Midterm PHYS130B Module 2

Lexy Clark
20630185

(2) 1a) $E = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$

$r = 1mm$ $\quad 2\times10^{-3} = \frac{1}{4\pi\varepsilon_0}\frac{q}{(1\times10^{-3})^2}$

$E = 2\times10^{-3}$ $\quad 2\times10^{-3}\times1\times10^{-6} = \frac{q}{4\pi\varepsilon_0}$

$r = 5mm$ $\quad E = \frac{1}{4\pi\varepsilon_0}\frac{q}{(5\times10^{-3})^2}$

$2\times10^{-3}\times10^{-6}\cdot\frac{1}{25\times10^{-6}}$

$E = 0.08\times10^{-3} \longrightarrow \boxed{8\times10^{-5}\ \frac{V}{C}}$

1b) $E = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$

$q = 1\mu C$ $\quad 8\times10^{-3} = \frac{1}{4\pi\varepsilon_0}\cdot\frac{1\times10^{-6}}{r^2}$

$E = 8\times10^{-3}\frac{V}{C}$ $\quad 8\times10^{3} = \frac{1}{4\pi\varepsilon_0 r^2}$

$q = 3\mu C$ $\quad E = \frac{1}{4\pi\varepsilon_0}\frac{3\times10^{-6}}{r^2}$

$E = 8\times10^{3}\times3\times10^{-6}$

$\boxed{E = 24\times10^{-3}\ N/C}$

2a)

$m = 4\times10^{-16}\ kg$

E-field = 6131.25 N/C

charge = q

$qE = mg \Rightarrow q = \frac{mg}{E} = \frac{4\times10^{-16}\times9.8}{6131.25} = 6.393480\times10^{-19}$

$q = ne$

$\frac{q}{e} = n$ $\quad n = 3.9959 \approx \boxed{4\ electrons}$

2b) $q = q - e = 4.793476045\times10^{-19}$

$(F_e) = q'E$

$= 2.939\times10^{-15}\ N$

$m' = m - m_e \approx 4.0\times10^{-16}$

$m_e = 9.1\times10^{-31}\ kg$

$F_g = m'g = 3.92\times10^{-5}\ N$

$a = \frac{F_g - F_e}{m}$

$\boxed{a = 2.4525\ m/s^2}$

(3) 1a) $KE = qV$ $\Delta V = 4\,kV$ $H = +1e$ $He = +2e$

$KE_{hydrogen} = 1.6 \times 10^{-19} \times 4 \times 10^{3} = \boxed{6.4 \times 10^{-16}\,J}$ - Hydrogen

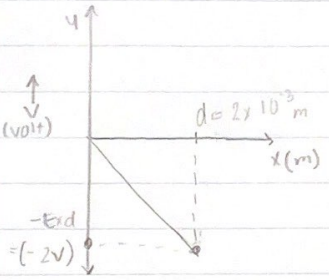
$KE_{He} = 2 \times 10^{-19} \times 4 \times 10^{3} = \boxed{12.8 \times 10^{-16}\,J}$ - Helium

1b) $E = \frac{\Delta V}{\Delta x} = \frac{4 \times 10^{3}}{5 \times 10^{-2}} = \boxed{8 \times 10^{4}\ V/m = E\text{-field}}$

$\Delta x = 5\,cm$

2) $E = 1\,kV/m \rightarrow E = 1000\ V/m$

as $E = \frac{-dv}{dx}$ or $V = -E \times x$



Slope = m = - 1000 V/m

The y-intercept of the function is 0 (zero) as the graph starts from the origin.

3a) $C = \frac{\varepsilon_0 A}{d} = \frac{8.85 \times 10^{-12} \times 10^{-4}}{2 \times 10^{-3}} = \boxed{4.425 \times 10^{-13}\,F}$

$A = 1\,cm^2$

$V = 5\,V$

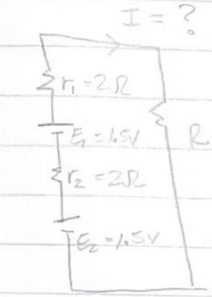
3b) $Energy = \frac{1}{2} CV^2 = \frac{1}{2} \times 4.425 \times 10^{-13} \times 25 = \boxed{55.31 \times 10^{-13}\,J}$

4a) For more capacitance we should connect the identical capacitors in parallel, because capacitance gets added up in parallel combination.

4b) $C_{net} = C_1 + C_2 = 2C$

$4.425 \times 10^{-13} + 4.425 \times 10^{-13} = \boxed{8.85 \times 10^{-13}\,F}$

(4) 1a)

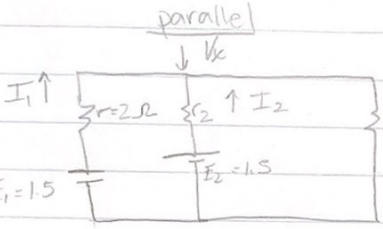


Series

$-E_2 + Ir_2 + Ir_1 - E_1 + IR = 0$

$-1.5 + I(r_1 + r_2 + R) - 1.5V = 0$

$I = \frac{3V}{r_1 + r_2 + R} = \frac{3}{2+2-50} = \frac{3}{54} = \boxed{55.56\,mA}$



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

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

$51V_r = 75 \quad \boxed{V_r = 1.47\,V}$

$I_1 = \frac{1.5 - 1.47}{2\Omega} = 15\,mAmp$

$I = I_1 + I_2$

$= \boxed{30\,mA}$

$I_2 = \frac{1.5 - 1.47}{2} = 15\,mAmp$

1b) Series power consumption

$P_{total} = P_{r1} + P_{r2} + P_R$

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

$= (55.56\,mA)^2 \times 2 + (55.56\,mA)^2 \times 2 + (55.56\,mA)^2 \times 50$

$= 6.17\,mW + 6.17\,mW + 154.34\,mW$

$= \boxed{777.51\,mW}$

$R \rightarrow \boxed{P_R = 154.34\,mW}$

Parallel power consumption

$P_{total} = P_{r1} + P_{r2} + P_R$

$= I_1^2 r_1 + I_2^2 r_2 + I^2 R$

$= (15m)^2 \times 2 + (15m)^2 \times 2 + (30m)^2 \times 50$

$= 0.45\,mW + 0.45\,mW + 45\,mW$

$= \boxed{45.9\,mW}$

$R \rightarrow P_R = I^2 R = (30m)^2 \times 50$

$= \boxed{45\,mW}$

2a) Pulse width = 2ms

2b) = 30 - (-75)

30 + 75 = 105mV Vpeak-peak

2c) It would take approximately 20-24 ms for the signal to travel from the toe to the spinal cord.