

Q1.5)

$$E_1 = \frac{9 \times 10^9 \times 6 \times 10^{-6}}{4^2}$$

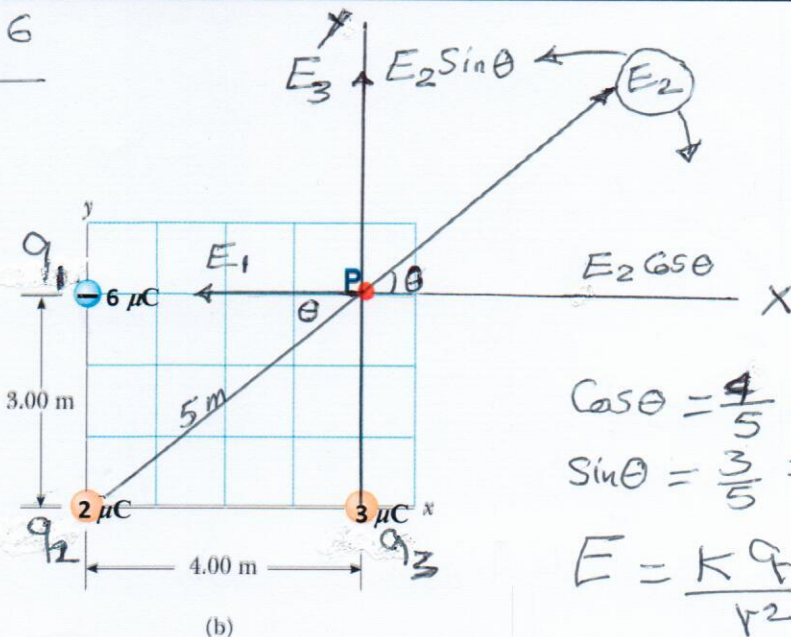
$$E_1 = 3375 \text{ N}$$

$$E_2 = \frac{9 \times 10^9 \times 2 \times 10^{-6}}{5^2}$$

$$E_2 = 720 \text{ N}$$

$$E_3 = \frac{9 \times 10^9 \times 3 \times 10^{-6}}{3^2}$$

$$E_3 = 3000 \text{ N}$$



$$\cos \theta = \frac{4}{5} = 0.8$$

$$\sin \theta = \frac{3}{5} = 0.6$$

$$E = \frac{kq}{r^2}$$

$$E_x = E_2 \cos \theta - E_1 = 720 \times 0.8 - 3375 = -2799 \text{ N/C}$$

$$E_y = E_2 \sin \theta + E_3 = 720 \times 0.6 + 3000 = 3432 \text{ N/C}$$

$$E_{\text{net}} = \sqrt{E_x^2 + E_y^2} = 4.43 \times 10^3 \text{ N/C}$$

$$\phi = \tan^{-1} \left(\frac{E_y}{E_x} \right) = \tan^{-1} \left(\frac{3432}{-2799} \right) = -51^\circ \text{ (in the 2nd Q)}$$

$$= 129^\circ \text{ (from +ve x axis)}$$

$$V = k \frac{q}{r} \Rightarrow V_{\text{tot}} = V_1 + V_2 + V_3$$

$$V = k \times 10^{-6} \left(\frac{-6}{4} + \frac{2}{5} + \frac{3}{3} \right) = -900 \text{ V}$$

$$U_{\text{tot}} = \frac{kq_1q_2}{r_{12}} + \frac{kq_1q_3}{r_{13}} + \frac{kq_2q_3}{r_{23}}$$

$$= 9 \times 10^9 \left[\frac{-6 \times 2 \times 10^{-12}}{3} + \frac{-6 \times 3 \times 10^{-12}}{5} + \frac{2 \times 3 \times 10^{-12}}{4} \right]$$

$$= -55 \times 10^{-3} \text{ J} = -55 \text{ mJ}$$


Q6) $E = 45 \times 10^9$

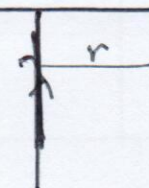
$$q = e = p^+ = 1.6 \times 10^{-19} \text{ C}$$

$$E = \frac{F}{q} \Rightarrow F = qE = 7.2 \times 10^9 \text{ N} \\ = 7.2 \text{ nN}$$

Q7) $E = 16 \times 10^9 \text{ N/C}$ ($m_p = 1.67 \times 10^{-27} \text{ kg}$)

$$ma = qE \Rightarrow a = \frac{qE}{m} = 1.5 \text{ m/s}^2$$

Q8) $Q_{in} = 0 \Rightarrow \phi = 0$ 

Q9) $E = 2k\lambda/r$ 

Q10) a (radius) = 30 cm $< r = 10$ cm (inside)

$$Q = 15 \times 10^{-6} \text{ C}$$

Insulating solid Sphere $E_{inside} = \frac{kQ}{a^3} r$

$$E = 0.5 \times 10^6 \frac{\text{N}}{\text{C}} = 0.5 \text{ MN/C}$$

Q11) Conductor solid Sphere $Q_{in} = 0 \Rightarrow E_{in} = 0$

Q12) Large flat insulator sheet $E = \frac{\sigma}{2\epsilon_0}$

$$\sigma = 2\epsilon_0 E = 2 \times 8.85 \times 10^{-12} \times 175$$

$$= 3.1 \times 10^{-9} \text{ C/m}^2 = 3.1 \text{ nC/m}^2$$