Midterm

°the pretty, neat, final version

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section 2 - Electric Charge & Electricfield

19/20

Well done

#1a) What's the value of E_c @ 5mm.

What I know
- $E = 2\times10^{-3}$

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

*scaling problem $E_c = \frac{E}{r^2}$

$= \frac{2\times10^{-3} \text{ v/m}}{25mm}$

$\boxed{E_c = 8\times10^{-5} \text{ v/m}}$ ✓

#1b) What's E_c value at the same distance w/ charge = $3\mu C$?

$E = (8\times10^{-5} \text{ v/m})(3\mu C)$

$\boxed{E_c = 2.4\times10^{-4} \text{ v/m}}$ ✓

#2a) Millkman Oil drop. How many electrons are in the drops?

$W = m*g$ mass $= \rho v$ mass(m) $= 4\times10^{-16}$ kg

E-field = 6131.25 N/C

$qE = mg$ $q = \frac{mg}{E} = \frac{(4\times10^{-16})(9.8)}{6131.25 \text{ N/C}}$ ✓

$q = 6.39347604\times10^{-19}$ $\rightarrow \frac{q}{e} = \frac{e}{e} = n$

$\frac{q}{e} = n$

$n = 3.978 = \boxed{4} = n$ ☆answer

Question 2b]

Suppose a cosmic ray comes along.....

$q' = q - e = 4.7934760 \times 10^{-19}$

Electrostatic force $= (F_e) = q'E = 2.94 \times 10^{-15}$

$m' = m - e = 4.0 \times 10^{-16}$ *no impact

Grav. Force

$\hookrightarrow F_g = m'g = 3.92 \cdot 10^{-15} N$

acceleration $= a = \frac{F_g - F_e}{m}$

$$\frac{(3.92 \times 10^{-15} N) - (2.94 \times 10^{-15} N)}{(4.0 \times 10^{-16} kg)}$$

$\boxed{a = 2.46 m/s^2}$ ✓

Section 3 - Potential Energy & Voltage Capacitor

Question 1

a) $KE = q*V$ $\Delta V =$

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Section 3 - Potential Energy & Voltage Capacitator

Question 1

a) $KE = q * V$

$\Delta V = 4KV$

$4KV = 4000V$

Hydrogens = +1 qe

He ions = +2e

$-\frac{1}{2}$

Hydrogen = $K.E = (1.6 \times 10^{-19} C) * 4KV$

$= KE = \boxed{6.4 \times 10^{-19} eV}$ $\times 10^3$

Helium = $K.E = (3.2 \times 10^{-19} c) * 4KV$

$-\frac{1}{2}$

$(1.6 \times 10^{-19}) \times 2 = 3.2 \times 10^{-19}$

$\boxed{KE = 1.28 \times 10^{-18} eV}$

b) If the plate seperation is $\Delta x = 5cm$, what's the electric field value?

$\Delta x = 5cm$

$E = \frac{\Delta V}{\Delta x^2} = \frac{4 \times 10^3}{5 \times 10^{-2}}$

$\boxed{8 \times 10^4 V/m}$

Midterm - Physics B cont.

3) Potential Energy & voltage, Capacitors CONT

Question 2

3-2) Iternal $\mathcal{E}$-field of 1 KV/m — plate seperation of 2mm

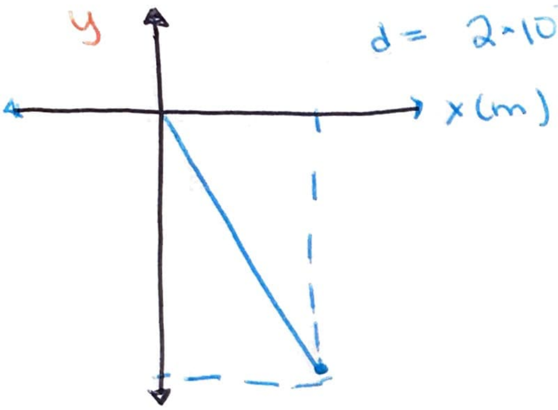
The y intercept is 0.

Answer: $-\mathcal{E} \cdot d = -2$ volt

$\mathcal{E} = -\frac{dv}{dx}$ or $v = \mathcal{E} \cdot x$

$m = -1000$ V/m

$d = 2 \times 10^{-3}$ m



Nice graph

What's the capacitance of the system?

Question 3

3-3) a) $C = \frac{\varepsilon_0 A}{d}$ area = 1 cm²

$$C = \frac{(8.85 \times 10^{-12})(10^{-4})}{2 \times 10^{-3}} = 4.425 \times 10^{-13} f$$

$$\boxed{C = 4.425 \times 10^{-13} f}$$

b) How much energy (in Jules) is stored in the capacitor if the voltage is 5V. $V = 5$

V^2

Energy $= \frac{1}{2} \cdot C \cdot V^2 =$

$C = 4.425 \times 10^{-13} f \times \frac{1}{2} \times 25$

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

5.53×10^{-12} J

$\boxed{5.53 \times 10^{-12} J = \text{Energy}}$

final answer $\boxed{\text{Energy} = 5.53 \times 10^{-12} J}$

3)
Question 4) Should we connect an identical capacitor to the 1st in series or in parrallel?

answer → we would connect the identical capacitor in parrallel due to the parrallel combination allowing the capitance to increase via

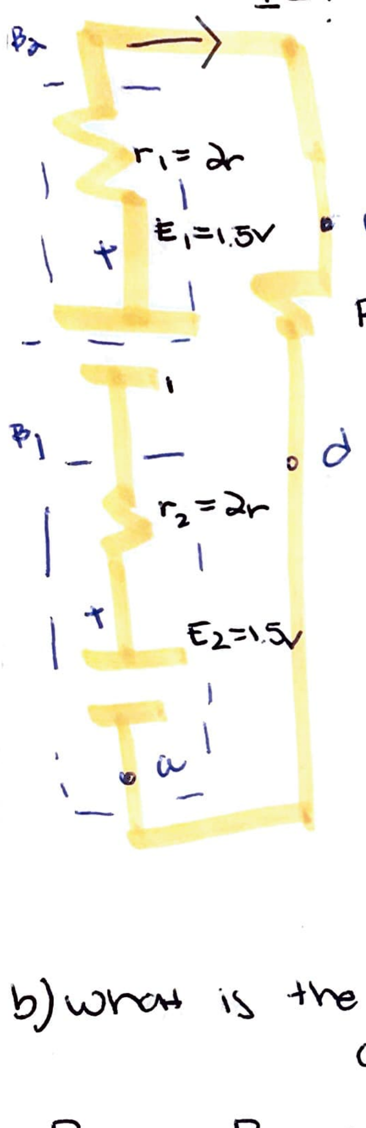
$$C_{net} = C_1 + C_2 = 2C. \leftarrow \text{in parrallel}$$

On the other hand, in a connection on the identical capacitor, the series will allow the Cnet to be $C/2$. ← in series

$$C_{net} = C/2$$

4- Current, Resistance, & DC Circuits

a) using Kirchoff's rules, find the current through R for the serial case (3v) & the parrallel case.



$-E_2 + Ir_2 + Ir_1 - \varepsilon_1 + IR = 0$

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

$I = \frac{3V}{r_1 + r_2 + R} = \frac{3}{2+2+50} = \frac{3}{54}$

$\boxed{= 55.56mA}$

Loop 1 (abcfa)

$\hookrightarrow E_1 - I_1 r_1 + I_2 r_2 - E_2 = 0$

$E_1 - Ir_1 + E_2 - Ir_2 = 0$

$I = \frac{(E_1 + E_2)}{r_1 + r_2 + R}$

Loop (fcde)

$E_2 - I_2 r_2 - IR = 0$

$E_1 = E_2 \qquad I_2 + I_1 = I$

Loop 1 $\rightarrow I_2 r_1 = I_2 r_2$

Loop 2 $\rightarrow E - I_2 r_2 - IR = 0$

b) what is the power consumption?

check next next page

$P_{Total} = P_{r_1} + P_{r_2} + P_R$

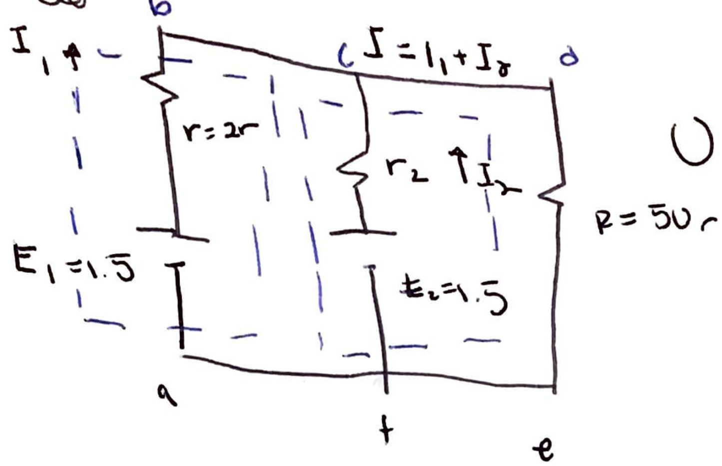
units...

$= I^2 r_1 + I^2 r_2 + I^2 R$

$= (55.56mA)^2 \cdot 2 + (55.56mA)^2 \cdot 2 + 50(55.56mA^2)$

$= 2 \cdot 6.17mW + 153 mV$

$\boxed{P_{total} \quad 776.17 mW}$



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

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

$$\underline{51 V_x = 75}$$

$V_x = 1.47$ volts

$$I_1 = \frac{1.5 - 1.47}{2r}$$

$= 15\,mAmp$

$$I_2 = \frac{1.5 - 1.47}{2} = 15\,mAmp$$

$I = I_1 + I_2$

$= 15mA + 15mA$

$\boxed{I = 30mA}$

Total Power consumption

$P_{total} = P_{r_1} + P_{r_2} + P_R$

$= I_1^2 r_1 + I_2^2 r_2 + I^2 R$

$= (15m)^2 2 + (15m)^2 \cdot 2 + (30m)^2 \times 50$

$= 0.45mW + 0.45mV + 45mW$

$P_{total} = \boxed{45.9mW}$

$P_R = I^2 R$

$= (30m^2) \times 50$

$= \boxed{45mV}$

4a) cont

Circuit 1 (series)

$$P_{total} = (I^2)r_1 + (I^2 r_2) + (I^2)R$$

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

Nice!

$$= 0.17W = \boxed{\cancel{170}\,170\,mW}$$

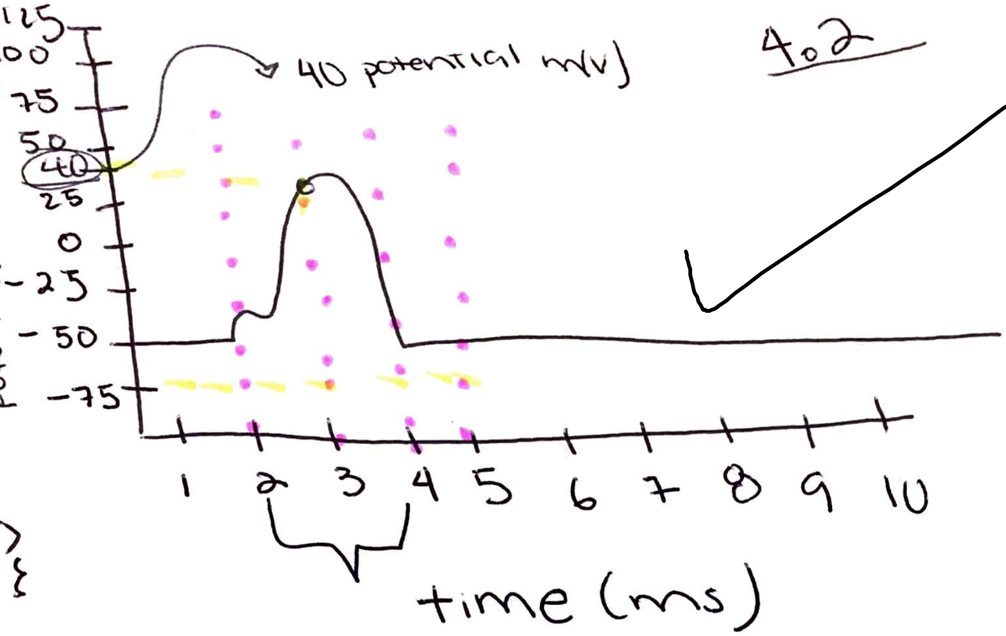
Circuit 2 (parallel)

$$P_{tot} = (I_1)^2 r_1 + (I_2)^2 r_2 + (I^2)R$$

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

$$= 0.045AW = \boxed{45.9mW}$$

4.2



a) pulse width in milliseond is

$4\,ms - 2\,ms = \boxed{2\,ms.}$

$V_{peak-peak} = \text{min } m(v)$

$= m(v) - (\text{min } mv)$

$= 40\,mv - -75\,mv$

$\boxed{V_{peak} = 115\,mv}$