Well done

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Physics 135 B
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Physics Midterm

20/20

1.) a.) $E_c = \frac{KQ}{r^2}$

$$2.00\times10^{-3} = 9\times10^{9} \times \frac{q}{(0.001)^2}$$

$$q = 2.2222\times10^{-19}$$

$$E_c = \frac{(9\times10^{9})(2.2222\times10^{-19})}{(0.005)^2}$$

$$\boxed{E_c = 7.99992\times10^{-5} \text{ or } 8\times10^{-5}\ V/m}$$

b.) $E_c = 8.00\times10^{-3}$ V/m at 1 μC charge

at 3 times the charge the value of E_c will change by the same factor so,

yes!

$$8.00\times10^{-3} \times 3 = \boxed{24\times10^{-3}\ V/m}$$

"Scaling"

2.7 a.) mass = 4×10^{-16} Kg oriented downward

$E_c = 6131.25$ N/C

$F = qE$ $\quad mg = qE$ $\quad q = ne$

number of electrons

Electron charge.

$q = \frac{mg}{E}$ $\quad e = (1.6\times10^{-19})$

$$ne = \frac{(4\times10^{-16})(9.8)}{(6131.25)}$$

$$n = \frac{(4\times10^{-16})(9.8)}{(6131.25)(1.6\times10^{-19})}$$

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

b.) Remove one electron.

4 electrons total so charge is

(charge of one electron)

$6.4\times10^{-19} - 1.6\times10^{-19} = 4.8\times10^{-19} = q$

$F_E = qE$

$F_E = (4.8\times10^{-19})(6131.25) = 2.943\times10^{-15}$

$F_g = mg$

$F = ma$ $\quad F_g = (4\times10^{-16})(9.8) = 3.92\times10^{-15}$

$$a = \frac{9.77\times10^{-16}}{(4\times10^{-16})} = \boxed{2.44 \text{ m/s}^2}$$ downwards

1.) a.) $\Delta V = 4kV$

$1\,eV = 1.60218\times10^{-19}\,J$

$1J = 6.242\times10^{18}$

$U = q\Delta V \qquad U_{tot} = KE_{tot}$

hydrogen $= (1.6\times10^{-19})(4000\,V) = 6.4\times10^{-16}\,J \times 6.242\times10^{18}$

helium $= 2(1.6\times10^{-19})(4000\,V) = 1.28\times10^{-15}\,J\times 6.242\times10^{18}$

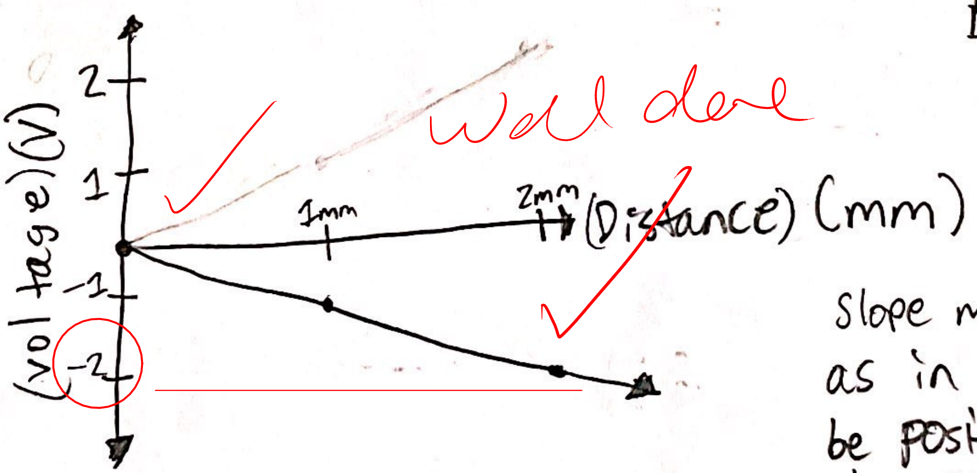
$$\boxed{\begin{aligned}\text{hydrogen} &= 3994.88\,eV\\ \text{helium} &= 7989.76\,eV\end{aligned}}$$

together would be $\boxed{11{,}984.64\,eV}$

b.) $E = -\dfrac{\Delta V}{\Delta x}$

$E = \dfrac{-4000}{0.05\,m} = \boxed{-80{,}000\ V/m}$

2.)



$E = 1\,kV/m$

$E = -\dfrac{\Delta V}{\Delta x}$

Slope must be negative as in order for E to be positive the voltage must be negative.

The y-intercept must be 0 as when distance is zero voltage must also be 0.

3.) a.) $C = \frac{\epsilon_0 A}{d}$ $\epsilon_0 = 8.85 \times 10^{-12}$

$$C = \frac{(8.85 \times 10^{-12})(0.0001\ m^2)}{(0.002)} = \boxed{4.43 \times 10^{-13}\ F}$$

b.) $E = \frac{CV^2}{2}$

$$= \frac{(4.43 \times 10^{-13})(25)}{2} = \boxed{5.54 \times 10^{-12}\ J}$$

4.) In parallel as it would be
$C = C_1 + C_2 + C_3 \ldots\ldots$ instead of the inverse
$C = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \ldots\ldots$
Parallel results in more capacitance.

1.) a.) $\overset{\downarrow \text{series}}{\varepsilon_1 + \varepsilon_2 \ldots = 0}$

$\varepsilon_1 - Ir_1 + \varepsilon_2 - Ir_2 - IR = 0$

$3V = Ir_1 + Ir_2 - IR$

$3V = I(r_1 + r_2 + R)$

$3V = I(54\,\Omega)$

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

In series $= \boxed{I = 0.0556\,A}$

b.) $\downarrow$ parallel

$I_T = I_1 + I_2$

Parallel will essentially only include one battery in the calculations.

V will only be 1.5 since it is in parallel. $I = \frac{1.5V}{50\Omega} = 0.03\,A$

$\boxed{I = 0.03\,A}$

$I = \frac{\left(\frac{1.5}{2} + \frac{1.5}{2}\right)}{50}$

b) Series

$P = IV$

$P = (0.0556)(3)$

$\boxed{P_{total} = 0.1668\ W}$ ✓

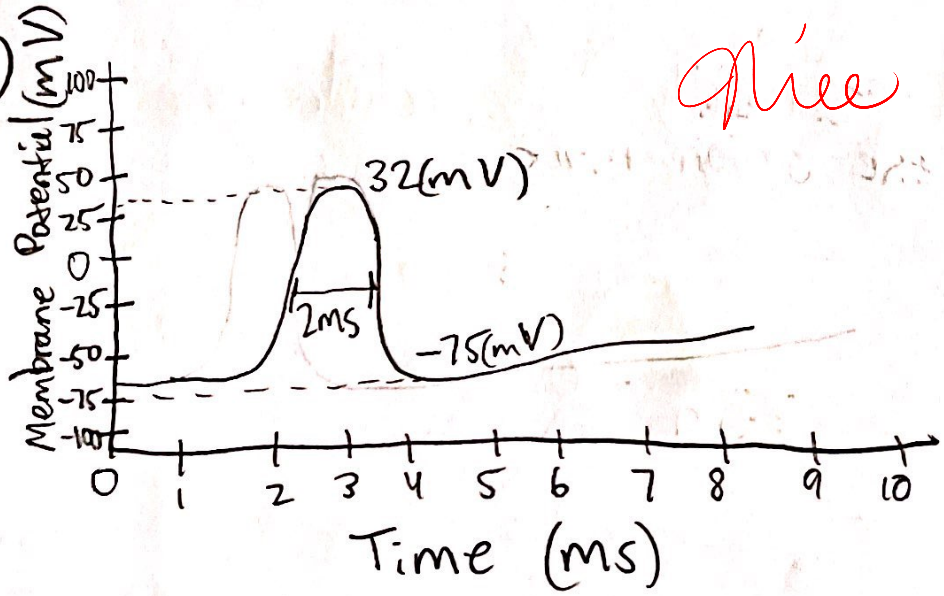
Parallel

$P = IV$ ← Since it is in parallel only 1.5 volts.

$P = (0.03)(1.5)$

$\boxed{P_{total} = 0.045\ W}$ ✓

2.)



Nice

a.) Pulse width is 2 ms.

b) Greatest Voltage = 32 mV ✓

Least voltage = -75 mV

$32 + 75 =$

$\boxed{107\ mV}$

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