

ANSWERS

1a) $E_C = \frac{8.0 \times 10^{-5} N/C}{r^2}$

1b) $E_C = 24.0 \times 10^{-3} N/C$

19.0
20

yay!

[2]

1) SCALING PROBLEM

$$E_C = 2.00 \times 10^{-3} V/m$$

$$r = 1 \text{ mm} = 10^{-3} \text{ m}$$

$$k = 9.0 \times 10^9 \frac{N \cdot m^2}{C^2}$$

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

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$$E_C r^2 = kQ$$

$$2.00 \times 10^{-3} V/m \cdot (10^{-3} \text{ m})^2 = \frac{9 \times 10^9 N \cdot m^2 / C^2}{k}$$

$$Q = \frac{E_C r^2}{k} = \frac{2.00 \times 10^{-3} V/m \cdot (10^{-3} \text{ m})^2}{9 \times 10^9 N \cdot m^2 / C^2}$$

$$Q = \frac{2.00 \times 10^{-3} V/m \cdot (10^{-3} \text{ m})^2}{9 \times 10^9 N \cdot m^2 / C^2}$$

$$Q = 2.22 \times 10^{-19} C @ 1 \text{ mm}$$

$$E_C @ r = 5 \text{ mm}?$$

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

$$E_C = \frac{(9 \times 10^9 N \cdot m^2 / C^2) (2.22 \times 10^{-19} C)}{(5.0 \times 10^{-3} \text{ m})^2}$$

$$= \frac{(9 \times 10^9 N \cdot m^2 / C^2) (2.22 \times 10^{-19} C)}{5.0 \times 10^{-6} \text{ m}^2}$$

$$E_C = 7.992 \times 10^{-5} V$$

$$\boxed{E_C = 8.0 \times 10^{-5} V/m}$$

$$= \frac{(9 \times 2.22) \times 10^{(9+(-19))} N \cdot m^2 C / C^2}{5.0 \times 10^{-6} \text{ m}^2}$$

$$= \frac{19.98 \times 10^{-10} N \cdot m^2 / C}{5.0 \times 10^{-6} \text{ m}^2}$$

b) ~~FOR 1000000 C~~

$$Q = 1 \mu C = 10^{-6} C$$

$$E_C = 8.00 \times 10^{-3} V/m$$

$$r = ?$$

$$E_C @ Q = 3 \mu C?$$

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

$$E_C = \frac{(9 \times 10^9 N \cdot m^2 / C^2) (3 \times 10^{-6} C)}{(1060.66 \text{ m})^2}$$

$$E_C = \frac{27 \times 10^3 N \cdot m^2 C / C^2}{1060.66 \text{ m}^2}$$

$$\boxed{E_C = 24.0 \times 10^{-3} N/C}$$

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

$$r^2 E_C = kQ$$

$$\sqrt{\frac{kQ}{E_C}}$$

$$r = \sqrt{\frac{kQ}{E_C}}$$

$$\sqrt{\frac{(9 \times 10^9 N \cdot m^2 / C) (10^{-6} C)}{8.00 \times 10^{-3} V/m}}$$

$$r = \sqrt{\frac{9 \times 10^3 \frac{N \cdot m^2 \cdot C}{C}}{8.00 \times 10^{-3} V/m}}$$

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

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2a) 4 electrons ✓

2b) 2.46 m/s^2 ✓

2) MILLIKAN OIL DROP

$$m = 4 \times 10^{-16} \text{ kg}$$

$$\vec{F} = q\vec{E}$$

$$E_0 = 6131.25 \text{ N/C}$$

$$g = 9.81 \text{ m/s}^2$$

$$|e| = 1.6 \times 10^{-19} \text{ C}$$

$$a) F_E = mg$$

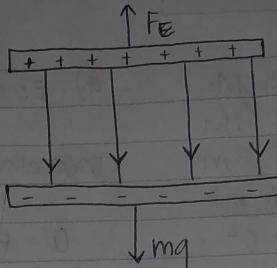
$$qE = mg$$

$$q = \frac{mg}{E}$$

$$q = \frac{(4 \times 10^{-16} \text{ kg})(9.81 \text{ m/s}^2)}{6131.25 \text{ N/C}} = \frac{6.4 \times 10^{-19} \text{ C}}{1.6 \times 10^{-19} \text{ C}} = 4 \text{ electrons}$$

$$q = \frac{39.24 \times 10^{-16} \text{ kg m/s}^2}{6131.25 \text{ N/C}}$$

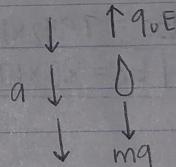
$$q = 6.4 \times 10^{-19} \text{ C}$$



b) $a = ?$

$$q_0 = (4e - 1e)(1.6 \times 10^{-19} \text{ C}) = 4.8 \times 10^{-19} \text{ C}$$

$$\frac{mg - q_0 E}{m}$$



$$a = \frac{mg - q_0 E}{m}$$

$$a = \frac{q}{m} = \frac{g - q_0 E}{m} = \frac{(9.81 \text{ m/s}^2) - (4.8 \times 10^{-19} \text{ C})(6131.25 \text{ N/C})}{4 \times 10^{-16} \text{ kg}}$$

$$a = \frac{(39.24 \times 10^{-16} \text{ kg m/s}^2) - 2.948 \times 10^{-15} \text{ N/C}}{4 \times 10^{-16} \text{ kg}}$$

$$a = \frac{9.84 \times 10^{-16}}{10.4 \times 10^{-16}}$$

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

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1a) $U_H = 6.4 \times 10^{-16} \text{ CV}$; $U_{He} = 12.8 \times 10^{-16} \text{ CV}$

1b) $8.0 \times 10^4 \text{ V/m}$

~~QUESTION~~

[3]

1) MASS SPECTROMETER

$$\Delta V = 4 \text{ kV} = 4 \times 10^3 \text{ V}$$

$$H = +1qe$$

$$He = +2qe \quad \text{slope} = Y/X$$

$$U = q \Delta V$$

$$1e = 1.6 \times 10^{-19} \text{ C}$$

$$a) U_H = (1.6 \times 10^{-19} \text{ C})(4 \times 10^3 \text{ V})$$

$$U_H = 6.4 \times 10^{(-19+3)} \text{ CV}$$

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

$$U_{He} = 2(1.6 \times 10^{-19} \text{ C})(4 \times 10^3 \text{ V})$$

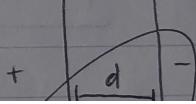
$$U_{He} = 12.8 \times 10^{-16} \text{ CV}$$

b) $\Delta x = 5 \text{ cm}$, $E_m = ?$

$$E = \frac{\Delta V}{\Delta x} = \frac{4 \times 10^3 \text{ V}}{5 \times 10^{-2} \text{ m}} = 4 / 5 \times 10^5 \text{ V/m} = 8.0 \times 10^4 \text{ V/m}$$

~~2) PARALLEL PLATE CAPACITOR~~

$$F = 1 \text{ N/V/m} = 10^3 \text{ N/m}$$



$$1/CV =$$

$$1/C \frac{J}{C} = J$$

2) $E = 1 \text{ kV/m} = 10^3 \text{ V/m}$

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

$$\vec{E} = -\frac{\Delta V}{\Delta x} \quad \text{neg slope}$$

$+ \quad | \quad -$

$$d$$

" $y = mx + b$ "

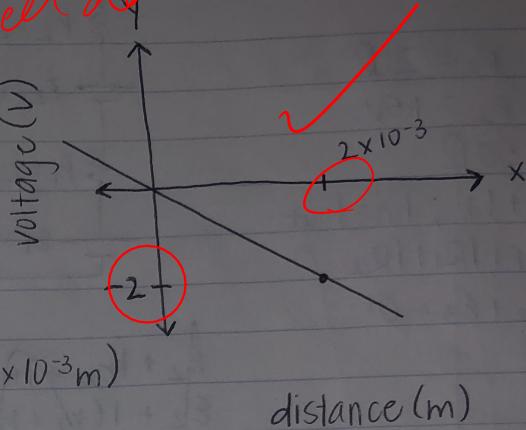
$$-\Delta V = E \Delta x$$

$$-\Delta V = (10^3 \text{ V/m})(2 \times 10^{-3} \text{ m})$$

$$-\Delta V = 2 \text{ V}$$

$$V = -2 \text{ V}$$

Well done



y-int @ 0

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3a) $4.42 \times 10^{-13} \text{ F}$

3b) $5.53 \times 10^{-12} \text{ J}$

3) PART 2

$$A = 1 \text{ cm}^2 = (10^{-2} \text{ m})^2 = 10^{-4} \text{ m}^2$$

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

$$\epsilon_0 \approx 8.85 \times 10^{-12} \text{ F/m}$$

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

$$a) V = \frac{\epsilon_0 A}{d}$$

$$= (8.85 \times 10^{-12} \text{ F/m})(10^{-4} \text{ m}^2)$$

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

$$C = \frac{8.85 \times 10^{-12} \text{ F/m} \cdot \text{m}^2}{2 \times 10^{-3} \text{ m}}$$

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

b) $V = 5V, U = ?$

$$U = \frac{1}{2} CV^2$$

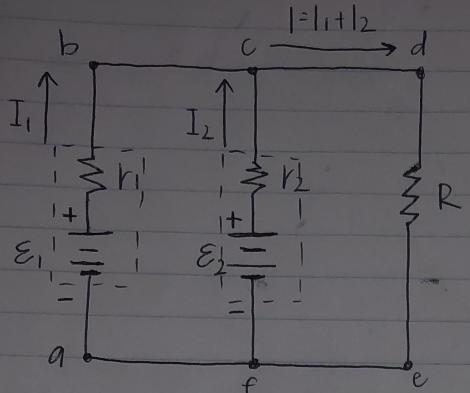
$$U = \frac{1}{2} (4.425 \times 10^{-13} \text{ F})(5V)^2$$

$$[U = 5.53 \times 10^{-12} \text{ J}]$$

4) You should connect the capacitor in parallel because then $C_{\text{tot}} = C_1 + C_2$.

If you were to connect in series, $C_{\text{tot}} = C_1^{-1} + C_2^{-1}$ or $\frac{1}{C_{\text{tot}}} = \frac{1}{C_1} + \frac{1}{C_2}$.

Connecting in parallel would allow more capacitance.



$$r_1 = r_2 = 2\Omega$$

$$\epsilon_1 = \epsilon_2 = 1.5V$$

$$R = 50\Omega$$

"in=out"

$$-IR - IR_1 - IR_2 = 0$$

$a \rightarrow b$

$$\Delta V = V_b - V_a = +\epsilon$$

$$\Delta V = V_b - V_a = -IR$$

$$+\epsilon_1 - Ir_1 + \epsilon_2 - Ir_2 - R(I_1 + I_2) = 0$$

$$+\epsilon_1 + \epsilon_2 - Ir_1 - Ir_2 - R(I_1 + I_2) = 0$$

$$+\epsilon_1 + \epsilon_2 - I(r_1 - r_2) - R(I_1 + I_2) = 0$$

$$-I(r_1 - r_2) - R(I_1 + I_2) = -\epsilon_1 - \epsilon_2$$

$$I - R(I_1 + I_2) = \frac{-\epsilon_1 - \epsilon_2}{r_1 - r_2}$$

$$I - I_1 + I_2 = \frac{-\epsilon_1 - \epsilon_2}{R(-\epsilon_1 - \epsilon_2)}$$

$$(I_1 + I_2) - I_1 + I_2 = \frac{-\epsilon_1 - \epsilon_2}{R(r_1 - r_2)}$$

$$2I_2 = \frac{-\epsilon_1 - \epsilon_2}{R(r_1 - r_2)}$$

$$2I_2 = \frac{-1.5 - 1.5}{50(2)}$$

lol!

If I had a
drill every
time that

Lapped in
my research.

Not sure
which loops
there are

(-1)

At this point, I
realized that my
computation had a zero
in the denom ; I thought
I was on the right track, but
this problem has me beat!
I'm sorry it is not complete,
this was the best I could do

-\(_{(")}\)_T-

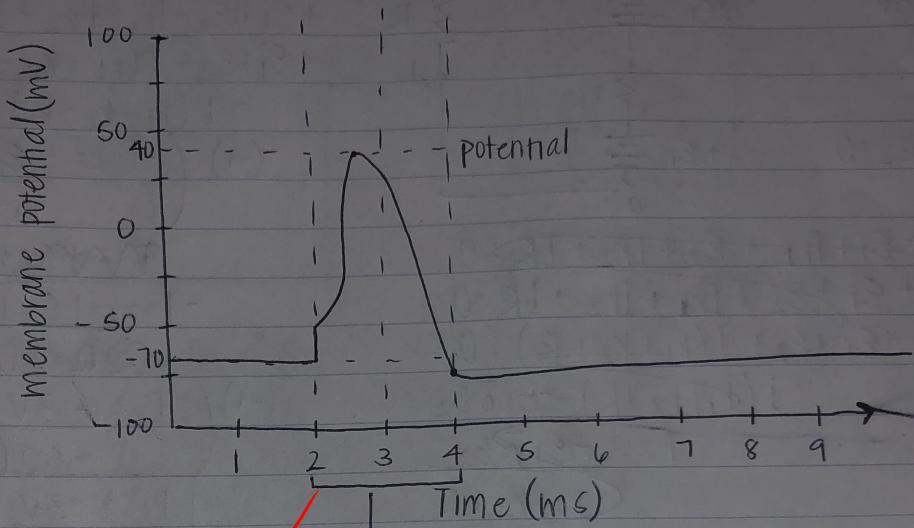
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2a) 2 ms

2b) 115 mV

2) NERVE STIMULATION

Membrane Potential vs. Time



a) Pulse width?

$$4 - 2 = \boxed{2 \text{ ms}}$$

b) peak to peak voltage

$$40 - (-75) = \boxed{115 \text{ mV}}$$