

Instructions:

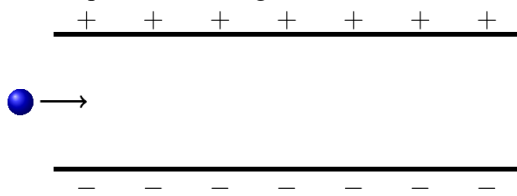
1. Do all of your work on this sheet.
2. **Show all of your steps** in problems for full credit.
3. **Be clear and neat** in your work. Any illegible work, or scribbling in the margins, will not be graded.
4. Place your **answers in a box**.
5. If you need more space, you may use the back of the page and write **On back** in the problem space.

1. **Multiple Guess (3 pts)** Find the answer which best fits the question and write it in the space provided.

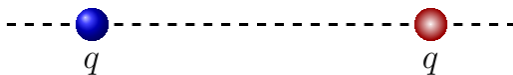
- a. A test charge is
  - a) positive; b) negative; c) electrically neutral: \_\_\_\_\_
- b. An proton placed in an electric field will move
  - a) along the field lines opposite to the field. b) along the field lines in the field direction. c) perpendicular to the field lines. d) It is not unaffected by the field. \_\_\_\_\_
- c. Two charges are separated by distance  $r$ . If one of the charges is replaced by another having twice the charge and the separation distance is doubled, then the force is
  - a) twice as much; b) half as much; c) four times as much; d) a quarter as much; e) the same as before. \_\_\_\_\_

2. **Definition/Principle (4 pts)**

- a. A positive charge enters the region between two parallel plates.
  - i. Draw an arrow indicating the direction of the E-field between the plates.
  - ii. Draw the path of the charge



- b. Sketch the electric field lines around the charges.

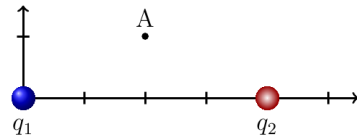


**Bonus:** Name two methods for charging a body.

\_\_\_\_\_, \_\_\_\_\_

**Constants:**  $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N}\cdot\text{m}^2$ ,  $m_e = 9.11 \times 10^{-31} \text{ kg}$ ,  
 $m_p = 1.67 \times 10^{-27} \text{ kg}$ ,  $m_\alpha = 6.64 \times 10^{-27} \text{ kg}$

3. **Problems (13 pts)** Let  $q_1 = q_2 = 3.0 \mu\text{C}$ .



- a. What are the magnitude and direction of the force on  $q_2$  if the other charge is 4.0 cm to the left?

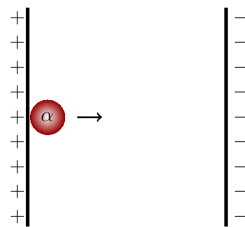
Direction \_\_\_\_\_

- b. What is the magnitude and direction of the electric field at point A due to the two charges?

Direction \_\_\_\_\_

- c. How many electrons are in  $-4.5 \text{ C}$ ?

- d. An alpha particle with charge  $2e$  is released from rest at the positive plate in a uniform field,  $E = 1.5 \times 10^3 \text{ N/C}$ .



- i. What is the acceleration of the alpha particle?

- ii. How fast is the particle moving 2.0 cm from the start?