P510/2

PHYSICS

PAPER 2

JULY/AUGUST 2022

TIME 2 ½ HOURS

ASSHU MBARARA JOINT MOCK EXAMINATIONS

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 section A or B.
- Any additional question(s) answered will not be marked.
- Mathematical tables and squared papers 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 vacuum $c = 3.0 \times 10^{8} ms^{-1}$
- Electronic charge $e = {}^{-}1.6 \times 10^{19} C$
- Speed of sound in air $v = 340 ms^{-1}$
- Permeability of free space $\mu o = 4.0^{10} \times 10^{-1} Hm^{-1}$
- Primitivity of free space $\mathcal{E}_o = 8.85 \times 10^{-12} Fm^{-1}$
- The constant $\frac{1}{4\pi\varepsilon_0} = 9 \times 10^{9} F^{-1}m$

SECTION A:

1. (a)(i) Define the focal length and radius of curvature of a convex mirror.

   (ii) Show by using a finite object that for a convex mirror $\frac{1}{U} + \frac{1}{V} = \frac{1}{f}$, where
   u = object distance
   v = Image distance and
   f = focal length (5marks)

   (b) A concave mirror of radius of curvature 40.0cm contains a liquid to a height of 2.0cm. A pin clamped horizontally and viewed from above is observed to coincide with its image when it is 27.0cm above the surface of the liquid. Calculate the refractive index of the liquid and deduce the expression used. (6marks)

   (c) Describe an experiment to determine the focal length of a convex mirror by using a plane mirror. (5marks)

   (d) With the aid of a diagram, explain how an optical fibre transmits light (3marks)

2. (a)(i) Explain why a convex lens refracts paraxial rays of light incident on to it towards the principal focus (3marks)

   (ii) Show that for a concave lens the distance between an object and its real image formed on a screen should be equal or greater than four times the focal length f of the convex lens used. (3marks)

   (b) Describe an experiment to determine the refractive index of a liquid by using an equi convex lens of radius of curvatures r, a plane mirror and an optical pin (5marks)

   (c) Draw the optical component of an optical spectrometer and state the adjustments made before it is used for a purpose. (5marks)

   (d) A convex lens is placed between a finite object and a screen. The position of the screen is adjusted until a clear magnified image of height 5cm is formed on the screen. Keeping the screen and object fixed, the lens is displaced through a distance of 16cm towards the screen until a diminished sharp image of height 1.8cm is formed on the screen. Calculate;

   i) the focal length f of the convex lens (3marks)

   ii) the distance between the object and the screen. (1mark).

SECTION B;

3. (a)(i) What is meant by the terms wave front and beats ? (2marks)
   (ii) Explain using the principle of super position of waves, the formation of beats. (3marks)
   (b)(i) What are the conditions necessary for the formation of audible beats from two separate sound sources. (3marks)
   (ii) Deduce algebraically, an expression for the frequency f of such beats in terms of the frequencies f_1 and f_2 of two sources whose equations are $y_1 = a \sin 2\pi f_1 t$ and $y_2 = a \sin 2\pi f_2 t$ (4marks)
   (c) Describe, with the aid of a well labelled diagram, an experiment to determine the speed of sound in air by using the Kundt's dust tube method (5marks).
   (d) A sound wave propagating in the x – direction is given by the equation. $y = 2 \times 10^{-7} \sin(8000t - 25x)$ metres. Find the speed of the wave. (3marks).

4. (a) What is meant by
   i) Huygens' principle (1mark)
   ii) Interference. (1mark)
   iii) State the conditions for the production of an interference pattern. (3marks)
   (b) With the aid of a diagram, use Huygens' principle to explain how the interference pattern is produced in a Young's double slit experiment. (4marks)
   (c) In a Young's double slit experiment, the slit separation is 0.05cm and the distance between the double slit and screen is 200cm. when blue light is used, the distance between the first bright fringe from the centre of the interference pattern is 0.13cm.
   i) Calculate the wave length λ of the blue light used in the experiment. (2marks)
   ii) Calculate the distance of the fourth dark fringe from the centre of the interference pattern. (3marks)
   (d) Describe an experiment to determine the wavelength λ of monochromatic light by using a spectrometer and a diffraction grating of known number of lines per metre. (6marks)

SECTION C:

5. (a)(i) Define the tesla. (1mark)

   (ii) Write down the expression for the force on an election of charge e, moving with an average velocity Vms^{-1} at an angle θ to a uniform magnetic field of flux density B. Hence deduce the force on the length L of the wire, carrying a current I through which the electrons are flowing (4marks)

   (b) A circular coil of 25 turns and mean radius 2.1cm is suspended on a torsion wire, at the centre of along solenoid of 750 turns per metre and connected in series with the solenoid. If the coil is placed so that the normal to its plane makes an angle of 30^0 with the axis of the solenoid, and a current of 5.0A is passed through the system, find

   i) the magnetic flux density at the centre of the solenoid. (2marks)

   ii) the initial torque experienced by the coil. (3marks)

   (c) (i) With the aid of a labelled diagram, describe the mode of operation of a moving coil galvanometer. (5marks)

   (ii) Explain why a strong permanent magnetic with concave curved poles is used in a moving coil galvanometer and also why its coil is wound around a metallic former. (3marks)

   (d) Sketch the resultant magnetic field pattern in a region where a bar magnet is placed east-west in the earth's magnetic field and mark the neutral point(s). (2marks)

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

   (ii) Describe an experiment to verify the Lenz's law of electromagnetic induction. (5marks)

   (b) A circular search coil of N turns each of area A m^2 is connected in series with a ballistic galvanometer to form a closed series circuit of resistance R. The search coil is placed between poles of a strong permanent magnet with its plane perpendicular to its magnetic fields of flux density B. The coil is quickly removed from the magnetic field. Show that the magnetic flux density B of the field between the poles of the magnet is given by $B = \frac{K\theta R}{NA}$, where K is the torsional constant of the ballistic galvanometer and θ is its deflection (4marks).

   (c) (i) What is meant by a back e.m.f in a d.c motor and explain how it is produced in a motor. (3marks)

   (ii) A d.c motor of armature resistance 1.5Ω is connected to a 240V d.c. supply. When the motor is running freely, the armature current is 4.0A and makes 420 revolution per minute.

When the load is connected to the motor in the circuit, the armature current increases to 20A. Calculate the speed of the motor when loaded. (4marks)

(d) What are eddy currents and state one of their uses (2marks)

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

(ii) Show that the root mean square value of an alternating voltage $V_{r.m.s} = \frac{V_m}{\sqrt{2}}$, where V_m is the peak value of the alternating voltage (3marks)

(b)(i) Describe with the aid of a labelled diagram, how the repulsive type of a moving iron ammeter works (5marks)

(ii) State two advantages of the moving iron meter over a moving coil meter. (2marks)

(c) A capacitor of capacitance 125μF is connected in series with a 30Ω resistor and an A.c supply operating at a voltage of 200V(r.m.s), and frequency $\left(\frac{100}{\pi}\right)$Hz. Calculate

i) the root mean square value of the circuit alternating current (3marks)

ii) the power dissipated in the circuit. (2marks)

(d)

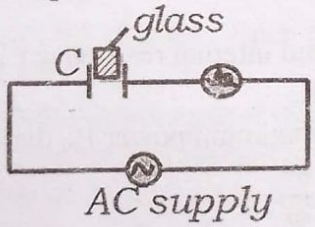


Fig (i)

When a parallel plate capacitor C and a filament lamp are connected in series to an a.c supply, the filament is lighted to a certain brightness. Explain what is observed when a piece of glass acting as a dielectric is inserted between the capacitor plates. (3marks)

SECTION D;

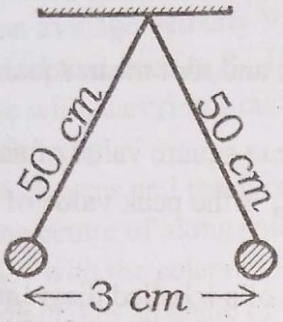
8. (a)(i) State coulomb's law of electrostatics.

(ii) Explain what is meant by electrostatic shielding with reference to two near opposite point charges, and corona discharge (4marks)

(b)(i) Show that the electric potential V at a point r metres from a charge of magnitude Q coulombs in a vacuum (air) is $V = \frac{Q}{4\pi\varepsilon_0 r}$ (5marks)

(ii) Explain why the electric field intensity close to the surface of a charged conductor is always at right angles to the surface of the conductor. (2marks)

(c)



Two light conducting spheres, each 6mm diameter and having a mass of 10mg, are suspended from the same point by fine insulating fibres 50cm long. Due to electrostatic repulsion the spheres are in equilibrium when 3cm apart. Find;

i) the force of repulsion between the spheres. (3marks)
ii) the magnitude of charge on each sphere (2marks)
iii) the electric potential of each sphere. (3marks)

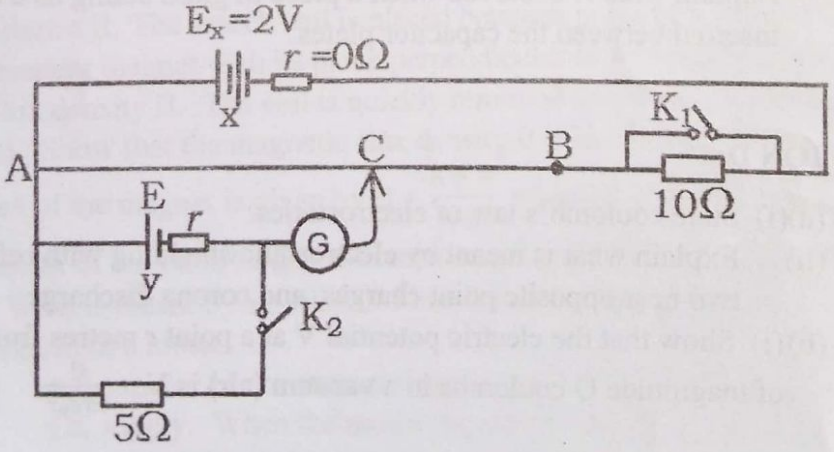
9. (a) State the ohm's law and describe a simple experiment to demonstrate it (4marks)

(b) A battery of e.m.f E and internal resistance r is connected to a variable resistor of resistance R.

i) Show that the maximum power P_m dissipated in the variable resistor is $P_m = \frac{E^2}{4r}$ (4marks)

ii) Sketch graphs, on the same axes, showing the variation of the electric power output P_0 and efficiency ε with load resistance R. (2marks)

(c)



In the figure (iii) shown, X is a cell of negligible internal resistance and has an e.m.f of 2V. AB is a uniform slide wire of length 100cm, and of resistance 50Ω. With both switches K_1 and K_2 open the balance length AC is 90cm. When K_2 is closed and K_1 is left open, the balance length changes to 75cm. Calculate

i) the e.m.f E of cell y. (2marks)

ii) the internal resistance r of cell y. (3marks)

iii) the balance length when K_1 and K_2 are both closed (3marks)

(d) Give two advantages of a potentiometer over a voltmeter when used to measure the electromotive force (e.m.f) of a cell. (2marks)

10.(a) Define the following terms as applied to a capacitor.

i) Dielectric constant. (1mark)

ii) Dielectric strength. (1mark)

(b) Describe an experiment to determine dielectric constant of a diclectric by using a vibrating reed switch circuit. (4marks)

(c) (i) By using graphical method, show that the energy E stored by a charged capacitor of capacitance C is $E = \frac{1}{2}CV^2$, where V is the p.d across the capacitor plates. (3marks)

(ii) Describe the energy changes which occur when a capacitor is charged from a buttery. (3marks)

(iii) Sketch a graph of current against time during the charging process of a capacitor and explain how it is used to find the charge on either of the capacitor plates. (3marks)

(d) Capacitors of capacitances 2μF and 3μF are charged to potential differences of 20V and 40V respectively. The corresponding plates of the charged capacitors are then connected together. Find;

i) the final common p.d after the capacitors being connected together. (2marks)

ii) heat energy lost after connecting the capacitors together (3marks)

END.