## Chapter 20 Problems

## Multiple Choice <br> Identify the choice that best completes the statement or answers the question.

1. Which of the following statements is true about electric forces?
a. Electric forces cause objects to only attract each other.
b. Electric forces cause objects to only repel each other.
c. Electric forces cause objects to repel or attract each other.
d. Electric forces have no effect on each other.
2. Three rods of different materials $\mathrm{P}, \mathrm{Q}$, and R , are charged by various methods. When the rods are brought near each other, the rods P and Q repel each other, while the rods P and R attract each other. Which of the following could be the signs of the charges on the rods?

## Rod $\mathbf{P}$

## $\operatorname{Rod} \mathbf{Q}$

$\operatorname{Rod} \mathbf{R}$

| a. | - | + | - |
| :--- | :--- | :--- | :--- |
| b. | - | + | - |
| c. | - | - | + |
| d. | - | - | - |

3. Which of the following materials is the best conductor of electricity?
a. Wet skin
c. Dry air
b. Glass
d. Rubber
4. When two bodies are charged, the total charge before and after charging remains the same because of:
a. quantization of charges
c. law of induction
b. conservation of charges
d. Coulomb's law
$\qquad$ 5. When a conducting sphere is charged positively, initially the charge is deposited on the left side.

However, due to the sphere's conducting nature, the charge spreads uniformly throughout the surface of the sphere. Charge is uniformly distributed because:
a. charged atoms at the location of charge distribute throughout the surface.
b. excess protons move from the location of charge to rest.
c. excess electrons within the sphere move toward excess protons.
d. excess charge within the sphere moves out into the ground from the surface.
6. The distance between two charges $q_{\mathrm{a}}$ and $q_{\mathrm{b}}$ is $r$, and the force between them is $F$. What is the force between them if the distance between them is doubled?
a. $F / 4$
b. $4 F$
c. $9 F$
d. $F / 9$
7. Charging by $\qquad$ charges a neutral body by touching it with a charged body; whereas charging by
$\qquad$ charges an object without touching it with a charged body.
a. conduction, induction
c. force, conduction
b. induction, conduction
d. force, induction
8. Electric forces can be either repulsive or attractive, whereas gravitational force is always:
a. attractive
c. both a and b
b. repulsive
d. neither a nor $b$
$\qquad$ 9. $\qquad$ charges attract.
a. Like, opposite
c. Positive, negative
b. Opposite, like
d. Negative, positive
10. A/An $\qquad$ is a material in which charges will not move easily, whereas a/an $\qquad$ is a material that allows charges to move about easily.
a. conductor, insulator
c. electroscope, conductor
b. insulator, conductor
d. insulator, electroscope
11. Metals contain $\qquad$ electrons; rubber has $\qquad$ electrons.
a. bound, free
c. excess, insufficient
b. free, bound
d. insufficient, excess
12. $\qquad$ forces between charges are enormous in comparison to $\qquad$ forces.
a. Electrical, gravitational
c. Positive, negative
b. Gravitational, electrical
d. Negative, positive
13. An area with excess electrons has a net $\qquad$ charge; an area with a deficit of electrons has a net
$\qquad$ charge.
a. negative, positive
c. positive, neutral
b. positive, negative
d. negative, neutral

## Problem

14. Two identical, electrically isolated conducting spheres, A and B, are separated by a distance $r$. Sphere A has a charge of $+Q$ and sphere B is electrically neutral. The spheres are connected for a short time with a thin conducting wire.
a. What is the magnitude of the electrostatic force between the spheres after the wire is removed?
b. Is the force attractive or repulsive?
15. What is the force between two small charged spheres that have charges of $2 \times 10^{-7} \mathrm{C}$ and $3 \times 10^{-7} \mathrm{C}$ and are placed 30 cm apart in air?
16. What is the value of charge of a body that carries 20 excess electrons?
17. Two like charged balloons, placed at a distance of 0.50 m , experience a repulsive force of 0.32 N . What is the force if the distance between the balloons is doubled?
18. Three charged objects, $\mathrm{X}, \mathrm{Y}$, and Z , are placed on the $x$-axis. Object X has a charge of $+58 \mu \mathrm{C}$ and is located at the origin. Object Y has a negative charge of $-44 \mu \mathrm{C}$ and is located at -1.4 m from the origin. Object Z has a charge of $+78 \mu \mathrm{C}$ and is located at the +2.4 m position. Determine the magnitude of the net electric force acting on object Y.
19. Three charges $q_{1}, q_{2}$, and $q_{3}$ are placed on the $x$-axis at points $\mathrm{A}, \mathrm{B}$, and C , respectively. The charge $q_{1}$ is equal to $1.5 \mu \mathrm{C}, q_{2}$ is equal to $0.20 \mu \mathrm{C}$, and $q_{3}$ is equal to $-0.50 \mu \mathrm{C}$. The distance between A and B is 1.2 m and between B and C is 0.60 m . Determine the resultant force on $q_{2}$.
20. Three equal charges are placed at three corners of a square as shown in the diagram. The force exerted by $q_{1}$ on $q_{2}$ is represented by $F_{12}$ and the force exerted by $q_{1}$ on $q_{3}$ is represented by $F_{13}$. Determine the ratio of the magnitude between $F_{12}$ and $F_{13}$.

21. The charges $+2.0 \mu \mathrm{C},+3.0 \mu \mathrm{C}$, and $+4.0 \mu \mathrm{C}$ are placed at points $\mathrm{A}, \mathrm{B}$, and C of an equilateral triangle with each side of 0.20 m . Determine the force on the charge $+4.0 \mu \mathrm{C}$ placed at the point C .

22. Three charges, $q_{1}, q_{2}$, and $q_{3}$, are placed as shown in the diagram. The magnitude of charges $q_{1}$ and $q_{2}$ is 3.0 C each. The magnitude of the charge $q_{3}$ is 1.0 C . The distance between $q_{1}$ and $q_{3}$ is 2.0 m . The distance between $q_{2}$ and $q_{3}$ is 3.0 m . The vector from $q_{1}$ to $q_{3}$ has an angle of $55^{\circ}$. Determine the net force on charge $q_{3}$.

23. Two charges $+5.0 \mu \mathrm{C}$ and $+2.0 \mu \mathrm{C}$ are placed at a distance of 3.0 m from each other as shown in the diagram. Where would you put a positive charge of $+1.0 \mu \mathrm{C}$ in the diagram so that the net electrostatic force on it is zero?


## 3.0 m

24. There are two balloons of charges $+3.37 \mu \mathrm{C}$ and $-8.21 \mu \mathrm{C}$. The distance between the two balloons is 2.00 m . Determine the force between the two balloons.
25. Charges A and B are placed on the $x$-axis. Another charges C is placed below A . The magnitude of charge A is $-7.0 \mu \mathrm{C}$ and that of charge B is $-8.0 \mu \mathrm{C}$. The magnitude of the charge C is $+6.0 \mu \mathrm{C}$. The distance between A and B is 14.0 cm and the distance between B and C is 20.0 cm . What is the net force on charge A?

26. Three charges $\mathrm{A}, \mathrm{B}$, and C , are placed on the $x$-axis as shown in the diagram. The charge on C is $+2 \mu \mathrm{C}$, the charge on B is $-4 \mu \mathrm{C}$, and the charge on A is $-8 \mu \mathrm{C}$. The distance between A and $\mathrm{B}, r_{1}$, is 15 cm . The distance between A and C, $r_{2}$, is 18 cm . Determine the net force on A.

27. Three charges $\mathrm{A}, \mathrm{B}$, and C are placed on the $x$-axis as shown in the diagram. The charge of C is +3.00 $\mu \mathrm{C}$, the charge on B is $-3.00 \mu \mathrm{C}$, and the charge on A is $-5.00 \mu \mathrm{C}$. The distance between A and B is 12.0 cm and distance between A and C is 20.0 cm . Determine the net force on A.

