upside down world!

Midterm

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Electric Charge and Electric Fields

1) a) $E_c = 2.00\times10^{-3}$ V/m at 1mm or 0.001m

E_c at 5mm (0.005m) is ?

$E_c = \frac{kq}{r^2}$ $\quad \frac{E_c r^2}{k} = q = \frac{(2.00\times10^{-3})(0.001)^2}{(9\times10^9)}$ $\quad q = 2.22\times10^{-19}$ $\quad$ ~~$q = 5.56\times10^{-18}$~~

$E_c = \frac{kq}{r^2}$ $\quad E_c = \cancel{\frac{(9\times10^9)(5.56\times10^{-18})}{(0.005)^2}}$ $\quad E_c = \frac{(9\times10^9)(2.22\times10^{-19})}{(0.005)^2} = \boxed{8\times10^{-5}\text{ V/m at 5mm}}$

b) $E_c = 8.00\times10^{-3}$ V/m $\quad q = 1\mu C$ $\quad E_c = ?$ when $q = 3\mu C$

$E_c = \frac{kq}{r^2} \rightarrow E_c = \frac{k3q}{r^2}$ $\quad$ charge is 3 times greater so E_c is 3 times greater

$(8\times10^{-3})\times3 = \boxed{24.0\times10^{-3}\text{ V/m}}$

2) Given: mass $= 4\times10^{-16}$ kg $\quad E = 6131.25$ N/C

a) $F = qE$ $\quad F = mg$ (weight) $\rightarrow mg = qE$ $\quad q = \frac{mg}{E}$ $\quad q = \frac{(4\times10^{-16})(9.8)}{6131.25}$

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

$q =$ # of electrons(n) x charge of electron(e) $\quad q = ne$

$\frac{q}{e} = n = \frac{6.39\times10^{-19}}{1.6\times10^{-19}}$ $\quad e = 1.6\times10^{-19}$ $\quad n = 3.996$ $\quad \boxed{n = 4\text{ electrons}}$

b) one e^- removed

$q - e = q_2 = 6.39\times10^{-19} - 1.6\times10^{-19} = 4.79\times10^{-19}$

$F_E = qE$

$F_g = mg$

$F_{Net} = F_g - F_E = ma$ $\quad a = \frac{F_g - F_E}{m}$ $\quad a = \frac{mg - qE}{m}$

$a = \frac{(4\times10^{-16})(9.8) - (4.79\times10^{-19})(6131.25)}{4\times10^{-16}}$ $\quad \boxed{a = 2.45\text{ m/s}^2 \text{ downwards}}$

A+ 100%

$(4\ keV, 8\ keV)$

Potential Energy and Voltage, Capacitance

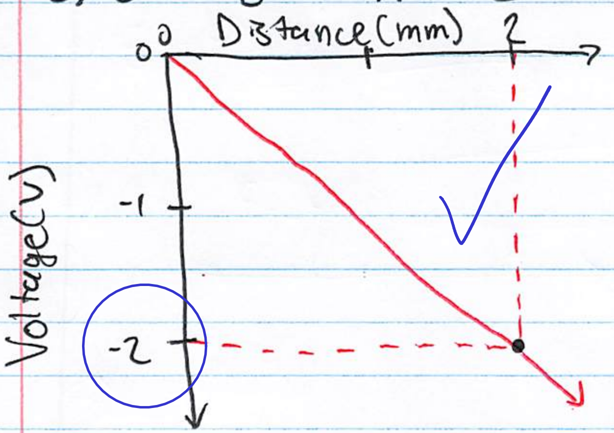
1) Given: $\Delta V = 4kV$ $\quad H = +1q_e$ $\quad He = +2q_e$ $\quad 1J = 6.242 \times 10^{18} eV$

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

hydrogen $KE = (1.6\times10^{-19})(4\times10^{3}) = 6.4\times10^{-16} J \times \frac{6.242\times10^{18} eV}{1J} = \boxed{3995 eV}$ hydrogen

helium $KE = 2(1.6\times10^{-19})(4\times10^{-3}) = 12.8\times10^{-16} J \times \frac{6.242\times10^{18} eV}{1J} = \boxed{7990 eV}$ helium

2) Given $E = 1kV/m$ $\quad \Delta x = 2mm$



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

well done

m (slope) = -1000 V/m
or
-1 V/mm

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

b) $E = m\frac{\Delta V}{\Delta x} = m\frac{(4\times10^{3})}{(5\times10^{-2})}$

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

3) a) $C = \frac{\varepsilon_0 A}{d}$ $\quad \varepsilon_0 = 8.85\times10^{-12}$ $\quad A = 1cm^2 \times \frac{1m}{100cm} \times \frac{1m}{100cm} = 1\times10^{-4} m^2$

$C = \frac{(8.85\times10^{-12})(1\times10^{-4})}{2\times10^{-3}} = \boxed{4.425\times10^{-13} F}$

b) $Energy = \frac{1}{2}CV^2 = \frac{1}{2}(4.425\times10^{-13})(5^2) = \boxed{5.53\times10^{-12} J}$

4) $C_{tot} = C_1 + C_2$ in parallel $\qquad \frac{1}{C_{tot}} = \frac{1}{C_1} + \frac{1}{C_2}$ in series

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

$\boxed{\text{parallel}}$

Potential Energy and Voltage, Capacitance

1) Given: $\Delta V = 4\,MeV$ $\quad H = +1q_e \quad He = +2q_e \quad 1J = 6.242\times10^{18}\,eV$

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

Hydrogen $KE = (1.6\times10^{-19})(4\times10^{6}) = 6.4\times10^{-13}\,J \times \frac{6.242\times10^{18}\,eV}{1J} = \boxed{3995\,eV}$ hydrogen

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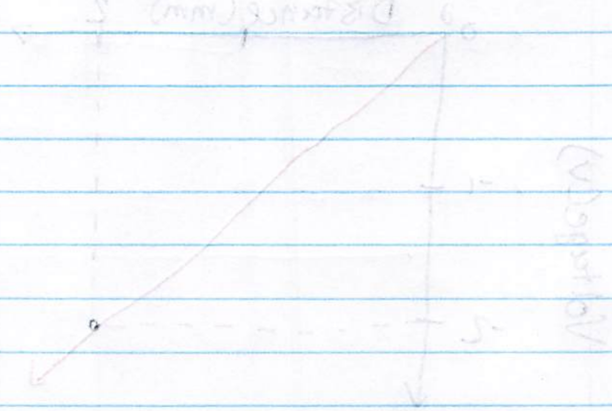
2) Given $E = 1\,kV/m \quad \Delta x = 2\,mm$



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

m(slope) = $-1000\,V/m$
or
$-1\,V/mm$

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

b) $E = -\frac{\Delta V}{\Delta x} \rightarrow m$

$\boxed{E = -1\times10^{3}\,V/m}$ negative

3) a) $C = \frac{\varepsilon_0 A}{d} \quad \varepsilon_0 = 8.85\times10^{-12} \quad A = 1cm^2 \times \frac{1m}{100cm} \times \frac{1m}{100cm} = 1\times10^{-4}\,m^2$

$$C = \frac{(8.85\times10^{-12})(1\times10^{-4})}{2\times10^{-3}} = \boxed{4.425\times10^{-13}\,F}$$

b) $Energy = \frac{1}{2}CV^2 = \frac{1}{2}(4.425\times10^{-13})(5^2) = \boxed{5.53\times10^{-12}\,J}$

4) $C_{tot} = C_1 + C_2$ in parallel $\quad \frac{1}{C_{tot}} = \frac{1}{C_1} + \frac{1}{C_2}$ in series

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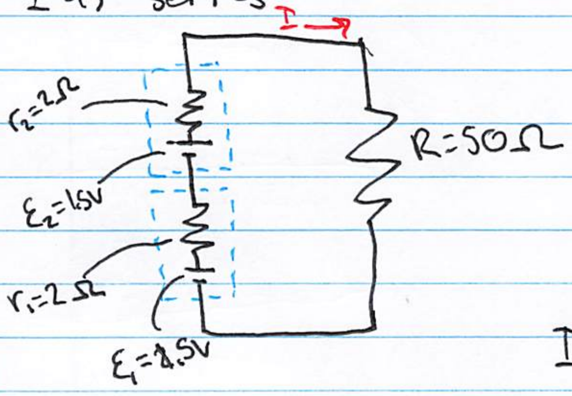
$\boxed{\text{parallel}}$

Current, Resistance, and DC circuits

1 a) series



$\varepsilon_1 + \varepsilon_2 + \ldots = 0$

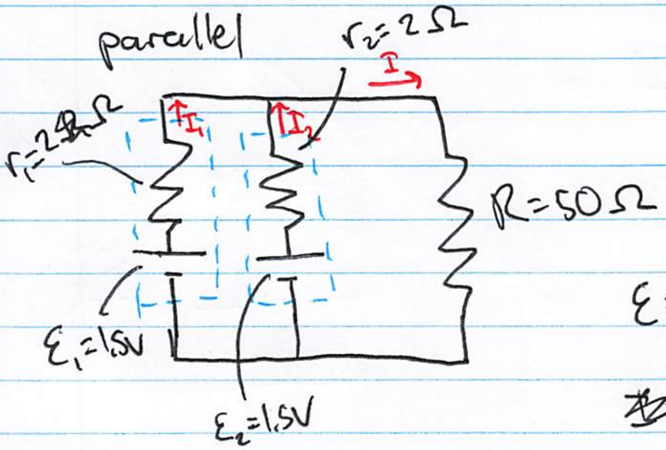
$\varepsilon_1 - Ir_1 - Ir_2 - IR + \varepsilon_2 = 0$

$\varepsilon_1 + \varepsilon_2 = Ir_1 + Ir_2 + IR$

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

$I = \dfrac{\varepsilon_1 + \varepsilon_2}{r_1 + r_2 + R} = \dfrac{1.5 + 1.5}{2 + 2 + 50} = \boxed{55.6\,mA \text{ series}}$

parallel



~~$I_1 + I_2 = I$~~

$I_1 + I_2 = I$

$\varepsilon = 1.5V$ because batteries are in parallel

$I = \dfrac{V}{R}$ $\quad I = \dfrac{1.5}{50} = 30\,mA$

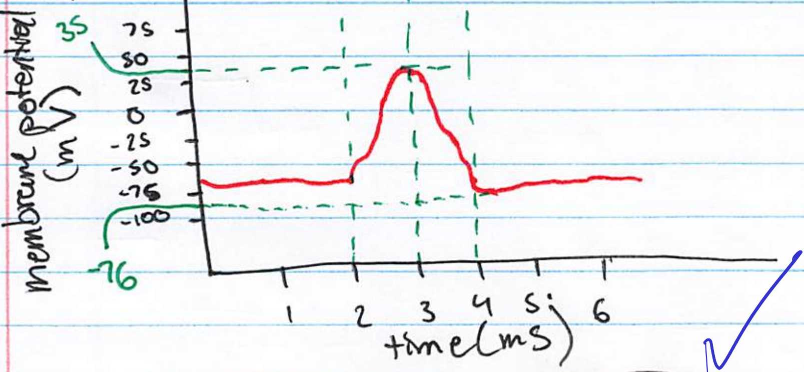
b) series $P = IV$ $\quad P = (55.6 \times 10^{-3})(3) = \boxed{166.8\,mW}$

$V_{tot} = V_1 + V_2$

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

$V_{tot} = 1.5V$

2)



a) pulse width ≈ ~~2ms~~ $\boxed{2\,ms}$

b) top peak = 35 mV

bottom peak = -76 mV

$35-(-76)$

$35+76 = \boxed{111\,mV}$