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yay!

2 Electric Charge & Electric Fields

a) physics Midterm

1. $E_C = 2.00 \times 10^{-3}$ V/m @ 1mm = 10^{-3} m

$E_C = \frac{kq}{r^2}$ $k = \frac{1}{4\pi\varepsilon_0}$ or 9×10^9 Nm

$10^{-6} \times\ 2 \times 10^{-3} = \frac{(9\times10^9)q}{(10^{-3})^2} \times 10^{-6}$

$\frac{(10^{-6})(2\times10^{-3})}{(9\times10^9)} = \frac{(9\times10^9)q}{(9\times10^9)}$

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

$E_C = \frac{kq}{r^2} = \frac{(9\times10^9)(2.22\times10^{-19})}{(5\times10^{-3})^2}$

$\boxed{E_C = 8.00 \times 10^{-5} V/m}$ ✓

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

$\frac{r^2 \times E_C}{E_C} = \frac{\frac{kq}{r^2} \times r^2}{E_C} = r^2 = \frac{kq}{E_C} = r = \sqrt{\frac{kq}{E_C}}$

$r = \sqrt{\frac{(9\times10^9)(1\times10^{-6})}{(8.00\times10^{-3})}} = 1060.66m$

3μC $E_C = \frac{kq}{r^2}$ $\frac{(9\times10^9)(3\times10^{-6})}{(1060.66m)^2}$

$mg = qE$ E_C @ 3μC = $\boxed{2.40 \times 10^{-2} V/m}$ ✓

4 Excess electrons

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

a) $\frac{4\times10^{-16}}{9.1\times10^{-31} kg} = 4.396 \times 10^{14} \approx \boxed{4.40\times10^{-14} \text{ electrons}}$ −1/2

b) q = # of e × e $4.396\times10^{14} \times 1.6\times10^{-19} = 7.033\times10^{-5}$

$q_e = 1.6\times10^{-19}C$ $\frac{qE}{m} = \frac{ma}{m}$ $a = \frac{qE}{m}$

$a = \frac{(7.033\times10^{-5})(6131.25)}{(4\times10^{-16})}$

−1/2 $\boxed{a = 1.08 \times 10^{15} m/s^2}$ → unphysical

Potential Energy & Voltage, Capacitors

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

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

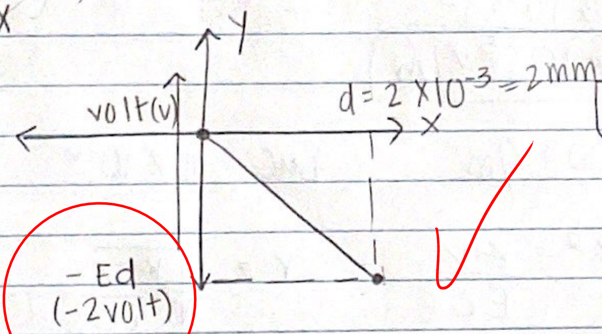
K helium $= (2)(1.6 \times 10^{-19})(4 \times 10^3) = \boxed{12.8 \times 10^{-16}\,J}$

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

2. $E = 1kV/m \quad r = 2mm = x$

$E = 1000\,V/m$

$x \times E = -\frac{dV}{dx} \times x \qquad X \times E = -V \qquad V = (-X)(E)$



$\boxed{y\text{-int} = (0,0)}$

Well done

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

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

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 $C/3$.

Current, Resistance, & DC circuits

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

series $\Rightarrow \varepsilon_{total} = \varepsilon_1 + \varepsilon_2 = 3V$

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

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

parallel

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

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

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

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

$P = 0.165$ 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: $+40mV - (-75mV) = \boxed{115mV}$