P510/2
PHYSICS
PAPER 2
$2\frac{1}{2}$hours

WAKISSHA

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.*
- *Non-programmable scientific calculators may be used.*
- *Mathematical tables and squared papers will be provided.*

Assume where necessary;

Acceleration due to gravity, g,	$= 9.81 ms^{-2}$
Speed of sound in air	$= 330 ms^{-1}$
Speed of light in vacuum, c,	$= 3.0 \times 10^{8} ms^{-1}$
Electronic charge, e,	$= 1.6 \times 10^{-19} C$
Electron mass	$= 9.11 \times 10^{-31} kg$
Planck's constant, h,	$= 6.63 \times 10^{-34} Js$
Permeability of free space, μ_o.	$= 4.0\pi \times 10^{-7} Hm^{-1}$
Permittivity of free space, ε_0,	$= 8.85 \times 10^{-12} Fm^{-1}$
The constant $\frac{1}{4\pi\varepsilon_0}$	$= 9 \times 10^{9} F^{-1}m$
One electron volt, (eV)	$= 1.6 \times 10^{-19} J$
Avogadro's number, N_A	$= 6.02 \times 10^{23} mol^{-1}$
Specific heat capacity of water	$= 4200 Jkg^{-1}k^{-1}$

SECTION A

1. (a) Define the following terms as applied to light.
   (i) **Magnifying power of an optical instrument.** (01 mark)
   (ii) **eye – ring.** (01 mark)

   (b) You are provided with two converging lenses of focal length 20cm and 155cm respectively. Find the position of the eye – ring when the two lenses are arranged to form an astronomical telescope in normal adjustment. (04 marks)

   (c) (i) Draw a ray diagram to show how an astronomical telescope can be improved upon to view the upright image of a distant object at the near point. (04 marks)
   (ii) State **two** disadvantages of the arrangement in c (i) above. (01 mark)

   (d) (i) Describe the structure and operation of the Newtonian reflecting telescope in normal adjustment. (04 marks)
   (ii) State **two** advantages of a reflecting telescope over a refracting telescope. (01 mark)

   (e) The figure 1 below shows light rays from a distant object incident on a concave reflector of radius of curvature 30 cm, such that the reflected rays form a real image of the distant object in a hole H drilled at the pole of the concave mirror.

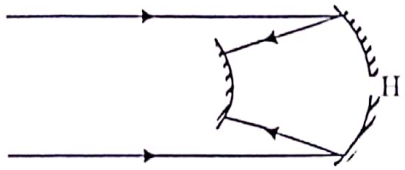

Fig. 1

   If the focal length of the convex mirror is 10cm, find the separation of the mirrors. (04 marks)

2. (a) What is meant by the following terms as applied to a converging mirror?
   (i) **Radius of curvature.** (01 mark)
   (ii) **Principal focus.** (01 mark)

   (b) (i) With the aid of ray diagram, derive the mirror formula for a convex mirror by using an extended object. (06 marks)

   (ii) State **two** reasons why convex mirrors are suitable for use as driving mirrors. (02 marks)

   (c) A concave mirror of focal length 20.0 cm focuses an image of an object at a distance of 40.0 cm onto a screen. When a glass block of refractive index 1.5 and thickness 5.0 cm is placed between the object and the mirror, the screen is adjusted through a distance α to refocus the image onto the screen. Find α (05 marks)

   (d) (i) Define the term **refractive index** of an optical medium. (1 mark)

   (ii) A ray of light incident from air at a glancing angle 0 on a glass block of refractive index n and thickness h takes a time t inside the glass.
   Show that thickness $t = \frac{hn^2}{Cos^2\theta}$ where c is the speed of light in a vacuum. (04 marks)

SECTION B

3. (a) Define the following as applied to wave motion:-
   (i) **path difference** (01 mark)
   (ii) **Wave front** (01 mark)
   (iii) **Wave length** (01 mark)

   (b) (i) State any **four** properties of waves. (02 marks)

   (ii) Distinguish **between progressive waves** and **stationary waves.** (04 marks)

   (c) A plane progressive wave is given by the equation:
   $y = a\sin\left[100\pi t - \frac{10}{9}\pi x\right]$ where x and y are in millimeters and t is in seconds.
   (i) Write the equation of the progressive wave which would give rise to a stationary wave if superimposed on the above equation. (01 mark)
   (ii) Find the equation of the stationary wave and hence determine its amplitude of vibration. (05 marks)
   (iii) Determine the frequency and velocity of the stationary wave. (05 marks)

4. (a) (i) What is meant by **interference of light?** (02 marks)

   (ii) State the conditions which must be satisfied in order to observe an interference pattern due to two waves. (03 marks)

   (b) (i) Distinguish between **constructive** and **destructive interference** between two waves. (03 marks)

   (ii) Explain how interference fringes are formed in an air wedge film between two glass slides when monochromatic light is used. (06 marks)

   (c) Two glass slides are in contact at one end and separated by a wire of diameter 0.04 mm at the other end to form a wedge. Fringes are observed when light of wave length 5.0×10^{-7} m in incident normally to the slides.
   (i) Determine the fringe spacing. (04 marks)
   (ii) Find the number of fringes that can be observed. (02 marks)

SECTION C

5. (a) (i) Define **capacitive reactance.** (01 mark)
   (ii) An alternative voltage $V = V_o \sin 2\pi f t$ volts is connected across a capacitor of capacitance C. Derive an expression for current through the capacitor and show that the voltage and current are out of phase with sketch graphs. (05 marks)

   (b)

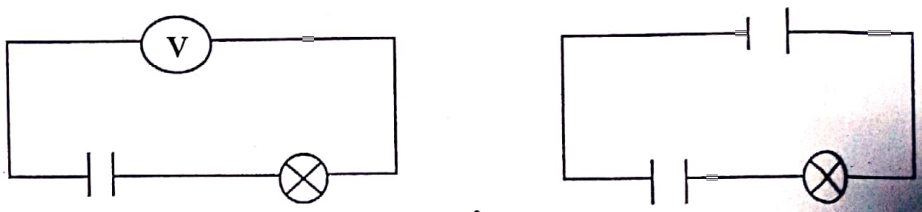

Figure 2

In figure 2 bulbs A and B have the same ratings. A is connected in series with a capacitor across an a.c source while B is in series with an identical capacitor across a a d. c source of emf equal to the root mean square of an a.c voltage. Explain why bulb A light continuously while B does not. (04 marks)

(c) (i) What is **rectification?** (01 mark)

(ii) Briefly explain how a person is able to obtain direct current from alternating current given only two rectifiers and a centre tapped transformer and sketch graph to show the variation of output voltage with time. (04 marks)

(d) (i) A transformer is designed to work on a 240V, 60W supply. It has 3000 turns in the primary and 200 turns in the secondary. If the transformer is 80% efficient, calculate the current in the secondary. (03 marks)

(ii) State what would happen to the current in the primary if a load is connected to the secondary. (02 marks)

6. (a) Define these terms;
(i) **magnetic meridian.** (01 marks)
(ii) **angle of dip.** (01 marks)

(b) Describe an experiment to determine the angle of dip at a location on the earths using the earth inductor and a ballistic galvanometer. (06 marks)

(c) A small rectangular coil of 12 turns and dimensions 5cm by 3 cm is suspended on a long selonoid so that its plane lies along the axis of the solenoid. If the coil is connected in series with the solenoid and a current of 3.0A is passed through the solenoid causing a deflection 40^0 on the coil, calculate the torsion constant in the suspension. (04 marks)

(d) Distinguish between, magnetic flux and magnetic flux density stating their SI units. (03 marks)

(e) A conductor is placed normal to a uniform magnetic field B. If a current I is passed through the conductor, the charge Q drifts at a velocity V across the conductor;
(i) derive an expression of force acting on the charge. (04 marks)
(ii) what is the effects of the force in (e) (i) on the potential of the conductor? (01 mark)

7. (a) (i) State the **laws of electromagnetic induction.** (02 marks)
(ii) Show that the magnitude of emf induced across the end of a rod of load L inclined at angle θ to the uniform magnetic field of flux density B and moving Velocity U is given by $E = BLU \sin \theta$. (04 marks)

(iii) At a certain place on the earth's surface, a horizontal metal rod of length 15 inclined to a uniform magnetic field at angle 30^0 is moved at a velocity of 200 and emf of 1.2mV develops across its ends.
Calculate the earth's magnetic flux density at the location. (03 marks)

(b) (i) With the aid of a labeled diagram describe the structure and action of a d.c generator. (05 marks)

(ii) Explain the structural modifications needed to improve on the efficiency of a motor. (02 marks)

(iii) State **two** applications of electric motors. (01 mark)

(c) (i) Explain the origin of eddy currents. (02 marks)

(ii) State **one** danger of eddy currents. (01 marks)

SECTION D

8. (a) (i) State **Coulomb's law of electrostatics.** (01 mark)

(ii) With the aid of a diagram, describe how two metal spheres can both be charged positively by induction. (04 marks)

(b) (i) What is meant by an **equipotential surfaces?** (03 marks)

(ii) Explain why electric field lines are always normal to the surface charged conductor. (03 marks)

(c) (i) Define the term **charge density.** (01 mark)

(ii) With the aid of a diagram, describe an experiment to determine surface charge density of a pear shaped conductor. (05 marks)

(d) An electron of charge 1.60×10^{-19} C moves from rest into an empty space between two points 3mm apart whose potential differences 150V.

Find the;-

(i) Electric field intensity between the points. (01 mark)

(ii) Energy acquired by the electron. (02 marks)

9. (a) (i) Define an Ohm. (01 mark)

(ii) Explain the factors affecting the resistance of a conductor. (06 marks)

(b) (i) State **Kirchhoff's laws of electrical circuit networks.** (02 marks)

(ii) With the aid of a diagram, describe an experiment to determine the electrical resistivity of a material in form of a wire. (05 marks)

(c) (i) Figure 3 below shows a battery of emf 12.6V and internal resistance 0.1Ω being charged from a D.C source of emf 24.0V and internal resistance 1.0Ω.

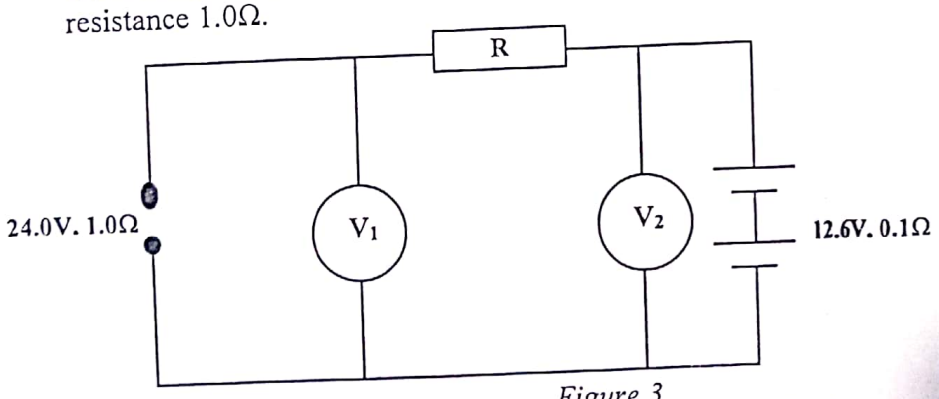

Figure 3

V_1 and V_2 are high resistance voltmeters and R is a fixed resistor.

Calculate the;-

(i) The value of R if the charging current is 0.5A. (03 marks)

(ii) The readings on the voltmetres, if the value of R is adjusted to 0.9Ω. (03 marks)

Turn Over

(a) Define the following

(i) Farad (01 mark)

(ii) Dielectric constant (01 mark)

(iii) Dielectric strength (01 mark)

(b) State the factors that affect the capacitance of a parallel plate capacitor. (03 marks)

(c) Describe an experiment to show that the capacitance of a parallel plate capacitor increased if the area of overlap of the plates is increased. (05 marks)

(d)

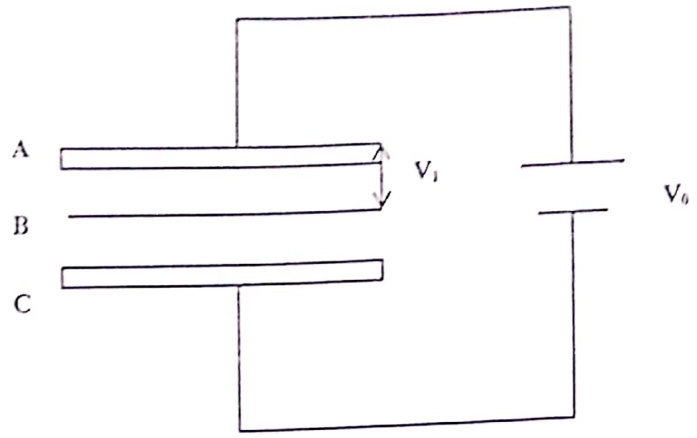

Figure 4

Figure 4 above shows an arrangement of parallel metal plates ABC at a spacing of d connected across a voltage source V_0.

(i) Show that when B is displaced downwards by a distance x, the P.D between A and B becomes $V = V_0\left[\frac{d + x}{2d}\right]$. (05 marks)

(ii) Find the P.D between B and C, if $V_0 = 12V$, $d = 3.0mm$ and $x = 0.8mm$ (04 marks)

END