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Physics 135B Midterm

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

$r = 1\,mm = 10^{-3}\,m$

$E_c = \frac{kq}{r^2} \quad k = 9 \times 10^{9}\ NC^{-2}m^{2}$

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

$q \approx 2.22 \times 10^{-19} C$

E_c at $r = 5m = 5 \times 10^{-3}\,m$

$E_c = \frac{kq}{r^2} = \frac{(9 \times 10^9 NC^{-2}m^2)(2.22 \times 10^{-19} C)}{(5 \times 10^{-3}_{m})^2}$

$\boxed{E_c = 8 \times 10^{-5}\ V/m \text{ at } 5mm}$

1.b) $q = 1\,\mu C \quad E_c = 8.00 \times 10^{-3}\ V/m$

$E_c = \frac{kq}{r^2} \quad k = 9.00 \times 10^9\ Nm^2C^{-2}$

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

$r = \sqrt{\frac{(9 \times 10^9 Nm^2 C^{-2})(1 \times 10^{-6} c)}{(8 \times 10^{-3}\ V/m)}}$

$r \approx 1060.66\,m$

$q = 3\,\mu C = 3.00 \times 10^{-6}\ C$

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

$E_c = \frac{(9 \times 10^9 Nm^2 C^{-2})(3 \times 10^{-6} C)}{(1060.66\ m)^2}$

$\boxed{E_c = 24.00 \times 10^{-3}\ V/m}$

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

$qE = mg$

$q = \frac{mg}{E} = \frac{4 \times 10^{-16} kg \times 9.8\ m/s^2}{6131.25\ N/C}$

$= 6.4 \times 10^{-19}\ C$

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

$q = ne \quad n = \frac{q}{e} = \frac{6.4 \times 10^{-19} C}{1.6 \times 10^{-19} C}$

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

b) $q_1 = 3 \times (1.6 \times 10^{-19} C)$

$= 4.8 \times 10^{-19} C$

$mg - q_1 E = ma$

$a = \frac{mg - q_1 E}{m}$

$a = \frac{(4 \times 10^{-16} kg) \cdot (9.81\ m/s^2) - (4.8 \times 10^{-19})(6131.25\ N/C)}{(4 \times 10^{-16})}$

$a = 2.4525 \approx \boxed{2.50\ m/s^2}$

acceleration of droplet

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1.a) $\Delta V = 4\,kV \quad H = +1qe \quad He = +2qe$

$KE = qV \quad KE_H = (1.6 \times 10^{-19} C) \cdot (4 \times 10^3)$

$\boxed{KE_H = 6.4 \times 10^{-16} J}$

$KE_{He} = (2(1.6 \times 10^{-19})) \cdot (4 \times 10^3)$

$KE_{He} = \boxed{12.8 \times 10^{-16} J}$

b) $E = \frac{\Delta V}{\Delta x} = \frac{4.0 \times 10^3 V}{0.05 m} = \boxed{8 \times 10^4\ V/m}$ Electric Field

2. a) E-Field = 1 kV/m = 1000 V/m
separation = 2 mm = 2×10^{-3} m

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

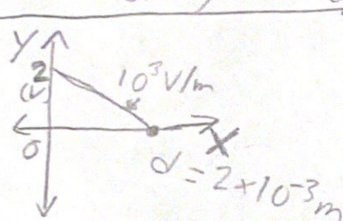
$\Delta V = 1000x$

$V - 0 = 1000x$

$V = 1000x$

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

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



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

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

capacitance

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

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 <u>parallel</u>, 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 $= r_1 = r_2 = 2\Omega$
Resistance (external) $= R = 50\Omega$

1.) Emf of Batteries $= \varepsilon_1 = \varepsilon_2 = 1.5V$

a) SERIES

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

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

SERIES

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

PARALLEL

$\varepsilon = \frac{\varepsilon_1 r_2 + \varepsilon_2 r_1}{r_1 + r_2} = \frac{(1.5\times2)+(1.5\times2)}{2+2} = \frac{6}{4} = 1.5V$

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

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

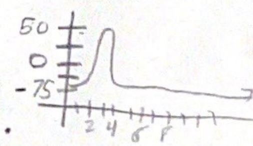
PARALLEL

b) Power Consumption

SERIES: $P = VI \Rightarrow \varepsilon \cdot i = 3\times0.055$
$\boxed{= 0.167 W}$

Parallel: $P = VI \Rightarrow \varepsilon \cdot i = 1.5\times0.0294$
$\boxed{= .0441 W}$

2.



a) Pulse Width in ms
$= \boxed{2 ms}$

b) peak to peak voltage in mV
$= 40 - (-75)$
$\boxed{V_{ptop} = 40 + 75 = 115 mV}$