2 Physics 135B Midterm 20/20 Kevin La

1.) a) $E_c = 2.00\times10^{-3}$ V/m
$r = 1mm = 10^{-3}m$

$E_c = \frac{kq}{r^2}$ $k = 9\times10^9 NC^{-2}m^2$

$q = \frac{E_c r^2}{k} = \frac{(2.00\times10^{-3} V/m)((10^{-3}_m)^2)}{9\times10^9 NC^{-2}m^2}$

$q \approx 2.22\times10^{-19} C$

E_c at $r = 5m = 5\times10^{-3} m$

$E_c = \frac{kq}{r^2} = \frac{(9\times10^9 NC^{-2}m^2)(2.22\times10^{-19}C)}{(5\times10^{-3}_m)^2}$ ✓

$\boxed{E_c = 8\times10^{-5} V/m \text{ at } 5mm}$

1.b) $q = 1\mu C$ $E_c = 8.00\times10^{-3} V/m$

$E_c = \frac{kq}{r^2}$ $k = 9.00\times10^9 Nm^2C^{-2}$

$r^2 = \frac{kq}{E_c}$ $r = \sqrt{\frac{kq}{E_c}}$

$r = \sqrt{\frac{(9\times10^9 Nm^2C^{-2})(1\times10^{-6}C)}{(8\times10^{-3} V/m)}}$

$r \approx 1060.66m$

$q = 3\mu C = 3.00\times10^{-6} C$

$E_c = \frac{kq}{r^2}$

$E_c = \frac{(9\times10^9 Nm^2C^{-2})(3\times10^{-6}C)}{(1060.66 m)^2}$ ✓

$\boxed{E_c = 24.00\times10^{-3} V/m}$

2.) a) $m = 4\times10^{-16} kg$ $E = 6131.25 N/C$ (downward)

yay!

$qE = mg$

$q = \frac{mg}{E} = \frac{4\times10^{-16}kg \times 9.8 m/s^2}{6131.25 N/C}$

$= 6.4\times10^{-19} C$

electron Charge $= 1.6\times10^{-19}C$

$q = ne$ ✓ $n = \frac{q}{e} = \frac{6.4\times10^{-19}C}{1.6\times10^{-19}C}$

$\boxed{n = 4 \text{ electrons}}$

b) $q_1 = 3\times(1.6\times10^{-19}C)$
$= 4.8\times10^{-19}C$

$mg - q_1E = ma$

$a = \frac{mg - q_1E}{m}$

$a = \frac{(4\times10^{-16}kg)\cdot(9.81 m/s^2) - (4.8\times10^{-19})(6131.25 N/C)}{(4\times10^{-16})}$

$a = 2.4525 \approx \boxed{2.50 m/s^2}$ ✓
acceleration of droplet

3

1.a) $\Delta V = 4kV$ $H = +1q_e$ $He = +2q_e$

$KE = qV$ $KE_H = (1.6\times10^{-19}C)\cdot(4\times10^3)$ ✓

$\boxed{KE_H = 6.4\times10^{-16}J}$

$KE_{He} = (2(1.6\times10^{-19}))\cdot(4\times10^3)$

$KE_{He} = \boxed{12.8\times10^{-16}J}$ ✓

b) $E = \frac{\Delta V}{\Delta x} = \frac{4.0\times10^3 V}{0.05m} = \boxed{8\times10^4 V/m}$ ✓ Electric Field

For a-b you can just use scaling

2. a) E-Field = 1 kV/m = 1000 V/m

separation = 2 mm = 2×10^{-3} m

$\mathcal{E} = \frac{-dv}{dx}$ $\quad 1000 = \frac{-\Delta V}{x}$

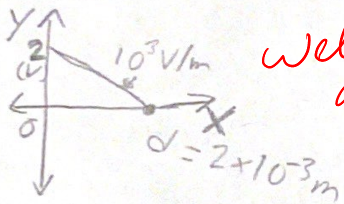
$\Delta V = 1000x$

$V - 0 = 1000x$

$V = 1000x$

$V = 1000(2\times10^{-3})$

$\boxed{V = 2 \text{ Volt } y\text{-intercept}}$



well done

3. a) $C = \frac{\varepsilon_0 A}{d}$

$C = \frac{(8.85\times10^{-12}\ F/m)\cdot(1\times10^{-4}\ m)}{(2\times10^{-3}\ m)}$

$C = 4.425\times10^{-13} = \boxed{0.4425\ pF}$ capacitance

b) $V_c = \frac{1}{2}CV^2 = \frac{1}{2}(4.425\times10^{-13}F)(5V)^2$

$\boxed{V_c = 5.53\times10^{-12} J}$ stored

4. If we wanted more capacitance we would connect the capacitors in parallel, as capacitance adds together to increase in parallel design.

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

The capacitance increases and potential difference remains the same allowing energy to increase.

$\boxed{4}$ Internal Resistance $= r_1 = r_2 = 2\Omega$

1.) Resistance (external) $= R = 50\Omega$

Emf of Batteries $= \mathcal{E}_1 = \mathcal{E}_2 = 1.5V$

a) SERIES

$\mathcal{E}_{total} = \mathcal{E}_1 + \mathcal{E}_2 = 3V$

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

SERIES

$I = \frac{3V}{4+50} = \frac{3}{54} = \boxed{55.56\ mA}$

PARALLEL

$\mathcal{E} = \frac{\mathcal{E}_1 r_2 + \mathcal{E}_2 r_1}{r_1 + r_2} = \frac{(1.5\times2)+(1.5\times2)}{2+2} = \frac{6}{4} = 1.5V$

$r = \frac{r_1 r_2}{r_1 + r_2} = \frac{4}{4} = 1$

$I = \frac{1.5}{51} = 0.02941\ A \boxed{\approx 2.94\ mA}$

PARALLEL

30 mA

b) Power Consumption

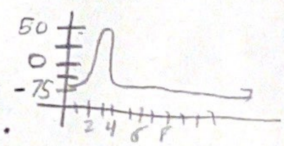
SERIES: $P = VI \Rightarrow \mathcal{E}\cdot i = 3\times0.055$

$\boxed{= 0.167\ W}$

Parallel: $P = VI \Rightarrow \mathcal{E}\cdot i = 1.5\times0.0294$

$\boxed{= .0441\ W}$

2.



a) Pulse Width in ms

$= \boxed{2\ ms}$

b) peak to peak voltage in mV

$= 40 - (-75)$

$\boxed{V_{ptp} = 40 + 75 = 115\ mV}$