P510/2
PHYSICS
Paper 2
July/ Aug: 2022
2 ½ hours

MATIGO MOCK EXAMINATIONS 2022
Uganda Advanced Certificate of Education

PHYSICS

Paper 2

2 hours 30 minutes

INSTRUCTIONS 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.*

Mathematical tables and squared papers are provided.

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	$= 1.6\times10^{-19}C$
Electron mass	$= 9.1\times10^{-31}kg$
Plank's constant, h	$= 6.6\times10^{-34}Js$
Permeability of free space, μ_0	$= 4.0\pi \times10^{-7}Hm^{-1}$
Permittivity of free space, ε_0	$= 8.85\times10^{-12}Fm^{-1}$
Gas constant, R	$=8.31Jmol^{-1}K^{-1}$
Charge to mass ratio, e/m	$=1.8 \times10^{11}Ckg^{-1}$
The constant $\frac{1}{4\pi\varepsilon_0}$	$= 9.0\times10^{9}F^{-1}m$
Avogadro's number N_A	$= 6.02 \times10^{23}\ mol^{-1}$
Speed of sound in air, V	$= 340ms^{-1}$

SECTION A

1. a) i) Define focal length as applied to a diverging lens. *(1 mark)*

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

b) i) A converging lens of focal length, f_1, and a diverging lens of focal length, f_2, are placed in contact with each other.
Derive an expression for the focal length, F, of the combined lenses. *(4 marks)*

ii) A convex lens of both focal length and radii of curvature equal to 15.0cm is placed on a liquid, on a plane mirror.
An object held above lens coincides with its image at a distance, 22.3cm from the lens. Calculate the refractive index of the liquid. *(3 marks)*

c) With the aid of diagrams, state the meaning of;

i) Chromatic aberration. *(2 marks)*

ii) Spherical aberration. *(2 marks)*

d)

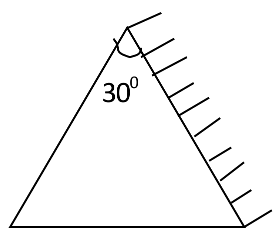

Fig 1

One face of a prism of refracting angle 30^0 and refractive index 1.41 is silvered. If the reflection at the silvered surface retraces its path, calculate the angle of incidence. *(3 marks)*

2. a) i) Define magnifying power of an optical instrument. *(1 mark)*

ii) What is meant by eye ring of an optical instrument? *(1 mark)*

b) i) Sketch a ray diagram to show how the final image is formed by a Galilean telescope when the final image is formed at the near point. *(2 marks)*

ii) Use the ray diagram in b (i) to derive the magnifying power of the telescope. *(3 marks)*

iii) The objective and eye piece of an astronomical telescope have focal lengths of 75.0cm and 2.5cm respectively.
Find the separation of the two lenses if the final image is 25cm from the eye piece. *(3 marks)*

c) i) With the aid of a labeled diagram, describe the essential parts of a photographic camera. *(4 marks)*

ii) Explain how chromatic and spherical aberration are minimized in the photographic camera. *(2 marks)*

d) The slide of a projection has dimensions 36mm by 24mm. Find the focal length of the lens required to project an image 1.44m by 0.98m on a screen placed 4.0m from the lens. *(4 marks)*

SECTION B

3. a) i) Define the terms frequency and wave length as applied to waves. *(2 marks)*

ii) Show that two waves of the same frequency and wave length travelling in opposite directions in the same medium produce stationary wave when they meet. *(3 marks)*

b) A plane progressive wave travelling in the $x-$direction is represented by the equation $y = 0.36 \sin 7\pi \left(40t - \frac{x}{25}\right)$, where t is time in seconds, y is the displacement in metres.

Determine the;

i) Periodic time. *(2 marks)*

ii) Speed of the wave. *(3 marks)*

c) i) What is meant by the term **beats**? *(1 mark)*

ii) Describe how you can determine the frequency of a tuning fork for using beats. *(4 marks)*

d) i) Define the term **Doppler effect**. *(1 mark)*

ii) The front and behind wagons of a train moving at a speed Us are fitted with sirens sounding at a frequency, f. A boy running just besides the railway track at a speed U_0 between the two wagons from the direction of the front wagon towards the behind wagon, hears beats of frequency f_b,
Show that the beat frequency, f_b heard by the boy assumed to be running in a straight line between the wagons is given by;

$$f_b = \frac{2vf\ (U_O + U_S)}{(V^2 - U_S^2)}$$

Where V is the velocity of sound in air. *(4 marks)*

4. a) i) Define the term **diffraction.** *(1 mark)*

ii) Explain the formation of fringes by transmission gratings. *(4 marks)*

b) When monochromatic light of wave length 6.0×10^{-7}m is incident normally on transmission grating, the second order diffraction image is observed at an angle of 30^0. Determine the number of lines per centimeter on the grating. *(4 marks)*

c) i) State **Huygens's principle**. *(1 mark)*

ii) Monochromatic light propagating in air is incident obliquely on a plane boundary with a material of refractive index, n. Use Huygens's principle to show that the speed, V of light in the material is given by $V = \frac{c}{n}$, where C is the speed of light in air. *(6 marks)*

d) i) What is meant by **interference of waves**? *(1 mark)*

ii) Explain the term **path difference** with reference to interference of two wave motions. *(3 marks)*

SECTION C

5. a) i) Define the terms **magnetic flux density** and **one tesla**. *(2 marks)*

ii) Two long conductors carrying current are placed parallel to each other in a vacuum at distance, *d* metres apart.

Derive an expression for the force per unit length acting on each wire when a current Y, I_1, flows through one and I_2 flows through the other. *(3 marks)*

b)

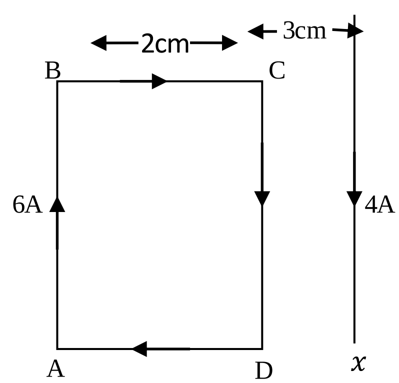

Fig 2

Fig **2** shows a fixed rectangular coil *ABCD* carrying current of 6A. A straight wire, x of length 15cm carrying current of 4A is placed 3cm from the coil.

Find;

i) Force experienced by wire, x. *(3 marks)*

ii) Magnetic flux density midway between CD and x. *(3 marks)*

c) i) With reference to the earth's magnetic field, define magnetic variation. *(1 mark)*

ii) Describe an experiment to determine the angle of dip using the earth inductor. *(5 marks)*

d) i) What are **eddy currents**? *(1 mark)*

ii) Explain why eddy currents are useful in a moving coil galvanometer. *(2 marks)*

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

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 1.2×10^{-2}T. The coil is rotated about a vertical axis so that it turns through 70^0 in 2 seconds. Calculate the;

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

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

c) i) Explain how back e.m.f is produced in a coil in an electric motor. *(3 marks)*

ii) A d.c motor of armature resistance 0.75Ω is connected to a 240V supply. When the motor is running freely, the armature current is 4.0A, and makes 400 revolutions per minute.
When a load is connected to the motor in the circuit, the armature current increases to 60A. Calculate the speed of rotation. *(5 marks)*

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

7. a) i) Define the terms **root mean square** *(r.m.s)* and **frequency of an alternating sinlisoidal current**. *(2 marks)*

ii) Show that the root mean square of an alternating current, I rms = $\frac{\text{Im}}{\sqrt{2}}$, where; Im is the peak value of alternating current. *(4 marks)*

b) i) Describe the structure and mode of operation of attraction type of moving Iron ammeter. *(5 marks)*

ii) State **one** advantage and **one** disadvantage of the above instrument over a moving coil ammeter. *(2 marks)*

c) A resistor of 300Ω is connected in series with a $12.5\mu F$ capacitor and an a.c source alternating at frequency of $\left(\frac{100}{\pi}\right)$ HZ and operating at, a p.d of *240V (rms*). Calculate the root mean square of the circuit current. *(3 marks)*

d) Explain why an inductor is describe as a wattles component. *(3marks)*

SECTION D

8. a) Define the terms **electrical resistivity** and **temperature coefficient of resistance**. *(2 marks)*

b) An electric heater consists of 5.0m of nichrome wire of diameter 0.58mm. When connected to a 240V supply, the heater dissipates 2.5Kw and the temperature of the heater is found to be 1020^0C. If the resistivity of nichrome at 10^0C is $1.02 \times 10^{-6}\Omega$m,

Calculate the;

i) Resistance of nichrome at 10^0C. *(2 marks)*

ii) Temperature coefficient of resistance of nichrome between 10^0C and 1020^0C. *(3 marks)*

c) i) What is meant by **internal resistance** of a cell. *(1 mark)*

ii) Describe with the aid of a circuit diagram how the internal resistance of a cell can be determined using a potentiometer. *(5 marks)*

d) A battery of *emf*, E and internal resistance, *r*, is connected across a variable resistor, R as shown in fig 3.

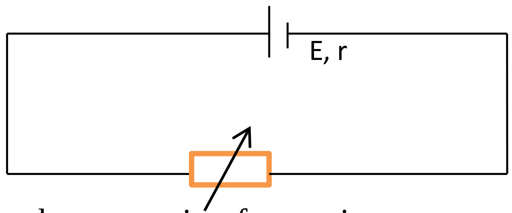

Fig. 3

c) i) Derive the expression for maximum power. *(4 marks)*

ii) If E = 9.0V and r = 3.0Ω, what is the maximum value of the power dissipated in the variable resistor, R? *(2 marks)*

9. a) i) Define **electrostatic potential difference**. *(1 mark)*

ii) Derive an expression for the potential at a point a distance, *r*, from charge *Q*. *(4 marks)*

b) Charges of 6μC, -5μC, 8μC and $^{-}$10μC are placed at the corners taken in order of a rectangle ABCD where AB = 6cm and BC = 4cm.
If E and F are mid points of AB and CD respectively. Find the work done against the electric forces in taking a small charge of +2μC from E to F. *(5 marks)*

c) Describe an experiment to show that when two insulators are rubbed together they develop equal and opposite charge. *(5marks)*

d) i) Explain briefly what happens to the potential energy as two point charges of the same sign are brought closer. *(2 marks)*

ii) A charged ebonite rod is brought up to an uncharged pith ball suspended by silk thread. The pitch ball is first seen to move to the rod, touches it and moves away from it.
Explain the above observations. *(3 marks)*

10. a) i) Define the term **capacitance of a capacitor**. *(1 mark)*

ii) Describe how a vibrating reed switch circuit can be used to determine the capacitance of a capacitor. *(4 marks)*

b) i) State **two** uses of capacitors in electrical circuits. *(2 marks)*

ii) Explain how a capacitor gets charged to the maximum p.d of a d.c source. *(3 marks)*

c) A capacitor of capacitance, C is charged to a p.d V_1. Another capacitor of the same capacitance, C is charged to a p.d, V_2.
Show that a loss of energy when the two charged capacitors are connected together is $\frac{1}{4}C(V_1 - V_2)^2$. *(4 marks)*

d) Four capacitors of capacitances 1.0μF, 2.0μF, $3.\mu0$F and 4.0μF are connected to a battery as shown in fig 4

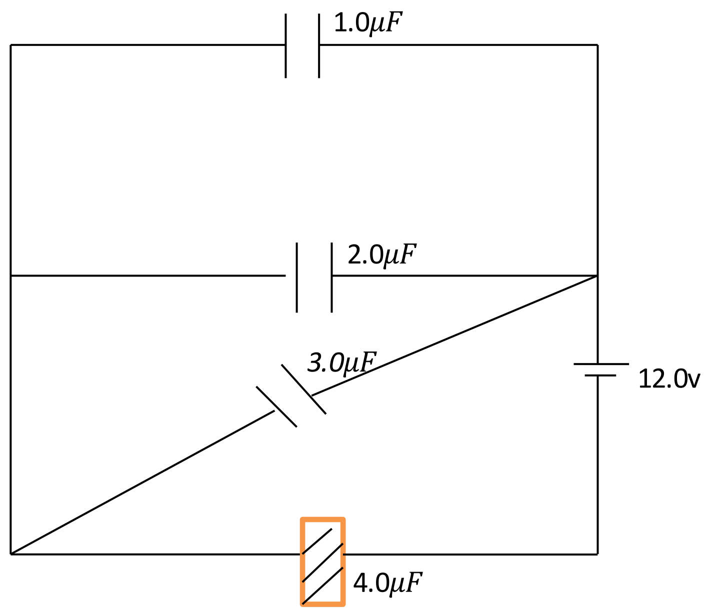

Fig 4

If the space between the plates of 4.0μF capacitor is filled with a dielectric of 1.5, Calculate the;

i) Charge stored in the network of capacitors. *(4 marks)*

ii) P.d across 3.0μF capacitor. *(3 marks)*

END