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2 Electric Charge & Electric Fields

a) physics Midterm

1. $E_c = 200 \times 10^{-3}$ V/m @ 1mm $= 10^{-3}$ m

$E_c = \dfrac{Kq}{r^2}$ $K = \dfrac{1}{4\pi\varepsilon_0}$ or 9×10^9 Nm

10^{-6} × $2 \times 10^{-3} = \dfrac{(9 \times 10^9)q}{(10^{-3})^2} \times 10^{-6}$

$\dfrac{(10^{-6})(2 \times 10^{-3})}{(9 \times 10^9)} = \dfrac{(9 \times 10^9)q}{(9 \times 10^9)}$

$2.22 \times 10^{-19} c = q$

$E_c = \dfrac{Kq}{r^2} = \dfrac{(9 \times 10^9)(2.22 \times 10^{-19})}{(5 \times 10^{-3})^2}$

$\boxed{E_c = 8.00 \times 10^{-5} \text{ V/m}}$

b) 1µC $E_c = 8.00 \times 10^{-3}$ V/m   1µC $= 1 \times 10^{-6}$

$\dfrac{r^2 \times E_c}{E_c} = \dfrac{Kq}{r^2} \times \dfrac{r^2}{E_c} = r^2 = \dfrac{Kq}{E_c}$ = $r = \sqrt{\dfrac{Kq}{E_c}}$

$r = \sqrt{\dfrac{(9 \times 10^9)(1 \times 10^{-6})}{(8.00 \times 10^{-3})}}$ = 1060.66m

3µC $E_c = \dfrac{Kq}{r^2}$ $\dfrac{(9 \times 10^9)(3 \times 10^{-6})}{(1060.66m)^2}$

$E_c @ 3µC = \boxed{2.40 \times 10^{-2} \text{ V/m}}$

2. mass $= 4 \times 10^{-16}$ kg   Efield ↓ 6131.25 N/C

a) $\dfrac{4 \times 10^{-16}}{9.1 \times 10^{-31} \text{kg}}$ = 4.396×10^{14} ≈ $\boxed{4.40 \times 10^{-14} \text{ electrons}}$

b) $q = \#$ of e × e $4.396 \times 10^{14} \times 1.6 \times 10^{-19} = 7.033 \times 10^{-5}$

$q_e = 1.6 \times 10^{-19}$ C $\dfrac{qE}{m} = \dfrac{ma}{m}$ $a = \dfrac{qE}{m}$

$a = \dfrac{(7.033 \times 10^{-5})(6131.25)}{(4 \times 10^{-16})}$

$\boxed{a = 1.08 \times 10^{15} \text{ m/s}^2}$
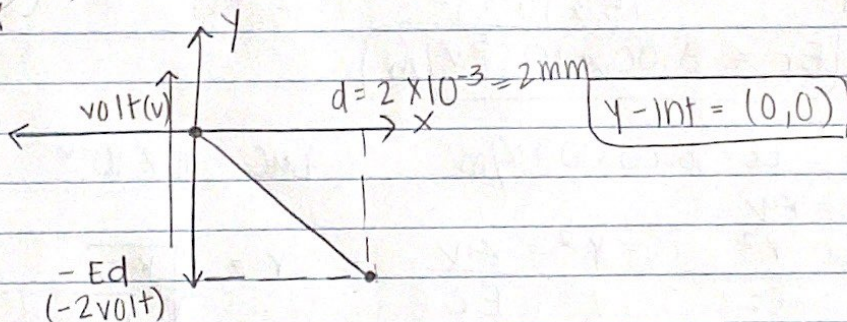
Potential Energy & Voltage, Capacitors

1. a) $KE = qV$ $q_e = 1.6 \times 10^{-19} C$ $4kV = 4 \times 10^3 V$

K Hydrogens $= (1.6 \times 10^{-19})(4 \times 10^3) = \boxed{6.4 \times 10^{-16} J}$

K helium $= (2)(1.6 \times 10^{-19})(4 \times 10^3) = \boxed{12.8 \times 10^{-16} J}$

b) $E = \dfrac{\Delta V}{\Delta X} = \dfrac{4 \times 10^3}{5 \times 10^{-2}} = \boxed{8.00 \times 10^4 V/m}$

2. $E = 1 kv/m$ $r = 2mm = X$

$E = 1000 v/m$

$X \times E = \dfrac{-dV}{dx} \times X$ $X \times E = -V$ $V = (-X)(E)$

$d = 2 \times 10^{-3} = 2mm$ $\boxed{y-\text{Int} = (0,0)}$

$-Ed$
$(-2 volt)$

3. a) area $= 1 cm^2$

$C = \dfrac{\varepsilon_0 A}{d} = \dfrac{(8.85 \times 10^{-12})(1 \times 10^{-4})}{2.00 \times 10^{-3}} = \boxed{4.43 \times 10^{-13} F}$

b) voltage $= 5V$

$V_c = \frac{1}{2} CV^2 = \frac{1}{2}(4.43 \times 10^{-13})(5)^2 = \boxed{5.53 \times 10^{-12} J}$

4. We should connect another capicitor in parallel because
$C_{tot} = C_1 + C_2 + C_3$ ... for parallel circuits, while series is
$C^{-1}_{tot} = C_1^{-1} + C_2^{-1} + C_3^{-1}$ which makes the total smaller
because it is $\%_3$.

Current, Resistance, & DC circuits.

1. $r_1 = r_2 = 2\Omega$ $\varepsilon_1 = \varepsilon_2 = 1.5V$ $R = 50\Omega$

$\boxed{\text{series}}$ $\varepsilon_{total} = \varepsilon_1 + \varepsilon_2 = 3v$

$r_{total} = r_1 + r_2 = 4\Omega$

$I = \dfrac{3V}{4\Omega + 50\Omega} = \dfrac{3}{54} = \boxed{0.055A}$

parallel

$$\varepsilon_{eq} = \frac{\varepsilon_1 r_2 + \varepsilon_2 r_1}{r_1 + r_2} = \frac{1.5 \times \overset{3}{2} + 1.5 \times \overset{3}{2}}{2 + 2 \quad 4} = 1.5v$$

$$r_{eq} = \frac{(r_1)(r_2)}{r_1 + r_2} \Rightarrow \frac{(2)(2)}{2+2} = 1\Omega$$

$$I = \frac{1.5}{1\Omega + 50\Omega} = \boxed{0.03A}$$

b) series case = power consumption $\quad = P = VI \quad P = 3v \times 0.055A$
$$P = 0.165 Watts$$

parallel case = $P = VI \quad P = 1.5V \times 0.03A$
$$P = 0.045 watts.$$

2. a) when looking at the graph for action potential (K^+, Na^+ ion channels, the pulse width is $\boxed{2ms}$

b) the peak to peak voltage is: $+40mv - (-75mv) = \boxed{115mv}$