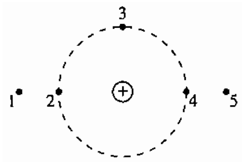
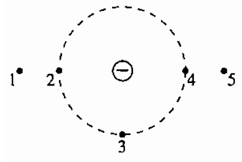
Ranking Rank in order, from largest (most positive) to smallest (most negative), the electric potentials for $V_1 - V_5$ at points $1 - 5$ and explain your reasoning. Repeat for each of the given configurations.

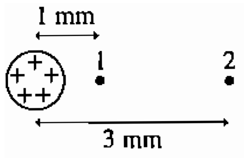




Two Points The figure shows two points near a positive charge.

A. What is the ratio $\frac{V_1}{V_2}$ of the electric potentials at these two points? Explain.

B. What is the ratio $\frac{E_1}{E_2}$ of the electric field strengths at these two points? Explain.



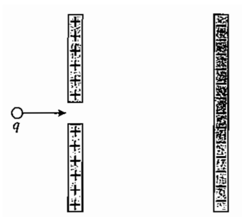
No Electric Potential For each pair of charges below, are there any points (other than infinity) at which the electric potential is zero? If so, identify them on the graph with a dot and a label. If not, why not?

Ring A ring has a radius R and charge Q. The ring is shrunk to a new radius $\frac{1}{2}R$ with no change in its charge. By what factor does the on-axis potential at $z = R$ change? Does it increase or decrease?

Fired Charge Charge q is fired through a small hole in the positive plate of a capacitor.

A. If q is a positive charge, does it speed up or slow down inside the capacitor? Explain your reasoning.
   - Solve using the concept of force.
   - Solve using the concept of energy.

B. Repeat A. using a negative charge instead.



[0]Select problems may be modified from PH 213 course textbook; Knight Physics for Scientists and Engineers, or past TAs

Name (please print) ______________________

Homework Problem - Due 10/25/2018

A. What potential difference is needed to accelerate electrons from rest to a speed of $5.25 * 10^6 \frac{m}{s}$ over a distance of $12.5cm$?

B. What would be the magnitude of the electrons' acceleration in this case?

Required Solution Format

1. **Understand the problem and devise a plan**

   a. **Read and translate the problem statement.** **Solution:**

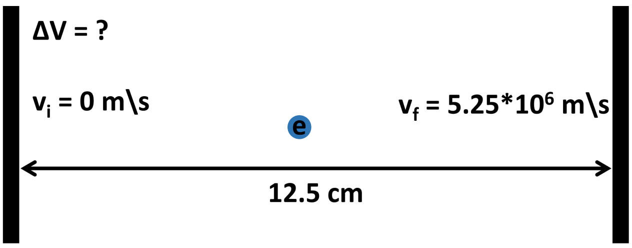
$$v_i = 0\frac{m}{s}$$
$$v_f = 5.25 * 10^6\frac{m}{s}$$
$$x_f = 12.5cm$$
$$\Delta V = ?$$
$$a = ?$$

   b. **Determine applicable concepts and/or laws and assumptions and/or simplifications.** **Solution:**

   Conservation of energy.
   No gravitational potential energy - only electric potential energy.
   Treat electron as point particle.

2. **Represent the problem physically and mathematically**

   a. **Represent physically.** **Solution:**



   b. **Represent the concepts and/or laws mathematically.** **Solution:**

$$K_f + U_f = K_i + U_i$$
$$U = qV$$
$$K = \frac{1}{2}mv^2$$
$$F = qE = ma = q\frac{\Delta V}{\Delta x}$$

3. **Solve for the unknown quantity (or quantities)**

   a. **Solve for the unknown quantity (or quantities) using algebra, geometry, trigonometry and/or calculus.** (***Be sure to have 3 significant figures.***) **Solution:**

A. Potential Difference

$$
\begin{aligned}
K_f + U_f &= K_i + U_i \\
K_f + qV_f &= K_i + qV_i \\
K_f + q(V_f - V_i) &= K_i \\
K_f - K_i &= -q\Delta V \\
\Delta V &= \frac{K_{iKf}}{q} \\
\Delta V &= \frac{\frac{1}{2}mv_i^2 - \frac{1}{2}mv_f^2}{2} \\
\Delta V &= \frac{m(v_i^2 - v_f^2}{2q} \\
\Delta V &= \frac{m(-v_f^2)}{2e} \\
\Delta V &= \frac{(9.11 * 10^{-31}kg)(-5.25 * 10^6 \frac{m}{s})^2}{2(1.60 * 10^{-19}C)} \\
\Delta V &= 78.5\frac{kgm^2}{Cs^2} = 78.5V
\end{aligned}
$$

B. Electron Acceleration

$$
\begin{aligned}
F = qE = ma &= q\frac{\Delta V}{\Delta x} \\
a &= \frac{\Delta Ve}{\Delta xm} \\
a &= \frac{(78.5V)(1.60 * 10^{-19}C)}{(0.125m)(9.11 * 10^{-31}kg)} \\
a &= 1.10 * 10^{14}\frac{m}{s^2}
\end{aligned}
$$

4. **Reflect. Is the answer reasonable? Does it make physical sense?**

   a. **Evaluate the result. Solution:**

   * This answer makes sense because I know that the units I expect for potential difference are Volts (V). I know these units are Volts because $[V] = \frac{[J]}{[C]} = \frac{[Nm]}{[C]} = \frac{[kgm^2]}{[s^2C]}$, which is what I got when I carried my units through my work, in the end.
     This check actually helped me catch a mistake in my algebra. I originally got an answer that had units of $\frac{m^2}{Cs^2}$ and that didn't make any sense to me so I looked back through my work and realized I'd dropped the mass term.
     This answer also makes sense in magnitude because $78V$ is something that is reasonable to apply. We worked with $30V$ in lab last week and my wall outlet gives $120V$ so $78V$ is totally reasonable.

   * The units cancel to what I'd expect for acceleration.
     I don't have a good sense for magnitudes of acceleration for electrons, "really big" is kind of all I've got, which this is. I know the electron goes from stationary to really fast in a very short distance, so it must do that fairly quickly. So since I know $a = \frac{\Delta v}{\Delta t}$ and the numerator of that is going to be big and the denominator small, I expect something big and of a similar order of magnitude as the velocity, which this is.