Midterm Physics

2. Electric charge & Electric fields

a) $E = \frac{1}{4\pi\varepsilon_0} \frac{q}{r^2}$ $r = 1mm$ $E = 2 \times 10^{-3}$

$2 \times 10^{-3} = \frac{1}{4\pi\varepsilon_0} \frac{q}{(1 \times 10^{-3})^2}$

$2 \times 10^{-3} \times 1 \times 10^{-6} = \frac{q}{4\pi\varepsilon_0}$

$r = 5mm$ $E = \frac{1}{4\pi\varepsilon_0} \frac{q}{(5 \times 10^{-3})^2}$

$2 \times 10^{-3} \times 10^{-6} \cdot \frac{1}{25 \times 10^{-6}}$

$E = 0.08 \times 10^{-3} = \boxed{8 \times 10^{-5} \frac{v}{c}}$

b) $E = \frac{1}{4\pi\varepsilon_0} \frac{q}{r^2}$ $q = 1\mu C$ $E = 8 \times 10^{-3} \frac{v}{c}$

$8 \times 10^{-3} = \frac{1}{4\pi\varepsilon_0} \cdot \frac{1 \times 10^{-6}}{r^2}$

$8 \times 10^{-3} = \frac{1}{4\pi\varepsilon_0 r^2}$

$q = 3\mu C$ $E = \frac{1}{4\pi\varepsilon_0} \frac{3 \times 10^{-6}}{r^2}$

$E = 8 \times 10^{3} \times 3 \times 10^{-6}$

$E = 24 \times 10^{-3} N/C$

2a) $m = 4 \times 10^{-16} kg$ E-field = 6131.25 N/C

charge = q $qE = mg \Rightarrow q = \frac{mg}{E}$

$\frac{4 \times 10^{-16} \times 9.8}{6131.25} = 6.393 \times 10^{-19}$

$q = ne \div \frac{q}{e} = n$ $n =$ 4 electrons

b) $q = q - e = 4.793 \times 10^{-19}$
$(Fe) = a^1 \xi = 2.939 \times 10^{-15}$

$m' = m - ne \approx 4.0 \times 10^{-16}$ kg
$me = 9.1 \times 10^{-31}$ kg
$F_g = m'g = 3.92 \times 10^{-9} N$

$\frac{Fg - Fe}{m} =$

$a = 2.452 \, m/s^2$

3. Potential Energy & Voltage, capacitors

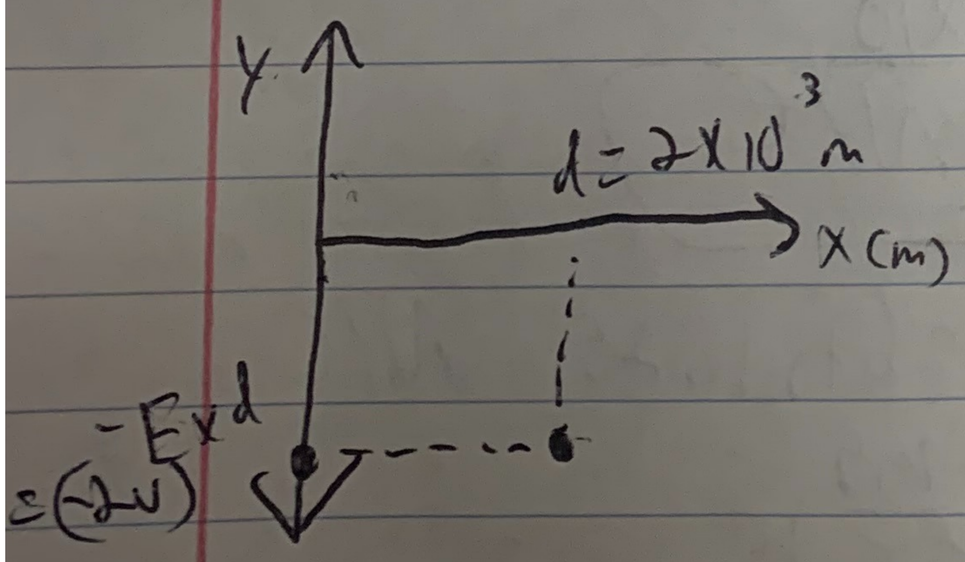
(a) $KE = qV$ $\Delta V = 4$ kV $H = +1e$ $He = +2e$

KE hydrogen $= 1.6 \times 10^{-19} \times 4 \times 10^{-3} =$ 6.4×10^{-22} J hydrogen

KE He $= 2 \times 10^{-19} \times 4 \times 10^{3} =$ 12.8×10^{-16} J helium

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

2. $E = 1$ kV/m $= E = 1000$ V/m $V = -E$ vx



Slope $= -1000$ V/m

y-intercept $= 0$ as it begins from 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. $1\ cm^2$ $V = 5V$

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

4a) Connect an identical capacitor in parallel because it adds up in a parallel combination

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

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

4. Current, Resistance, & DC Circuits

1a) $-E_2 + Ir_2 + Ir_1 - E_1 + IR = 0$

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

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

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

$25V_r - 37.5 + 25V_r - 37.5 + V_r = 0$

$51V_r = 75$

$\boxed{V_r = 1.47V}$

$I_1 = \frac{1.5 - 1.47}{2\Omega} = 15mAmp$ $I_2 = \frac{1.5 - 1.47}{2} = 15mAmp$

$I = I_1 + I_2 = \boxed{30mA}$

b) Series P.C $P_{total} = P_{r1} + P_{r2} + P_R$

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

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

$= 6.17mW + 6.17mW + 154.34mW$

$= \boxed{172.51mW}$ R -> $\boxed{P_r = 154.34mW}$

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

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

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

$= 0.45mW + 0.45mW + 45mW = \boxed{45.9mW}$

R -> $P_R = I^2 R = (30m)^2 \times 50$ $\boxed{45mW}$

2a) Pulse width = 2ms

b) $30 - (-75) = 30 + 75 = \boxed{105 V_{P-P}}$ $V_{peak-peak}$

Should take from 20-24ms for a nerve signal to travel from your toe to your Spinal Cord