1. A pith ball with charge 3.0 nC is located 30.0 cm, 90.0° from a metal sphere with charge –2.0 μC. (a) Find the electric force on the pith ball. (b) Find the electric force on the metal sphere. (c) If the mass of the pith ball is 0.11 grams what charge would allow it to "hover" at that position.

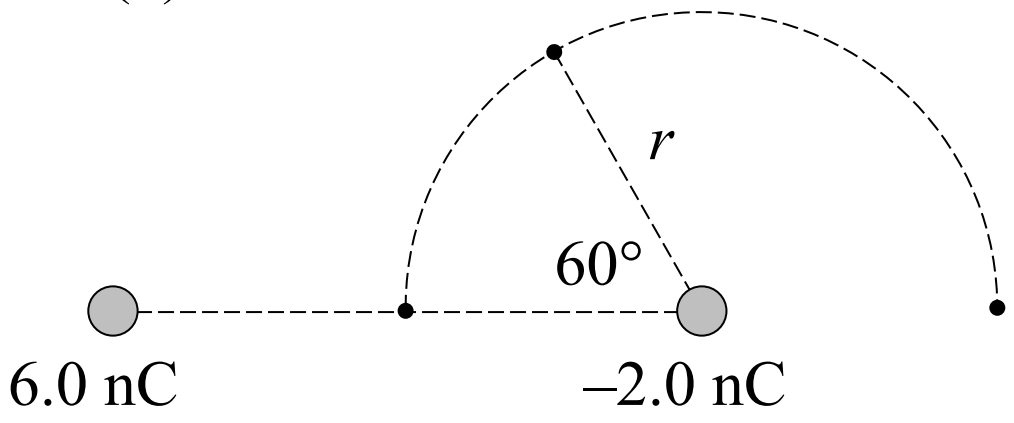
2. Same pith ball and sphere as above, but charge on pith ball –3.0 nC. (a) At what position would the ball be able to "hover". (b) What acceleration would ball have if it is released at position 30.0 cm, 90.0°.

3. A pith ball is electrically repelled by a metal sphere. When it is 5.0 cm from the center of the sphere the pith ball experiences a force equal to its own weight, 1.0 mN. The charge on the sphere is 25 times that of the ball. Determine the charge on each object.

4. Determine the force that the nucleus of a neon atom exerts on a single electron at distances ranging from 38 pm to 160 pm (a range of values for the radius of the electron "cloud"). Why doesn't the electron get "sucked into" the nucleus?

5. If the electron in the previous problem happens to be in the outermost orbital shell would the net electric force be larger or smaller than the values calculated? Explain.

6. Two point charges are fixed in place on the *x*-axis separated by 0.30 m. Find the net electrostatic force on a third point charge of –3.0 nC at the three indicated positions on the circular arc for (a) $r = 0.15$ m, and (b) $r = 0.60$ m.



7. At what distance could the *two* point charges be assumed to be *one* point charge of amount 4.0 nC? Create a graph of net electric force along x-axis relative to the midpoint and compare to a graph using a single charge of 4.0 nC located at the origin.

8. Use a pith ball to test the electric field of the Van de Graaff. Find the electric field at a point where the ball of mass 0.10 gram and charge −2.0 nC experiences a force equal its weight.

9. In Millikan's experiment, an oil drop with mass 3.3×10^{-15} kg is suspended by a vertical electric field of 34 kN/C, upward. (a) Determine the charge on the drop. (b) Find the number of excess or deficit electrons for the drop.

10. Sensitive measurements indicate there is an electric field at earth's surface with value 150 N/C directed towards earth's center. (a) What force is exerted by this field on a Van de Graaff sphere with charge +2.0 μC? (b) If the sphere has mass 1.20 kg, what charge upon it would cause it to levitate in the earth's electric field?

11. Two parallel metal plates are separated by 1 mm and connected to a 6 volt lantern battery. The result of this is an electric field of 6.0 kN/C between the plates. (a) Find the force on an electron in this field. (b) An electron starting at rest on the negative plate gains what speed moving to the other plate?

12. In a spacecraft's ion propulsion engine an electric field of 1.3 MN/C accelerates singly ionized Xenon atoms between oppositely charged metallic grids. (a) Find the acceleration of the Xenon ions. (b) If the ions attain a speed of 30 km/s, what is the separation of the grids? (c) If the thrust of engine is 91 mN, at what rate is the Xenon propellant used?

13. Determine the electric field strength at distances of 0.300 m, 0.600 m, and 3.00 m away from the center of a sphere with charge −4.0 μC. Sketch the field.

14. Suppose a second sphere with charge +4.0 μC is located 0.600 m away from the sphere in the previous problem. (a) Find the field at the midpoint of the spheres. (b) Find the force on an electron at this point. (c) Find the force on a proton at this point.

15. (a) Based on the field of 150 N/C down, what is the net charge on the earth? (b) At what distance from a pith ball of charge 2.0 nC would the electric field be equally strong?

16. Find the net charge on the Van de Graaff sphere based on the electric field determined previously.

17. In a certain electrochemical cell, 0.500 J of work is done in transferring 0.330 C of charge from the positive to negative terminals. (a) Find the voltage of the cell. (b) How much energy may be obtained by allowing 2.00 mC of charge to go from the negative to positive terminals.

18. A car's battery maintains a potential difference of 12.0 V. (a) If 20$\underline{0}$ C of charge is transferred through the battery to start the car, how much energy is used? (b) How much charge must be "pulled" from the battery in order to "obtain" 10$\underline{0}$ J of energy?

19. A typical alkaline "D" cell has an energy storage capacity of 7$\underline{0}$ kJ and is rated 1.5 V. (a) Determine the amount of charge that can pass through the cell before it "dies". (b) If a "C" cell has the same voltage but it is rated 6900 mAh, what is its energy storage?

20. A Tesla Model 3 has a battery pack with ratings: 350 V, 230 Ah, 78 kWh. (a) Check the consistency of these ratings by calculation. Can you explain any discrepancy? (b) If the total effective friction working against the moving car is 530 N and the motor is 95% efficient, what is its range? (c) How much charge passes through the battery each mile?

21. A Van de Graaff generator produces 100 kV of potential difference between spheres of opposite charge ±2 μC. (a) How much work is needed to transfer one more electron once the two spheres are at this potential? (b) How much energy is released when a spark jumps between the two spheres?

22. An electron volt (eV) is an amount of energy used by scientists to describe subatomic particles. It is equal to the change in energy of an electron moving through a potential difference of 1 Volt. Find its value in Joules.

23. An electron is accelerated from rest to a speed of 50 Mm/s between two oppositely charged parallel plates. (a) Find the potential difference between the plates. (b) Determine the speed of a proton that accelerates from rest between the same plates.

24. A certain electron gun has parallel plates connected to a voltage of 4700 V and separated by a distance of 5.0 mm. (a) Determine the kinetic energy gained by an electron moving from the negative to the positive. (b) Determine the speed of the electron assuming it starts at rest. (c) Find the strength of the electric field between the plates.

25. In a certain apparatus for doing Millikan's oil drop experiment an electric field of strength of 50.0kN/C is desired between two parallel plates separated by a vertical distance of 0.75 cm. (a) What voltage is required? (b) In order to suspend a positively charge oil drop which plate should connect to the positive terminal of the voltage source?

26. A positively charged pith ball of mass m starts at rest atop a sphere of radius R and positive charge Q. The repulsion causes the ball to rise a distance R above the surface of the sphere before falling back down. (a) Determine the potential difference through which the ball rises. (b) Determine the charge q on the pith ball.

27. A proton is flying through the corona of the Sun headed directly toward an isolated iron ion Fe^{13+} with speed 30.0 km/s. How close will the proton get to the ion before it reverses direction? Assume the ion does not move.

28. Consider a hydrogen atom. (a) Determine the electric potential at a distance of 5.29×10^{-11} m from a proton. (b) If an electron in the lowest energy orbital is this distance from the proton, what work (at most) must be done to remove it? (c) Given that the actual ionization energy for such an electron is 13.6 eV how can the difference be explained?