1. (2 pts) What is the direction of the net force on q_3?

   a. +x
   b. -x
   c. +y
   d. -y

2. (2 pts) What is the direction of the total electric field at point P?

   a. +x
   b. -x
   c. +y
   d. -y

3. (2 pts) If a test charge travels in the same direction as the electric force, the electric potential energy:

   a. increases
   b. decreases
   c. stays the same

4. (2 pts) Two copper wires of equal length but different diameters are joined end to end and connected to a battery. The current flowing through the connected wires is:

   a. greater in the larger diameter wire
   b. greater in the smaller diameter wire
   c. the same in both wires

5. (2 pts) Two copper wires of equal length but different diameters are joined end to end and connected to a battery. The resistance of the larger wire is:

   a. greater than the smaller diameter wire
   b. less than the smaller diameter wire
   c. the same as the smaller diameter wire

6. (4 pts) What is the equivalent resistance of the system shown?

   ![Diagram of a circuit with resistors connected in series and parallel]

   - 2 Ω
   - 2 Ω + 4 Ω = 6 Ω
   - ![Resistor values and symbols]
   - \( R = \frac{1}{\frac{1}{2} + \frac{1}{3}} = 2 \ Ω \)

7. (14 pts) Three charges of values \( q_1 = +6.6 \ μC, q_2 = -7.2 \ μC, \) and \( q_3 = +5.9 \ μC \) are placed along the x-axis. When \( q_2 \) is centered between the other two charges, it experiences a net force of 6.0 N in the +x direction. What is the distance between \( q_1 \) and \( q_3 \) for this scenario?

   ![Diagram of charges]

   - 1 unit
   - 2.87 m
   - 3. Math Error
   - 4. Forcing \( F_{q_2} = k \ \frac{q_1 q_2}{r^2} \) and \( F_{q_3} = k \ \frac{q_2 q_3}{r^2} \)
   - 5. Wrong Distance
   - 6. For \( F_{k q_2} \cdot \frac{1}{r^2} = \frac{0.9842 \ μN}{r^2} \) and \( 1.6457 \times 10^{-18} \ N \cdot m \)
   - 7. Not Generating a \( q \)
   - 8. 1.6457 \times 10^{-18} \ N \cdot m \)

8. (14 pts) A stationary proton attracts an electron from infinity. What is the work that must be done to bring the electron to a distance of \( 1.4 \times 10^{-10} \ m \) from the proton? Express answer in eV.

   ![Diagram of proton and electron]

   - 1.602 \times 10^{-19} \ J
   - 1.6457 \times 10^{-18} \ eV
   - 10.27 eV

6 right concept \( W = U + q \ E \) but no work/answer is given.
9. (14 pts) A cylindrical copper cable 750 m long is connected across a 220 V potential difference. What should be its diameter such that it dissipates power at a rate of 60 W? Assume copper's resistivity $\rho = 1.72 \times 10^{-8}$ $\Omega \cdot m$.

\[ R = \frac{\rho L}{A} \]

\[ P = \frac{V^2}{R} \]

\[ 60 W = \left(\frac{220 V}{R}\right)^2 
\]

\[ R = \frac{806.7 \Omega}{2.12 mm} \]

\[ R = \frac{806.7 \Omega}{2.12 mm} = \frac{1.72 \times 10^{-8} \Omega \cdot m}{(950 mm)} + 6 \]

\[ R = \frac{1.6 \times 10^{-8} \Omega \cdot m}{\pi r^2} \]

\[ r = \frac{7.135 \times 10^{-9} m}{2.12 mm} \]

\[ d = 1.43 \times 10^{-9} m \]

10. (14 pts) The area of each plate of a parallel-plate capacitor in a vacuum is 3.2 m². A potential difference of 12,000 V is applied across the plates. If the electric field in the space between the plates is $2.55 \times 10^4$ N/C, what is the capacitance?

\[ V_a - V_b = \varepsilon_0 \frac{Q}{A} \]

\[ 12000 V = (2.55 \times 10^4 N/C) d \]

\[ d = 4.706 \times 10^{-3} m \]

\[ C = \varepsilon_0 \frac{A}{d} = \left(8.854 \times 10^{-12} F/m\right) \frac{3.2 m^2}{4.706 \times 10^{-3} m} \]

\[ C = 6.02 \times 10^{-9} F \]

11. (14 pts) A proton travels through a magnetic field at 1300 m/s and experiences a force of $2.7 \times 10^{-16} N$. What is the magnitude and direction of the magnetic field?

\[ F = qvB \sin \theta \]

\[ \frac{q}{v} = 9 \times 10^9 \]

\[ 2.7 \times 10^{-16} N \times 9 \times 10^9 \]

12. (16 pts) Find the currents through each resistor.