

upside down world!

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Electric Charge and Electric Fields

1) a) $E_c = 2.00 \times 10^3 \text{ V/m}$ at 1mm or 0.001m

E_c at 5mm (0.005m) is ?

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

$$E_c = \frac{kq}{r^2} \quad E_c = \frac{kq}{(0.005)^2}$$

$$8 \times 10^{-5} \text{ V/m at 5mm}$$

b) $E_c = 8.00 \times 10^3 \text{ V/m}$ $q = 1 \mu\text{C}$ $E_c = ?$ when $q = 3 \mu\text{C}$

$$E_c = \frac{kq}{r^2} \rightarrow E_c = \frac{k \cdot 3q}{r^2}$$

charges 3 times greater so E_c is 3 times greater

$$(8 \times 10^{-3}) \times 3 = 24.0 \times 10^{-3} \text{ V/m}$$

2) Given: mass = $4 \times 10^{-16} \text{ kg}$ $E = 6131.25 \text{ N/C}$

a) $F = qE$ $F = mg$ (weight) $\rightarrow mg = qE$ $q = \frac{mg}{E}$ $q = \frac{(4 \times 10^{-16})(9.8)}{6131.25}$

$q = \# \text{ of electrons} \times \text{charge of electron}(e)$ $q = ne$ $e = 1.6 \times 10^{-19}$

$$\frac{q}{e} = n = \frac{6.39 \times 10^{-19}}{1.6 \times 10^{-19}}$$

$$n = 3.996$$

$$n = 4 \text{ electrons}$$

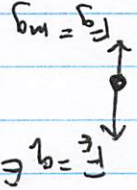
b) one e^- removed

$$q - e = q_2 = 6.39 \times 10^{-19} - 1.6 \times 10^{-19} = 4.79 \times 10^{-19}$$

$$F_{\text{net}} = F_g - F_e = ma \quad a = \frac{F_g - F_e}{m} \quad a = \frac{mg - qE}{m}$$

$$q = \frac{(4 \times 10^{-16})(9.8) - (4.79 \times 10^{-19})(6131.25)}{4 \times 10^{-16}}$$

$$a = 2.45 \text{ m/s}^2$$



✓ 100%

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Electric Charge and Electric Fields

1) a) $E = 2000 \text{ N/C}$ at 1 mm or 0.001 m

b) at 2 mm (0.002 m) is?

$$E = \frac{kQ}{r^2} \Rightarrow \frac{E_1}{E_2} = \frac{r_2^2}{r_1^2} \Rightarrow \frac{2000}{E_2} = \frac{(0.002)^2}{(0.001)^2} \Rightarrow E_2 = \frac{2000 \times (0.001)^2}{(0.002)^2} = 500 \text{ N/C}$$

$$E = \frac{kQ}{r^2} \Rightarrow Q = \frac{E r^2}{k} = \frac{(500 \text{ N/C}) (0.001 \text{ m})^2}{9 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2} = 5.56 \times 10^{-12} \text{ C}$$

d) $E = 8000 \text{ N/C}$ at 1 mm $E = ?$ when $d = 3 \text{ cm}$

$$E = \frac{kQ}{r^2} \Rightarrow \frac{E_1}{E_2} = \frac{r_2^2}{r_1^2} \Rightarrow \frac{8000}{E_2} = \frac{(0.03 \text{ m})^2}{(0.001 \text{ m})^2} \Rightarrow E_2 = \frac{8000 \times (0.001)^2}{(0.03)^2} = 88.9 \text{ N/C}$$

$(8 \times 10^3) \times 3 = 2.4 \times 10^4 \text{ N/C}$

2) Given: mass = $4.10 \times 10^{-10} \text{ kg}$ $E = 2.18152 \text{ N/C}$

a) $F = qE$ $F = \text{weight} \Rightarrow \text{weight} = qE$ $q = \frac{F}{E} = \frac{mg}{E} = \frac{(4.10 \times 10^{-10} \text{ kg})(9.8 \text{ m/s}^2)}{2.18152 \text{ N/C}} = 1.84 \times 10^{-9} \text{ C}$

$n = \frac{q}{e} = \frac{1.84 \times 10^{-9} \text{ C}}{1.6 \times 10^{-19} \text{ C}} = 1.15 \times 10^{10}$

b) one removed $q = -e = -1.6 \times 10^{-19} \text{ C}$ $n = \frac{q}{e} = \frac{-1.6 \times 10^{-19} \text{ C}}{1.6 \times 10^{-19} \text{ C}} = -1$

$F_{\text{net}} = F_g - F_e = ma$ $0 = \frac{F_g}{m} - \frac{F_e}{m} \Rightarrow F_e = F_g = mg$

$q = \frac{F_e}{E} = \frac{mg}{E} = \frac{(4.10 \times 10^{-10} \text{ kg})(9.8 \text{ m/s}^2)}{2.18152 \text{ N/C}} = 1.84 \times 10^{-9} \text{ C}$

$n = \frac{q}{e} = \frac{1.84 \times 10^{-9} \text{ C}}{1.6 \times 10^{-19} \text{ C}} = 1.15 \times 10^{10}$

(4 keV, 8 keV)

Potential Energy and Voltage, Capacitance

1) Given: $\Delta V = 4 \text{ kV}$ $H = +1q_e$ $He = +2q_e$ $1 \text{ J} = 6.242 \times 10^{18} \text{ eV}$

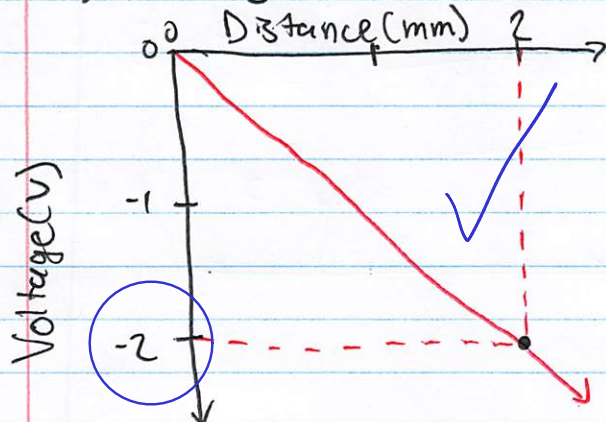
a) $U = qV$ $U_{\text{tot}} = KE_{\text{tot}} \rightarrow KE = qV$

hydrogen $KE = (1.6 \times 10^{-19})(4 \times 10^3) = 6.4 \times 10^{-16} \text{ J} \times \frac{6.242 \times 10^{18} \text{ eV}}{1 \text{ J}} = 3998 \text{ eV}$

helium $KE = 2(1.6 \times 10^{-19})(4 \times 10^3) = 12.8 \times 10^{-16} \text{ J} \times \frac{6.242 \times 10^{18} \text{ eV}}{1 \text{ J}} = 7996 \text{ eV}$

hydrogen
3998 eV
helium
7996 eV

2) Given $E = 1 \text{ kV/m}$ $\Delta x = 2 \text{ mm}$



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

well done

$$m(\text{slope}) = -1000 \text{ V/m}$$

or
 -1 V/mm

y-intercept is zero. when distance is zero, voltage is zero ($V = E\Delta x$)

b) $E = \frac{\Delta V}{\Delta x} = \frac{(4 \times 10^3)}{(5 \times 10^{-2})}$

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

negative Δ

3) a) $C = \frac{\epsilon_0 A}{d}$ $\epsilon_0 = 8.85 \times 10^{-12}$ $A = 1 \text{ cm}^2 \times \frac{1 \text{ m}}{100 \text{ cm}} \times \frac{1 \text{ m}}{100 \text{ cm}} = 1 \times 10^{-4} \text{ m}^2$

$$C = \frac{(8.85 \times 10^{-12})(1 \times 10^{-4})}{2 \times 10^{-3}} = 4.425 \times 10^{-13} \text{ F}$$

b) Energy = $\frac{1}{2} CV^2 = \frac{1}{2} (4.425 \times 10^{-13}) (5^2) = 5.53 \times 10^{-12} \text{ J}$

4) $C_{\text{tot}} = C_1 + C_2$ in parallel

$$\frac{1}{C_{\text{tot}}} = \frac{1}{C_1} + \frac{1}{C_2} \text{ in series}$$

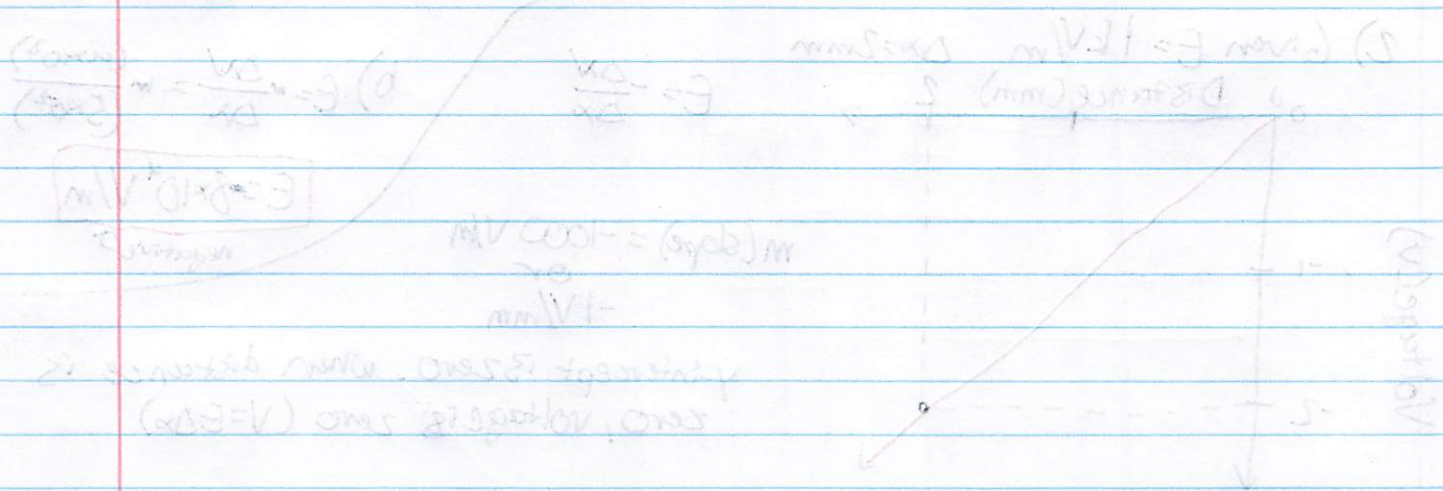
to store more energy we should add the other capacitor in parallel.

parallel

Potential Energy and Voltage Capacitance
 1) Given: $W = 10 \mu\text{C}$ $H = 10 \mu\text{C}$ $V = 2.5 \times 10^{-8} \text{ V}$

Hydrogen $KE = (1.6 \times 10^{-19} \text{ C})(1.5 \times 10^{-12} \text{ J}) = 2.4 \times 10^{-31} \text{ J}$
 $KE = \frac{1}{2}mv^2 \rightarrow v = \sqrt{\frac{2KE}{m}} = \sqrt{\frac{2(2.4 \times 10^{-31} \text{ J})}{1.67 \times 10^{-27} \text{ kg}}} = 1.7 \times 10^{-5} \text{ m/s}$

Helium $KE = 2.1 \times 10^{-12} \text{ J}$
 $KE = \frac{1}{2}mv^2 \rightarrow v = \sqrt{\frac{2KE}{m}} = \sqrt{\frac{2(2.1 \times 10^{-12} \text{ J})}{4.0 \times 10^{-27} \text{ kg}}} = 1.05 \times 10^5 \text{ m/s}$



2) $E = \frac{dV}{dx} = \frac{1.5 \times 10^{-12} \text{ J}}{1.5 \times 10^{-12} \text{ m}} = 1 \text{ V/m}$

$E = \frac{dV}{dx} = \frac{1.5 \times 10^{-12} \text{ J}}{1.5 \times 10^{-12} \text{ m}} = 1 \text{ V/m}$

3) Energy $= \frac{1}{2}CV^2 = \frac{1}{2}(1.5 \times 10^{-12} \text{ F})(2.5 \times 10^{-8} \text{ V})^2 = 2.3 \times 10^{-17} \text{ J}$

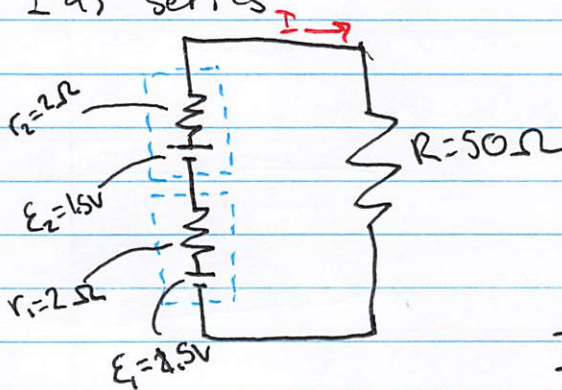
4) $C_{\text{total}} = C_1 + C_2 = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2}}$

to store more energy we should add the other capacitor in parallel.

parallel

Current, Resistance, and DC circuits

1 a) series



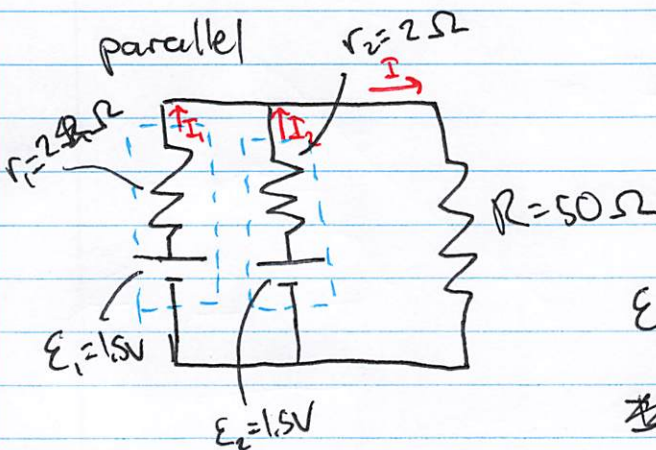
$$\mathcal{E}_1 + \mathcal{E}_2 + \dots = 0$$

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

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

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

$$I = \frac{\mathcal{E}_1 + \mathcal{E}_2}{r_1 + r_2 + R} = \frac{1.5 + 1.5}{2 + 2 + 50} = 55.6 \text{ mA series}$$



$$I_1 + I_2 = I$$

$$I_1 + I_2 = I$$

$\mathcal{E} = 1.5 \text{ V}$ because batteries are in parallel

$$I = \frac{V}{R} = \frac{1.5}{50} = 30 \text{ mA}$$

b) series $P = IV$ $P = (55.6 \times 10^{-3})(3) = 166.8 \text{ mW}$

$$V_{\text{tot}} = V_1 + V_2$$

parallel $P = IV$ $P = (30 \times 10^{-3})(1.5) = 45 \text{ mW}$

$$V_{\text{tot}} = 1.5 \text{ V}$$

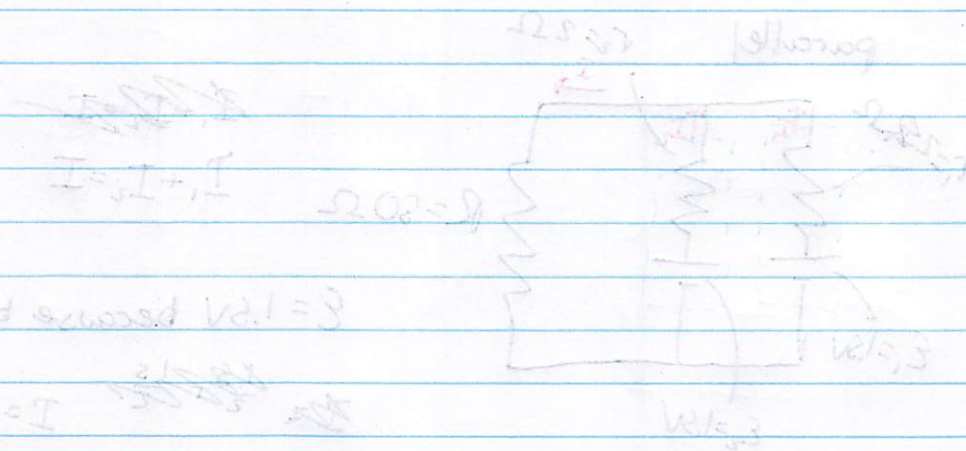
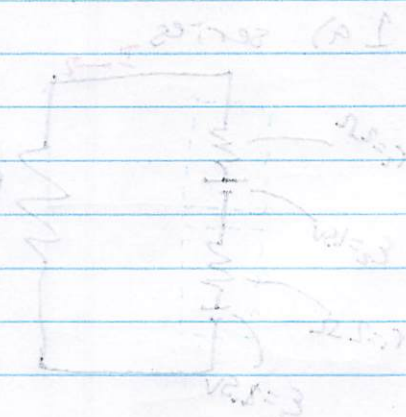
Current Resistance and DC Circuits

$$0 = 3 + 9I - 7I - 3$$

$$9I + 7I = 3 + 3$$

$$(9 + 7)I = 3 + 3$$

$$I = \frac{3 + 3}{9 + 7} = \frac{6}{16} = 0.375 \text{ A}$$

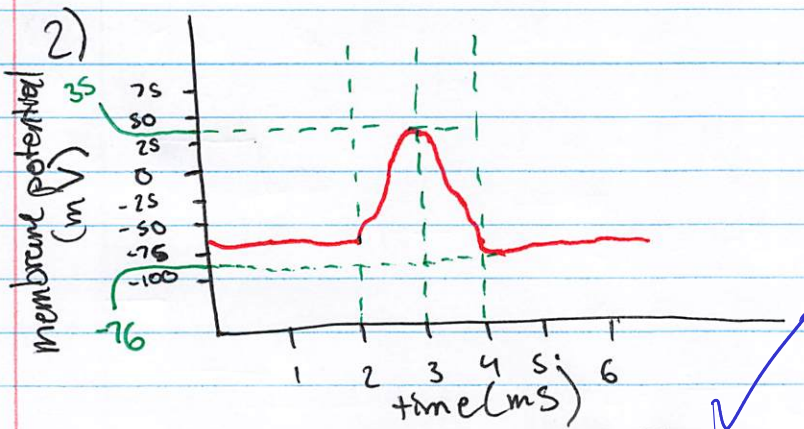


parallel because resistors are in parallel

$$I = \frac{V}{R} = \frac{20}{10} = 2 \text{ A}$$

$$W_{max} = P = (I^2 R) = (2^2 \times 10) = 40 \text{ W}$$

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a) pulse width $\approx 2 \text{ ms}$ 2 ms

b) top peak = 35 mV
bottom peak = -76 mV

$$35 - (-76) = 35 + 76 = 111 \text{ mV}$$

$V_{m25} = 25 \text{ mV}$ (d)
 $V_{m25} = 25 \text{ mV}$ (d)

$$V_{m111} = 111 \text{ mV}$$

2 mV (e)

(e)

