Practice Questions: Topic 1– Electrostatics

Multiple Choice

1. Which of the following are the fundamental forces in nature?

I. Gravitational force
II. Electromagnetic force
III. Weak nuclear force
IV. Strong nuclear force

A. I and II only
B. II and IV only
C. I, II and IV only
D. I, II, III and IV

2. Which of the four fundamental forces in nature is the weakest as well as long ranged force?

A. Gravitational force
B. Electromagnetic force
C. Weak nuclear force
D. Strong nuclear force

3. Which one of these systems has the most negative charge?

A. 2 electrons
B. 3 electrons and 1 proton
C. 5 electrons and 5 protons
D. N electrons and N – 3 protons

4. Which of the following is an SI unit of charge?

A. Coulomb (C)
B. Ampere (A)
C. Joule (J)
D. Volt (V)

5. Which of the following is correct for the charge of electrons, protons and neutrons?

	Electrons	**Protons**	**Neutrons**
A.	Positive	Negative	Neutral
B.	Negative	Neutral	Positive
C.	Negative	Positive	Neutral
D.	Neutral	Positive	Negative

6. Consider two protons placed near one another with no other objects close by. They would ____.

A. accelerate away from each other
B. remain motionless
C. accelerate toward each other
D. be pulled together at constant speed

7. When a metal plate is given a positive charge, which of the following is taking place?

A. Positive charges are transferred to the plate from another object
B. Negative charges are transferred from the plate to another object
C. Negative charges are transferred from the plate to another object, and positive charges are also transferred to the plate from another object
D. It depends on whether the object conveying the charge is a conductor or an insulator

8. Like charges _____ and unlike charges _____ each other.

A. attract repel
B. attract attract
C. repel attract
D. repel repel

9. Which of the following statements is/are true regarding electric charges?

I. Like charges attract
II. Unlike charges attract
III. If a neutral object gains electrons, it becomes positively charged
IV. If a neutral object loses electrons, it becomes positively charged

A. I and III
B. I and IV
C. II and III
D. II and IV

10. When a rubber rod is rubbed with rabbit fur, the rod becomes ___.

A. negatively charged
B. positively charged
C. neutral
D. either negatively charged or positively charged, depending on whether the fur is always moved in the same direction or is moved back and forth

11. When a glass rod is rubbed with a polyester scarf, the rod becomes _____.

A. negatively charged
B. positively charged
C. neutral
D. either negatively charged or positively charged, depending on whether the scarf is always moved in the same direction or is moved back and forth

12. A metal sphere, X, has an initial net charge of $-6 \times 10^{-6}\ C$ and an identical sphere, Y, has an initial net cherge of $+2 \times 10^{-6}\ C$. The spheres touch each other and then separate. What is the net charge on sphere X after the spheres have separated?

A. $0\ C$
B. $-2 \times 10^{-6}\ C$
C. $-4 \times 10^{-6}\ C$
D. $-6 \times 10^{-6}\ C$

13. How many electrons does it take to make $1.00\ C$ of charge?

A. 1.60×10^{19}
B. 6.60×10^{19}
C. 3.20×10^{16}
D. 6.24×10^{18}

14. A glass rod is charged by friction during which 13×10^{10} electrons are removed from the rod. What is the charge on the rod?

A. $-20.8\ nC$
B. $-6.40\ nC$
C. $+8.12\ nC$
D. $+20.8\ nC$

15. A negatively charged conductor attracts a second object. The second object could be which of the following?

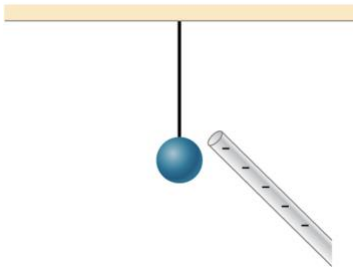
I. A conductor with positive net charge
II. A conductor with zero net charge
III. An insulator with zero net charge

A. I only
B. II only
C. II and III only
D. I, II, or III

16. Two lightweight metal spheres are suspended near each other from insulating threads. One sphere has a net charge; the other sphere has no net charge. The spheres will ___.

A. attract each other
B. exert no net electrostatic force on each other
C. repel each other
D. attract or repel depending on the sign of the charge on the one sphere

17. The figure below shows a negatively charged rod brought close to, but not touching an uncharged conductor.



Which of the statements below is true regarding what happens to the conductor.

A. The conductor is attracted to the rod due to polarization of charge

B. The conductor is repelled away from the rod due to polarization of charge

C. The conductor is attracted to the rod due to transfer of electrons by conduction

D. The conductor is repelled away from the rod due to transfer of electrons by conduction

18. A neutral metal ball is suspended by a string. A positively charged insulating rod is placed near the ball, which is observed to be attracted to the rod. This is because ____.

A. the ball becomes positively charged by induction

B. the ball becomes negatively charged by induction

C. the number of electrons in the ball is more than the number in the rod

D. there is a rearrangement of the electrons in the ball

19. Which of the following is an example of a semiconductor?

A. Copper

B. Silicon

C. Wood

D. Glass

20. Materials that have zero resistance to the conduction of electricity are called as _____.

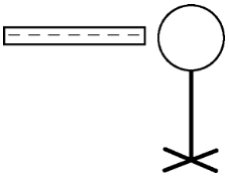
A. Conductors

B. Insulators

C. Superconductors

D. Semiconductors

21. A spherical conductor is on an insulating stand, as shown in the figure below. A negatively charged rod is brought close to the sphere but does not touch the sphere. Which of the following describes the resulting charge on the sphere?



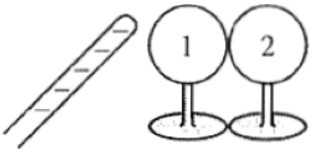
A. Positive

B. Negative

C. No net charge, but the sphere is polarized with positive charge on the left side

D. No net charge, but the sphere is polarized with negative charge on the left side

22. Two initially uncharged conductors, 1 and 2, are mounted on insulating stands and are in contact, as shown below. A negatively charged rod is brought near but does not touch them. With the rod held in place, conductor 2 is moved to the right by pushing its stand, so that the conductors are separated. Which of the following is now true of the conductor 2?



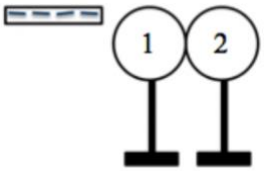
A. Uncharged

B. Positively charged

C. Negatively charged

D. Charged, but its sign can't be predicated

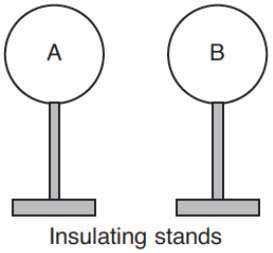
23. The figure below shows a negatively charged rod held close to, but not touching, a pair of conducting spheres 1 & 2, which are in contact with each other. While the rod is still held in place, sphere 2 is moved away from sphere 1. Which of the following statements is true about the charges on the two spheres?



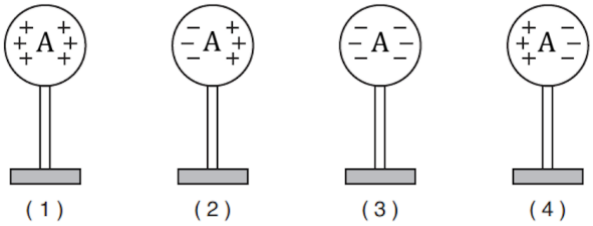
	Sphere 1	Sphere 2
A.	Positive	Positive
B.	Positive	Negative
C.	Negative	Negative
D.	Negative	Positive

Questions 24 and 25

Two identically-sized metal spheres, *A* and *B*, are on insulating stands, as shown in the diagram below. Sphere *A* possesses an excess of 6.3×10^{10} electrons and sphere *B* is neutral.

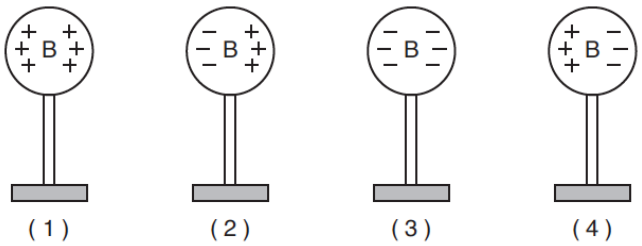


24. Which diagram best represents the charge distribution on sphere *A*?



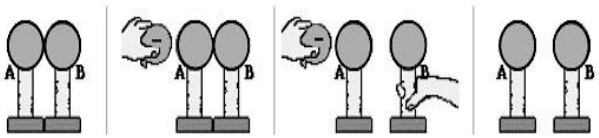
A. 1
B. 2
C. 3
D. 4

25. Which diagram best represents the charge distribution on sphere *B*?



A. 1
B. 2
C. 3
D. 4

26. The diagrams below show two conducting spheres A and B in contact with each other. With a negatively charged object close to them, the spheres are separated.



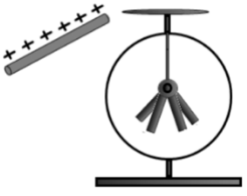
Identify the charges on A and B after separation.

	Charge on A	Charge on B
A.	Positive	Negative
B.	Positive	Positive
C.	Negative	Positive
D.	Negative	Negative

27. A positively charged rod is brought close to a charged electroscope. What is the charge on the electroscope?

I. Negative if the leaves fall
II. Positive if the leaves move apart
III. Negative if the leaves don't move

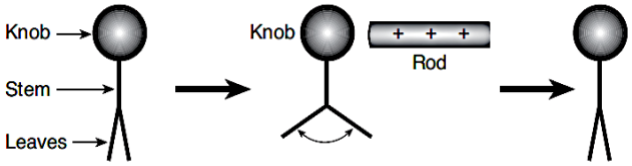
A. I only
B. II only
C. I and II only
D. II and III only



28. When a rod is brought near a positively charged electroscope, the leaves separate further. What charge, if any, does the rod carry?

A. Zero
B. Positive
C. Negative
D. Unknown

29. The electroscope shown in the diagram below is made completely of metal and consists of a knob, a stem, and leaves. A positively charged rod is brought near the knob of the electroscope and then removed.



The motion of the leaves results from electrons moving from the ____.

A. leaves to the knob, only
B. knob to the leaves, only
C. leaves to the knob and then back to the leaves
D. knob to the leaves and then back to the knob

30. The diagram below shows the steps followed by a student to charge a neutral conducting sphere with a positively charged object. The sphere is charged by the process of _____.

A. friction
B. induction
C. conduction
D. grounding

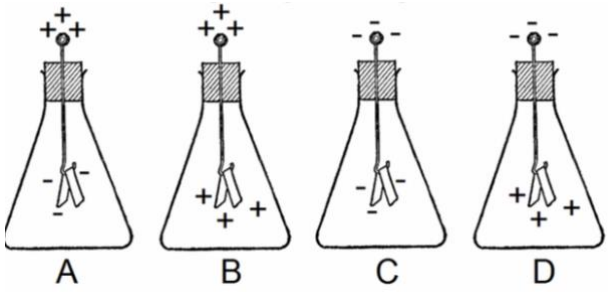
31. The figure below shows an electroscope. The hinged conductor moves away from the fixed conductor if a charge is applied to the electroscope, because ____.

A. like charges repel each other
B. like charges attract each other
C. unlike charges attract each other
D. unlike charges repel each other

32. The leaves of a positively charged electroscope diverge more when an object is brought near the knob of the electroscope. The object must be _____.

A. a conductor
B. an insulator
C. positively charged
D. negatively charged

33. Which of the following figures show an electroscope that is charged by conduction using a positively charged rod?



A. A
B. B
C. C
D. D

34. You place two charges a distance r apart. Then you double each charge and double the distance between the charges. How does the force between the two charges change?

A. The new force is twice as large
B. The new force is half as large
C. The new force is four times larger
D. The new force is the same

35. The magnitude of the electrostatic force between two point charges is F. If the distance between the charges is doubled, the electrostatic force between the charges will become ___.

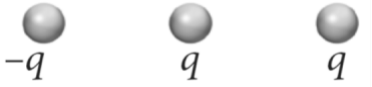
A. $F/4$
B. $F/2$
C. $2F$
D. $4F$

36. The force between a charge of 25 μC and a charge of -10 μC is 8.0 N. What is the separation between the two charges?

A. 0.15 m
B. 0.28 m
C. 0.45 m
D. 0.53 m

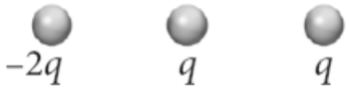
37. Three charges are arranged on a straight line as shown in the figure. What is the direction of the electrostatic force on the middle charge?

A. →
B. ←
C. ↓
D. ↑



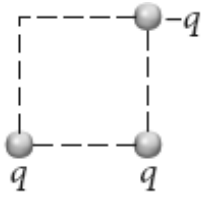
38. Three charges are arranged on a straight line as shown in the figure. What is the direction of the electrostatic force on the right charge?

A. →
B. ←
C. ↓
D. ↑



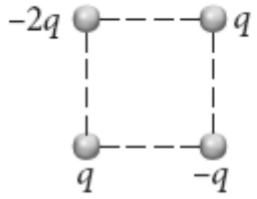
39. Three charges are arranged at the corners of a square as shown in the figure. What is the direction of the electrostatic force on the lower-right charge?

A. ↙
B. ↖
C. ↗
D. ↘



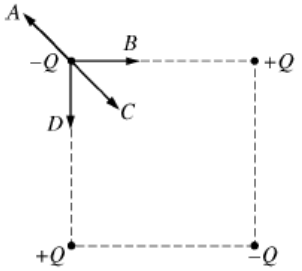
40. Four charges are arranged at the corners of a square as shown in the figure. What is the direction of the electrostatic force on the lower-right charge?

A. ↙
B. ↖
C. ↗
D. ↘

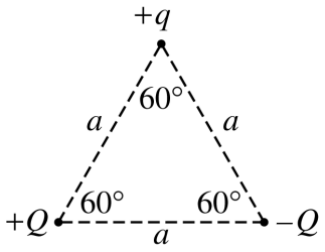


41. Four, point charges of equal magnitude but different signs are arranged on the corners of a square as shown below. Which of the vectors shown represents the direction of the net force acting on the charge at the upper left-hand corner of the square due to the other charges?

A. A
B. B
C. C
D. D



42. Three particles having charges of +q, +Q, and -Q are placed at the corners of an equilateral triangle of side a, as shown below. The net force on the particle with charge +q due to the other two charges is in the plane of the page and directed ___.



A. vertically upward

B. vertically downward

C. horizontally to the right

D. horizontally to the left

43. Which of the following produces the largest net force on the charge Q?

A. Charge $Q = 1\ C$ is $1\ m$ from a charge of $-2\ C$

B. Charge $Q = 1\ C$ is $0.5\ m$ from a charge of $-1\ C$

C. Charge $Q = 1\ C$ is halfway between 2 charges of $-2\ C$, that are $2\ m$ apart

D. Charge $Q = 1\ C$ is a distance of $2\ m$ from a charge of $-4\ C$

44. Find the magnitude of the net force on a $+1.20\ mC$ charge at the origin if there is a $+2.40\ mC$ charge at $(3.0\ m, 0)$ and a $-5.70\ mC$ charge at $(0, 4.0m)$.

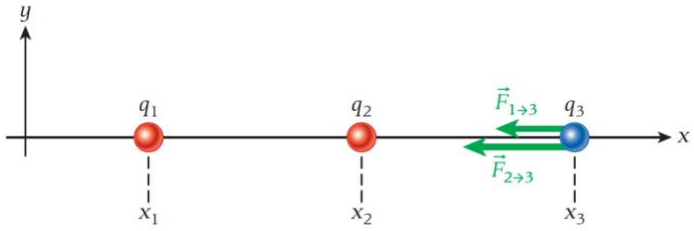
A. $1.8\ kN$

B. $2.9\ kN$

C. $3.8\ kN$

D. $4.8\ kN$

Questions 45 and 46



45. What do the forces acting on the charge q_3 in the figure below indicate about the signs of the three charges?

A. All three charges must be positive

B. All three charges must be negative

C. Charge q_3 must be zero

D. Charges q_1 and q_2 must have the same sign, and q_3 must have the opposite sign

46. Assuming that the lengths of the vectors in the figure are proportional to the magnitudes of the forces they represent, what do they indicate about the magnitudes of the charges q_1 and q_2? (The distance between x_1 and x_2 is the same as the distance between x_2 and x_3).

A. $|q_1| < |q_2|$

B. $|q_1| = |q_2|$

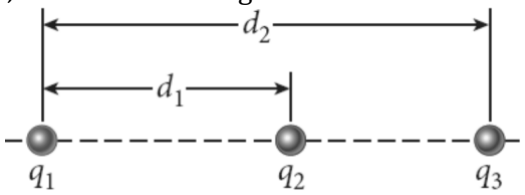
C. $|q_1| > |q_2|$

D. The answer cannot be determined from the information given in the figure

47. Object A and object B are separated by distance *d*. Object A has charge + *q*, and object B has charge – *2q*. Object A has a force of magnitude *F* exerted on it by object B. What are the magnitude and direction of the force exerted on object B?

	Magnitude	**Direction**
A.	F/2	Away from object A
B.	F	Away from object A
C.	2F	Away from object A
D.	F	Toward object A

48. Consider three charges placed along the x-axis, as shown in the figure.



The values of the charges are:
$q_1 = -8.10\ \mu C$,
$q_2 = 2.16\ \mu C$,
$q_3 = 2.16\ pC$.

The distance between q_1 and q_2 is $d_1 = 1.71\ m$.
The distance between q_1 and q_3 is $d_2 = 2.62\ m$.
What is the magnitude of the total electrostatic force exerted on q_3 by q_1 and q_2?

A. $2.77 \times 10^{-8}\ N$
B. $7.92 \times 10^{-6}\ N$
C. $1.44 \times 10^{-5}\ N$
D. $2.22 \times 10^{-4}\ N$

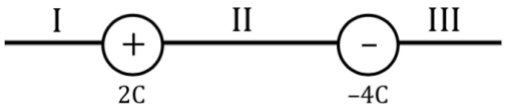
49. Three electrons are located at the vertices of an equilateral triangle, one at each vertex. The length of one side of the triangle is 1.00 nm. What is the magnitude of the net electrostatic force on each electron?

A. $2.30 \times 10^{-10}\ N$
B. $3.25 \times 10^{-10}\ N$
C. $3.39 \times 10^{-10}\ N$
D. $4.60 \times 10^{-10}\ N$

50. Two charges are placed at the corners of an equilateral triangle that is 0.25 m on each side. The first charge is 4.5 μC and the second is 3.2 μC. If a charge if 2.5 μC is placed at the third corner of the triangle, what is the magnitude of the electric force on the third charge due to the first two charges?

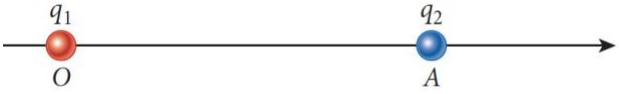
A. $0.602\ N$
B. $1.96\ N$
C. $2.41\ N$
D. $3.19\ N$

51. Two point charges are arranged as shown. In which region could a third charge $+1\ C$ be placed so that the net electrostatic force on it is zero?



A. I only
B. II only
C. III only
D. I and II only

52. Two point charges are fixed on the x-axis: $q_1 = 6.0\ \mu C$ is located at the origin, O, with $x_1 = 0.0\ cm$, and $q_2 = -3.0\ \mu C$ is located at point A, with $x_2 = 8.0\ cm$. Where should a third charge, q_3, be placed on the x-axis so that the total electrostatic force acting on it is zero?



A. 0.0 cm
B. 8.0 cm
C. 19 cm
D. 27 cm

53. A charge $Q_1 = Q$ is positioned on the x axis at $x = a$. Where should a charge $Q_2 = 9Q$ be placed to produce a net electric force of zero on a charge placed at the origin?

A. At $x = -3a$
B. At $x = -2a$
C. At $x = 2a$
D. At $x = 3a$

54. A fixed $+2.0\ mC$ charge is located at the origin, and a fixed $-5.0\ mC$ charge is located at $x = 1.0\ m$. Where could a $+7.0\ mC$ charge be placed so that the net force on it is zero?

A. $-1.7\ m$
B. $-0.67\ m$
C. $-0.39\ m$
D. $+0.39\ m$

55. A charge Q_1 is positioned on the x-axis at $x = a$. Where should a charge $Q_2 = -4Q_1$ be placed to produce a net electrostatic force of zero on a third charge, $Q_3 = Q_1$, located at the origin?

A. At the origin

B. At $x = -2a$

C. At $x = -a$

D. At $x = 2a$

Free Response:

1. Give the charge of the following elementary particles or atoms in terms of the elementary charge, $e = 1.602 \times 10^{-19}\ C$.

a. Proton

b. Electron

c. Neutron

d. Helium atom (2 protons, 2 neutrons and 2 electrons)

e. Hydrogen atom (one proton and one electron)

f. Alpha particle (2 protons, 2 neutrons)

2. An atomic nucleus contains positively charged protons and uncharged neutrons. Since nuclei do stay together, what must we conclude about the forces between these nuclear particles?

3. Two bodies attract each other electrically.

a. Do they both have to be charged?

b. Do they both have to be charged if the bodies repel one another

4. Suppose you place a charge q near a large metal plate.

a. If q is attracted to the plate, is the plate necessarily charged?

b. If q is repelled by the plate, is the plate necessarily charged?

5. How would you determine whether the charge on a particular rod is positive, negative or neutral?

6. Common static electricity involves charges.

a. How many electrons are needed to form a charge of −2.00 nC?

b. How many electrons must be removed from a neutral object to leave a net charge of 0.500 μC?

7. To start a car engine, the car battery moves 3.75×10^{21} electrons through the starter motor. How many coulombs of charge were moved?

8. When a positively charged rod is brought near to an isolated neutral conductor without touching it, will the rod experience an attractive force, a repulsive force, or no force at all?

A. an attractive force

B. a repulsive force

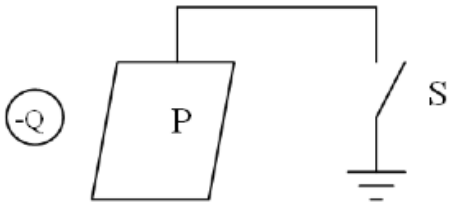
C. no force at all

9. An uncharged metal plate (P) is connected by a conductor to ground through a switch (S). The switch (S) is initially closed. A negative charge -Q is brought close to P without touching it and then the switch (S) is opened. After the switch (S) is open, the negative charge -Q is removed. After the negative charge -Q is removed, what is the charge on the plate (P)?

A. It is now positively charged

B. It is now negatively charged

C. It is still uncharged



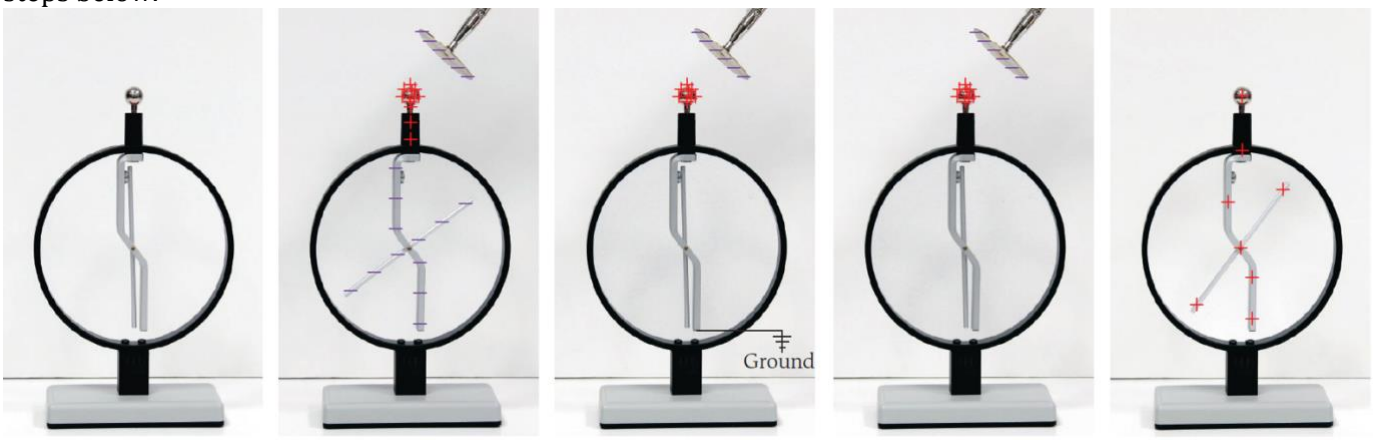
10. You bring a negatively charged rubber rod close to a grounded conductor without touching it. Then you disconnect the ground. What is the sign of the charge on the conductor after you remove the charged rod?

A. Negative

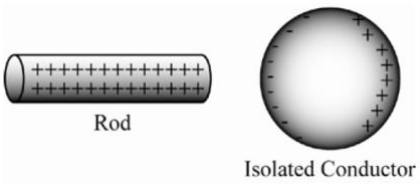
B. Positive

C. No charge

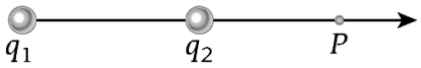
11. The figure below shows the process of charging an electroscope by induction. Describe each of the steps below.



12. When a positively charged rod is brought close to a neutral conductor without touching it, will the rod experience an attractive force, a repulsive force, or no force at all? Explain.



13. A positive point charge $+q$ is placed at point P, to the right of two charges q_1 and q_2, as shown in the figure below. The net electrostatic force on the positive charge $+q$ is found to be zero. Identify each of the following statements as true or false.



a. Charge q_2 must have the opposite sign from q_1 and be smaller in magnitude.
b. The magnitude of charge q_1 must be smaller than the magnitude of charge q_2.
c. Charges q_1 and q_2 must have the same sign.
d. If q_1 is negative, then q_2 must be positive.
e. Either q_1 or q_2 must be positive.

14. Two point particles with charges +3 μC and +5 μC are held in place by 3.0 N forces on each charge in appropriate directions.

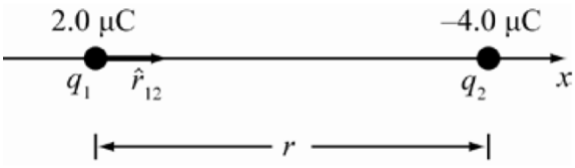
a. Draw a free-body diagram for each particle.

b. Find the distance between the charges.

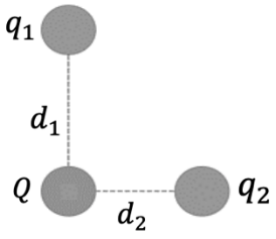
15. Two charged spheres are 8.00 cm apart. They are moved closer to each other by enough that the force on each of them increases four times. How far apart are they now?

16. Two identically charged particles separated by a distance of 1.00 m repel each other with a force of 1.00 N. What is the magnitude of the charges?

17. A $-4.00\ \mu C$ charge lies 20.0 cm to the right of a 2.00 μC charge on the x-axis as shown below. What is the force on the 2.00 μC charge?



18. Three charges are located in the xy −plane as shown below. Charge $Q = 5.0\ \mu C$ is located at the origin, charge $q_1 = -3.0\ \mu C$ is located on the $+y$ −axis, a distance $d_1 = 4.0\ cm$ from Q and charge $q_2 = -2.0\ \mu C$ is located on the $+x$ −axis, a distance $d_2 = 2.0\ cm$ from Q.



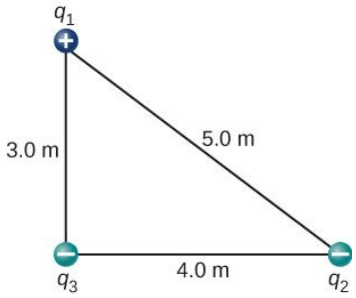
a. Determine the magnitude of the force that charge q_1 exerts on Q.

b. Determine the magnitude of the force that charge q_2 exerts on Q.

c. Determine the magnitude of the net force on the charge Q.

d. Determine the direction (angle from the $+x$ −axis) of the net force.

19. The charges $q_1 = 2.00 \times 10^{-7} C$, $q_2 = -4.00 \times 10^{-7} C$, and $q_3 = -1.00 \times 10^{-7} C$, are placed at the corners of the triangle shown below. What is the force on q_1?



20. Two charged objects experience a mutual repulsive force of 0.100 N. If the charge of one of the objects is reduced by half and the distance separating the objects is doubled, what is the new force?

21. Two point charges lie on the x-axis. If one point charge is 6.00 μC and lies at the origin and the other is -2.00 μC and lies at 20.0 cm, at what position must a third charge be placed to be in equilibrium?