Electric Charge & Electric Fields

2, 1. a) $E_c = 2.00 \times 10^{-3}$ V/m

$$\frac{2.00 \times 10^{-3}}{25} = 8 \times 10^{-5} \text{ V/m}$$

$q = 1\mu C$ b) $E = \frac{1}{4\pi\epsilon_0} \cdot \frac{q}{r^2}$

$1\mu C = 1 \cdot 10^{-6} C$ $\quad 8 \cdot 10^{-3} = \frac{1}{4\pi\epsilon_0} \cdot \frac{1 \times 10^{-6}}{r^2}$

$$\left(\frac{1}{1 \times 10^{-6}}\right)(8 \times 10^{-3}) = \frac{1 \times 10^{-6}}{4\pi\epsilon_0 r^2} \cdot \left(\frac{1}{1 \cdot 10^{-6}}\right)$$

$$8 \cdot 10^{3} = \frac{1}{4\pi\epsilon_0 r^2}$$

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

$$E = \frac{1}{4\pi\epsilon_0} \cdot \frac{q}{r^2}$$

$$E = \frac{1}{4\pi\epsilon_0} \cdot \frac{3 \times 10^{-6}}{r^2}$$

$$E = \frac{3 \cdot 10^{-6}}{4\pi\epsilon_0 r^2}$$

$$E = \frac{1}{4\pi\epsilon_0 r^2} \cdot \frac{3 \times 10^{-6}}{1}$$ ★ Substitution for $\frac{1}{4\pi\epsilon_0 r^2}$

$$E = (8 \times 10^{3})(3 \cdot 10^{-6})$$

$$E = 2.4 \times 10^{-2}$$

Electric Charge & Electric Fields

2 a) $q = \frac{mg}{E}$

$= \frac{(4\times10^{-15})(9.8)}{6131.25}$

$q = 6.39\times10^{-19}$

b) $q' = q - e$

$(6.39\times10^{-19}) - (1.6\times10^{-19})$

$q' = 4.79\times10^{-19}$

solve for Fe

$F_e = q' \cdot E$

$= (4.79\times10^{-19})(6131.25)$

$F_e = 2.94\times10^{-15}\ N$

solve for oil drop mass

$m' = m - m_e$ (mass of oil) − (mass of e^-)

$m' = (4\times10^{-15}) - (9.1\times10^{-31})$

$m' \approx 4\times10^{-15}$

Solve for Fg

$F_g = m'g$

$= (4\times10^{-15})(9.8)$

$F_g = 3.92\times10^{-15}\ N$

Finally, solve for a

$a = \frac{F_g - F_e}{m} = \frac{(3.92\times10^{-15}) - (2.94\times10^{-15})}{(4\times10^{-15})}$

$a = 2.45\ m/s^2$

Potential Energy & Voltage, Capacitors

3 1. a) $KE = qV$

$= (1.6\times10^{-19})(4)$

$= 6.4\times10^{-19}$ eV Hydrogen

Hydrogen: $+1q_e = 1(1.6\times10^{-19}) = 1.6\times10^{-19}$

Helium: $+2q_e = 2(1.6\times10^{-19}) = 3.2\times10^{-19}$

~~$\Delta V = 4kV = 4000 = 4\times10^{3}V$~~

$eV = kV$

$2(1.6\times10^{-19})(4)$

$= 1.28\times10^{-18}$ eV

b) $E = \frac{\Delta V}{\Delta x^2}$ $\Delta x = 5cm$ $5cm = 5\times10^{-2}m$

$E = \frac{4\times10^{3}}{5\times10^{-2}}$

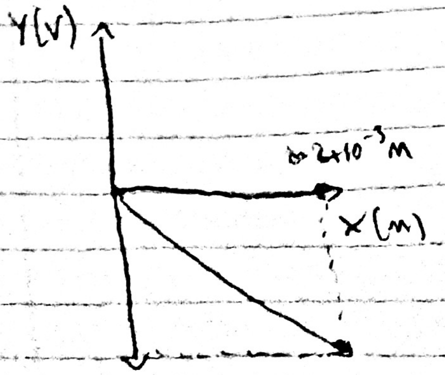
$E = 8\times10^{4}$ V/m

2. $E = 1kV/m = 1000$ V/m

- B/C question deals w/ parallel plate capacitor, E-field is constant
- E-field also slope of voltage function
- This makes the function linear due to the constant slope
- function will also point downward since E-field relative to potential

1000 V/m $2mm = 2\times10^{-3}m$

$E = \frac{-\Delta V}{\Delta x}$



$y = mx + b$

$y = 1000x + \cancel{b}$

- Y-intercept is 0 due to function beginning at (0,0)

Potential Energy of Voltage, Capacitors

3 3. a) $C = \frac{\varepsilon_0 A}{d}$ $1cm^2 = (1 \cdot 10^{-2} m)^2$ $d = 2mm = 2 \cdot 10^{-3} m$

$$C = \frac{(8.85 \cdot 10^{-12})(1 \cdot 10^{-2})^2}{(2 \cdot 10^{-3})}$$

$$C = 4.43 \cdot 10^{-13} F$$

b) $W = \frac{1}{2} C V^2$ $V = 5$

$$W = \frac{1}{2}(4.43 \cdot 10^{-13})(5^2)$$

$$W = 5.54 \cdot 10^{-12} J$$

4. The identical capacitors should be connected in parallel in order to achieve more energy

A parallel combination allows for the sum of all capacitances

$C_{tot} = C_1 + C_2 \dots$ $\uparrow C$

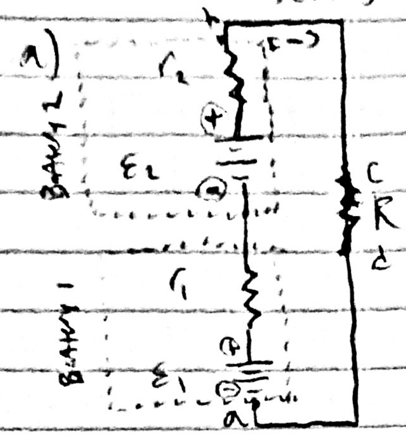
A series combination adds the reciprocals of all capacitors, which results in the equivalent capacitance being smaller than the smallest individual capacitance & results in less energy

$C_{tot}^{-1} = C_1^{-1} + C_2^{-1}$ $\downarrow C$

Current, Resistance, & DC Circuits

Series

4 1. a)



$E_1 - Ir_1 + E_2 - Ir_2 = 0$

$I = \frac{E_1 + E_2}{r_1 + r_2 + R}$

$I = \frac{1.5 + 1.5}{2 + 2 + 50} \approx 55.6 mA$

b) $P_{tot} = P_{r_1} + P_{r_2} + P_R$

$= I^2 r_1 + I^2 r_2 + I^2 R$

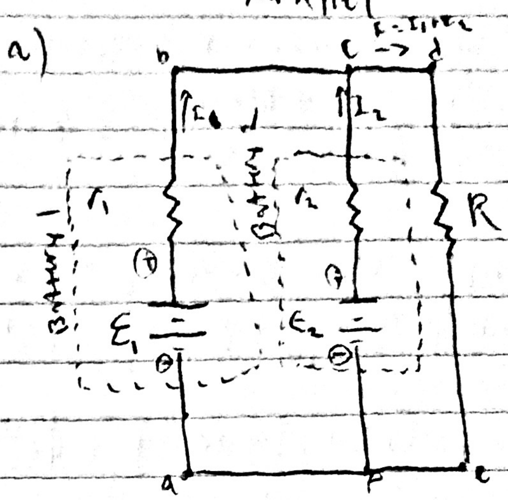
$= (55.6)^2 2 + (55.6)^2 2 + (55.6)^2 50$

=

$\approx 166 mW$

Parallel

a)



$\frac{1}{R_{tot}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

$0 = \frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{R}$

$0 = \frac{V_x - 1.5}{2} + \frac{V_x - 1.5}{2} + \frac{V_x}{50}$

Obtain common denominator

$0 = \left(\frac{25}{25}\right)\left(\frac{V_x - 1.5}{2}\right) + \left(\frac{25}{25}\right)\left(\frac{V_x - 1.5}{2}\right) + \frac{V_x}{50}$

$0 = \frac{25V_x - 37.5 + 25V_x - 37.4 + V_x}{50}$

$0 = 75 + 51V_x$

$V_x = 1.47 V$

$V = IR \rightarrow I = \frac{V}{R}$

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

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

$I = 30 mA$

b) $P_{tot} = P_{r_1} + P_{r_2} + R_R$

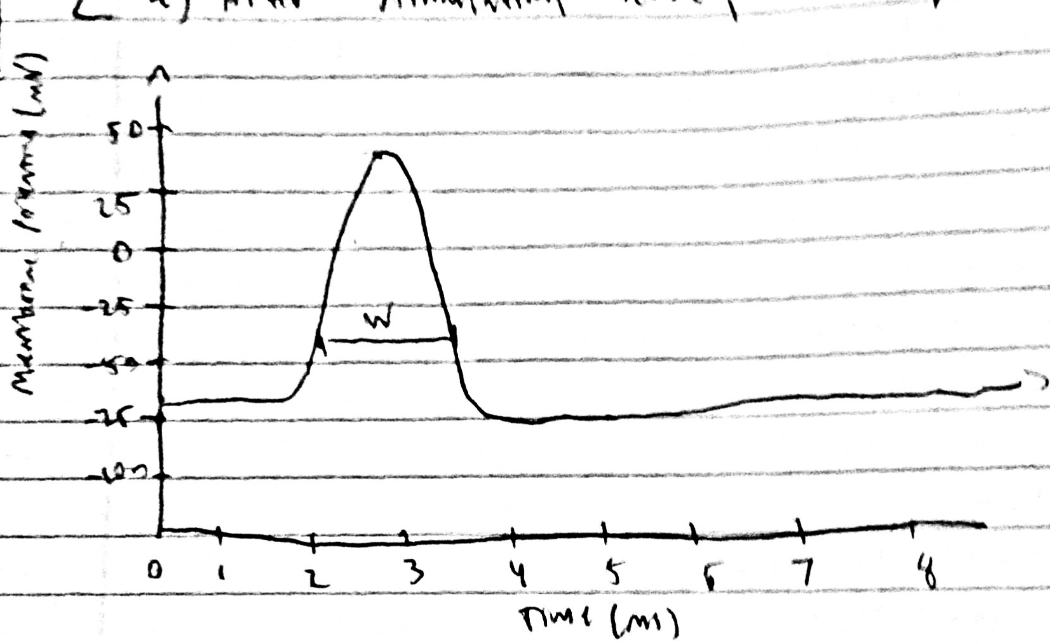
$= I^2 r_1 + I^2 r_2 + I^2 R$

$= (15)^2 2 + (15)^2 2 + (30)^2 50$

$\approx 45.9 mW$

Current, Resistance, & DC circuits

4 2 a) After stimulating nerve, I then graphed membrane potential vs time



$4 - 2$

$= 2\,ms$

b) greatest voltage - least

$40 - (-75)$

$= 115V$