ANSWERS

1a) $E_c = \cancel{\ } \, 8.0 \times 10^{-5}$ N/c

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

2

1) SCALING PROBLEM

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

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

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

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

a) $E_c = \frac{kQ}{r^2}$ $\quad \frac{E_c r^2}{k} = \frac{\cancel{k}Q}{k}$

$Q = \frac{E_c r^2}{k} = \frac{2.00\times10^{-3} V/m \,(10^{-3} m)^2}{9\times10^9 N\cdot m^2/C^2}$

$Q = \frac{2.00\times10^{-3} V/m\,(10^{-6} m^2)}{9\times10^9 N\cdot m^2/C^2}$

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

E_c @ r = 5mm?

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

$E_c = \frac{(9\times10^9 N\cdot m^2/C^2)(2.22\times10^{-19} C)}{(5.0\times10^{-3} m)^2}$

$= \frac{(9\times10^9 N\cdot m^2/C^2)(2.22\times10^{-19} C)}{5.0\times10^{-6} m^2}$

$= \frac{(9\times2.22)\times10^{(9+(-19))} \ Nm^2C/C^2}{5.0\times10^{-6} m^2}$

$= \frac{19.98\times10^{-10} \ Nm^2/C}{5.0\times10^{-6} m^2}$

$E_c = 7.992\times10^{-5}$

$\boxed{E_c = 8.0\times10^{-5} V/m}$

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

$E_c = 8.00\times10^{-3}$ V/m

$r = ?$

$E_c = \frac{kQ}{r^2}$ $\quad r^2 E_c = kQ$

$\sqrt{r^2} = \sqrt{\frac{kQ}{E_c}}$

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

$= \sqrt{\frac{(9\times10^9 N\cdot m^2/C)(10^{-6} C)}{8.00\times10^{-3} V/m}}$

$r = \sqrt{\frac{9\times10^3 \ \frac{N\cdot m^2}{C}\cdot C}{8.00\times10^{-3} V/m}}$

$r = 1060.66$ m

E_c @ $Q = 3\mu C$?

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

$E_c = \frac{(9\times10^9 N\cdot m^2/C^2)(3\times10^{-6} C)}{(1060.66 m)^2}$

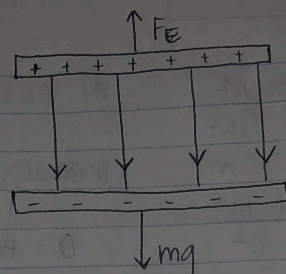
$E_c = \frac{27\times10^3 \ N\cdot m^2 C/C^2}{1060.66 m^2}$

$\boxed{E_c = 24.0\times10^{-3} N/C}$

ANSWERS

2a) 4 electrons

2b) $2.46\ m/s^2$



2) MILLIKAN OIL DROP

$m = 4\times10^{-16}\ kg$ $\qquad \vec{F} = q\vec{E}$

$E_c = 6131.25\ N/C$

$g = 9.81\ m/s^2$

$1e = 1.6\times10^{-19}\ C$

a) $F_E = mg$

$qE = mg$

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

$q = \dfrac{(4\times10^{-16}\ kg)(9.81\ m/s^2)}{6131.25\ N/C}$

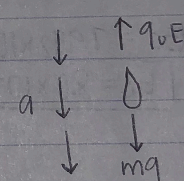
$q = \dfrac{39.24\times10^{-16}\ kgm/s^2}{6131.25\ N/C}$

$q = 6.4\times10^{-19}\ C$

$\dfrac{6.4\times10^{-19}\ C}{1.6\times10^{-19}\ C} = \boxed{4 \text{ electrons}}$

b) $a = ?$

$q_0 = (4e - 1e)(1.6\times10^{-19}\ C) = 4.8\times10^{-19}\ C$



$\dfrac{mg - q_0E = ma}{m}$

$\cancel{a = \dfrac{mg - q_0E}{m}}$

$\cancel{a = g - q_0E}$

$\cancel{a = (9.81\ m/s^2) - (4.8\times10^{-19}\ C)(6131.25\ N/C)}$

$a = \dfrac{mg - q_0E}{m} = \dfrac{((4\times10^{-16}\ kg)(9.81\ m/s^2)) - ((4.8\times10^{-19}\ C)(6131.25\ N/C))}{4\times10^{-16}\ kg}$

$a = \dfrac{(39.24\times10^{-16}\ kgm/s^2 - 2.94\times10^{-15}\ N/C)}{4\times10^{-16}\ kg}$

$a = \dfrac{9.84\times10^{-16}}{4.0\times10^{-16}}$

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

ANSWERS

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

1b) 8.0×10^{4} V/m

[illegible]

3

1) MASS SPECTROMETER

$\Delta V = 4kV = 4 \times 10^3 V$

$H = +1qe$

$He = +2qe$ slope = Y/x

$U = q\Delta V$

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

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

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

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

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

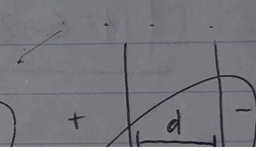
$\boxed{U_{He} = 12.8 \times 10^{-16} \text{ CV}}$

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

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

~~2) PARALLEL PLATE CAPACITOR~~

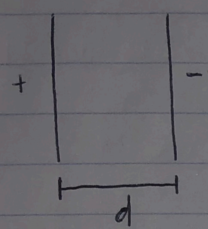
~~$E = 1k$ V/m $= 10^3$ V/m~~



2) $E = 1\,kV/m = 10^3\,V/m$

$d = 2\,mm = 2\times10^{-3}\,m$

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



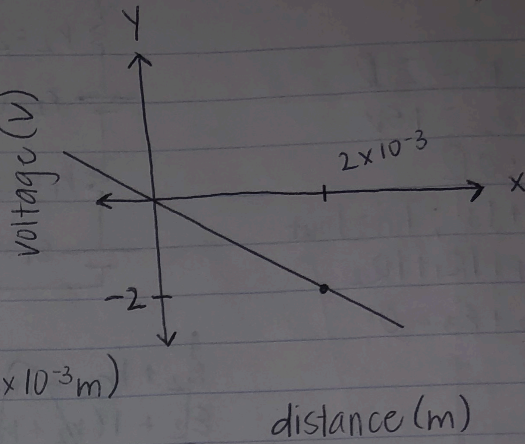
"$y = mx + b$"

$-\Delta V = E\Delta x$

$-\Delta V = (10^3\,V/m)(2\times10^{-3}\,m)$

$-\Delta V = 2V$

$V = -2V$



$\boxed{\text{y-int @ 0}}$

ANSWERS

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

3b) 5.53×10^{-12} J

3) ~~part~~ PART 2

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

$C = \frac{\varepsilon_0 A}{d}$

$\varepsilon_0 \approx 8.85 \times 10^{-12} F/m$

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

a) $C = \frac{\varepsilon_0 A}{d}$

$= \frac{(8.85 \times 10^{-12} F/m)(10^{-4} m^2)}{2 \times 10^{-3} m}$

$C = \frac{8.85 \times 10^{-6} F/\cancel{m} \cdot \cancel{m^2}}{2 \times 10^{-3} \cancel{m}}$

$\boxed{4.425 \times 10^{-13} F}$

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

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

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

$\boxed{U = 5.53 \times 10^{-12} J}$

4) you should connect the capacitor in $\boxed{\text{parallel}}$ because then $C_{tot} = C_1 + C_2$. if you were to connect in series, $C_{tot}^{-1} = C_1^{-1} + C_2^{-1}$ or $\frac{1}{C_{tot}} = \frac{1}{C_1} + \frac{1}{C_2}$. connecting in parallel would allow more capacitance

4

1) AA BATTERIES

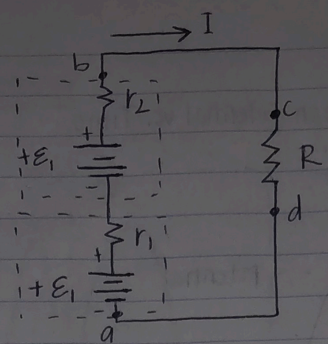
$r_1 = r_2 = 2\Omega$

$\mathcal{E}_1 = \mathcal{E}_2 = 1.5V$

$R = 50\Omega$

in = out

$-Ir - IR_1 - IR_2 = 0$



$\cancel{+\mathcal{E}_1 + Ir_2 + \mathcal{E}_2 + Ir_2 + IR > 0}$

$+\mathcal{E}_1 + \mathcal{E}_2 + Ir_1 + Ir_2 + IR = 0$

$+\mathcal{E}_1 + \mathcal{E}_2 + I(r_1 + r_2 + R) = 0$

$I(r_1 + r_2 + R) = -\mathcal{E}_1 - \mathcal{E}_2$

$I = \dfrac{-\mathcal{E}_1 - \mathcal{E}_2}{r_1 + r_2 + R}$

$= \dfrac{-1.5V - 1.5V}{2\Omega + 2\Omega + 50\Omega}$

$I = \dfrac{-3V}{54\Omega} = -55.5 \times 10^{-3}\ V/\Omega$

$\cancel{\boxed{I = -55.5 \times 10^{-3}\ A}}$

$\cancel{+\mathcal{E} - IR}$

$+\mathcal{E}_1 - Ir_1 + \mathcal{E}_2 - Ir_2 - IR = 0$

$+\mathcal{E}_1 + \mathcal{E}_2 - Ir_1 - Ir_2 - IR = 0$

$+\mathcal{E}_1 + \mathcal{E}_2 - I(r_1 - r_2 - R) = 0$

$-I(r_1 - r_2 - R) = -\mathcal{E}_1 - \mathcal{E}_2$

$(-1)\left(-I = \dfrac{-\mathcal{E}_1 - \mathcal{E}_2}{r_1 - r_2 - R}\right)$

$-I = \dfrac{-1.5 - 1.5}{2\Omega - 2\Omega - 50\Omega}$

$(-1)\left(-I = \dfrac{-3V}{-50\Omega}\right)$

$\boxed{I = \dfrac{3V}{50\Omega} = .06\ \dfrac{V}{\Omega}}$

b)

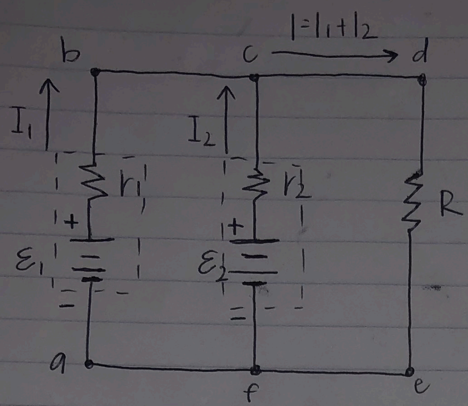
power consumption

$I = \dfrac{E}{R} = \dfrac{1.5V}{50\Omega} = .03A$

$P = I \cdot E$

$P = .03A(1.5V)$

$\boxed{P = .045W}$



$r_1 = r_2 = 2\Omega$

$\varepsilon_1 = \varepsilon_2 = 1.5V$

$R = 50\Omega$

in=out

$-Ir - IR_1 - IR_2 = 0$

$a \rightarrow b$

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

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

$\cancel{+\varepsilon_1 - Ir_1 + \varepsilon_2 - Ir_2 - IR}$

$+\varepsilon_1 - Ir_1 + \varepsilon_2 - Ir_2 - R(I_1 + I_2) = 0$

$+\varepsilon_1 + \varepsilon_2 - Ir_1 - Ir_2 - R(I_1 + I_2) = 0$

$+\varepsilon_1 + \varepsilon_2 - I(r_1 - r_2) - R(I_1 + I_2) = 0$

$-I(r_1 - r_2) - R(I_1 + I_2) = -\varepsilon_1 - \varepsilon_2$

$I - R(I_1 + I_2) = \frac{-\varepsilon_1 - \varepsilon_2}{r_1 - r_2}$

$I - I_1 + I_2 = \frac{-\varepsilon_1 - \varepsilon_2}{R(\cancel{-\varepsilon_1 - \varepsilon_2})}$

$(I_1 + I_2) - I_1 + I_2 = \frac{-\varepsilon_1 - \varepsilon_2}{R(r_1 - r_2)}$

$2I_2 = \frac{-\varepsilon_1 - \varepsilon_2}{R(r_1 - r_2}$

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

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

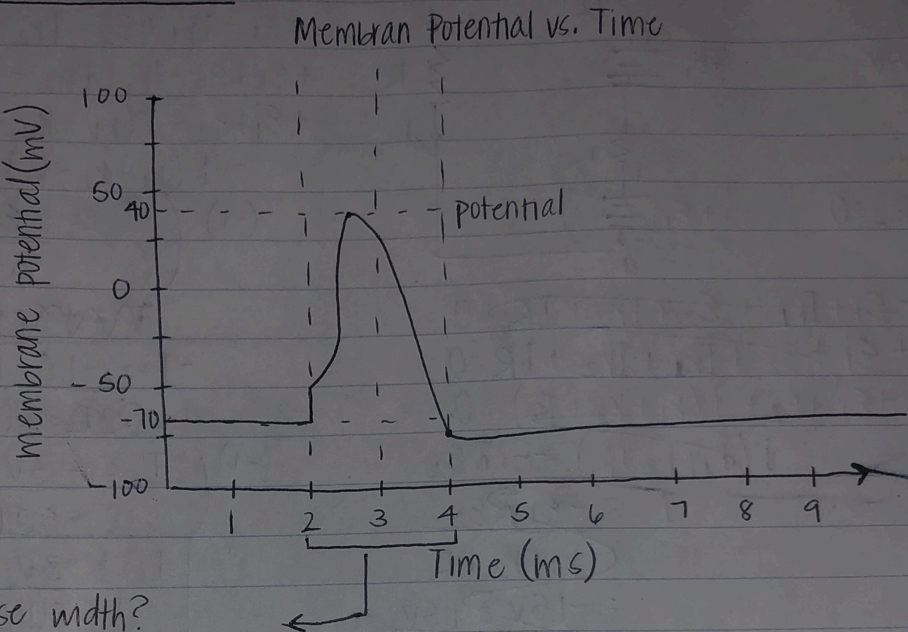
¯_(ツ)_/¯

ANSWERS

2a) 2ms

2b) 115mV

2) NERVE STIMULATION



a) pulse width?

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

b) peak to peak voltage

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