① # of e^- removed: Unif ∅

$$2.00\,\mu C \times \frac{1\,C}{1\times10^{6}\,\mu C} \times \frac{1\,p}{1.6\times10^{-19}\,C} =$$

$1.25\times10^{13}\ e^-$

$$\frac{50.0\,g}{1} \times \frac{1\ mol}{63.5\,g} \times \frac{6.02*10^{23}\ atoms}{1\ mol} =$$

$$4.74\times10^{23}\ atoms\ of\ Cu \times \frac{29\ protons}{1\ atoms\ Cu} =$$

$1.37\times10^{25}\ p$

$1.37\times10^{25}\ e^-$

$$\frac{1.25\times10^{13}\,e^-}{1.37\times10^{25}\,e^-} =$$

9.12×10^{-13} electrons have been removed

(2)

$$F_{1,2} = \frac{8.99\times10^{4}\,|6\times10^{-6}\cdot 2\times10^{-6}|}{(0.05)^2}$$

$$F_{1,2} = 43.2\ N$$

$$F_{2,3} = \frac{8.99\times10^{9}\,|2\times10^{-6}\times 4\times10^{-6}|}{0.05^2}$$

$$F_{2,3} = 28.8\ N$$

$$43.2\ N - 28.8\ N = 14.4\ N$$

(b) the force is pointing away.

(3)

$$\frac{8.99\times10^{9}\,|1\times10^{-6}\times2\times10^{-6}|}{0.03^{2}} - \frac{8.99\times10^{9}\,|1\times10^{-6}\times2\times10^{-6}|}{0.05^{2}} =$$

$$19.978 - 7.192 \quad F_t = 12.78\ N$$

(4)

$$k\left[\frac{5\times10^{-9}}{0.13^{2}} - \frac{5\times10^{-9}}{0.04^{2}} - \frac{1.5\times10^{-8}}{0.07^{2}}\right] =$$

$$= 8.99\times10^{9}\left[(2.95\times10^{-7}) - (3.12\times10^{-6}) - (3.06\times10^{-6})\right]$$

$$= -5.29\times10^{4}\ \frac{N}{C}$$

(5)

$$\sqrt{0.05^{2}+0.05^{2}} = \sqrt{c^{2}} \rightarrow c = 0.0707\ m$$

$$F = \frac{8.99\times10^{9}\left[(7.5\times10^{-6})\times(2\times10^{-6})\right]}{(0.0707)^{2}}$$

*(a) $F = 26.98\ N$ direction is going down

(b) $F = 26.98\cos(45)$

$F = 19.08\ N$

⑥

$$40{,}000\ V = \frac{\Delta PE}{1.6\times10^{-19}}$$

$$\Delta PE = 6.4\times10^{-15}\ J$$

$$KE = 6.4\times10^{-15}\ J$$

$$V = \frac{\sqrt{2(6.4\times10^{-15}\ J)}}{9.11\times10^{-31}}$$

$$= 1.18\times10^{8}\ m/s$$

$$= \boxed{1.19\times10^{8}\ m/s}$$

⑦ (a)

$$V = 7.5\times10^{4}\ V/m\ (0.04\ m)$$

$$V = 3{,}000\ V$$

(b) $\frac{1}{4}(3000\ V) = 750\ V$

(c) $\frac{0.08\ V}{9 \times 10^{-9}\ m} = 8.8 \times 10^{6} \frac{V}{m}$

(8)

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

$= 3.2 \times 10^{-19}\ C$

To find ΔPE

$32\ KeV \times \frac{1000\ eV}{1\ KeV} \times \frac{1.6 \times 10^{-19}\ J}{1\ eV}$

$\Delta PE = 5.12 \times 10^{-15}$

To find V

$\frac{5.12 \times 10^{-15}\ J}{3.2 \times 10^{-19}\ C} = 1.6 \times 10^{4}\ V$

$$E = \frac{1.6 \times 10^{4} V}{0.02} = -$$

$$\boxed{E = 8.0 \times 10^{5} \frac{V}{m}}$$

(9)

$$q = 3.2 \times 10^{-19} C$$

$$5\ MeV \times \frac{10^{6}\ eV}{1\ MeV} \times \frac{1.6 \times 10^{-19}\ J}{1\ eV} =$$

$$= 8 \times 10^{-13}\ J$$

$$\Delta V = \frac{8 \times 10^{-13} J}{3.2 \times 10^{-19} C} \qquad \Delta V = 2.5 \times 10^{6} V$$

$$r = \frac{9 \times 10^{9} (1.264 \times 10^{-17})}{2.5 \times 10^{6}}$$

$$r = \boxed{4.55 \times 10^{-14} m}$$

Unit 1

(1)

$$C = \frac{3 \times 10^{-6} C}{120 V}$$

$$C = 25 \times 10^{-8} F$$

(2) (a) $E = \frac{10 \times 10^{-6} F (9 \times 10^3 V)^2}{2}$

$= 405 J$

(b) $q = (10 \times 10^{-6} F)(9 \times 10^3 V) =$

$\boxed{0.09 C}$

(c)

$V = \sqrt{\frac{2(40J)}{8 \times 10^{-6}}}$

$V = \boxed{3.16 \times 10^3 V}$

(d) $q = (8 \times 10^{-6}) * (3.16 \times 10^3)$

$q = 0.03 C$

(3)

$$C = \frac{0.03 \div 4}{9.00 \times 10^{3} V}$$

$C = 8.33 \times 10^{-7}$ each individual capacitator needs this

$$\frac{0.03C}{4} = 0.075$$

$$= 7.5 \times 10^{-2} C$$

↑ the charge stored on each capacitor

They would not choose this b/c the voltage requirement is much higher & not safe to do.

(4) $A = \frac{\pi (1.0 \times 10^{-3})^2}{4}$

$= 7.9 \times 10^{-7} m^2$

$L = \frac{2\,\Omega \times (7.9 \times 10^{-7} m^2)}{1.68 \times 10^{-8}\,\Omega \cdot m}$

$= \boxed{93.4 \text{ meters}}$

(5) (a) $I = \frac{3.0V}{1003\,\Omega}$

$= 2.99 \text{ mA}$

(b) $P = 3.0\,V * (2.99 \times 10^{-3} A)$

$= .00897\ W$

or

$8.9\ mW$

(c)

$Q = (2.99 \times 10^{-3} A)(10 \cdot 60)s$

$= 179.4\,C$

Unit 2

1)

(a) $R_3 = 2\ k\Omega - 10\ k\Omega - 5\ k\Omega$

$$R_3 = -13\ k\Omega$$

(b)

$$I_{total} = \frac{12V}{2k\Omega}$$

$$= 6\ mA$$

(c)

$$I_1 = \frac{12V}{10k\Omega} = 1.2\ mA$$

$$I_2 = \frac{12V}{5k\Omega} = 2.4\ mA$$

$$I_3 = 6\ mA$$

2)

(a) $V_{total} = 1.5V + 1.5V + 1.5V = 4.5V$

$$I = \frac{4.5V}{500\Omega} = 9 \times 10^{-3} C$$

$$P = \frac{(4.5V)^2}{500\Omega} = 4.05 \times 10^{-2} V$$

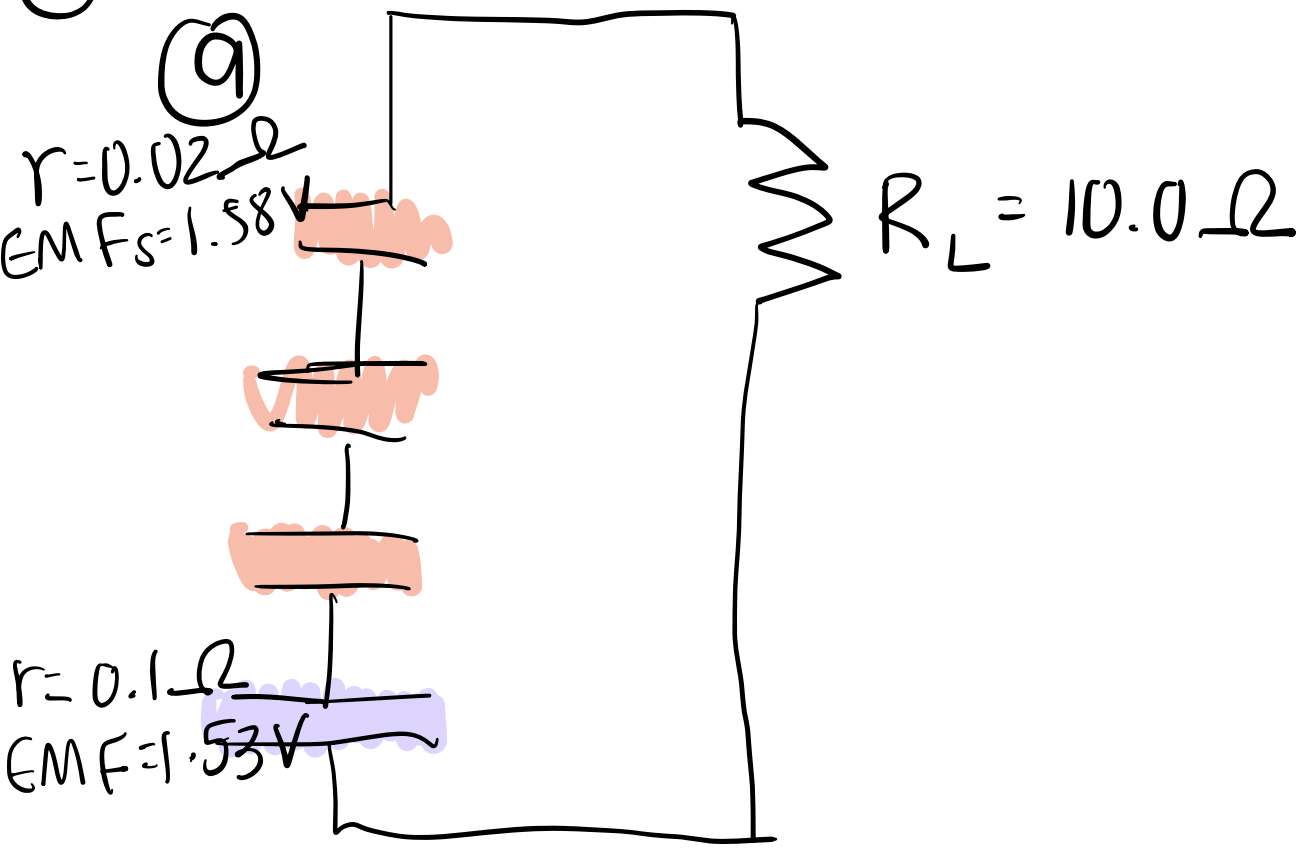
(b) $V_{total} = 4.5V - 15V = \boxed{-10.5V}$

$$I = \frac{3(-10.5V)}{500} = -6.3 \times 10^{-2} C$$

$$P = \frac{(3 \cdot -10.5V)^2}{500} = 1.98 V$$

③

⑨



(b) $V_{total} = (1.58\,V \times 3) + 1.53V = 6.35V$

$R_{total} = (0.02\,\Omega \times 3) + 0.10\,\Omega = 0.16\,\Omega$

$$\frac{6.35\,V}{0.16\,\Omega} = 39.68\,A$$

(c) $P = (6.35\,V)(39.68\,A)$

$= 251.97\,W$

(d)

$$V_{load} = \frac{0.500\ W}{39.68\ A} = 0.013\ V$$

$$V_{dry} = 1.53V - (0.10\ \Omega \times 39.68A)$$

$$= 1.53V - 3.968\ V$$

$$= -2.438\ V$$

(4) $$R = \frac{1}{72 * (25 \times 10^{-9})}$$

$$= 55556$$

$$\boxed{55.6\ k\Omega}$$

⑤

$$C = \frac{1.00 \times 10^{-4} s}{10^{3} \Omega}$$

$$= 1.00 \times 10^{-7} F$$

Unit 3

①

Case	V direction	B direction	F direction
a	$-\hat{\jmath}$	$\hat{k}$	$\hat{\imath}$
b	$\hat{\jmath}$	$\hat{\jmath}$	$-\hat{k}$
c	$-\hat{\imath}$	$-\hat{k}$	$-\hat{\jmath}$
d	x	x	x

(2)

$$\sin\theta = \frac{1.40\times10^{-16}\,N}{(1.6\times10^{-19})(4\times10^{3})(1.25\,T)}$$

$$= \sin^{-1}(0.175)$$

$$= 10.08^\circ = \theta$$

$$180 - 10.08^\circ = 169.92^\circ = \theta$$

(3)

(a)

$$q = \frac{(2.66\times10^{-26}\,kg)(5.00\times10^{6}\,m/s)}{(0.231\,m)(1.20\,T)}$$

$$= 4.8\times10^{-19}\,C$$

(b) $$\frac{4.8 \times 10^{-19} C}{-1.6 \times 10^{-19} C} \approx -3$$

(c) The charge of the electron cannot be a fraction or ratio therefore it needs to be an interger.

(d) $$\frac{9}{8} \times 0.231m$$

$$= 0.259m$$

④ $F = 100\,A\,(0.25m)(2T)\sin(90°)$

$= \boxed{50\ N}$

⑤ $$\frac{300\ N \cdot m}{200\,(25A)\,(0.2^2)\sin 90}$$

$B = 1.5\ T$

⑥

case	B direction
a	k
b	$\hat{\imath}$
c	$-\hat{\imath}$

(7) $\frac{450 \times 10^6}{300{,}000\ V} = 1500$

$$B = \frac{4\pi \times 10^{-7}(15\ W)}{2\pi(20)}$$

$$= 1.5 \times 10^{-5}\ T$$

(8)

a) $1.0 = \frac{(4\pi \times 10^{-7})(10^6)(10^5)}{2\pi(5.0)}$

$= 8 \times 10^9$

N & I $\rightarrow$ 10^6 loops & 10^5 A

⑥ $$\frac{(1.6\times10^{-19}\,C)(1.0\,T)}{2\pi(1.67\times10^{-27}\,kg)}$$

$$= 5.7\times10^{34}\,Hz$$