Physics Midterm

1a) $F = \frac{Kq_1q_2}{r^2}$ $F = 2.00 \times 10^{-3}$ J/m at 1mm
K = Coulomb constant: 8.98755×10^9

$$2.00 \times 10^{-3} = \frac{(8.98755 \times 10^9)(q_1)}{(1 \times 10^{-3})^2}$$

$$q_1 = 2.2253 \times 10^{-14}$$

For 5 mm

$$F = \frac{(8.98755 \times 10^9)(2.2253 \times 10^{-14})}{(5 \times 10^{-3})^2}$$

$$F \approx 0.00008 = 8 \times 10^{-5} \text{ V/C}$$

1b) $q_1 = 1\mu C$ charge $F = 8.00 \times 10^{-3}$ V/m 3μC

$$8.00 \times 10^{-3} = \frac{(8.98755 \times 10^9)(1 \times 10^{-6})}{r^2}$$

$$r \approx 1059.92 = 1.060 \times 10^4$$

$$F = \frac{(8.98755 \times 10^9)(3 \times 10^{-6})}{(1.060 \times 10^4)^2}$$

$$\approx 0.0002394 = 24 \times 10^{-3} \text{ N/C}$$

2a) mass (m) $= 4 \times 10^{-16}$ kg
Electric Field $= 6131.25$ N/C

$qE = mg \quad q = \frac{mg}{E} = \frac{4 \times 10^{-16} \times 9.81}{6131.25}$

$= 6.39348 \times 10^{-19}$

$\frac{q}{e} = n \quad n = 3.996 \approx 4$

2b. $mg - qoE = ma \rightarrow a = \frac{mg - qoE}{m}$

$qo = (4+1)(1.6 \times 10^{-19} C)$
$= 4.3 \times 10^{-19} C$

$$\frac{(4 \times 10^{-16} \times 9.81) - (4.3 \times 10^{-19} \times 6131.25)}{4 \times 10^{-16}}$$

$a) = 2.45 \ m/s^2$

3. Potential Energy and Voltage, Capacitors

$q_e = 1.6 \times 10^{-19}$ C

1a) = KE = qV 4 kV

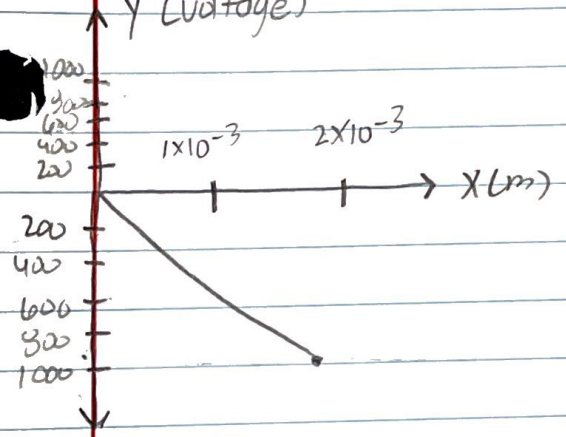
$KE_{(Hydrogen)} = (1.6 \times 10^{-19})(4 \times 10^3) = 6.4 \times 10^{-16}$ J

$KE_{(Helium)} = (3.2 \times 10^{-19})(4 \times 10^3) = 1.28 \times 10^{-15}$ J

1b) $E = \frac{V}{X} = \frac{(4 \times 10^3)}{(5 \times 10^{-2})} = 8 \times 10^4$ V/m

2. E-field = 1 KV/m Plate separation: 2mm

E = 1000 kV/m



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

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

3b) $\frac{1}{2} CV^2 = \frac{1}{2}(4.425 \times 10^{-13})(25)$ $(5)^2 = 25$

$= 55.31 \times 10^{-13}$ J

4a) The identical capacitors should be in parallel

4b) The formula for capacitors in parallel is $C_{tot} = C_1 + C_2 + C_3$

so total energy is $3 \times 4.425 \times 10^{-13} = 1.3275 \times 10^{-12}$

4. Current, Resistance, and DC Circuits

1a) Serial case

$V_B - V_1 - V_{B_2} - V_2 - V_3 = 0$

$1.5V - 2I + 1.5V - 2I - 50I = 0$

$3V - 54I = 0$

$+54I \quad +54I$

$\frac{3V}{3} = \frac{54I}{3}$

$I = .055\ A$

Parallel case

$\frac{25V - 37.5 + 25V - 32.5 + V = 0}{50}$

$= 1.47$

$\frac{1.5 - 1.47}{2} = .015\ A$

$.015A + .015A = .030\ A$

$P_{tot} = P_1 + P_2 + P_R$

$= (.055)^2 \times 2 + (.055)^2 \times 2 + (0.55A)^2 \times (50)$

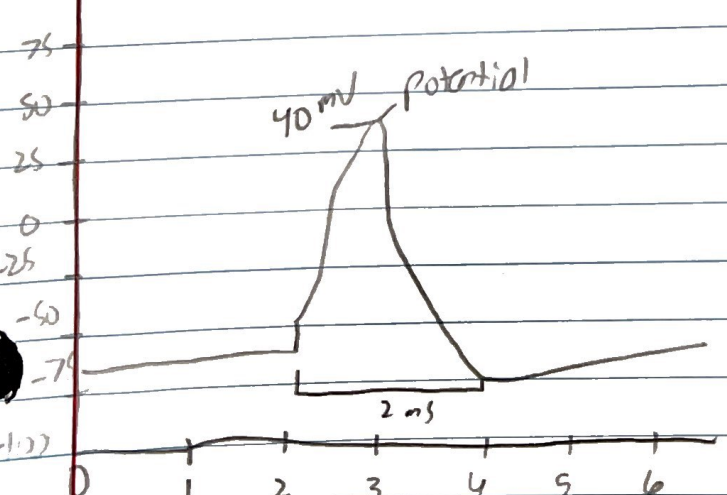
$= .164\ W$

$(.20)^2 (50)$

$= .045\ W$

2.

a) The pulse width in milliseconds is 2 ms



b) Peak to peak voltage:

$40 - (-75)$

$40 + 75$

$V = 115\ mV$