



$$\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N.m}^2, k = 9 \times 10^9 \text{ N.m}^2/\text{C}^2, e = 1.6 \times 10^{-19} \text{ C}, m_e = 9.11 \times 10^{-31} \text{ Kg},$$

$$m_p = 1.6 \times 10^{-27} \text{ Kg}.$$

Question (1) [25 marks]

- (a) Derive the electric field due to an infinite line charge distribution. [6 marks]
- (b) An electron is fired with an initial speed of $1.5 \times 10^5 \text{ m/s}$ parallel to a uniform electric field, the electric force on the electron in this field is $27.33 \times 10^{-21} \text{ N}$, What is its final velocity after $5 \mu\text{s}$? [6 marks]
- (c) A cylindrical shell of radius **7 cm** and length **3 m** has its charge uniformly distributed on its curved surface. The magnitude of the electric field at a point **20 cm** radially inward to its axis (measured from the midpoint of the shell) is **60 kN/C**. Find (i) the net charge on the shell and (ii) the electric field at a point **4 cm** from the axis, measured radially outward from the midpoint of the shell. [6 marks]
- (d) A **100 KV** battery is connected between two parallel large metal plates.
- (i) If a proton enters from the positive plate with an initial speed $4 \times 10^6 \text{ m/s}$, what is its final speed? (3 marks)
- (ii) If the separation between the two plates **20 cm**, what will be the electric field between them? and what will be the charge density on each plate?? (4 marks)
- [7 marks]

Question (2) [25 marks]

- (a) Derive how to calculate the refractive index of a thin film using Fresnel's biprism. [6 marks]
- (b) In double-slit experiment using light of wavelength **600 nm**, the slit spacing is **0.6 mm** and the screen is **2 m** from the slits.
- (i) What is the fringe width? (2 marks)
- (ii) Find the distance to the second dark fringe? (2 marks)
- (iii) What is the intensity of the second dark fringe? (2 marks)

[6 marks]

- (c) A thin film of oil ($n = 1.25$) is located on smooth, wet pavement ($n_{\text{water}}=1.33$). When viewed perpendicular to the pavement, the film reflects most strongly violet light at **400 nm** and reflects no blue light at **480 nm**. How thick is the oil film?

[6 marks] (من فضلك وضع اجابتك بالرسم)

- (d) Unpolarized beam of light is sent into a system of three polarizing sheets whose polarizing directions makes angles of $\theta_1 = 0^\circ$, $\theta_2 = 45^\circ$, $\theta_3 = 90^\circ$ with the vertical.

- (i) What percentage of the light's initial intensity is transmitted by the system?

(5 marks) (من فضلك وضع اجابتك بالرسم)

- (ii) If $\theta_1 = \theta_2 = \theta_3 = 45^\circ$, what percentage of the light's initial intensity is transmitted by the system?

(2 mark)

[7 marks]

Question (3) [20 marks] (for midterm)

- (a) A solid sphere of radius **10 cm** has a total positive charge of **20 μC** uniformly distributed throughout its surface. Calculate the magnitude of the **electric field** and the **electric potential** at (i) **0 cm**, and (ii) **10 cm** from the center of the sphere. ($k = 9 \times 10^9 \text{ N.m}^2/\text{C}^2$)

[10 marks]

- (b) If the speed of a light in air is $3 \times 10^8 \text{ m/s}$ and its frequency $5 \times 10^{14} \text{ Hz}$. Calculate:

- (i) The speed of the light in glass of refractive index **1.5**

(3 marks)

- (ii) The wavelength of the light in glass

(4 marks)

- (iii) The frequency of the light in glass

(3 marks)

[10 marks]

نرجوا لكم التوفيق

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