P510/2
PHYSICS
Paper 2
July/August,2024
2½ Hours

ERETA EDUCATION CONSULTS LTD

JOINT MOCK EXAMINATIONS 2024

Uganda Advanced Certificate of Education

PHYSICS
PAPER 2
2Hours 30minutes

INSTRUCTIONS TO CANDIDATES:

*Answer only **five** questions, taking at least **one** question from each of the sections **A**, **B**, **C** and **D**, but **not** more than **one** question should be chosen from **either** section **A** or section **B**.*
*Any additional question(s) answered will **not** be marked.*
Mathematical tables and squared paper will be provided.
Non-programmable Silent Scientific Calculators may be used.

Assume where necessary:

Acceleration due to gravity,	g	=	9.81m s^{-2}
Speed of light in Vacuum,	c	=	$3.0 \times 10^{8} \text{m s}^{-1}$
Speed of sound in air,	*v*	=	330 m s^{-1}
Electronic charge,	e	=	$1.60 \times 10^{-19} \text{C}$
Electronic mass,	m_e	=	$9.11 \times 10^{-31} \text{kg}$
Permeability of free space,	μ_o	=	$4\pi \times 10^{-7} \text{H m}^{-1}$
Permittivity of free space,	ε_0	=	$8.85 \times 10^{-12} \text{F m}^{-1}$
The Constant,	$\frac{1}{4\pi\varepsilon_0}$	=	$9.0 \times 10^{9} \text{F}^{-1} \text{m}$

SECTION A

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

b) A luminous point object is placed on the principal axis of a converging lens of focal length 40.0 cm. A plane mirror placed 150.0 cm from the lens with its reflecting surface facing the lens and on side-remote to the object forms an image on the screen placed 50 cm from the plane mirror.

i. Determine the position of the object from the lens. (4 marks)

ii. Sketch a ray diagram showing the formation of the final image. (2 marks)

c) Describe an experiment to determine refraction index of a liquid using a concave mirror. (5 marks)

d) A rod 10cm long is placed along the principal axis of a concave mirror such that the mid-point of the rod is 35cm from the pole of the mirror. Calculate the radius of curvature of the mirror if it forms a real image of the rod which is 20cm long (4 marks)

e) Explain the importance of a concave reflector in a solar concentrator.

(3 marks)

2. a) Define the following term as applied to a convex lens (2 marks)

i. Principal foci

ii. Conjugate foci

b) Describe an experiment to determine focal length of a diverging lens using a converging lens. (4 marks)

c) Show that when a ray of light passes nearly normally through a prism of small angle, $\boldsymbol{\alpha}$ and refraction index, $\boldsymbol{n}$ the deviation, $\boldsymbol{d}$ produced by the prism is given by $\boldsymbol{d = (n - 1)\alpha}$ (3 marks)

d) A glass prism of refracting angle 10^0 has refraction index 1.65 for yellow light and 1.60 for blue light. Find the angle of separation of yellow light and blue light when white light is incident on the prism. (3 marks)

e) (i) Define the term **magnifying power** of an optical instrument. (1 mark)

(ii) Derive the expression for magnifying power of a Galilean telescope in normal adjustment. (4 marks)

f) A telescope consists of two thin converging lenses of focal length 0.3m and 0.03m separated by 0.33m. It is used to focus the moon which subtends angle of 0.5^0 at the objective. Find the angle subtended at the observer's eye by the final image formed by the telescope. (3 marks)

SECTION B

3. a) Distinguish between **free oscillations** and **forced oscillations**. (2 marks)

b) Define the terms as applied to musical organs. (2 marks)

i. harmonics

ii. overtones

c) Two tuning forks of the same frequency 512 Hz are sounded near the open ends of two tubes A and B of the same diameter but of different lengths. Tube A is closed at only one end while tube B is open at both ends. If both tubes are made to sound at their first resonance. Determine;

i. the ratio of length of tube A to the length of tube B. (3 marks)

ii. the value of end correction of tube A if its length is 16.0 cm (3 marks)

d) i. Explain the occurrence of beats (2 marks)

ii. Describe an experiment to determine speed of sound in this dust-tube method. (4 marks)

e) A stretched wire of length 0.75m, radius 1.36 mm and density 1380 $kgm^{-3}$is clamped at its both ends and plucked in the middle. The fundamental note produced by the wire resonates with the first overtone of a closed pipe of length 0.15m. Calculate the tension in the wire. (4 marks)

4. a) What is meant by the following as applied to light waves.

i. Diffraction (1 mark)
ii. Polarization (1 mark)

b) A diffraction grating of space, d is illuminated normally with light of wavelength, λ.

i. Derive the condition for occurrence of diffraction maxima. (3 marks)
ii. Describe briefly the intensity distribution on a screen placed beyond the grating. (2 marks)
iii. What is the effect on the diffraction pattern when a grating with a large number of lines is used. (2 marks)

c) Light of wave length 5.8 x 10^{-7} m is incident on a diffraction grating of 500 lines per mm. Find the;

i. diffraction angle for the 2^{nd} order image. (3 marks)
ii. Maximum number of images formed. (2 marks)

d) i. Describe how polarized light can be produced by reflection. (4 marks)

ii. List any two uses of polarized light. (2 marks)

SECTION C

5. a) Define the terms as applied to magnetism.

i. magnetic flux density. (1 mark)
ii. weber. (1 mark)

b) Figure 1 shows two straight parallel wires X and Y placed 3.0 cm apart in air and carrying currents 10A and 4A respectively.

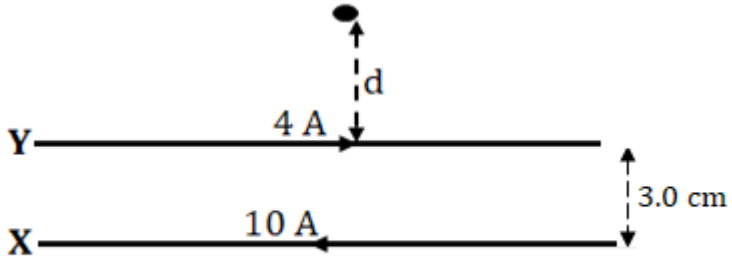

Fig. 1

i. Determine the distance, d from wire Y where the magnetic force is zero. (3 marks)

ii. Calculate the force per meter on wire X. (3 marks)

c) i. Derive an expression for the magnetic torque experienced by a rectangular coil of N turns each of area A carrying current, I with its plane parallel to the uniform magnetic field of flux density, B. (4 marks)

ii. A coil of 10 turns each of radius 10.0 cm is suspended with its plane along a uniform magnetic field of flux density 0.2T. Find the initial torque on the coil when a current of 2A is passed through it. (3 marks)

d) i. Explain the origin of hall voltage developed across a metal slab placed in a uniform magnetic field when a current flows through the slab. (3 marks)

ii. Derive the expression for the hall voltage. (2 marks)

6. a) (i) Define **peak value** and **root mean square value** of the alternating current. (2 marks)

(ii)An alternating current $I = 4.0 \sin 120\pi t$ is passed through an inductor of self-inductance 0.5H. Determine the root mean square value of the voltage across the inductor. (4 marks)

b) i. Describe the mode of operation the repulsive-type of moving iron meter. (5 marks)

ii. State two advantages of a.c meters over moving coil meter. (2 marks)

c) i. A sinusoidal voltage of amplitude V_0 and frequency, f is applied across a capacitor of capacitance, C. Derive the expression for capacitive reactance of the capacitor. (4 marks)

ii. Explain why current through the capacitor is out of phase with the voltage. (3 marks)

7. a) What is meant by the terms

i. Electromagnetic induction (1 mark)
ii. Mutual induction (1 mark)

b) Describe briefly an experiment to demonstrate mutual induction. (3 marks)

c)

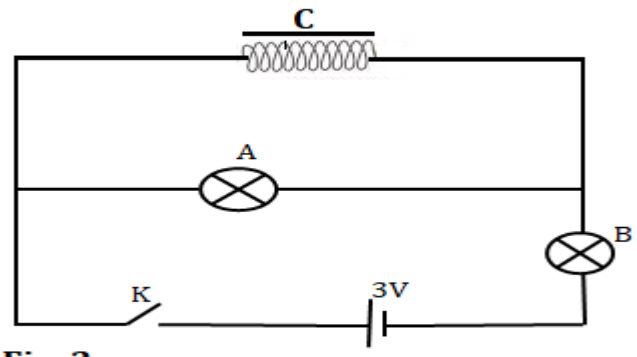

Fig. 2

Figure 2 shows bulbs A and B of the same power rating connected to iron cored coil, C of large self-inductance. Explain what is observed when;

i. switch K is closed. (4 marks)
ii. switch K is opened. (3 marks)

d) i. Describe the mode of operation of a transformer. (4 marks)

ii. A transformer is designed to work on a 240V, 60W supply. It has 300 turns in the primary and 200 turns in the secondary. Its efficiency is 80%. Calculate the current in the secondary coil. (4 marks)

SECTION D

8. a) i. Define the term **volt** and **electromotive force** of a battery. (2 marks)

(ii) Three identical dry cells each of emf, **E** and internal resistance, ***r*** are connected in parallel and then across two resistors of resistance 3Ωand 6Ω as shown in figure 3.

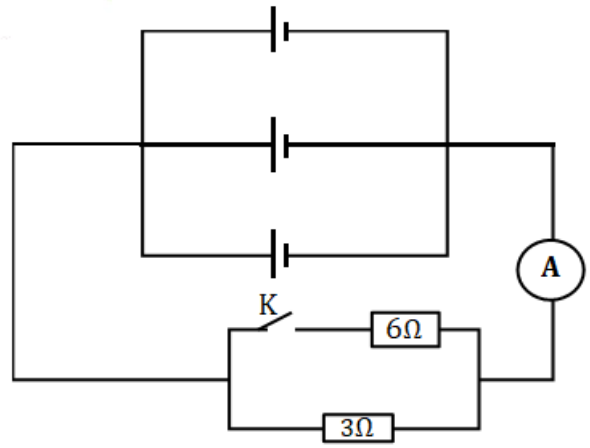

Fig. 3

When switch K is closed the ammeter reads 0.64 A and when it is open the ammeter reads 0.45A. Determine the emf, ***E*** and internal resistance, ***r*** of each cell. (4 marks)

b) i. Distinguish between **electrical resistivity** and **temperature coefficient** of resistance. (2 marks)

ii. Describe an experiment to determine temperature coefficient of resistance. (6 marks)

c) Figure 4 shows thermistor connected to the circuit in order to monitor the temperature changes. The thermistor has a resistance of 3900Ω at 0^0C and 1250Ω at 30^0C and the battery of emf 1.5V and negligible resistance is connected across the thermistor and a resistance R. The voltmeter reads 1.0V.

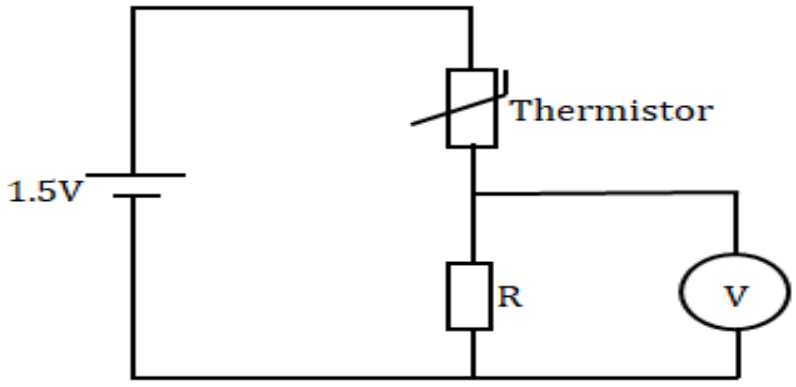

Fig. 4

Determine the;

i. resistance R if the voltmeter reads 1.0V at 0^0C (2 marks)
ii. the voltmeter reading if the temperature of thermistor is increased to 50^0C. (4 marks)

9 a (i) Define **capacitance** of a capacitor. (1 mark)

(ii) Derive an expression for the energy stored in a capacitor of capacitance, ***C*** with a charge, **Q** stored by each plate of the capacitator. (4 marks)

b i. State two properties of a dielectric material placed between the plates of the capacitator (2 marks)

ii. Explain why the potential difference across the plates of a capacitor reduces when mica is placed between its plates. (3 marks)

c) A battery of emf 12V is connected across a system of capacitors as shown in the figure 5.

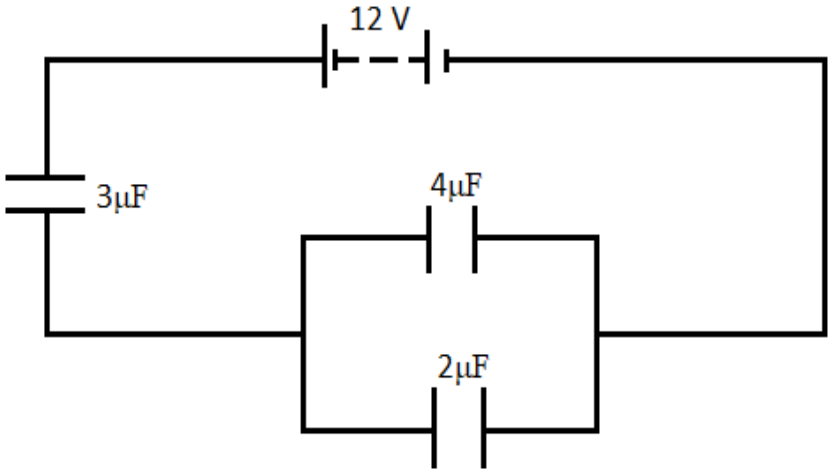

Fig. 5

Find the;

i. charge stored on the 3μF capacitor. (3 marks)
ii. energy stored in the 2μF when a dielectric constant 2.0 is placed between its plates. (3marks)

d) Describe an experiment to determine the relative permittivity using a vibrating reed switch. (4 marks)

10 a) Distinguish between **electric potential** and **electric potential difference**.

(2 marks)

b) Derive the relationship between the electric potential ***V*** at a point a distance, ***x*** from a charge, ***Q*** placed in a vacuum. (4 marks)

c) Two-point charges of magnitude - 4.0μC and +8.0μC are placed at points A and B as shown in figure 6.

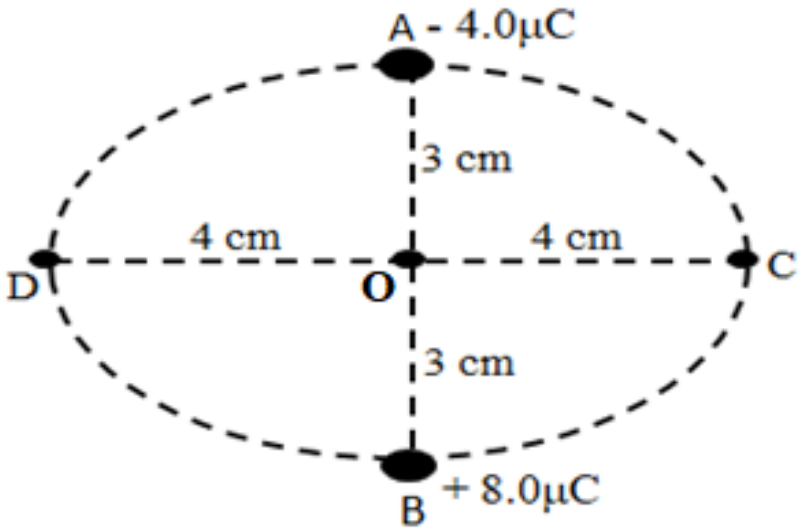

Fig. 6

Find the

i. electric field intensity at point C. (4 marks)
ii. work done to move a charge of -3.0μC from D to O (5 marks)

d) Describe how you would distinguish a conductor and an insulator using an electroscope. (3 marks)

e) Show that lines of force from a charged conductor are at right angles to the conductor. (2 marks)

END