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Midterm PHYS 135 B Module 2, Spring 2021

~ 2 Electric charge and Electric Fields ~

1a) $E = 2 \times 10^{-3}$

$r = 5\,mm$

$r^2 = (5mm)^2 = 25mm$

$E_c = E/r^2 = 2 \times 10^{-3} / 25 = \boxed{8 \times 10^{-5}\ V/m}$

1b) $E_c = 8 \times 10^{-5}(3) = \boxed{2.4 \times 10^{-4}\ V/m}$

2a) $q = mg/E = (4 \times 10^{-16})(9.8)/6131.25 = 6.39 \times 10^{-19}$

$n = q/e = (6.39 \times 10^{-19})/(1.6 \times 10^{-19}) = 3.99 \approx \boxed{4}$

2b) $q' = q - e = (6.39 \times 10^{-19}) - (1.6 \times 10^{-19}) = 4.79 \times 10^{-19}$

$F_e = q'E = (4.79 \times 10^{-19}) \times (6131.25) = 2.94 \times 10^{-15}\ N$

$m' = m - e = 4 \times 10^{-16}$

$F_g = m'g = (4 \times 10^{-16}) \times (9.8) = 3.92 \times 10^{-15}\ N$

$a = F_g - F_e / m'$

$(3.92 \times 10^{-15}) - (2.94 \times 10^{-15}) / (4 \times 10^{-16}) = \boxed{2.45\ m/s^2}$

~ 3 Potential Energy and Voltage, Capacitors

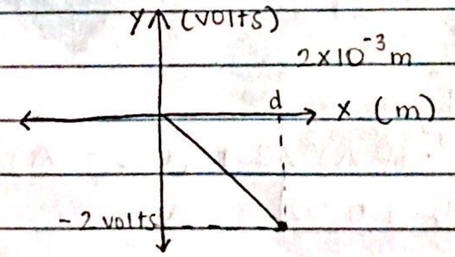
1a) $KE = qV$

(Hydrogens) $KE = 1.6 \times 10^{-19} \times (4 \times 10^3) = \boxed{6.4 \times 10^{-16}\ J}$

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

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

2)



Slope = -1000 V/m

y-int = 0

3a) $C = \varepsilon_0 A/d$

$$C = \frac{8.85 \times 10^{-12} \times 10^{-4}}{2 \times 10^{-3}} = \boxed{4.425 \times 10^{-13}\ F}$$

3b) $U_c = 1/2\, CV^2$

$U_c = 1/2 \times 4.425 \times 10^{-13} \times 25 = \boxed{5.531 \times 10^{-12}\ J}$

4) For more capacitance, you should connect an identical capacitor to the first in parallel; $C_{net} = C_1 + C_2 = 2C$

~ 4 Current, Resistance, and DC Circuits ~

1a) In series:

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

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

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

In parallel:

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

$$25\left(\frac{Vr - 1.5}{2}\right) + 25\left(\frac{Vr - 1.5}{2}\right) + \frac{Vr}{50} = 0$$

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

$$\frac{51 Vr}{51} = \frac{75}{51} \quad Vr = 1.47 \text{ volts}$$

$I_1 = 1.5 - 1.47 / 2r$ $\quad I_2 = 1.5 - 1.47/2$

$= 15\ mA$ $\quad = 15\ mA$

$I = I_1 + I_2 = 15\ mA + 15\ mA = \boxed{30\ mA}$

1b) serial case:

$P_{TOT} = I^2 r_1 + I^2 r_2 + I^2 R$

$= (0.056A)^2 \times 2 + (0.056A)^2 \times 2 + (0.056A)^2 \times 50$

$P_{TOT} = 0.17\ W = \boxed{170\ mW}$

Parallel case:

$P_{TOT} = I_1^2 r_1 + I_2^2 r_2 + I^2 R$

$= (0.015A)^2 \times 2 + (0.015A)^2 \times 2 + (0.030A)^2 \times 50$

$P_{TOT} = 0.0459\ W = \boxed{45.9\ mW}$

2a) $4\ ms - 2\ ms = \boxed{2\ ms}$

2b) $40\ mV - -75\ mV$

$40\ mV + 75\ mV$

$= \boxed{115\ mV}$

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