii). Find the value of θ **(3mks)**

(iii). Explain what happens when the angle of incidence is greater than θ **(2mks)**

(b) Describe an experiment to determine the refractive index of a liquid using a travelling microscope **(5mks)**

(c) A pin is clamped horizontally above a concave mirror with its tip along the principal axis. When the pin is adjusted, it coincides with its image at a distance, K from the mirror. When a small amount of liquid of refractive index, $\cap$ is put on the mirror, the pin again coincides with its image at a distance K' from the mirror. Show that the refractive index, $\cap$ is given by $\cap = \frac{K}{K'}$ **(4mks)**

(d) Explain with the aid of a diagram, why thick plane mirrors form multiple images **(4mks)**

SECTION B

3 (a) (i) Define the term diffraction **(1mk)**

(ii) What is meant by plane polarized light **(1mk)**

(b) (i) Describe how polarized light is produced by double refraction **(5mks)**

(ii) State two uses of polarized light **(2mks)**

(iii) A parallel beam of unpolarized light incident on a transparent medium of refractive index 1.62 is reflected as plane polarized light. Calculate the angle of incidence in air and angle of refraction in the medium **(3mks)**

(c) (i) What is diffraction grating? **(1mk)**

(ii) Sodium light of wavelength 5.890×10^{-7}m and 5.896×10^{-7}m falls normally on a diffraction grating. If in the first order beam, the two sodium lines are separated by 2minutes, find the spacing of the grating **(4mks)**

(d) State three differences between the spectra produced by a prism and that by a diffraction grating **(3mks)**

4 (a) Define the following terms as applied terms as applied to musical sound **(1mk)**

(i) Overtone **(1mk)**

(ii) Harmonic

(b) The displacement of a particle in a progressive wave is $y = a\sin(wt + kx)$ where x and y are in cm and t is in seconds.

(i) Write an equation for the wave which when super imposed with the above wave will form a stationary wave **(1mk)**

(ii) Derive an expression for the wave formed when the above two waves are super imposed and hence deduce that the wave is stationary. **(4mks)**

(iii) Show that the distance between any two successive antinodes on such a wave is half the wavelength of the wave. **(3mks)**

(c) Explain why the amplitude of a sound wave decreases as the distance from the source increases **(3mks)**

(d) A closed tube of length 1m has its lowest resonant frequency at 86.2Hz. With a tube of identical dimensions but open at both ends, the first resonance occurs at 171Hz. Calculate the speed of sound **(3mks)**

(e) Describe the dust tube method of determining the speed of sound in air **4mks)**

SECTION C

5 (a) (i) What is meant by back emf in a motor? **(2mks)**

(ii) Explain the importance of back emf in operation of a motor. **(2mks)**

(b). A motor of armature resistance 0.75Ω is operated from a 240V d.c supply.

(i) When the motor turns freely without a load, the current in the armature is 4.0A and the motor makes 400rev per min. Calculate the back emf. **(2mks)**

(ii) When a load is placed on the motor, the armature current increases to 60.0A. Find the new speed of rotation of the motor. **(3mks)**

(c) A rectangular coil of N turns each of dimensions $l \times b$ is inclined at an angle θ to a uniform magnetic field of flux density B. Derive an expression for the torque on the coil if a current, I is passed through it. **(5mks)**

(d) With the aid of a labeled diagram, describe the structure and mode of operation / action of a simple d.c motor. **(6mks)**

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

(b) Draw a labeled diagram of an induction coil and explain how it operates. **(7mks)**

(c) (i) Power of 6000W produced at 100V is to be transmitted over a distance of 2km through cables of resistance $0.2\Omega m^{-1}$. Determine the voltage at the output of a transformer needed to transmit the power so that only 5% of it is lost. (Assume the transformer is 100% efficient) **(5mks)**

(ii) State three factors which limit the efficiency of a transformer and indicate how they are minimized in practice **(3mks)**

(d) Explain why when a current is switched off in some circuits, a spark is seen across the gap of the switch. **(3mks)**

7 (a) Define the following terms as applied to alternating current

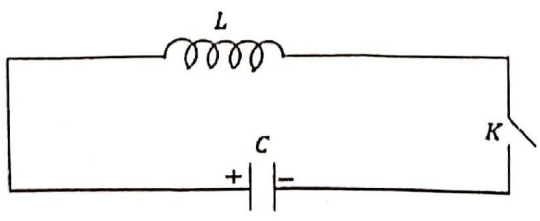
(i) resonant frequency **(1mks)**

(ii) Impedance **(1mk)**

(b)(i) Describe with the aid of a diagram, the structure and mode of operation of an attraction moving Iron ammeter. **(5mks)**

(ii) Outline any two differences between moving coil and moving iron instruments **(2mks)**

(c). An inductor, L, a capacitor, C and switch K are connected as shown in the figure below.



Explain briefly what happens when the switch is closed. **(4mks)**

(d) An inductor of self-inductance, L is connected across a source of alternating voltage $V = V_0 \sin \omega t$.

(i) Find the current which flows. **(3mks)**

(ii) Sketch using the same axes, the variation with time of the voltage across the inductor **(2mks)**

(e) A sinusoidal voltage of r.m.s 10V is applied across a capacitor of capacitance 50μF. Find the peak value of charge of the capacitor. **(2mks)**

SECTION D

8 (a) Describe with the aid of a circuit diagram, an experiment to determine the electrical resistivity of a given wire using a metre bridge **(7mks)**

(b) What is the disadvantage of the potentiometer over an ordinary voltmeter in measurement of voltages? **(2mks)**

(c) In an experiment to measure the internal resistance, r of a cell using a potentiometer slide wire, the following results were obtained.

$R(\Omega)$	2	3	4	5	10	20	40
$l(cm)$	50.0	60.6	66.7	71.4	83.3	90.9	95.2

Given that R are the resistances and l are the balance lengths of the slide wire, plot a suitable graph and use it to determine the internal resistance r of the cell. **(6mks)**

(d) Two wires A and B of resistivities ρ_1 and ρ_2 respectively have the same length and cross section area. The wires are connected in series and a cell of emf ϵ is connected across the wires. Show that the p.d across the wire A is given by; $V_1 = \frac{\rho_1 \epsilon}{\rho_1 + \rho_2}$ **(3mks)**

(e) Explain any one factor that affects the resistance of a conductor **(2mks)**

9 (a) Define the following terms as applied to capacitors

(i) dielectric strength **(1mk)**

(ii) dielectric constant **(1mk)**

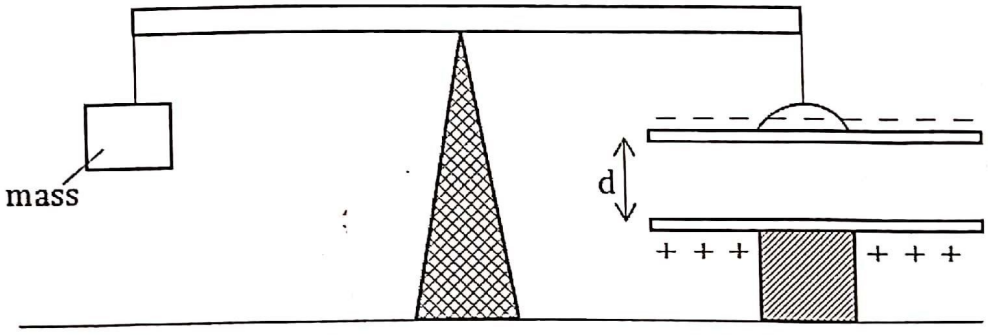
(b) Describe how the relative permittivity of a an insulating material is determined by using a ballistic galvanometer **(5mks)**

(c) (i) You have been given three capacitors of capacitances C_1, C_2 and C_3 and a source of voltage V. Draw a circuit diagram to obtain the minimum capacitance of the capacitors. **(2mks)**

(ii) Two capacitors of capacitances C_1 and C_2 are connected in series across a d.c source of emf V_0. If V_1 is the p.d across C_1, show that $C_2 = \frac{V_1(C_1+C_2)}{V_0}$ **(3mks)**

(d) Show by graphical method that the energy stored in a capacitor of capacitance, C charged to a p.d, V is equal to $\frac{1}{2}CV^2$. **(4mks)**

(e) The figure below shows a uniform rod pivoted at its mid-point and horizontally kept by a 9.8g mass suspended at one end and the other end is connected by means of an electric string to the negative plate of an air spaced parallel plate capacitor consisting of two plates each of area $412.\,cm^2$ placed at a distance of 4mm apart.



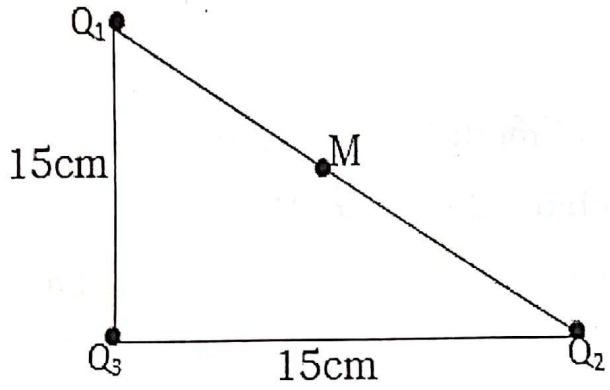
Calculate the potential difference across the plates of the capacitor **(4mks)**

10.(a) Distinguish between electric field intensity and electric potential at a point. **(2mks)**

(b) (i) What is the relationship between electric potential and electric field intensity? **(1mk)**

(ii) Derive the relationship between the electric field intensity and electric potential **(4mks)**

(c) Charges Q_1, Q_2 and Q_3 of magnitudes $+2\mu C$, $-3\mu C$ and $+5\mu C$ are situated at the corners of a triangle respectively as shown in the figure below.



Find the work done to move a charge Q_3 to point, M midway between Q_1 and Q_2. **(4mks)**

(d) Briefly explain why trucks carrying petroleum products have a dangling chain at the rear end **(3mks)**

(e) Describe with the aid of a diagram, how a high voltage can be generated using a Van Der Graaff generator **(6mks)**

THE END