518

Paper 2

P510/2

2½ HOURS

**S6 INTERNAL MOCK 2022**

**PHYSICS**

**Paper 2**

**2hours 30minutes**

**INSTRUCTIONS TO CANDIDATES**

*Answer **five** questions, including at least **one** from each section, but **not more than one** from any of the sections A and B.*

*Where necessary assume the following constants:*

| | | | |
|---|---|---|---|
| Acceleration due to gravity | $g$ | = | $9.81ms^{-2}$ |
| Speed of light in vacuum | $c$ | = | $3.0 \times 10^{8}ms^{-1}$ |
| Speed of sound in air | $v$ | = | $340ms^{-1}$ |
| Electronic Charge | $e$ | = | $1.6 \times 10^{-19}C$ |
| Electronic mass | $m_e$ | = | $9.1 \times 10^{-31}kg$ |
| Permeability of free space | $\mu_0$ | = | $4.0\pi \times 10^{-7}Hm^{-1}$ |
| Permittivity of free space | $\varepsilon_0$ | = | $8.85 \times 10^{-12}\ Fm^{-1}$ |
| The Constant, | $\frac{1}{4\pi\varepsilon_0}$ | = | $9.0 \times 10^{9}F^{-1}m$ |

## SECTION A

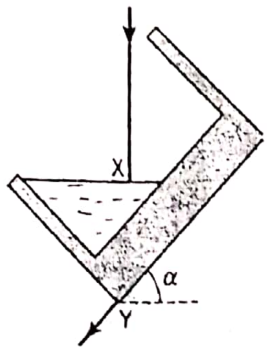
1. (a) Define the term **refraction** of light. (1mark)

(b)

(i) Describe an experiment to determine refractive index of a transparent liquid using an air cell and monochromatic source of light. (5marks)

(ii) Explain why mono chromatic light is used instead of white light in the above experiment. (2marks)

(c)




A glass container with a thick bottom is half field with water and a narrow beam of light is shone vertically down into the water. The glass is tilted until an angle $\propto$ such that the light is refracted along the lower surface of the glass. If the refractive indices of water and glass are 1.33 and 1.5 respectively,

(i) Copy and complete the diagram to show the path of light from when it enters water at X to when it leaves glass at Y. (1marks)

(ii) Calculate the critical angle at the glass-air interface. (2marks)

(iii) Calculate the value of $\propto$ . (3marks)

(d) Explain how radio waves travel from the transmitting station to the radio receiver. (4 marks)

(e) why are total reflecting prisms preferred over plane mirrors for use in optical instruments. (2marks)

2. (a) Define the terms **principal axis** and **focal plane** as applied to convex lenses. (2marks)

(b)

(i) A convex lens of focal length $f$ forms a real image I of a real object O on a screen. If the distance between the object O and the screen is $d$, show that for the distance $d \leq 4f$, no image can be formed on the screen. (5marks)

(ii) State another condition apart from that derived in (i) above for which a convex lens can not form a real image on a screen. (1mark)

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

(d) An astronomical telescope consisting of an objective lens of focal length 60cm and an eye piece of focal length 3cm is focused on the moon so that the final image if formed at minimum distance of distinct vision (25cm) from the eye piece.

(i) calculate the angular magnification. (4marks)

(ii) Assuming that the diameter of the moon subtends an angle of $0.5^o$ at the objective, find the actual size of the image. (3marks)

## SECTION B

3. (a) Distinguish between longitudinal and transverse wave motions. (2marks)

(b) A progressive simple harmonic wave of frequency $250Hz$ and velocity $30ms^{-1}$ propagates in the positive $x$ direction in a time $t$, seconds.

(i) Determine the equation of propagation of the progressive wave if its amplitude is 0.03m. (3marks)

(ii) the phase difference between two vibrating points on the progressive wave which are 10cm apart. (2marks)

(c) Describe an experiment to determine velocity of sound in air using a resonance tube including graphical analysis. (5marks)

$V = \lambda f$

palls perpendicular

$y = A \sin wt$

$y = A \sin$

$W = 2\pi f$

$V = \lambda f$

$A = 0.03$

(d) A wire whose mass per unit length is $10^{-3}kgm^{-1}$ is stretched by a load of 4kg over the two bridges of a sonometer 1m apart. The wire is struck at its middle point.

(i) explain how notes are produced by subsequent vibrations. (2marks)

(ii) calculate the frequency of the subsequent fundamental vibrations. (3marks)

(iii) determine the frequency of the 2$^{nd}$ overtone produced by the vibrations of the wire. (2marks)

(e) state the factors that determine the pitch of the note given by a closed pipe. (1mark)

✓4. (a) (i) State Huygens's principle. (1mark)

(ii) A wave is transmitted across a boundary between two media of refractive indices $n_1$ *and* $n_2$ with velocities $v_1$ and $v_2$ respectively. Using Huygens's principle, show that $\frac{n_2}{n_1} = \frac{v_1}{v_2}$. (4marks)

(b) Describe an experiment to determine wavelength of light using Newton's rings. (5marks)

(c) An air wedge is made by separating two plane sheets of glass by a fine wire at one end. When the wedge is illuminated normally by light of wave length $5.9 \times 10^{-7}m$, a fringe pattern is observed in the reflected light. The distance between the center of the 1$^{st}$ fringe and the center of the 11$^{th}$ fringe is 8.1mm.

(i) explain how the fringes are formed. (4marks)

(ii) calculate the angle of the air wedge. (4marks)

(d) Explain why its not possible to observe light interference using two lamps (2marks)

$2d\sin\theta = n\lambda$.

$y = \frac{ad}{T}$.

$f_0 = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$.

## SECTION C

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

(ii) Describe an experiment to show the variation of magnetic flux density with perpendicular distance from a straight wire carrying current. (5marks)

(b) Two identical wires R and S lie parallel in a horizontal plane, their axes being 0.10m apart. A current of 10A flows in R in opposite direction to the current of 30A in S.

(i) Sketch the magnetic field pattern around the two wires and indicate the direction of force between the wires. (2marks)

(ii) calculate the magnitude and direction of the magnetic flux density at a point P, 0.05m from R and 0.15m from S. (4marks)

(c) A moving coil galvanometer consists of a rectangular coil of N turns each of area A suspended in a radial magnetic field of flux density B.

(i) Derive an expression for the torque on the coil when current I passes through it. (3marks)

(ii) If the coil is suspended by a torsion wire for which the couple per unit twist is C, show that the instrument will have a linear scale. (2marks)

(d) explain why a conductor carrying current in the magnetic field experiences a force. (2marks)

6. (a) What is meant by the term **electromagnetic induction.** (01marks)

b) Describe an experiment to demonstrate Lenz's law of electromagnetic induction. (05 marks)

c) A rectangular coil 30cm long and 20cm wide has 25 turns. It rotates at the uniform rate of 3000 rev $min^{-1}$ about the axis parallel to its alongside and at right angles to a uniform magnetic field of flux density $5.0 \times 10^{-2}$T.

(i) Calculate the peak value of the induced emf in the coil. (04 marks)

(ii) Describe with the aid of a diagram how the rotating coil above can be arranged to supply alternating current. (05 marks)

d) when a wheel with metal spokes 120cm long is rotated in a magnetic field of flux density $0.5 \times 10^{-4} Wbm^{-1}$ normal to the plane of the wheel, an emf of $10^{-2}$ volts is induced between the rim and the axel. Find the rate of rotation of the wheel. (03 marks)

e) Explain any one application of eddy currents. (2marks)

7. (a) Define root mean square value and peak value of a.c. (2marks)

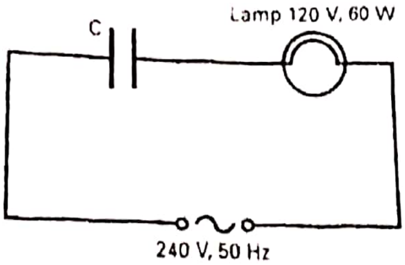
(b) A sinusoidal alternating voltage of frequency $f$ is connected in series with a capacitor of capacitance C,

(i) Derive an expression for capacitive reactance. (4marks)

(ii) Sketch a graph to show the variation of p.d across the capacitor and instantaneous charge stored with time. (2marks)

(c) With the aid of a diagram, describe the operation of a moving- iron meter in measurement of alternating current. (4marks)

(d) A 120v,60W lamp is connected in series with a capacitor and a 240v,50Hz ac supply as shown below.




$Q = CV$.

$I = \frac{dQ}{dt}$.

Calculate:

(i) The p.d across the capacitor. (3marks)

(ii) Capacitive reactance $X_c$, of the capacitor. (3marks)

(iii) The capacitance of the capacitor. (2marks)

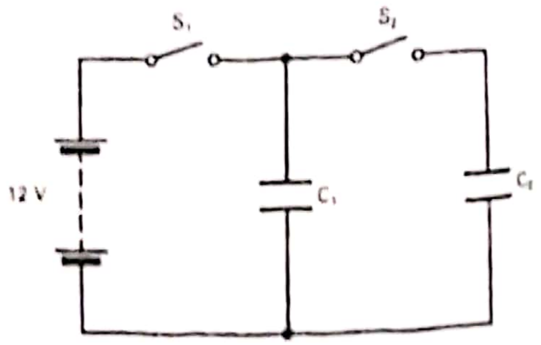
## SECTION D

8. (a) Define the term **capacitance** and state ***its SI units.*** (2 mark)

(b Describe an experiment to determine the dielectric constant using a vibrating reed switch. (5marks)

(c) Derive an expression for the energy stored by a capacitor of capacitance C charged to a p.d V. (4marks

(d)




Capacitors $C_1$ *and* $C_2$ of capacitances $2\mu F$ and $3\mu F$ respectively are connected in a circuit as shown above. Switch $s_1$ is closed with $s_2$ open.

(i)calculate the charge on $c_1$ and the energy stored. (3marks)

(ii) $S_1$ *is open after which* $S_2$ is closed. Calculate the final p.d across $c_2$ and total energy stored on the capacitors. (5marks)

(iii) account for the difference in energy in (i) and (ii). (1mark)

9. (a) Define the term *electric potential* and *potential gradient.* (2 marks)

(ii) Derive an expression that relates electric field intensity and potential gradient. (4marks)

(b) Describe an experiment to show that the potential over the surface of a pear shaped conductor is constant. (4marks)

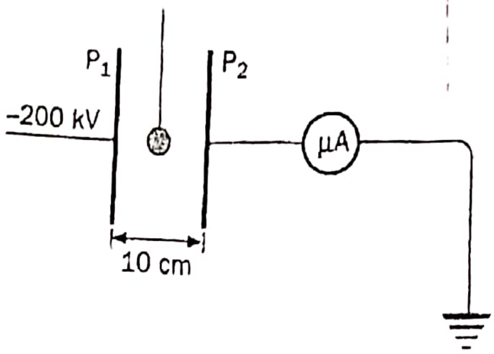
$Q = CV$

(c) Derive an expression for electric field intensity perpendicular to a charged conductor of charge density **δ** in air. (3marks)

$E = -\frac{dv}{dx}$

$C = 8V$

(d)




Two parallel metal plates $P_1$ *and* $P_2$ are placed 10cm apart in air, $P_1$ is maintained at -200Kv while $P_2$ is earthed through the micro ammeter. A light plastic sphere coated with conducting paint is suspended between the plate. The sphere shuttles back forth between the plates 360 times per minute and acquires a charge of $-1.2 \times 10^{-7} C$ every time it touches $P_1$.

(i) Explain why the sphere shuttles between the plates. (3marks)

(ii) Calculate the electric field strength between the plates. (2marks)

(iii) Calculate the current through the micro ammeter. (2marks)

10. (a) (i) Define temperature coefficient of resistance. (1mark)

(ii) Explain why metals have positive temperature coefficient of resistance. (3marks)

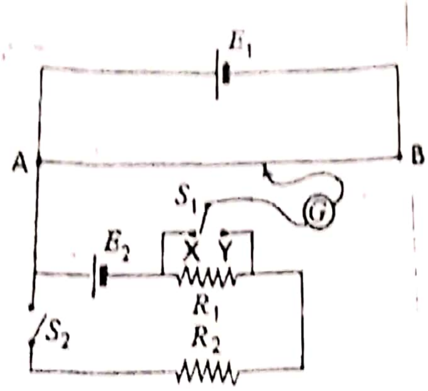
(b) For a certain material, the electrical resistance is effectively zero when the temperature is $-270^oC$, and the resistance varies linearly with temperature over a wide range from $-270^oC$ upwards.

(i) Draw a sketch graph to illustrate this statement. (2marks)

(ii) Deduce the temperature coefficient of resistance for this material. (3marks)

(c) with the aid of a diagram, describe how resistances of two conductors can be compared using a meter bridge. (4marks)

(d)




In the circuit above, AB is a uniform wire of length 100cm long and $E_1$ is an accumulator of emf 2V and negligible internal resistance. $E_2$ is a cell of emf 1.1V and internal resistance $1\Omega$. The values of resistors $R_1$ *and* $R_2$ are $1\Omega$ *and* $2\Omega$ *respectively*. Calculate the balance length obtained with switch $S_2$ is closed when,

(i) Switch $S_1$ is connected to X. (3marks)

(ii) Switch $S_1$ is connected to Y.(4marks)

END