2 Electric Charge & Electric Fields

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

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

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

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

b

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

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

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

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

$q = 3\mu C$

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

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

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

2

a

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

$E = 6131.25$ N/C

$$\frac{4\times10^{-16}}{9.1\times10^{-31}} = \boxed{4.4\times10^{14}}$$

b

$q = Ne =$

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

$qE = ma$

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

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

③ Potential Energy and Voltage, Capacitors

① (a)

$1.6 \times 10^{-19} \cdot 4 \times 10^{3} =$

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

$2 \cdot 1.6 \times 10^{-19} \times 4 \times 10^{3} \rightarrow$

$\boxed{12.8 \times 10^{-16} J}$ heliums

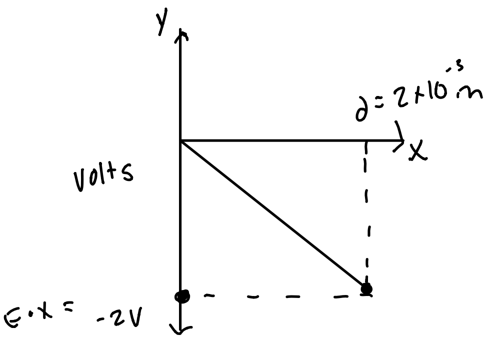
(b)

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

$\dfrac{4 \times 10^{3}}{5 \times 10^{-2}} = \boxed{80000 \text{ or } 8 \times 10^{4} \frac{V}{m}}$

② $E = 1000 \, V/m$

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



slope $= -1000 \, V/m$

V int zero as the graph starts from the origin

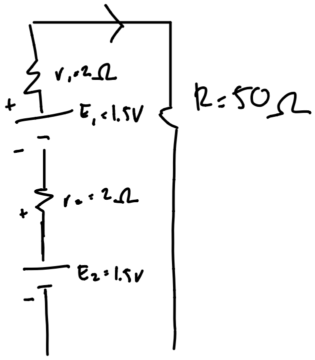
③ (a) $C = \dfrac{E_0 A}{d} = \dfrac{8.8 \times 10^{-12} \cdot 10^{-4}}{2 \times 10^{-3}} = \boxed{4.4 \times 10^{-13} F}$

(b) $\frac{1}{2} CV^2 \rightarrow \frac{1}{2}(4.4 \times 10^{-13})(25) = \boxed{5.5 \times 10^{-12} J}$

④ In this case, we would connect an identical capacitor 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, then C_{net} would change to $\frac{C}{2}$.

4 Current, Resistance, & DC Circuits

1 (a)



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

$-E + I_2 R_2 = 0$

$-E + I_1 R_1 = 0$

$+E_2 + I_2 r_2 - E_1 + I_1 R_1$

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

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

$= 0.055$ Amp

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

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

$P = IR$

$\hookrightarrow P = I^2 R$

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

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

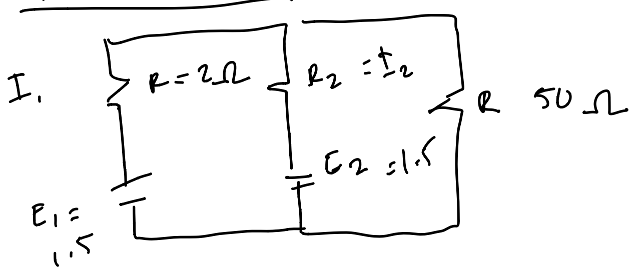
$P = 0.00605 + 0.00605 + 0.15125$

$P = 0.16335$ W

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

$\boxed{P_R = 154.34 \text{ mW}}$

For Parallel



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

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

$51 V_R = 75$

$\boxed{V = 1.47 V}$

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

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

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

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

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

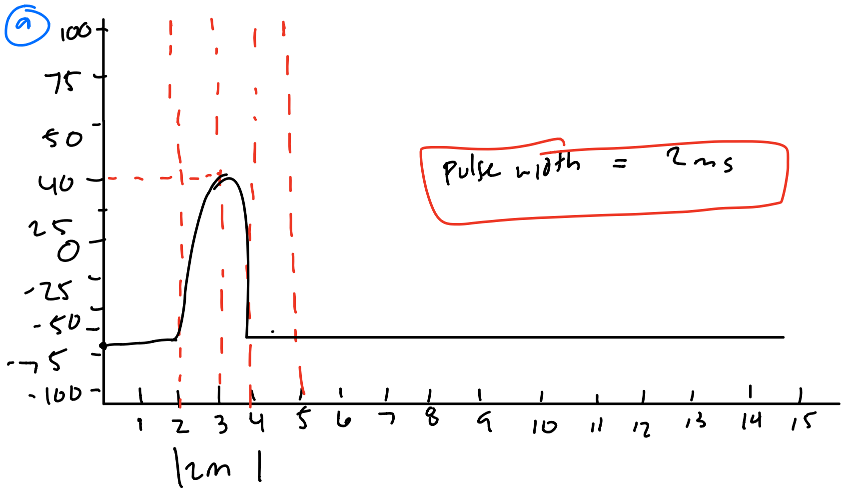
$0.45mW + 0.45mW + 45mW$

$\boxed{= 45.9mW}$

$P_R = I^2 R \rightarrow (30m)^2 \times 50$

$45 mW$

(2) (a)



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

(b) peak voltage in mV

$= 40 - (-75)$

$\boxed{= 115mV}$