P510/2
PHYSICS
Paper 2
June. 2022
2½ hours

EXTERNAL MOCK EXAMINATIONS 2022 (SET 2)

Uganda Advanced Certificate of Education

PHYSICS

Paper 2

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES:

Answer **five** *questions including at least* **one** *but not more than* **two** *from each of the sections* **A**, **B**, **C** *and* **D**.
Mathematical tables and squared paper will be 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	=	$1.6 \times 10^{-9} C$
Electron mass	=	$9.11 \times 10^{-31} kg$
Plank's constant, h	=	$6.6 \times 10^{-34} Js$
Permeability of free space, μ_0	=	$4.0\pi \times 10^{-7} Hm^{-1}$
Permeability of free space, ε_0	=	$8.85 \times 10^{-12} Fm^{-1}$
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, NA	=	$6.02 \times 10^{23} mol^{-1}$
Resistivity of Nichrome wire at $25°C$	=	$1.2 \times 10^{-6}\ \Omega m$
Specific heat capacity of water	=	$4.2 \times 10^{3} Jkg^{-1}K^{-1}$

SECTION A

1. (a) Describe an experiment to determine the focal length of a concave lens using a convex of known focal length. *(05marks)*

(b) A convex lens and a concave lens of focal lengths 17.5 and 15.0cm respectively are mounted coaxially $7.5cm$ apart with the concave lens facing a distant object. Find:

(i) the final position of the image *(03marks)*

(ii) the magnification of the image produced by the concave lens *(02marks)*

(c) Explain why a paraboloid mirror is used in search lights instead of a concave.*(03marks)*

(d) Describe how the angle of a prism can be measured using a spectrometer *(05marks)*

(e) Differentiate between **chromatic and spherical aberrations** *(02marks)*

2. (a) Define the terms **refraction** and **refractive index** *(02marks)*

(b) Derive an expression for the apparent displacement of an object when viewed normally through a parallel sided glass block. *(05marks)*

(c) (i) A glass block of refractive index n_g is immersed in a liquid of refractive index n_l. A ray of light is partially reflected and refracted at the interface such that the angle between the reflected ray and the refracted ray is 90^0.
Show that $n_g = n_l tan\ \alpha$, where α is the angle from the liquid to glass. *(04marks)*

(ii) When the procedure in (i) is repeated with the liquid removed, the angle of incidence increases by 8^0. Given that $n_l = 1.33$, find n_g and the angle of incidence at the liquid glass interface. *(06marks)*

(d) A point source of white light is placed at the bottom of a water tank in a dark room. The light from the source is observed obliquely at the water surface. Explain what is observed. *(03marks)*

SECTION B

3. (a) Use Huygen's principles to show that the angle of incidence is equal to the angle of reflection for light falling on a plane reflecting surface. *(05marks)*

(b) (i) Draw a ray diagram showing the path of light rays through the experimental arrangement for the determination of the wave length of light using a single slit and bi−prism. *(02marks)*

(ii) In a single slit and bi−prism experiment a prism of refracting angle 1.5^0 and refractive index 1.5 is used. The slit and the screen are $5cm$ and $1m$ respectively from the bi−prism. If light of wavelength 5.80×10^{-7} is used, find the width of the fringes. *(05marks)*

(iii) State **one** advantage of the biprism method over Young's double slit method. *(01mark)*

(c) Distinguish between **continuous** and **line emission spectra**. *(03marks)*

(d) Describe **one** application of absorption line spectra. *(04marks)*

4. (a) Explain the terms **wave length** and **wave front** as applied to wave motion. *(02marks)*

(b) (i) Define the term **resonance** *(01mark)*

(ii) Describe how you would determine the velocity of sound in air using a resonance tube. *(05marks)*

(c) Explain with the aid of suitable diagrams the terms **fundamental note** and **overtone** as applied to a vibrating wire fixed at both ends. *(05marks)*

(d) A stretched wire of length $0.75m$, radius $1.36mm$ and density $1380kgm^{-3}$ 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 $0.15m$ closed at one end.

(i) Sketch the standing wave pattern in the wire *(01mark)*

(ii) Calculate the tension in the wave (The speed of sound along the stretched wire is $\sqrt{T/\delta}$where T is the tension in the wire and δ the mass per unit length. Speed of sound in $air = 330ms^{-1}$). *(06marks)*

SECTION C

5. (a) A circular coil of N turns, each of radius *R* carries current I.

(i) Write an expression for magnetic flux at the centre of the coil *(01mark)*

(ii) Sketch the magnetic field pattern associated with the coil. *(02marks)*

(iii) Describe a simple experiment to verify the expression in (i) when N and R are constant. *(06marks)*

(b) (i) What is meant by **magnetic moment** of a current carrying coil? *(02marks)*

(ii) A circular coil of 10 turns each of radius $10cm$ is suspended with its plane along a uniform magnetic field of flux density $0.1T$. Find the initial torque on the coil when a current of 1.0 A is passed through it. *(03marks)*

(c)

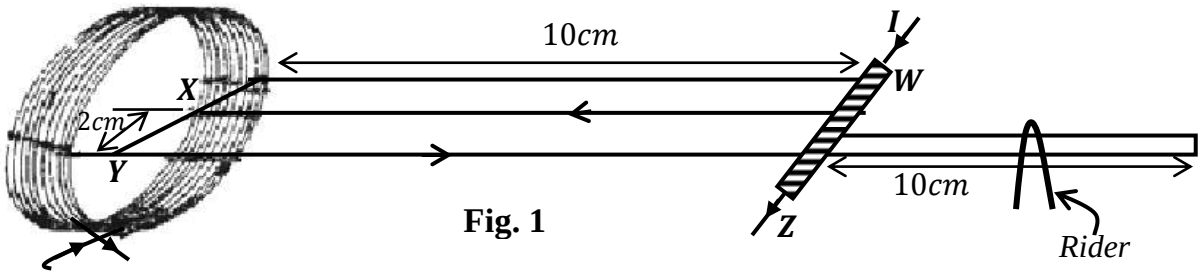

Fig. 1

A rectangular loop of wire *WXYZ* is balanced horizontally so that the length *XY* is at the centre of a circular coil of 500 turns of mean radius 10.0cm as shown in figure **1**. When a current I is passed through *XY* and the circular coil, a rider of mass $5.0 \times 10^{-4}kg$ has to be placed at a distance of $9.0cm$ from *WZ* to restore balance. Find the value of the current *I* *(06marks)*

6. (a) (i) Derive the relationship between peak value and root-mean square value of a sinusoidal current. *(04marks)*

(ii) Calculate the root mean square value of an alternating current which dissipates energy in a heating coil immersed in a liquid in a calorimeter at two times the rate at which direct current of $4A$ would if passed through the same coil under the same conditions. *(03marks)*

(b) A source of sinusoidal voltage of amptitude V_0 and frequency f is connected across a capacitor of capacitance C.

(i) Without using any formula explain why a current apparently flows through the capacitor and is out of phase with the voltage. *(03marks)*

(ii) Find the amplitude of the current which flows and sketch a graph of the amplitude against frequency if the resistance of the connecting wire is negligible. *(04marks)*

(c) Draw a labelled diagram of a moving coil galvanometer and explain why it cannot be used to measure an alternating current. *(05marks)*

7. (a) What is meant by:

(i) **mutual induction**

(ii) **self induction** *(02marks)*

(b) Describe an experiment to demonstrate mutual induction. *(03marks)*

(c)

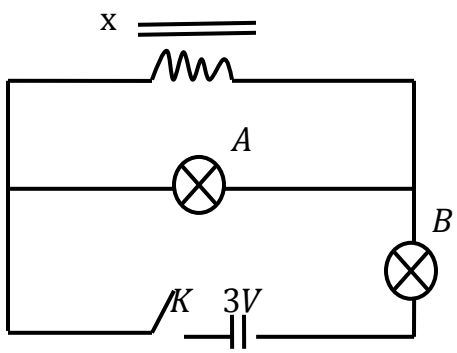

Fig. 2

Bulbs A and B rated $3W$, $6W$ are connected to an inductor, X of large inductance as shown in figure **2**. Explain what is observed when;

(i) Switch K is first closed *(04marks)*

(ii) Switch K is opened *(02marks)*

(d) (i) Describe briefly the action of a transformer *(04marks)*

(ii) Describe briefly **four** causes of inefficiency in a transformer *(02marks)*

(e) A transformer is designed to work on a $240V$, $60W$ supply. It has 3000 turns in the primary and 200 turns in the secondary and its efficiency is 80%. Calculate the current in the secondary coil. *(04marks)*

SECTION D

8. (a) (i) Draw the circuit diagram of the metre bridge and use it to derive the condition for balance. *(06marks)*

(ii) Explain why the metre bridge is unsuitable for comparison of low resistances. *(02marks)*

(iii) When resistors of resistances 4Ω and 8Ω are connected respectively in the left and right hand gaps of a metrebridge a balance point is obtained at a point a distance of $32.0cm$ from the left hand end of the bridge wire. On interchanging the resistors a balance point is obtained at a point $68.0cm$ from the left hand end. The resistance of the uniform wire of the metrebridge is 5Ω. Calculate the end errors. (04marks)

(b)

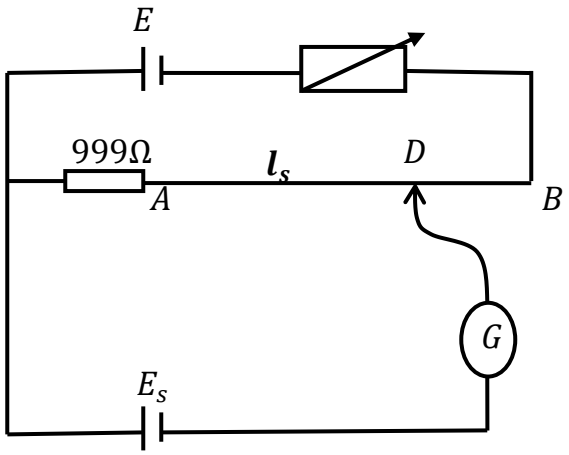

Fig. 3

In figure **3** above E is a driver cell of e.m.f. $2V$ and negligible internal resistance. E_s is standard cell of e.m.f. $1.00V$ and AB is a uniform wire of resistance 10Ω and length $100.0cm$. The galvanometer G shows no deflection when $l_s = 10.0cm$. Find:

(i) the current flowing in the driver circuit *(02marks)*

(ii) the resistance of the rheostat *(04marks)*

(iii) the e.m.f of a thermo−couple which is balanced by a length of $60.0cm$ of the slide wire AB. *(02marks)*

9. (a) (i)

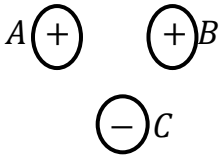

Fig. 4

In figure **4**, *A*, *B* and *C* are point charges of equal magnitudes.

(i) Sketch the field lines due to the charges and show the position of the neutral point. *(03marks)*

(ii) Explain why a charged material attracts an uncharged conductor *(03marks)*

(b) With the aid of a labeled diagram describe how a large electric potential can be built up using a Van der Graaf generator. *(07marks)*

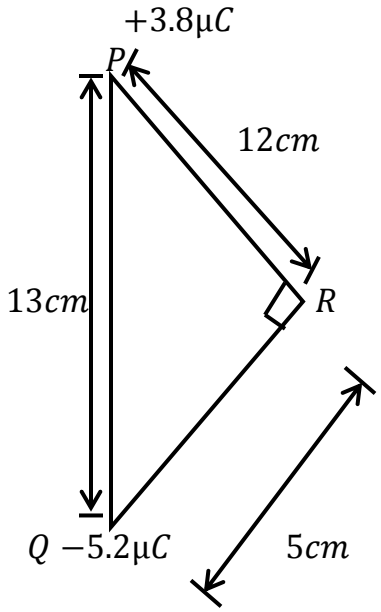

Fig. 5

Two point charges of $+3.8\ \mu C$ and $-5.2\mu C$ are placed in air at points P and Q as shown in figure **5**. Determine the electric field intensity at R. *(07marks)*

10. (a) What is meant by **capacitance of a capacitor**? *(01mark)*

(b) Describe an experiment you would carry out to verify that the capacitance of a parallel plate capacitor is proportional to $\varepsilon A/d$, where d is the plate separation, A is the area of overlap of the plates and ε is the permittivity of the medium between the plates *(06marks)*

(c) (i) Derive an expression for the effective capacitance of three capacitors of capacitances C_1 , C_2 and C_3 connected in parallel. *(03marks)*

(ii)

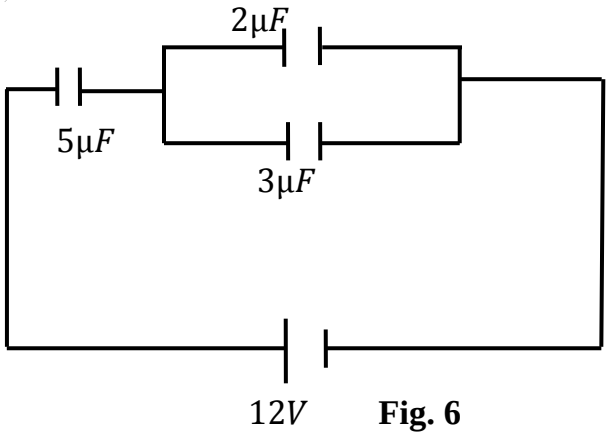

Fig. 6

A battery of e.m.f $12V$ is connected across a system of capacitors as shown in figure **6**.

Calculate the total energy stored in the capacitors. *(04marks)*

(d) (i)

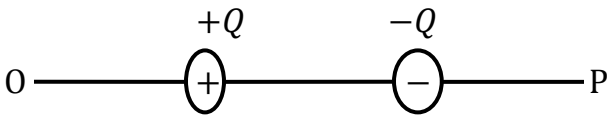

Fig. 7

Figure **7** shows two charges ^{+}Q and ^{-}Q placed along a line OP. Sketch the variation of electric potential along OP. *(02marks)*

(ii) Explain with the aid of a diagram the term electrostatic shielding *(04marks)*

END