THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY

SECOND SEMESTER EXAMINATION - 2022

DEPARTMENT OF APPLIED PHYSICS

AP 121: FUNDAMENTAL PHYSICS (II)

TIME ALLOWED: 3 HOURS

INFORMATION FOR CANDIDATES

1. YOU HAVE TEN (10) MINUTES TO READ THIS QUESTION PAPER. YOU MUST NOT BEGIN WRITING DURING THIS TIME.

2. ANSWER ALL FIVE (5) QUESTIONS GIVEN PAGES 1 TO 5.

3. All answer must be written in the answer book(s) provided.

4. Write your name and student number clearly on the front cover of each answer book you have used.

5. Calculators are permitted in the examination room. Notes and textbooks are NOT allowed in the examination room.

6. The figure on the right side of the question indicates full marks. All questions carry equal marks of 20. Maximum marks = 100.

QUESTION ONE

(a) Define the following terms which deal with geometrical optics. **(4 marks)**

(i) real image

(ii) virtual image

(iii) lateral magnification

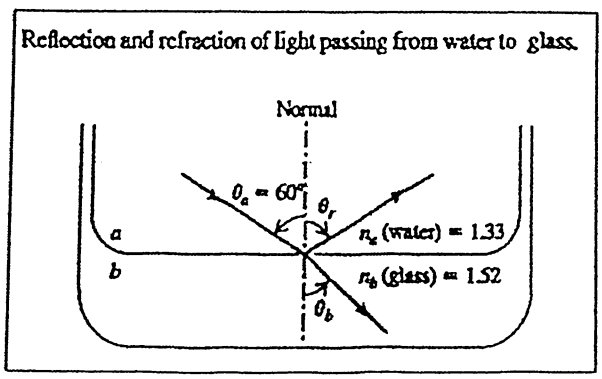
(iv) optical axis

(b) An image is formed 22cm behind a concave mirror whose radius of curvature is 76cm. Describe the nature of the image. What is the size of the image relative to the object? **(5 marks)**

(c) (i) Differentiate between a diverging lens and a converging lens. **(2 marks)**

(ii) A light 5.0 cm tall is held 30 cm in front of a converging lens with focal length of 24.0 cm. Locate and describe the image(real or virtual, enlarged or reduced in size, upright or inverted, magnification and location of the image). **(5 marks)**

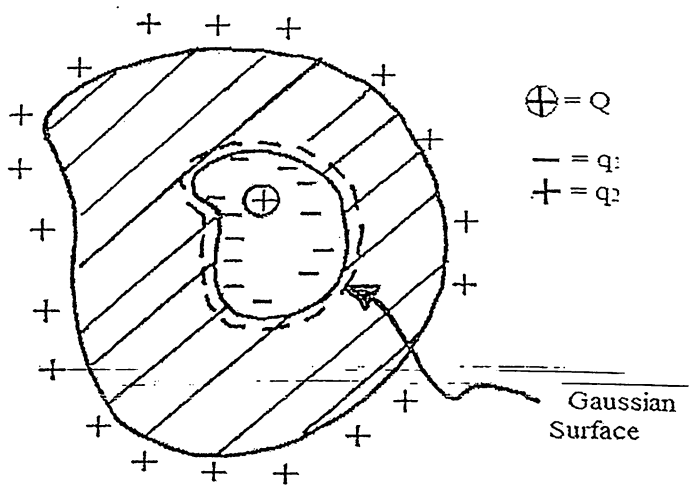
(d) In the figure below, material **a** is water and material **b** is a glass with index of refraction 1.52. If the incident ray makes an angle of 60^0 with the normal, find the directions of the reflected and refracted rays. **(4 marks)**



QUESTION THREE

(a) (i) State Gauss law. **(2 marks)**

(ii) A conductor carries a net charge of 10μC as shown below. Inside the conductor there is a hollow cavity. A point charge Q = 3μC is located within the cavity. Calculate the charge q_1 on the inner surface of the conductor(ie: on the cavity wall) and the charge q_2 on the outer surface of the conductor. **(8 marks)**



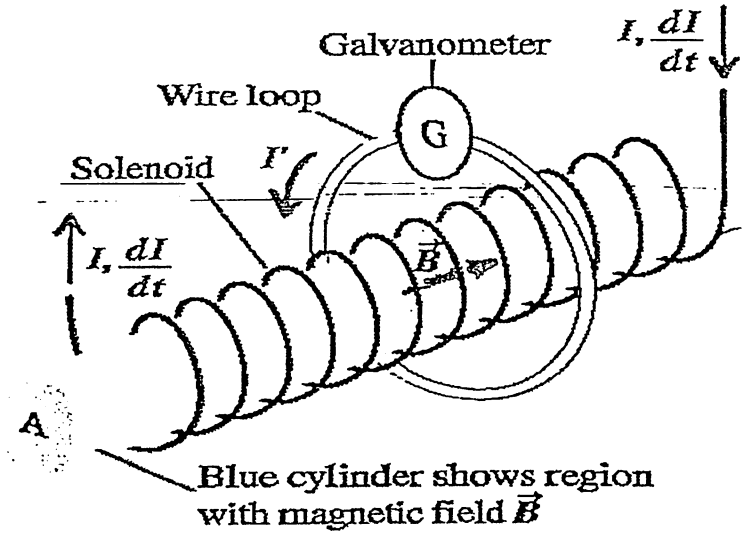
(b) Suppose two parallel plates each having an area of 2000 cm^2 (2.00 x 10^{-1} m^2) are 1.00 cm (1.00 x 10^{-1} m) apart. The capacitor is connected to a power supply and charged to a potential difference Vo = 3000 V = 3.00 kV. It is then disconnected from the power supply, and a sheet of insulating plastic material is inserted between the plates, completely filling the space between them. We find that the potential difference decreases to 1000 V while the charge on each capacitor plate remains constant. Compute: **(10 marks)**

(i) the original capacitance Co;
(ii) the magnitude of charge Q on each plate;
(iii) the capacitance C after the dielectric is inserted;
(iv) the dielectric constant K of the dielectric;
(v) the permittivity E of the dielectric.

QUESTION FIVE.

(a) State the Faraday's law of induction. (2 marks)

The windings of a long solenoid carry a current I that is increasing at a rate 0.5 T in 1.0 seconds as shown below. The magnetic flux in the solenoid is increasing at a rate $\frac{d\Phi_B}{dt}$ and this changing flux passes through a wire loop. Calculate the magnitude of the induced emf in the coil given the radius of the solenoid is 2 cm and 10 cm in length with 12 turns as shown below. (6 marks)



(b) Explain why some materials are classified as diamagnetic, paramagnetic, and ferromagnetic in terms of magnetic susceptibilities(χ). (6 marks)

(d) Draw the magnetization of a paramagnetic as a function of temperature. (3 marks)

(e) Draw the susceptibility of a ferromagnet as a function of temperature. (3 marks)

END OF EXAMS

DATA SHEET

$$F = k_e \frac{|q_1||q_2|}{r^2}$$

$$k_e = 8.9875 \times 10^9 \ \mathrm{N \cdot m^2}$$

$$k_e = \frac{1}{4\pi\epsilon_0}$$

$$\epsilon_0 = 8.8542 \times 10^{-12}$$

$$e = 1.602\,19 \times 10^{-19}$$

$$\mathbf{F}_e = q\mathbf{E}$$

$$\mathbf{F}_{12} = k_e \frac{q_1 q_2}{r^2} \hat{\mathbf{r}}$$

$$\mathbf{E} = k_e \frac{q}{r^2} \hat{\mathbf{r}}$$

$$V = k_e \frac{q}{r}$$

$$U = k_e \frac{q_1 q_2}{r_{12}}$$

$$\Phi_E = \oint \mathbf{E} \cdot d\mathbf{A} = \frac{q_{\text{in}}}{\epsilon_0}$$

$$E_r = -\frac{dV}{dr}$$

$$C \equiv \frac{Q}{\Delta V}$$

$$C = \frac{\epsilon_0 A}{d}$$

$$U = \frac{Q^2}{2C} = \frac{1}{2} Q \Delta V = \frac{1}{2} C (\Delta V)^2$$

$$C = \kappa C_0$$

$$I \equiv \frac{dQ}{dt}$$

$$I_{\text{av}} = \frac{\Delta Q}{\Delta t} = nqv_d A$$

$$E = \frac{\sigma}{\epsilon_0}$$

$$R = \rho \frac{\ell}{A}$$

$$\rho = \frac{1}{\sigma}$$

$$\mathcal{P} = I \Delta V$$

$$\sum_{\text{closed loop}} \Delta V = 0$$

$$\mathbf{J} = \sigma \mathbf{E}$$

$$\sum I_{\text{in}} = \sum I_{\text{out}}$$

$$P = I^2 R = \frac{(\Delta V)^2}{R}$$

$$\Delta V \equiv \frac{\Delta U}{q_0} = -\int_A^B \mathbf{E} \cdot d\mathbf{s}$$

$$R \equiv \frac{\Delta V}{I}$$

$$\Phi_E = EA' = EA \cos\theta$$

$$\boldsymbol{\mu} = I\mathbf{A}$$

$$U = U_C + U_L = \frac{Q_{\max}^2}{2C} \cos^2 \omega t + \frac{L I_{\max}^2}{2} \sin^2 \omega t$$

$$\mathbf{F}_B = q\mathbf{v} \times \mathbf{B}$$

$$\mathbf{F}_B = I\mathbf{L} \times \mathbf{B}$$

$$\boldsymbol{\tau} = \boldsymbol{\mu} \times \mathbf{B}$$

$$d\mathbf{B} = \frac{\mu_0}{4\pi} \frac{I\, d\mathbf{s} \times \hat{\mathbf{r}}}{r^2}$$

$$\frac{F_B}{\ell} = \frac{\mu_0 I_1 I_2}{2\pi a}$$

Mirror Equations	Lenz Equations	Magnification factor	Snell's Law
$\frac{1}{d_o}+\frac{1}{d_i}=\frac{1}{f}$	$\frac{1}{d_o}-\frac{1}{d_i}=\frac{1}{f}$	$M=\frac{h_i}{h_o}=-\frac{d_i}{d_o}$	$\frac{\sin\theta_1}{\sin\theta_2}=-\frac{\lambda_1}{\lambda_2}=\frac{v_1}{v_2}=\frac{n_2}{n_1}$

$R = R_O\left[1+\alpha\left(T-T_O\right)\right]$, $\phi_E = EA$, $U = k\frac{q_1 q_2}{r}$, $I = \frac{dQ}{dt}$, $k = 9.0\times10^9\, kg.m^3 s^{-4} m^{-2}$ $R = \rho\frac{l}{A}$,

$\rho_{tungsten} = 5.25\times10^{-8}\,\Omega.m$, $\alpha_{tungsten} = 0.0045\left({}^0C\right)^{-1}$, $q_{electron} = 1.602\times10^{-19}C$