1. (4 pts) Two 9 V batteries are connected in parallel with a light bulb whose filament has a resistance of 150 Ω. What is the expected current through the filament?

\[ V_{ab} = 9 \quad V_{oa} = 9 \]

\[ I = \frac{V}{R_e} = \frac{9}{150} = 0.06 A \]

- 2 tried to add V's or \( \frac{1}{V} \)

2. (4 pts) An electron moves across a potential difference of 18 V. How much energy is gained by the electron?

\[ U = Vq = 18 \times (1.6 \times 10^{-19} C) \frac{j}{v} \]

\[ = 2.88 \times 10^{-18} J \]

\[ \text{or} \ 18 \text{ eV} \]

\[ \text{or} \ 18 \text{ eV} \]

3. (4 pts) What is the equivalent resistance of an 18Ω and a 4Ω resistor connected in parallel?

\[ R_e = \frac{R_1R_2}{R_1 + R_2} \]

\[ = \frac{18 \times 4}{18 + 4} \]

\[ = 12.6 \Omega \]

4. (4 pts) What current is required to produce a magnetic field of 50 μT at a distance of 3.2 cm from a long straight wire?

\[ B = \frac{\mu_0 I}{2\pi r} \]

\[ I = \frac{2\pi r B}{\mu_0} \]

\[ I = \frac{2\pi \times 0.032 \times 10^{-2} T}{4\pi \times 10^{-7} T/m/A} \]

\[ I = 8.0 A \]

- 2 Math error

5. (14 pts) Two charges are separated as shown. What is the value of \( x \) such that the electric field at point A is zero?

\[ \text{Given:} \]

\[ +3.8 \text{ nC} \quad +1.5 \text{ nC} \]

\[ -2 \text{ m} \quad -2 \text{ m} \]

\[ \text{Distance:} \ 1.1 \text{ m} \]

\[ E = \frac{kq_1}{r_1^2} \]

\[ E = \frac{kq_2}{r_2^2} \]

\[ \frac{3.8 \times 10^6}{(1.1 - x)^2} = \frac{1.6 \times 10^6}{x^2} \]

\[ 2.2x^2 + 3.52x - 13.76 = 0 \]

\[ x = 0.433 \text{ m} \]

\[ \text{or} \ x = 2.03 \text{ m} \]

6. (14 pts) An electron moving at \( 3 \times 10^7 \) m/s enters an electric field that directly opposes the path of the electron. What is the magnitude of the electric field that would be required to bring the electron to rest in 4 cm?

\[ E = \text{?} \]

\[ \text{Given:} \]

\[ 3 \times 10^5 \text{ m/s} \quad \text{or} \ 3 \text{ cm} \]

\[ F = \frac{1}{2} (9.109 \times 10^{-33} kg) (3 \times 10^5 m/s)^2 \]

\[ 0.04 \text{ m} \]

\[ = 1.0247 \times 10^{-18} \text{ N} \]

\[ E = \frac{F}{q} = \frac{1.0247 \times 10^{-18} \text{ N}}{1.6022 \times 10^{-19} \text{ C}} = 64 \text{ N/C} \]
7. (14 pts) Three point charges are arranged at the corners of a rectangle as shown. What is the electric potential at the fourth corner (point A)?

\[ V = \frac{1}{4 \pi \varepsilon_0} \sum \frac{q_i}{r_i} \]

\[ = \frac{9 \times 10^9 \text{ Nm}^2}{\text{C}^2} \left( \frac{2 \times 3 \text{ C}}{0.44 \text{ m}} + \frac{3 \times 3 \text{ C}}{\sqrt{3.3^2 + 3.3^2}} + \frac{4 \times 3 \text{ C}}{3.3 \text{ m}} \right) \]

\[ = 199 \text{ V} \]

8. (14 pts) Two parallel plates, each with an area of 625 mm², are separated by an air gap of 3.0 mm. How much energy is stored when the voltage between the plates is 6.0 V?

\[ U = \frac{1}{2} CV^2 = \frac{1}{2} \left( 1.8446 \times 10^{-12} \frac{\text{C}^2}{\text{Nm}} \right) (6 \text{ V})^2 \]

\[ U = 3.32 \times 10^{-11} \text{ J} \]

9. (14 pts) A horizontal wire carries a current of 8 A. A second parallel wire carries a current of 15 A and is suspended below the first wire by the magnetic field between the two wires. What is the distance between the wires if the lower wire weighs 0.12 g per meter of length?

\[ F = \frac{\mu_0 I_1 I_2}{2\pi r} \]

\[ r = \frac{0.12 \text{ g/m}}{9.81 \text{ m/s}^2} \]

\[ r = 0.0204 \text{ m} \]

10. (14 pts) What is the current through the 18 \( \Omega \) resistor? Give the current as a positive value and use 'right' or 'left' to specify its direction.

\[ I_1 = 0.0274 \text{ A left} \]

Loop 1: \( 9 + 18I_2 - 22I_1 = 0 \)
Loop 2: \( +12I_1 + 6 - 18I_2 = 0 \)

June a: \( I_1 + I_2 + I_3 = 0 \)

\[ \begin{bmatrix} 22 & -18 & 0 & 9 \\ 0 & 18 & -12 & 6 \\ I_1 & I_2 & I_3 & \text{Const} \\ 1 & 1 & 1 \end{bmatrix} \]

\[ I_1 = 0.4315 \text{ A} \]
\[ I_2 = 0.0274 \text{ A} \]
\[ I_3 = -0.4589 \text{ A} \]