

Well done! Last problem?
Nerve?

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$$① @ E_{field} = 2 \times 10^{-3} \text{ V/m} \quad r = 1 \text{ mm} = 10^{-3} \text{ m}$$

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

$$2 \times 10^{-3} = \frac{(9 \times 10^9) q}{(10^{-3})^2}$$

$$q = \frac{2 \times 10^{-3} \times (10^{-3})^2}{9 \times 10^9}$$

$$= 2.22 \times 10^{-19} \text{ C}$$

$$\boxed{\frac{18.5}{20}}$$

E_C at 5 mm

$$r = 5 \text{ mm} = 5 \times 10^{-3} \text{ m}$$

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

$$= \frac{(9 \times 10^9)(2.22 \times 10^{-19})}{(5 \times 10^{-3})^2}$$

$$\boxed{E_C = 8 \times 10^{-5} \text{ V/m}} \quad \checkmark$$

$$② E_C \text{ at } 3 \mu\text{C} \quad E_C = 8 \times 10^{-3} \text{ V/m}$$

$$E_C = \frac{kq}{r^2} \Rightarrow \sqrt{\frac{kq}{E_C}} = r$$

$$r = \frac{(9 \times 10^9)(1 \times 10^{-6})}{8 \times 10^{-3}}$$

$$r = 1060.66 \text{ m}$$

$$q = 3 \mu\text{C} = 3 \times 10^{-6} \text{ C}$$

$$E_C = \frac{9 \times 10^9 \times 3 \times 10^{-6}}{(1060.66)^2}$$

$$= 0.02400$$

$$\boxed{= 2.4 \times 10^{-2} \text{ V/m}} \quad \checkmark$$

2)

a) $w = m \times g$

$$m_{\text{mass}} = \rho V$$

$$m_{\text{mass}}(n) = 4 \times 10^{-15} \text{ kg}$$

$$E_{\text{field}} = 6131.25 \text{ N/C}$$

$$qE = mg \quad q = \frac{mg}{E} = \frac{(4 \times 10^{-15})(9.8)}{6131.25 \text{ N/C}}$$

$$= 6.3934 \times 10^{-19}$$

$$\frac{e \cdot q}{c} = \frac{e}{c} = n$$

$n = 3.9$

(4)

b) $F_E = q' E = 2.94 \times 10^{-15}$

$$m' = m - c = 4.0 \times 10^{-16}$$

$$F_g = mg = 3.92 \times 10^{-15} \text{ N}$$

$$a = \frac{F_g - F_E}{m} = \frac{(3.92 \times 10^{-15} \text{ N}) - (2.94 \times 10^{-15} \text{ N})}{4.0 \times 10^{-16} \text{ kg}}$$

$a = 2.46 \text{ m/s}^2$



c) a) conditions

or $\text{G} = \text{G}_0 \cdot \text{exp}(-\alpha \cdot \text{t})$

b) Energy (5)

$E = E_0 \cdot \text{exp}(-\alpha \cdot \text{t})$

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$$1) \textcircled{a} KE = qV$$

$$KE_H = (1.6 \times 10^{-19}) \times (4 \times 10^3)$$

$$= 6.4 \times 10^{-16} \text{ J}$$

$$KE_{He} = (2 \times 10^{-19}) (4 \times 10^3)$$

$$= 12.8 \times 10^{-16} \text{ J}$$

(easier to use
eV →
4 keV
8 keV)

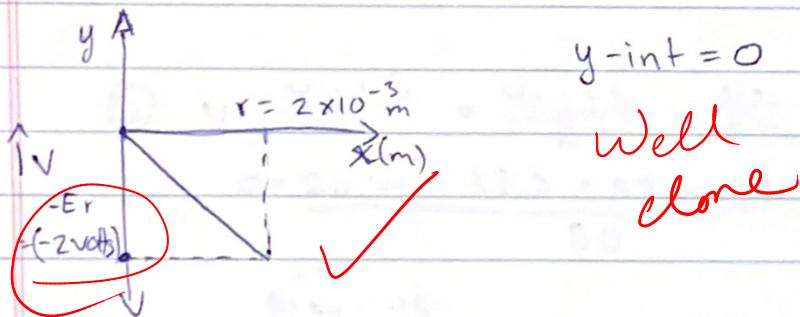
$$\textcircled{b} E = \frac{\Delta V}{\Delta x}$$

$$= \frac{4 \times 10^3}{5 \times 10^{-2}}$$

$$= 8 \times 10^4 \text{ V/m}$$

$$2) E = 1000 \text{ N/C} \quad \boxed{V = -Ex}$$

$$x = 2 \text{ mm} = 2 \times 10^{-3} \text{ m}$$



$$3) \text{ a) capacitance}$$

$$C = \frac{\epsilon_0 A}{r} = \cancel{11.25 \times 10^{-13} \text{ F}}$$

$$= \frac{8.85 \times 10^{-12} \times 10^{-4}}{2 \times 10^{-3}}$$

$$= 4.425 \times 10^{-13} \text{ F}$$

$$\text{b) Energy (J)}$$

$$= \frac{1}{2} C V^2$$

$$= \frac{1}{2} \times 4.425 \times 10^{-13} \times 25$$

$$= 55.31 \times 10^{-13} \text{ J}$$

4) We should connect capacitance in parallel since parallel systems keep the potential difference the same while increasing the total capacitance

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$$① r_1 = 2r \quad r_2 = 2r \quad R = 50r$$

$$E_1 = 1.5V \quad E_2 = 1.5V \quad I = ?$$

Kirchhoff's rule

$$-E_2 + Ir_2 + Ir_1 - E_1 + IR = 0$$

$$-1.5 + I(r_1 + r_2 + R) - 1.5 = 0$$

$$I = \frac{3V}{r_1 + r_2 + R} = \frac{3}{2+2+50} = \frac{3}{54} = 55.56 \text{ mA}$$

$$② V = \frac{V_r - 1.5}{2} + \frac{V_x - 1.5}{2} + \frac{V_x}{5V}$$

$$0 = \frac{25V_r - 37.5}{50} + \frac{25V_r - 37.5}{50} + V_r$$

$$51V_r = 75V$$

$$V_r = 1.47V$$

$$I_1 = \frac{1.5 - 1.47}{2r} = 15 \text{ mA}$$

$$I_2 = \frac{1.5 - 1.47}{2r} = 15 \text{ mA}$$

$$I = I_1 + I_2$$

$$= 15 + 15$$

$$= 30 \text{ mA}$$

→

$\frac{1}{2}$

$$\text{Total } P_C = P_{r_1} + P_{r_2} + P_R$$

$$= (15\text{ m})^2 \cdot 2 + (15\text{ m})^2 \cdot 2 + (30\text{ m})^2 \cdot 50$$

$$= 45.9 \text{ mW}$$

Total

$$= 45 \text{ mW}$$

What circuit
is this?

C₁

$$P_{\text{total}} = (I^2) r_1 + (I^2 r_2) R$$

$$= (0.056\text{ A})^2 (2) + (0.056\text{ A}^2) (2)$$

$$= (0.056\text{ A})^2 (50)$$

$$= 0.17 \text{ W}$$

$$= 170 \text{ mW}$$



C₂ Parallel

$$P_{\text{total}} = (I_1)^2 r_1 + (I_2)^2 r_2 + (I^2) R$$

$$= (0.015\text{ A})^2 (2) + (0.015\text{ A})^2 + (0.030)^2 (50)$$

$$= 0.045 \text{ W}$$

$$= 45.9 \text{ mW}$$



