## (2) Electric Charge & Electric Fields

19/20

Well done

(1)

(a)

$2\times10^{-3} = \frac{1}{4\pi\varepsilon_0}\frac{q}{(1\times10^{-3})^2}$

$2\times10^{-3}\cdot1\times10^{-6} = \frac{q}{4\pi\varepsilon_0}$

Ec @ 5mm

$E = \frac{1}{4\pi\varepsilon_0}\frac{q}{(5\times10^{-3})^2}$

it's 1/25

$E = 2\times10^{-3}\times10^{-6}\cdot\frac{1}{25\times10^{-6}}$ ✓

$E = 0.05\times10^{-3} \rightarrow \boxed{5\times10^{-5}\ \frac{V}{C}}$

$-\frac{1}{2}$ $8\times10^{-5}\ \frac{N}{C}$

(b)

$q = 1\mu C$ $E = 5\times10^{-3}\ \frac{V}{C}$

$E = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$

$8\times10^{-3} = \frac{1}{4\pi\varepsilon_0}\frac{1\times10^{-6}}{r^2}$

$5\times10^{3} = \frac{1}{4\pi\varepsilon_0 r^2}$

$q = 3\mu C$

$E = \frac{1}{4\pi\varepsilon_0}\frac{3\times10^{-6}}{r^2}$

$E = 5\times10^{3}\times3\times10^{-6}$ ✓

$\boxed{E = 24\times10^{-3}\ \frac{N}{C}}$

(2)

(a)

$m = 4\times10^{-16}\ kg$

$E = 6131.25\ N/C$ → (-1) what about p+ and neutrons?

$\frac{4\times10^{-16}}{9.1\times10^{-31}} = \boxed{4.4\times10^{14}}$ → also, I mean the excess e⁻ (4e⁻)

(b) $q = Ne$ =

$4.4\times10^{14}\cdot1.6\times10^{-19} = 7.0\times10^{-5}C$

$qE = ma$

$\hookrightarrow \frac{7.0\times10^{-5}\cdot6131.25}{4\times10^{-16}}$

$\boxed{a = 1.07\times10^{-15}\ m/s^2}$

(would have been right)

# ③ Potential Energy and Voltage, Capacitors

① a

$1.6\times10^{-19}\cdot 4\times10^{3} =$

$\boxed{6.4\times10^{-14}\,J}$ hydrogens

$2\cdot 1.6\times10^{-19}\times 4\times10^{3} =$

$\boxed{12.8\times10^{-16}\,J}$ heliums

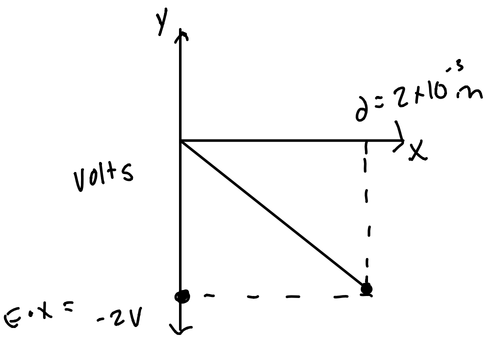
b

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

$\dfrac{4\times10^{3}}{5\times10^{-2}} = \boxed{80000 \text{ or } 8\times10^{4}\,\frac{V}{m}}$

② $E = 1000\,V/m$

$E = -\dfrac{\partial v}{\partial x} \rightarrow V = -E\cdot x$




nice graph

slope $= -1000\,V/m$

V int zero as the graph starts from the origin

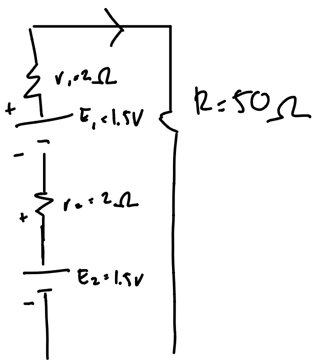
③ a $C = \dfrac{\varepsilon_0 A}{d} = \dfrac{8.8\times10^{-12}\cdot 10^{-4}}{2\times10^{-3}} = \boxed{4.4\times10^{-13}\,F}$

b $\frac{1}{2}CV^2 \rightarrow \frac{1}{2}(4.4\times10^{-13})(25) = \boxed{5.5\times10^{-12}\,J}$

④ ~~In this case, we~~ would connect an identical capacitor $\boxed{\text{in parallel}}$ b/c the capacitance is added up in parallel combination. It goes as follows: $C_{net} = C_1 + C_2 = 2C$. If it were a series, ~~they~~ $C_{net}$ would change to $\frac{C}{2}$.

## 4 Current, Resistance, & DC Circuits

1 (a)




$E = I(r+R) = Ir_{tot}$

$-E + I_2 R_2 = 0$

$-E + I_1 R_1 = 0$

$+E_2 + I_2 V_2 - E_1 + I_1 R_1$

$-1.5 + I(\pi_1 + \pi_2 + R) - 1.5V = 0$

$$I = \frac{3V}{\pi_1 + \pi_2 + R} = \frac{3}{2+2+50} = \frac{3}{54}$$

$= 0.055 \text{ Amp}$

$\boxed{= 55.5 \text{ mAmp}}$

good conversion

(b) $P_{tot} = P_1 + P_2 + P$

$P = IR$

$\hookrightarrow P = I^2 R$

$P = I^2{}_1 r_1 + I_2^2 r_2 I^2 R$

$P = (0.055 \text{ Amp})^2 (2\Omega) + (0.055 \text{ Amp})^2 (2\Omega) + 0.055 \text{ Amp})(50\Omega)$

$P = 0.00605 + 0.00605 + 0.15125$

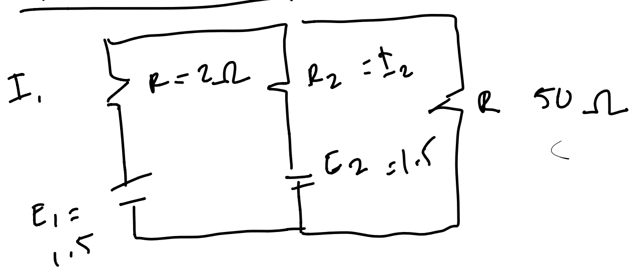
$P = 0.16335 \text{ w}$

$\boxed{P = 163.35 \text{ mW}}$

units!

$\boxed{P_R = 154.38 \text{ mW}}$

For Parallel




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

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

$51 V_n = 75$

$\boxed{V = 1.47 V}$

$$I_1 = \frac{1.5 - 1.47}{2\Omega} = \boxed{15 \text{ mAmp}}$$

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

$P_{tot} = P_1 + P_2 + P$

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

$(15\text{m})^2 2 + (15\text{m})^2 + 2 + (30\text{m})^2 \times 50$

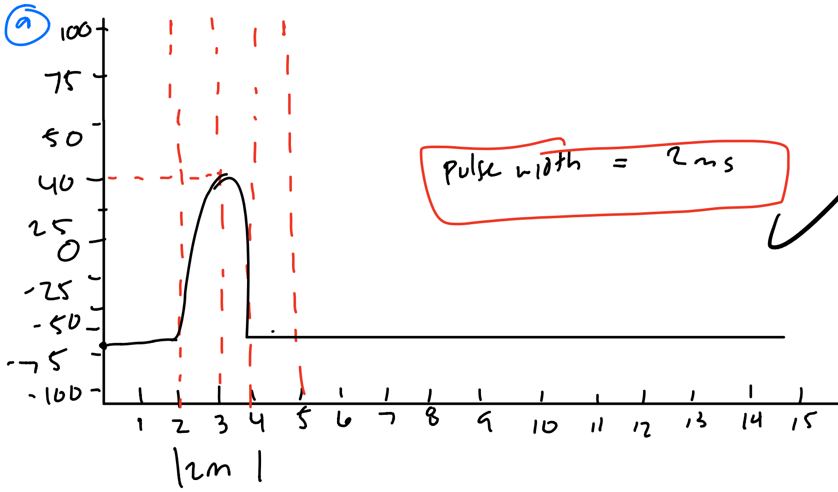
$0.45\text{mW} + 0.45\text{mW} + 45\text{mW}$

$\boxed{= 45.9\text{mW}}$

$P_R = I^2 R \to (30\text{m})^2 \times 50$

$45\text{mW}$

② ⓐ




$\boxed{\text{Pulse width} = 2\text{ms}}$

ⓑ peak voltage in mV

$= 40 - (-75)$

$\boxed{= 115\text{mV}}$