

Quiz 9

Name: _____ Student Number: _____

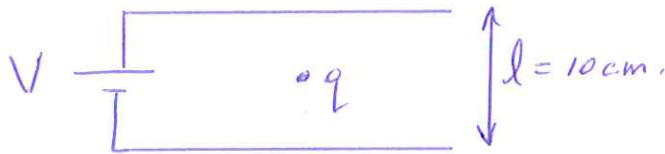
CALCULATORS ALLOWED.

5 x 2 = 10 marks

1. How much work is done in each second accelerating 10^8 electrons across a potential of 1 kV?

$$\begin{aligned} \text{Work} &= \text{Charge} \times \text{Voltage} \\ &= 10^8 \times 1.6 \times 10^{-19} \text{ Coul} \times 10^3 \text{ Volts} \\ &= 1.6 \times 10^{-8} \text{ J} \end{aligned}$$

2. A lonely electron sits in a vacuum between two plates separated by 10 cm. What voltage should be applied across the plates to levitate the electron?



Electric field between plates $E = \frac{V}{d}$.

levitation requires $qE = mg$.

$$\frac{qV}{d} = mg$$

$$V = \frac{mgd}{q}$$

$$= \frac{9.11 \times 10^{-31} \text{ kg} \times 9.8 \text{ m/sec}^2 \times 10^{-1} \text{ m}}{1.6 \times 10^{-19} \text{ Coul}}$$

$$= 5.6 \times 10^{-12} \text{ Volts.}$$

3. Consider the axis below. What charge should be placed at $3z$ for the electric field at z to be 0?

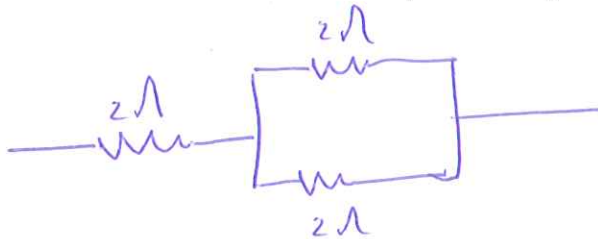


$$\vec{E}(z) = \left[\frac{kq_1}{z^2} - \frac{kq}{(2z)^2} \right] \hat{z}$$

$$\vec{E}(z) = 0 \Rightarrow q_1 = \frac{q}{4}$$

$$\text{or } q = 4q_1 = 4 \text{ Coulomb}$$

4. Draw a circuit that has a resistance of 3 ohms if you only have 2 ohm resistors.



5. How long would it take to heat 1 liter of water from 20 to 100 °C if the kettle has 100 ohm resistance and is plugged into a standard wall outlet?

$$\begin{aligned} \text{Energy Required} &= 80^\circ\text{C} \times \frac{1 \text{ cal}}{^\circ\text{C gm}} \times 4.2 \frac{\text{J}}{\text{cal}} \times 1000 \text{ gm} \\ &= 3.36 \times 10^5 \text{ Joules.} \end{aligned}$$

$$\therefore \text{Power} \times \text{time} = 3.36 \times 10^5 \text{ Joules.}$$

$$\frac{V_{\text{rms}}^2}{R} \times \text{time} = 3.36 \times 10^5 \text{ Joules}$$

$$\therefore t = \frac{3.36 \times 10^5 \times 100 \Omega}{(120 \text{ Volts})^2}$$

$$= 2.3 \times 10^3 \text{ sec.} \Rightarrow \text{a long time to wait!}$$