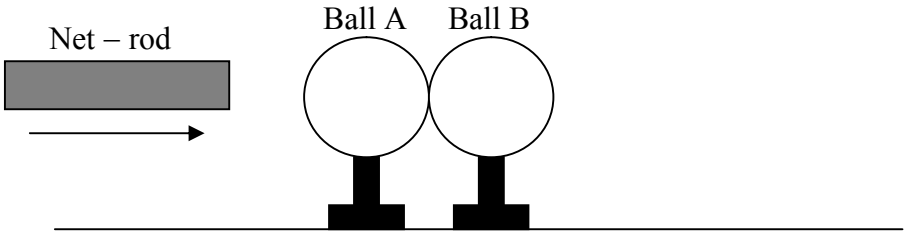
UNIT 2 REVIEW #1: ELECTRIC FIELDS AND FORCES

1. A person who is wearing socks drags his feet as he walks across the rug, and as a result, he gains a net negative charge. When he comes close (without touching) the handle of a door, he experiences a shock. Using the principles of physics, explain:
   a) why he gained a negative charge when dragging his feet across the rug
   b) why he experienced a shock

2. Two neutral metal balls, on insulated stands, are initially in contact with each other. A negatively-charged rod is then brought near one of the metal balls, as shown.



   While the rod is still close to the metal ball, the two metal balls are moved away from each other. Determine the charge of each ball at the end, and identify the method of charging for each.

3. A metal sphere with a charge of +64.0 μC is touched to an identical metal sphere with a charge of –87.0 μC. If they are then moved 14.8 cm apart, then determine the electric force (magnitude and direction) on each sphere.

4. One charge has 6 times the magnitude of another charge. When they are a distance of 72.0 mm apart, the magnitude of the electric force between them is 8.15 μN. Determine the magnitude of both charges.

5. The electric force between two point charges is *F*. If both charges are doubled, and the distance between the charges is tripled, then determine the new electric force (in terms of *F*).

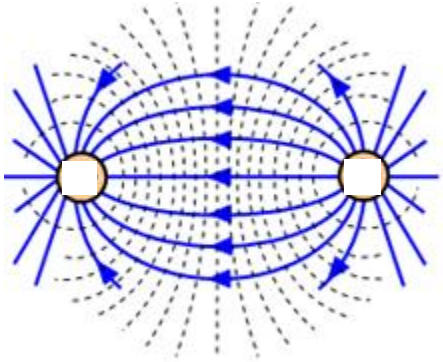
6. A point P is located 73.5 cm East of a point charge *Q*. If the electric field at P is 4.18 kN/C towards the West, then determine the point charge *Q*.

   Be certain to determine whether *Q* is positive or negative.

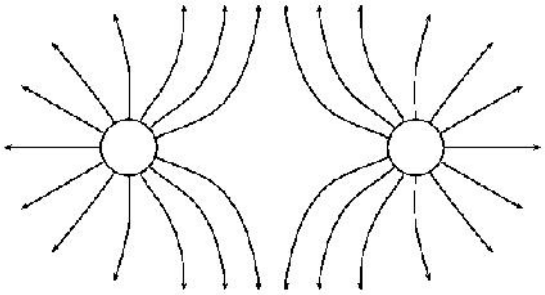
7. When a proton is placed at location A, it experiences an electric force of 8.35×10^{-7} N towards the North. If an electron is placed at the same location A, then determine the electric force (magnitude and direction) on the electron.

8. Determine the nature of the charges for each field diagram:

a)

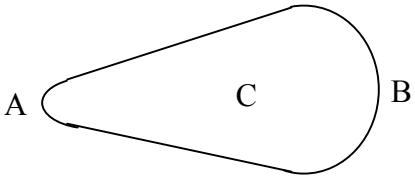


b)

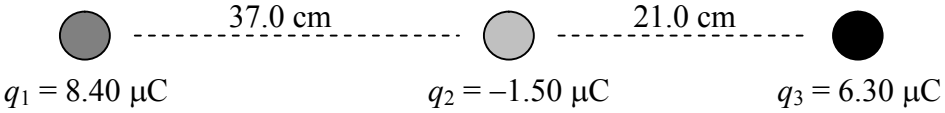


9. The hollow metal object shown has a positive charge. Compare the electric fields at locations A, B, and C.

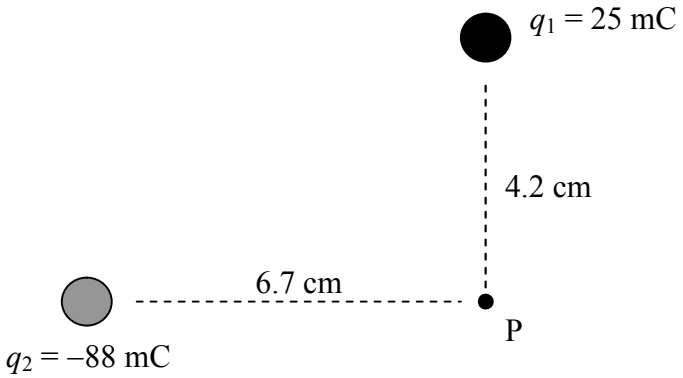
   Note: Location C is inside the hollow object.



10. For the arrangement of point charges shown below, determine the net electric force (magnitude and direction) on q_3 .

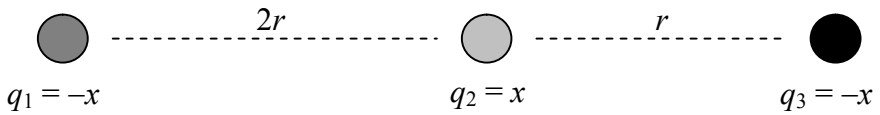


11. For the arrangement of charges below, determine the net electric field (magnitude and direction) at location P

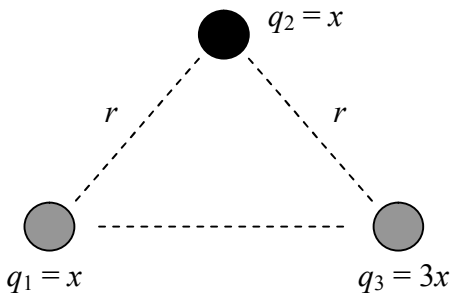


12. For each, sketch a force diagram for q_2. Be certain to draw the force vectors to scale.

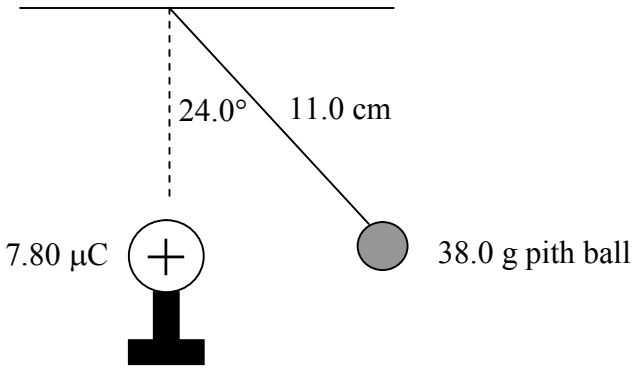
a)



b)



13. In the diagram shown, a pith ball on a string is suspended from a positive sphere (on an insulated stand).



a) Sketch a complete force diagram of the pith ball.

Hint: There are three forces.

b) Using the principles of physics, determine the electric force on the pith ball.

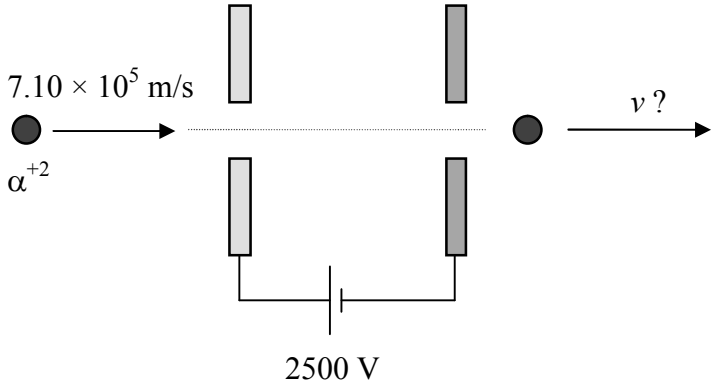
c) Determine the charge of the pith ball.

14. An electron is initially travelling at 8.15×10^6 m/s.

a) Determine the potential difference required to stop the electron.

b) Sketch a parallel plate apparatus that would cause this electron to stop.

15. An alpha particle, initially moving at a speed of 7.10×10^5 m/s, goes through a potential difference of 2500 V, as shown.



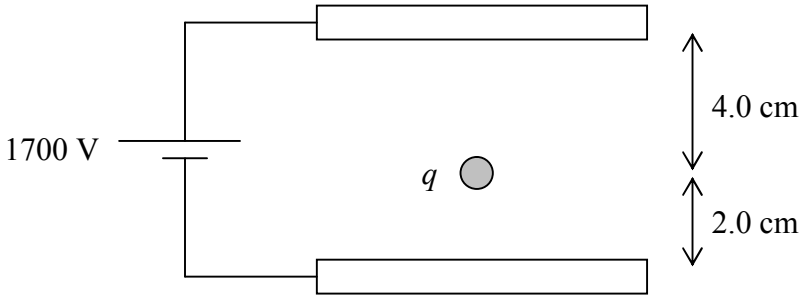
Determine the final speed of the alpha particle.

16. In the diagram shown, the charge q has 12 electrons in deficit. If it is moved to the top plate, determine:

a) whether its electric potential increases or decreases

b) the magnitude and direction of the electric field between the plates

c) the minimum work required to move the charge to the upper plate

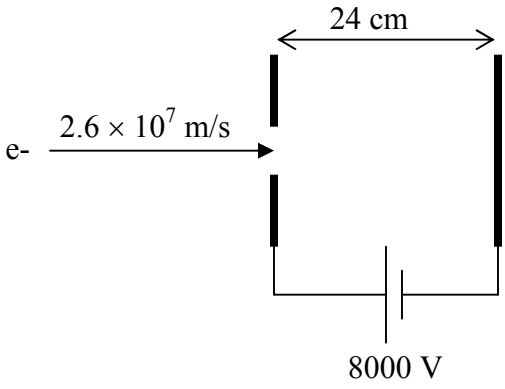


17. An electron enters a parallel plate region with an initial speed of 2.6×10^7 m/s.

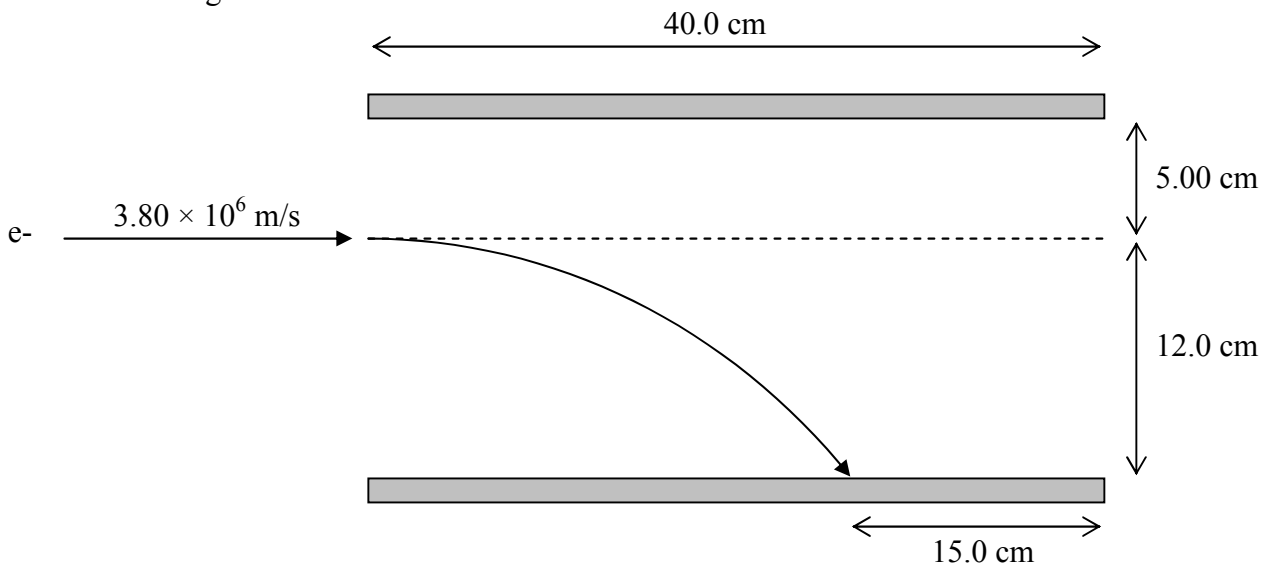
Determine:

a) the acceleration (magnitude and direction) of the electron while between the plates

b) how close the electron gets to the right plate



18. Consider the diagram below:

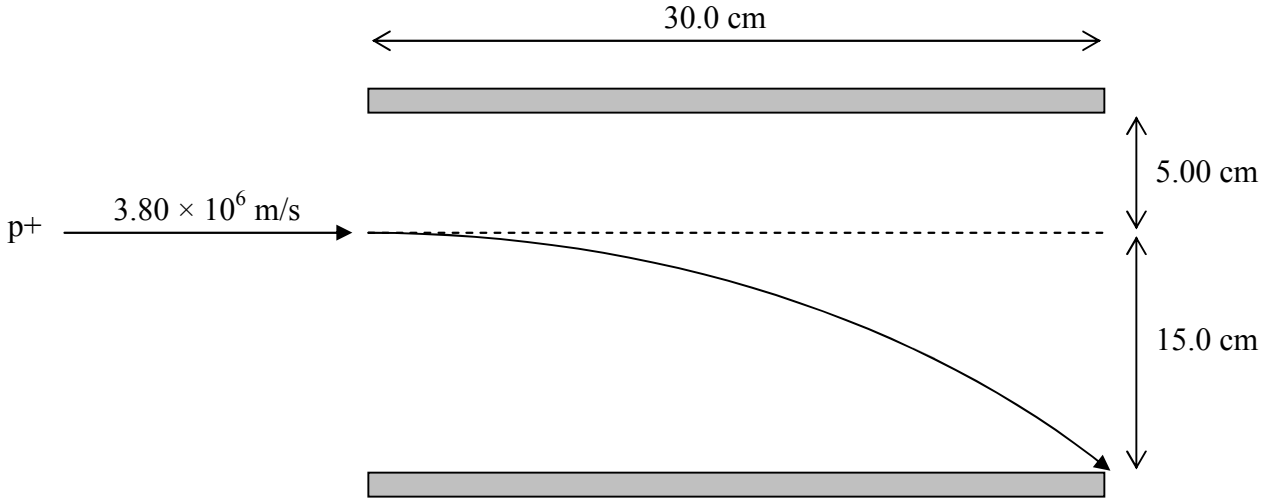


a) Determine the time it takes for the electron to smash into the bottom plate.

b) Determine the vertical acceleration of the electron.

c) Determine the magnitude and direction of the electric field between the plates.

19. Consider the diagram below:



If the proton experiences 4.80×10^{-15} J of work on it as it passes through the parallel plates, then determine the potential difference between the plates.

SOLUTIONS

1. a) Charging by friction: When the person drags his socks across the rug, friction creates heat energy. The socks must be higher on the electrostatic series, which means that the sock material has a stronger hold on the electrons than the rug material does. As a result, the socks strip the excited electrons from the rug, thereby gaining a net negative charge.

   b) Induced separation of charge: When the net negative finger is brought close to the handle, it repels the electrons inside the handle (due to like charges). This induces a net positive charge in the part of the handle that is closest to the finger. Due to the strong attraction between the finger and the handle (opposite charges), the electrons conduct through the air from the finger into the handle. This is called an electrical discharge.

2. Ball A gains a net positive charge by induction, while Ball B gains a net negative charge by conduction.

3. Charges after contact: $-11.5\ \mu C$; Electric force: 54.3 N (away from each other)

4. 8.85×10^{-10} C ; 5.31×10^{-9} C

5. $\frac{4}{9}F$

6. -2.51×10^{-7} C

7. 8.35×10^{-7} N towards the South

8. a) Left is negative ; Right is positive b) Both are positive charges

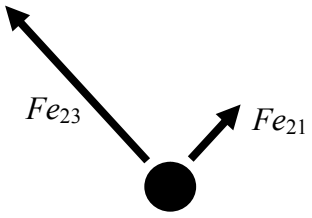
9. A: The electric field is directed outward, perpendicular to the surface, and strongest.
   B: Also outward and perpendicular, but weaker. C: No field.

10. 0.512 N left

11. 2.2×10^{11} N/C at 36° S of W (or 54° W of S)

12. a)

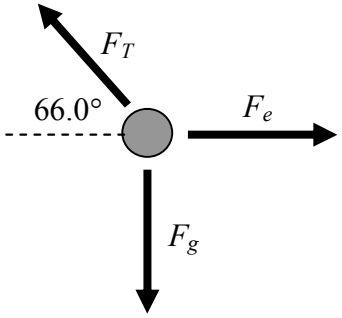
b)



13. a) See diagram to the right.

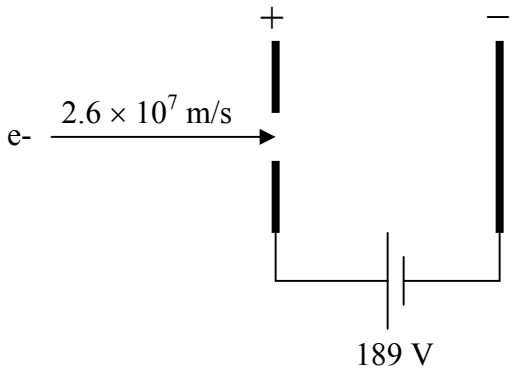
    b) 0.166 N

    c) 5.32×10^{-9} C



14. a) 189 V

b)



15. 8.63×10^5 m/s

16. a) It is gaining electrical potential energy.
    b) 2.8×10^4 V/m downward
    c) 2.2×10^{-15} J

17. a) 5.85×10^{15} m/s^2 left
    b) 18 cm

18. a) 6.58×10^{-8} s
    b) 5.55×10^{13} m/s^2 downward
    c) 316 N/C upward

19. 4.00×10^4 V