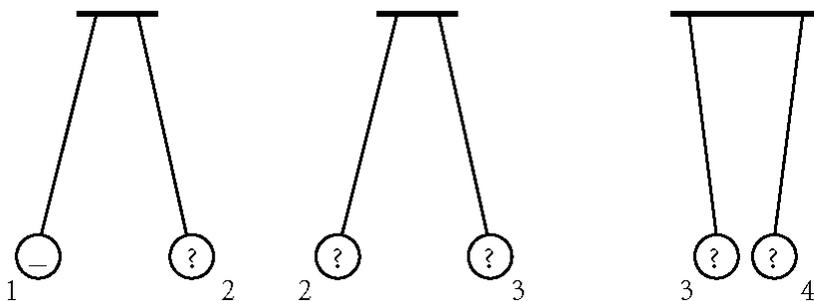


Phys.12-Q3W5-Electric forces and fields-Qs. Bank

Multiple Choice

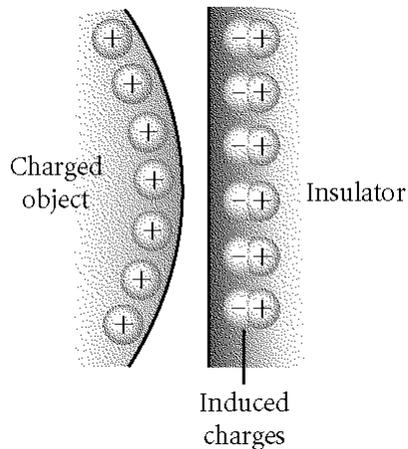
Identify the choice that best completes the statement or answers the question.

- ___ 1. What happens when a rubber rod is rubbed with a piece of fur, giving it a negative charge?
- Protons are removed from the rod.
 - Electrons are added to the rod.
 - Electrons are added to the fur.
 - The fur is left neutral.
- ___ 2. A repelling force occurs between two charged objects when the charges are of
- unlike signs.
 - like signs.
 - equal magnitude.
 - unequal magnitude.
- ___ 3. An attracting force occurs between two charged objects when the charges are of
- unlike signs.
 - like signs.
 - equal magnitude.
 - unequal magnitude.
- ___ 4. When a glass rod is rubbed with silk and becomes positively charged,
- electrons are removed from the rod.
 - protons are removed from the silk.
 - protons are added to the silk.
 - the silk remains neutral.
- ___ 5. Electric charge is
- found only in a conductor.
 - conserved.
 - found only in insulators.
 - not conserved.
- ___ 6. If a positively charged glass rod is used to charge a metal bar by induction, the charge on the bar
- will be equal in magnitude to the charge on the glass rod.
 - must be negative.
 - must be positive.
 - will be greater in magnitude than the charge on the glass rod.
- ___ 7. Charge is most easily transferred in
- nonconductors.
 - conductors.
 - semiconductors.
 - insulators.



- ___ 8. In the diagram shown above, the circles represent small balls that have electric charges. Ball 1 has a negative charge, and ball 2 is repelled by ball 1. Next, you see that ball 2 repels ball 3 and that ball 3 attracts ball 4. What is the electric charge on ball 4?
- Ball 4 may have either a positive or negative charge.
 - Ball 4 has a negative charge.
 - Ball 4 has a positive charge.
 - It is not possible to determine the charge on ball 4.

- ___ 9. Which sentence best describes electrical conductors?
- Electrical conductors have low mass density.
 - Electrical conductors have high tensile strength.
 - Electrical conductors have electric charges that move freely.
 - Electrical conductors are poor heat conductors.
- ___ 10. Which statement is the *most* correct regarding electric insulators?
- Charges within electric insulators do not readily move.
 - Electric insulators have high tensile strength.
 - Electric charges move freely in electric insulators.
 - Electric insulators are good heat conductors.
- ___ 11. The process of charging a conductor by bringing it near another charged object and then grounding the conductor is called
- contact charging.
 - induction.
 - polarization.
 - neutralization.



- ___ 12. The figure shown above demonstrates charging by
- grounding.
 - induction.
 - polarization.
 - contact.
- ___ 13. Both insulators and conductors can be charged by
- grounding.
 - induction.
 - polarization.
 - contact.
- ___ 14. A surface charge can be produced on insulators by
- grounding.
 - induction.
 - polarization.
 - contact.
- ___ 15. Conductors can be charged by ____, while insulators cannot.
- grounding
 - induction
 - polarization
 - contact
- ___ 16. When a charged body is brought close to an uncharged body without touching it, a(n) ____ charge may result on the uncharged body. When a charged body is brought into contact with an uncharged body and then is removed, a(n) ____ charge may result on the uncharged body.
- negative; positive
 - positive; negative
 - induced; residual
 - residual; induced

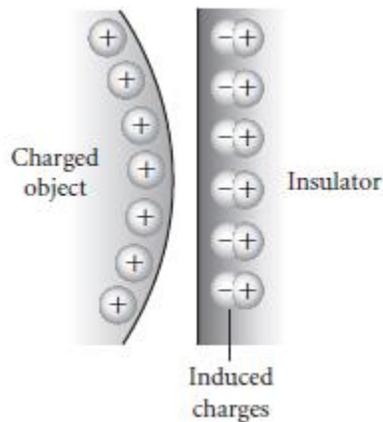
- ___ 17. Which of the following is *not* true for both gravitational and electric forces?
- The inverse square distance law applies.
 - Forces are proportional to physical properties.
 - Potential energy is a function of distance of separation.
 - Forces are either attractive or repulsive.
- ___ 18. Two point charges, initially 2 cm apart, are moved to a distance of 10 cm apart. By what factor does the resulting electric force between them change?
- 25
 - 5
 - $\frac{1}{5}$
 - $\frac{1}{25}$
- ___ 19. If the charge is tripled for two identical charges maintained at a constant separation, the electric force between them will be changed by what factor?
- $\frac{1}{9}$
 - $\frac{2}{3}$
 - 9
 - 18
- ___ 20. Two point charges, initially 1 cm apart, are moved to a distance of 3 cm apart. By what factor do the resulting electric and gravitational forces between them change?
- 9
 - 3
 - $\frac{1}{3}$
 - $\frac{1}{9}$
- ___ 21. Two positive charges, each of magnitude q , are on the y -axis at points $y = +a$ and $y = -a$. Where would a third positive charge of the same magnitude be located for the net force on the third charge to be zero?
- at the origin
 - at $y = 2a$
 - at $y = -2a$
 - at $y = -a$
- ___ 22. Which is the *most* correct statement regarding the drawing of electric field lines?
- Electric field lines always connect from one charge to another.
 - Electric field lines always form closed loops.
 - Electric field lines can start on a charge of either polarity.
 - Electric field lines never cross each other.
- ___ 23. The relative distribution of charge density on the surface of a conducting solid depends upon which of the following?
- the shape of the conductor
 - the mass density of the conductor
 - the type of metal the conductor is made of
 - the strength of Earth's gravitational field
- ___ 24. Where is the electric field of an isolated, uniformly charged, hollow metallic sphere greatest?
- at the center of the sphere
 - at the sphere's inner surface
 - at infinity
 - at the sphere's outer surface
- ___ 25. A conductor that is in electrostatic equilibrium has an electric field inside the conductor that
- depends on the radius of the conductor.
 - is zero.
 - is greatest near the conductor's surface.
 - is parallel to the surface of the conductor.

- _____ 26. The electric field just outside a charged conductor in electrostatic equilibrium is
- zero.
 - at its minimum level.
 - the same as it is in the center of the conductor.
 - perpendicular to the conductor's surface.
- _____ 27. For a conductor that is in electrostatic equilibrium, any excess charge
- flows to the ground.
 - resides entirely on the conductor's outer surface.
 - resides entirely on the conductor's interior.
 - resides entirely in the center of the conductor.
- _____ 28. If an irregularly shaped conductor is in electrostatic equilibrium, charge accumulates
- where the radius of curvature is smallest.
 - where the radius of curvature is largest.
 - evenly throughout the conductor.
 - in flat places.
- _____ 29. Electric field strength depends on
- | | |
|-------------------------|----------------------------------|
| a. charge and distance. | c. Coulomb constant and mass. |
| b. charge and mass. | d. elementary charge and radius. |
- _____ 30. What occurs when two charges are moved closer together?
- The electric field doubles.
 - Coulomb's law takes effect.
 - The total charge increases.
 - The force between the charges increases.
- _____ 31. Resultant force on a charge is the _____ sum of the individual forces on that charge.
- | | |
|-----------|---------------|
| a. scalar | c. individual |
| b. vector | d. negative |

Choose the best answer from the options that follow each question.

- _____ 32. What happens when a rubber rod is rubbed with a piece of fur, giving it a negative charge?
- Protons are removed from the rod.
 - Electrons are added to the rod.
 - Electrons are added to the fur.
 - The fur is left neutral.
- _____ 33. A repelling force occurs between two charged objects when the charges are of
- unlike signs.
 - like signs.
 - equal magnitude.
 - unequal magnitude.
- _____ 34. An attracting force occurs between two charged objects when the charges are of
- unlike signs.
 - like signs.
 - equal magnitude.
 - unequal magnitude.
- _____ 35. When a glass rod is rubbed with silk and becomes positively charged,
- unlike signs.
 - like signs.
 - equal magnitude.
 - unequal magnitude.

- ___ 36. Electric charge is
- found only in a conductor.
 - conserved.
 - found only in insulators.
 - not conserved.
- ___ 37. Charge is most easily transferred in
- nonconductors.
 - conductors.
 - semiconductors.
 - insulators.
- ___ 38. The process of charging a conductor by bringing it near another charged object and then grounding the conductor is called
- contact charging.
 - induction.
 - polarization
 - neutralization.
- ___ 39.



- The figure shown above demonstrates charging by
- grounding.
 - induction.
 - polarization.
 - contact.
- ___ 40. Both insulators and conductors can be charged by
- grounding.
 - induction.
 - polarization.
 - contact.
- ___ 41. A surface charge can be produced on insulators by
- grounding.
 - induction.
 - polarization.
 - contact.

- ___ 42. Conductors can be charged by ____, while insulators cannot.
- grounding.
 - induction.
 - polarization.
 - contact.
- ___ 43. Which of the following is *not* true for both gravitational and electric forces?
- The inverse square distance law applies.
 - Forces are proportional to physical properties.
 - Potential energy is a function of distance of separation.
 - Forces are either attractive or repulsive.
- ___ 44. Electric field strength depends on
- charge and distance.
 - charge and mass.
 - Coulomb constant and mass.
 - elementary charge and radius.
- ___ 45. What occurs when two charges are moved closer together?
- The electric field doubles.
 - Coulomb's law takes effect.
 - The total charge increases.
 - The force between the charges increases.
- ___ 46. Resultant force on a charge is the ____ sum of individual forces on that charge.
- scalar
 - vector
 - individual
 - negative
- ___ 47. The electric field just outside a charged conductor in electrostatic equilibrium is
- zero.
 - at its minimum level.
 - the same as it is in the center of the conductor.
 - perpendicular to the conductor's surface.
- ___ 48. For a conductor that is in electrostatic equilibrium, any excess charge
- flows to the ground.
 - resides entirely on the conductor's outer surface.
 - resides entirely on the conductor's interior.
 - resides entirely on the conductor's conductor.
- ___ 49. If an irregularly shaped conductor is in electrostatic equilibrium, charge accumulates
- where the radius of curvature is smallest.
 - where the radius of curvature is largest.
 - evenly throughout the conductor.
 - in flat places.

Choose the best answer from the options that follow each question.

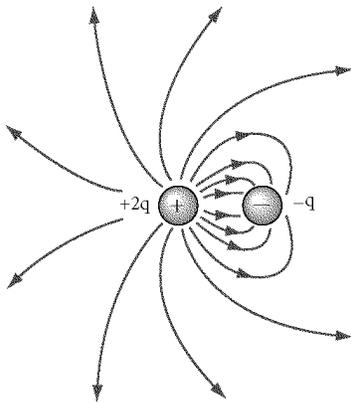
- ___ 50. If a positively charged glass rod is used to charge a metal bar by induction, the charge on the bar
- will be equal in magnitude to the charge on the glass rod.
 - must be negative.
 - must be positive.
 - will be greater in magnitude than the charge on the glass rod.

- ___ 51. Which sentence best describes electrical conductors?
- Electrical conductors have low mass density.
 - Electrical conductors have high tensile strength.
 - Electrical conductors have electric charges that move freely.
 - Electrical conductors are poor heat conductors.
- ___ 52. Which statement is the most correct regarding electric insulators?
- Charges within electric insulators do not readily move.
 - Electric insulators have high tensile strength.
 - Electric charges move freely in electric insulators.
 - Electric insulators are good heat conductors.
- ___ 53. When a charged body is brought close to an uncharged body without touching it, a(n) ___ charge may result on the uncharged body. When a charged body is brought into contact with an uncharged body and then is removed, a(n) ___ charge may result on the uncharged body.
- negative; positive
 - positive; negative
 - induced; residual
 - residual; induced
- ___ 54. Two point charges, initially 2 cm apart, are moved to a distance of 10 cm apart. By what factor does the resulting electric force between them change?
- 25
 - 5
 - $\frac{1}{5}$
 - $\frac{1}{25}$
- ___ 55. If the charge is tripled for two identical charges maintained at a constant separation, the electric force between them will be changed by what factor?
- $\frac{1}{9}$
 - $\frac{2}{3}$
 - 9
 - 18
- ___ 56. Two point charges, initially 1 cm apart, are moved to a distance of 3 cm apart. By what factor do the resulting electric and gravitational forces between them change?
- 3
 - 9
 - $\frac{1}{3}$
 - $\frac{1}{9}$
- ___ 57. Two positive charges, each of magnitude q , are on the y -axis at points $y = +a$ and $y = -a$. Where would a third positive charge of the same magnitude be located for the net force on the third charge to be zero?
- at the origin
 - at $y = 2a$
 - at $y = -2a$
 - at $y = -a$

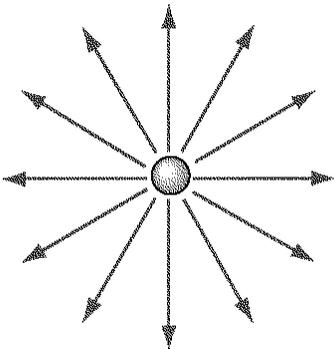
- _____ 58. Which is the most correct statement regarding the drawing of electric field lines?
- a. Electric field lines always connect from one charge to another.
 - b. Electric field lines always form closed loops.
 - c. Electric field lines can start on a charge of either polarity.
 - d. Electric field lines never cross each other.
- _____ 59. If an irregularly shaped conductor is in electrostatic equilibrium, charge accumulates
- a. where the radius of curvature is smallest.
 - b. where the radius of curvature is largest.
 - c. evenly throughout the conductor.
 - d. in flat places.

Short Answer

1. When a conductor is given a negative charge, the charge will move on the conductor until the repulsive forces between the free electrons are in _____.
2. A negatively charged rubber rod is brought near a neutral, conductive sphere that has no charge. As a result, the part of the sphere closest to the rod becomes positively charged. Explain how this positive charge occurs.
3. How does the electric force between two charged objects change when the distance between the two objects is doubled? Explain.
4. How does the electric force between two charged objects change when the charge on one of the objects is doubled? Explain.
5. What is electric force?
6. How are gravitational force and electric force different?

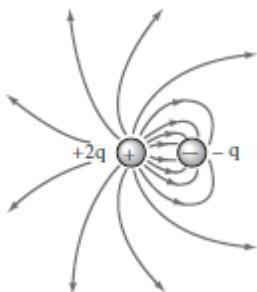


7. In the figure shown above, why do only half of the lines originating from the positive charge terminate on the negative charge?



8. Is the charge shown in the figure above positive or negative?
9. Draw the lines of force representing the electric field around two charges if both charges are positive and of the same magnitude.
10. The electric field strength at the single electron of a hydrogen atom is more than 50 million times the field strength in a lightning bolt. How can you account for this vast difference?

11. A steel plate passes through an electrostatic spray-painting process designed to paint only one side of the plate. When the plate is examined, some paint is found on the reverse side of the plate. How can you account for this observation?
12. Any force between two objects that are not touching is called a (n) _____ force.
13. Draw the lines of force representing the electric field surrounding two objects that have equal magnitude charges of opposite polarity.
14. Explain what happens when you vigorously rub your wool socks on a carpeted floor, touch a metal doorknob, and get a shock.
15. What property was discovered in Millikan's experiments? Explain this property.
16. A negatively charged rubber rod is brought near a neutral, conductive sphere that has no charge. As a result, the part of the sphere closest to the rod becomes positively charged. Explain how this positive charge occurs.
- 17.

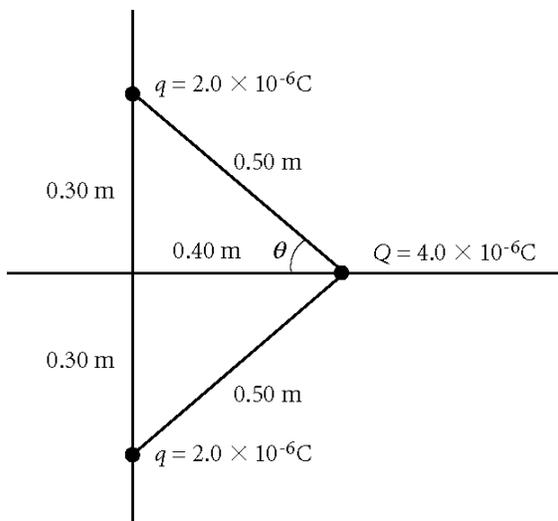


In the figure shown above, why do only half of the lines originating from the positive charge terminate on the negative charge?

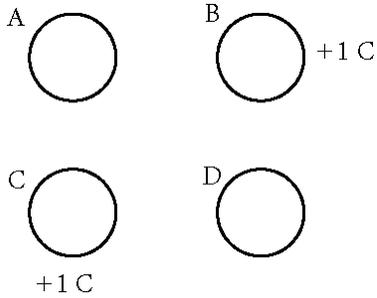
18. Two equal charges are separated by 3.7×10^{-10} m. The force between the charges has a magnitude of 2.37×10^{-3} N. What is the magnitude of q on the charges? ($k_C = 8.99 \times 10^9$ N•m²/C²)
19. Two charges are located on the positive x -axis of a coordinate system. Charge $q_1 = 2.00 \times 10^{-9}$ C, and it is 0.020 m from the origin. Charge $q_2 = 23.00 \times 10^{-9}$ C, and it is 0.040 m from the origin. What is the electric force exerted by these two charges on a third charge, $q_3 = 5.00 \times 10^{-9}$, located at the origin? ($k_C = 8.99 \times 10^9$ N•m²/C²)
20. Two point charges are 4.0 cm apart and have values of $30.0 \mu\text{C}$ and $230.0 \mu\text{C}$, respectively. What is the electric field at the midpoint between the two charges? ($k_C = 8.99 \times 10^9$ N•m²/C²)
21. Charges of $4.0 \mu\text{C}$ and $26.0 \mu\text{C}$ are placed at two corners of an equilateral triangle with sides of 0.10 m. What is the magnitude of the electric field created by these two charges at the third corner of the triangle?

Problems

1. What is the electric force between an electron and a proton that are separated by a distance of 3.4×10^{-10} m? Is the force attractive or repulsive? ($e = 1.60 \times 10^{-19}$ C, $k_C = 8.99 \times 10^9$ N•m /C)
2. What is the electric force between a proton and an alpha particle (charge $2e$) that are separated by a distance of 4.5×10^{-10} m? ($e = 1.60 \times 10^{-19}$ C, $k_C = 8.99 \times 10^9$ N•m /C)
3. An electron is separated from a potassium nucleus (charge $19e$) by a distance of 5.7×10^{-10} m. What is the electric force between these particles? ($e = 1.60 \times 10^{-19}$ C, $k_C = 8.99 \times 10^9$ N•m /C)
4. Two equal charges are separated by 2.6×10^{-10} m. The force between the charges has a magnitude of 8.51×10^{-9} N. What is the magnitude of q on the charges? ($k_C = 8.99 \times 10^9$ N•m /C)
5. An alpha particle (charge $2e$) is sent at high speed toward an atomic nucleus. The electric force acting on the alpha particle is 79.8 N when it is 2.29×10^{-14} m away from the nucleus. What is the charge on the nucleus, as a whole number multiple of e ? ($e = 1.60 \times 10^{-19}$ C, $k_C = 8.99 \times 10^9$ N•m /C)
6. Two charges are located on the positive x -axis of a coordinate system. Charge $q_1 = 6.26 \times 10^{-9}$ C, and it is 0.026 m from the origin. Charge $q_2 = -3.17 \times 10^{-9}$ C, and it is 0.043 m from the origin. How large is the electric force exerted by these two charges on a third charge, $q_3 = 5.33 \times 10^{-9}$ C, located at the origin? ($k_C = 8.99 \times 10^9$ N•m /C)



7. Two equal positive charges, both $q = 2.0 \times 10^{-6}$ C, interact with a third charge, $Q = 4.0 \times 10^{-6}$ C, as shown in the figure above. What is the magnitude of the electric force on Q ? ($k_C = 8.99 \times 10^9$ N•m /C)



8. The diagram above shows four charges—A, B, C, and D— at the corners of a square. Charges A and D, on opposite corners, have equal charge, whereas both B and C have a charge of 1.0 C. If the force on B is zero, what is the charge on A?
9. Two point charges are 15.2 cm apart and have charges of 4.9 μC and $-4.9 \mu\text{C}$, respectively. What is the magnitude of the electric field at the midpoint between the two charges?
10. Two point charges are 4.8 cm apart and have values of 56.5 μC and $-56.5 \mu\text{C}$, respectively. What is the electric field at the midpoint between the two charges? ($k_C = 8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$)
11. Charges of 5.2 μC and $-8.7 \mu\text{C}$ are placed at two corners of an equilateral triangle with sides of 0.12 m. What is the magnitude of the electric field created by these two charges at the third corner of the triangle?
12. An electric field of 2715 N/C is produced by a charge of $4.68 \times 10^{-11} \text{ C}$. For this field strength, what is the distance to the charge? ($k_C = 8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$)
13. Two equal but oppositely charged points are 1.2 m apart in a vacuum. The electric field intensity at the midpoint between the charges is $4.8 \times 10^5 \text{ N/C}$. What is the magnitude of each charge? ($k_C = 8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$)
14. What is the electric force between an electron and a proton that are separated by a distance of $1.0 \times 10^{-10} \text{ m}$? Is the force attractive or repulsive? ($e = 1.60 \times 10^{-19} \text{ C}$, $k_C = 8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$)
15. An electron is separated from a potassium nucleus (charge $19e$) by a distance of $5.2 \times 10^{-10} \text{ m}$. What is the electric force between these particles? ($e = 1.60 \times 10^{-19} \text{ C}$, $k_C = 8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$)

**Phys.12-Q3W5-Electric forces and fields-Qs. Bank
Answer Section**

MULTIPLE CHOICE

1. ANS: B	PTS: 1	DIF: I	OBJ: 16-1.1
2. ANS: B	PTS: 1	DIF: I	OBJ: 16-1.1
3. ANS: A	PTS: 1	DIF: I	OBJ: 16-1.1
4. ANS: A	PTS: 1	DIF: I	OBJ: 16-1.1
5. ANS: B	PTS: 1	DIF: I	OBJ: 16-1.1
6. ANS: B	PTS: 1	DIF: II	OBJ: 16-1.1
7. ANS: B	PTS: 1	DIF: I	OBJ: 16-1.2
8. ANS: C	PTS: 1	DIF: II	OBJ: 16-1.1
9. ANS: C	PTS: 1	DIF: I	OBJ: 16-1.2
10. ANS: A	PTS: 1	DIF: I	OBJ: 16-1.2
11. ANS: B	PTS: 1	DIF: I	OBJ: 16-1.3
12. ANS: C	PTS: 1	DIF: I	OBJ: 16-1.3
13. ANS: D	PTS: 1	DIF: I	OBJ: 16-1.3
14. ANS: C	PTS: 1	DIF: I	OBJ: 16-1.3
15. ANS: B	PTS: 1	DIF: I	OBJ: 16-1.3
16. ANS: C	PTS: 1	DIF: I	OBJ: 16-1.3
17. ANS: D	PTS: 1	DIF: I	OBJ: 16-2.2
18. ANS: D	PTS: 1	DIF: II	OBJ: 16-2.2
19. ANS: C	PTS: 1	DIF: II	OBJ: 16-2.2
20. ANS: D	PTS: 1	DIF: II	OBJ: 16-2.2
21. ANS: A	PTS: 1	DIF: II	OBJ: 16-2.3
22. ANS: D	PTS: 1	DIF: II	OBJ: 16-3.2
23. ANS: A	PTS: 1	DIF: I	OBJ: 16-3.3
24. ANS: D	PTS: 1	DIF: I	OBJ: 16-3.3
25. ANS: B	PTS: 1	DIF: I	OBJ: 16-3.3
26. ANS: D	PTS: 1	DIF: I	OBJ: 16-3.3
27. ANS: B	PTS: 1	DIF: I	OBJ: 16-3.3
28. ANS: A	PTS: 1	DIF: I	OBJ: 16-3.3
29. ANS: A	PTS: 1	DIF: I	OBJ: 16-3.1
30. ANS: D	PTS: 1	DIF: I	OBJ: 16-2.1
31. ANS: B	PTS: 1	DIF: I	OBJ: 16-2.3
32. ANS: B	PTS: 1	TOP: Chapter 16 Test A	
33. ANS: B	PTS: 1	TOP: Chapter 16 Test A	
34. ANS: A	PTS: 1	TOP: Chapter 16 Test A	
35. ANS: A	PTS: 1	TOP: Chapter 16 Test A	
36. ANS: B	PTS: 1	TOP: Chapter 16 Test A	
37. ANS: B	PTS: 1	TOP: Chapter 16 Test A	
38. ANS: B	PTS: 1	TOP: Chapter 16 Test A	
39. ANS: C	PTS: 1	TOP: Chapter 16 Test A	
40. ANS: D	PTS: 1	TOP: Chapter 16 Test A	

41. ANS: C	PTS: 1	TOP: Chapter 16 Test A
42. ANS: B	PTS: 1	TOP: Chapter 16 Test A
43. ANS: D	PTS: 1	TOP: Chapter 16 Test A
44. ANS: A	PTS: 1	TOP: Chapter 16 Test A
45. ANS: D	PTS: 1	TOP: Chapter 16 Test A
46. ANS: B	PTS: 1	TOP: Chapter 16 Test A
47. ANS: D	PTS: 1	TOP: Chapter 16 Test A
48. ANS: B	PTS: 1	TOP: Chapter 16 Test A
49. ANS: A	PTS: 1	TOP: Chapter 16 Test A
50. ANS: B	PTS: 1	TOP: Chapter 16 Test B
51. ANS: C	PTS: 1	TOP: Chapter 16 Test B
52. ANS: A	PTS: 1	TOP: Chapter 16 Test B
53. ANS: C	PTS: 1	TOP: Chapter 16 Test B
54. ANS: D	PTS: 1	TOP: Chapter 16 Test B
55. ANS: C	PTS: 1	TOP: Chapter 16 Test B
56. ANS: D	PTS: 1	TOP: Chapter 16 Test B
57. ANS: A	PTS: 1	TOP: Chapter 16 Test B
58. ANS: D	PTS: 1	TOP: Chapter 16 Test B
59. ANS: A	PTS: 1	TOP: Chapter 16 Test B

SHORT ANSWER

1. ANS:
equilibrium

PTS: 1 DIF: I OBJ: 16-1.2

2. ANS:
The negatively charged rod repels electrons from the part of the sphere nearest the rod. As a result, this part becomes deficient in electrons, thus acquiring a positive charge.

PTS: 1 DIF: II OBJ: 16-1.3

3. ANS:
The force decreases to one-fourth its previous value because the force is inversely proportional to the square of the distance between the two objects.

PTS: 1 DIF: IIIA OBJ: 16-2.1

4. ANS:
The force increases to twice its previous value because the force is directly proportional to the charge on each of the objects.

PTS: 1 DIF: IIIA OBJ: 16-2.1

5. ANS:
Electric force is a field force exerted by one charge on another object. This force is attractive between opposite charges and repulsive between like charges.

PTS: 1 DIF: I OBJ: 16-2.2

6. ANS:

Electric force is stronger than gravitational force. Also, electric force can be attractive or repulsive, but gravitational force is always attractive.

PTS: 1 DIF: I OBJ: 16-2.2

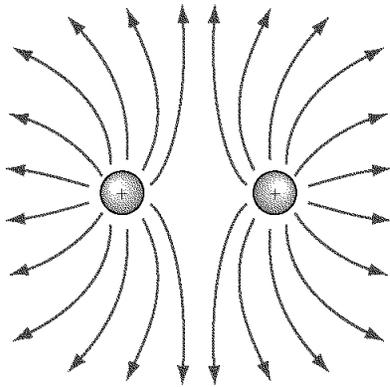
7. ANS:
because the positive charge is twice the magnitude of the negative charge

PTS: 1 DIF: II OBJ: 16-3.2

8. ANS:
positive

PTS: 1 DIF: I OBJ: 16-3.2

9. ANS:



PTS: 1 DIF: I OBJ: 16-3.2

10. ANS:
Despite the fact that only one electron is involved, the distances in a hydrogen atom are so small that the field strength is much greater.

PTS: 1 DIF: IIC OBJ: 16-3.1

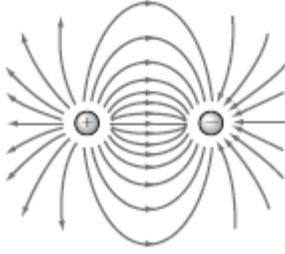
11. ANS:
The paint nozzle and the plate have opposite electric charges during the painting process. Thus, the droplets follow paths similar to the electric field lines between the nozzle and the plate. If a droplet passes by the edge of the plate, its path then curves around and the droplet strikes the reverse side of the plate.

PTS: 1 DIF: II OBJ: 16-3.2

12. ANS:
field

PTS: 1 TOP: Chapter 16 Test A

13. ANS:



PTS: 1 TOP: Chapter 16 Test A

14. ANS:

Loosely held electrons are transferred from the carpet to the socks when the socks are rubbed against the carpet. The body and socks have an excess of electrons and are negatively charged. Touching the doorknob allows the electrons to escape. The shock felt is the sudden movement of charges as the body and socks return to a neutral state.

PTS: 1 TOP: Chapter 16 Test B

15. ANS:

Millikan discovered that charge is quantized. This means that when any object is charged, the net charge is always a multiple of a fundamental unit of charge. The fundamental unit of charge, which is the charge on the electron, is $-1.60 \times 10^{-19} \text{ C}$. The charge on a proton is $1.60 \times 10^{-19} \text{ C}$.

PTS: 1 TOP: Chapter 16 Test B

16. ANS:

The negatively charged rod repels electrons from the part of the sphere nearest the rod. As a result, this part becomes deficient in electrons, thus acquiring a positive charge.

PTS: 1 TOP: Chapter 16 Test B

17. ANS:

because the positive charge is twice the magnitude of the negative charge

PTS: 1 TOP: Chapter 16 Test B

18. ANS:

$$1.9 \times 10^{-16} \text{ C}$$

Given

$$q_1 = q_2$$

$$F_{\text{electric}} = 2.37 \times 10^{-3} \text{ N}$$

$$r = 3.7 \times 10^{-10} \text{ m}$$

$$k_C = 8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$$

Solution

$$F_{\text{electric}} = k_C \frac{q_1 q_2}{r^2} = \frac{k_C q^2}{r^2}$$

$$q = \sqrt{\frac{F_{\text{electric}} r^2}{k_C}} = \sqrt{\frac{(2.37 \times 10^{-3} \text{ N})(3.7 \times 10^{-10} \text{ m})^2}{8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2}}$$

$$q = \sqrt{\frac{(2.37 \times 10^{-3} \text{ N})(1.4 \times 10^{-19} \text{ m})^2}{8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2}}$$

$$q = 1.9 \times 10^{-16} \text{ C}$$

PTS: 1

TOP: Chapter 16 Test B

19. ANS:

$$1.4 \times 10^{-4} \text{ N}$$

Given

$$q_1 = 2.00 \times 10^{-9} \text{ C}$$

$$q_2 = 23.00 \times 10^{-9} \text{ C}$$

$$q_3 = 5.00 \times 10^{-9} \text{ C}$$

$$r_{3,1} = 0.020 \text{ m} = 2.0 \times 10^{-2} \text{ m}$$

$$r_{3,2} = 0.040 \text{ m} = 4.0 \times 10^{-2} \text{ m}$$

$$k_C = 8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$$

Solution

$$F_{3,1} = k_C \frac{q_3 q_1}{(r_{3,1})^2} = (8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2)$$

$$\frac{(5.00 \times 10^{-9} \text{ C})(2.00 \times 10^{-9} \text{ C})}{(2.0 \times 10^{-2} \text{ m})^2} = 2.2 \times 10^{-4} \text{ N}$$

$$F_{3,2} = k_C \frac{q_3 q_2}{(r_{3,2})^2} = (8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2)$$

$$\frac{(5.00 \times 10^{-9} \text{ C})(-3.00 \times 10^{-9} \text{ C})}{(4.0 \times 10^{-2} \text{ m})^2} = -8.4 \times 10^{-5} \text{ N}$$

$$F_{\text{tot}} = F_{3,1} + F_{3,2} = (2.2 \times 10^{-4} \text{ N}) + (28.4 \times 10^{-5} \text{ N}) = 1.4 \times 10^{-4} \text{ N}$$

$$F_3 = 1.4 \times 10^{-4} \text{ N}$$

PTS: 1

TOP: Chapter 16 Test B

20. ANS:

$$1.3 \times 10^9 \text{ N/C}$$

Given

$$r_1 = r_2 = 2.0 \text{ cm} = 2.0 \times 10^{-2} \text{ m}$$

$$\theta_1 = 0^\circ$$

$$\theta_2 = 180^\circ$$

$$q_1 = 30^\circ \text{C} = 3.0 \times 10^{-5} \text{ C}$$

$$q_2 = -30^\circ \text{C} = 23.0 \times 10^{-5} \text{ C}$$

$$k_C = 8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$$

Solution

$$E_1 = k_C \frac{q_1}{r_1^2} = (k_C = 8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2)$$

$$\left(\frac{3.0 \times 10^{-5} \text{ C}}{(2.0 \times 10^{-2} \text{ m})^2} \right) = 6.7 \times 10^8 \text{ N/C}$$

$$E_2 = k_C \frac{q_2}{r_2^2} = (k_C = 8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2)$$

$$\left(\frac{3.0 \times 10^{-5} \text{ C}}{(2.0 \times 10^{-2} \text{ m})^2} \right) = 6.7 \times 10^8 \text{ N/C}$$

$$\text{For } E_x: E_{x,1} = (E_1)(\cos 0^\circ) = (6.7 \times 10^8 \text{ N/C})(\cos 0^\circ) = 6.7 \times 10^8 \text{ N/C}$$

$$E_{y,1} = 0 \text{ N/C}$$

$$\text{For } E_2: E_{x,2} = (E_2)(\cos 180^\circ) = (26.7 \times 10^8 \text{ N/C})(\cos 180^\circ) = 6.7 \times 10^8 \text{ N/C}$$

$$E_{y,2} = 0 \text{ N/C}$$

$$E_{x,tot} = E_{x,1} + E_{x,2} = 6.7 \times 10^8 \text{ N/C} + 6.7 \times 10^8 \text{ N/C} = 1.3 \times 10^9 \text{ N/C}$$

$$E_{y,tot} = E_{y,1} + E_{y,2} = 0 \text{ N/C} + 0 \text{ N/C} = 0 \text{ N/C}$$

$$E_{tot} = \sqrt{(E_{x,tot})^2 + (E_{y,tot})^2} = \sqrt{(1.3 \times 10^9 \text{ N/C})^2 + 0}$$

$$1.3 \times 10^9 \text{ NC}$$

$$E_{tot} = 1.3 \times 10^9 \text{ NC}$$

PTS: 1

TOP: Chapter 16 Test B

21. ANS:

$$4.8 \times 10^6 \text{ N/C}$$

Given

$$q_1 = 4.0 \times 10^{-6} \text{ C}$$

$$q_2 = 26.0 \times 10^{-6} \text{ C}$$

$$\theta = 60^\circ$$

$$r_1 = 1.0 \times 10^{-1} \text{ m}$$

$$r_2 = 1.0 \times 10^{-1} \text{ m}$$

$$k_C = 8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$$

Solution

$$E_1 = k_C \frac{q_1}{r_1^2} = (8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2)$$

$$\left(\frac{4.0 \times 10^{-6} \text{ C}}{(1.0 \times 10^{-1} \text{ m})^2} \right) = 3.6 \times 10^6 \text{ N/C}$$

$$E_2 = k_C \frac{q_2}{r_2^2} = (8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2)$$

$$\left(\frac{-6.0 \times 10^{-6} \text{ C}}{(1.0 \times 10^{-1} \text{ m})^2} \right) = -5.4 \times 10^6 \text{ N/C}$$

$$\text{For } E_1: E_{x,1} = (E_1)(\cos 60^\circ) = (3.6 \times 10^6 \text{ N/C})(\cos 60^\circ) = 1.8 \times 10^6 \text{ N/C}$$

$$E_{y,1} = (E_1)(\sin 60^\circ) = (3.6 \times 10^6 \text{ N/C})(\sin 60^\circ) = 3.1 \times 10^6 \text{ N/C}$$

$$\text{For } E_2: E_{x,2} = -(E_2)(\cos 60^\circ) = -(-5.4 \times 10^6 \text{ N/C})(\cos 60^\circ) = 2.7 \times 10^6 \text{ N/C}$$

$$E_{y,2} = (E_2)(\sin 60^\circ) = (-5.4 \times 10^6 \text{ N/C})(\sin 60^\circ) = -4.7 \times 10^6 \text{ N/C}$$

$$E_{x,tot} = E_{x,1} + E_{x,2} = 1.8 \times 10^6 \text{ N/C} + 2.7 \times 10^6 \text{ N/C} = 4.5 \times 10^6 \text{ N/C}$$

$$E_{y,tot} = E_{y,1} + E_{y,2} = 3.1 \times 10^6 \text{ N/C} + (-4.7 \times 10^6 \text{ N/C}) = -1.6 \times 10^6 \text{ N/C}$$

$$E_{tot} = \sqrt{(E_{x,tot})^2 + (E_{y,tot})^2} = \sqrt{(4.5 \times 10^6 \text{ N/C})^2 + (-1.6 \times 10^6 \text{ N/C})^2} = 4.8 \times 10^6 \text{ N/C}$$

$$E_{tot} = 4.8 \times 10^6 \text{ N/C}$$

PTS: 1

TOP: Chapter 16 Test B

PROBLEM

1. ANS:

$$-2.0 \times 10^{-9} \text{ N; attractive}$$

Given

$$q_e = -e = -1.60 \times 10^{-19} \text{ C}$$

$$q_p = +e = +1.60 \times 10^{-19} \text{ C}$$

$$r = 3.4 \times 10^{-10} \text{ m}$$

$$k_C = 8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$$

Solution

$$F_{\text{electric}} = k_C \frac{q_e q_p}{r^2} = \left(8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2 \right) \left(\frac{(-1.60 \times 10^{-19} \text{ C})(+1.60 \times 10^{-19} \text{ C})}{(3.4 \times 10^{-10} \text{ m})^2} \right)$$

$$F_{\text{electric}} = -2.0 \times 10^{-9} \text{ N}$$

The force is negative, and therefore attractive.

PTS: 1

DIF: IIIA

OBJ: 16-2.1

2. ANS: $2.3 \times 10^{-17} \text{ N}$

Given

$$q_p = +e = +1.60 \times 10^{-19} \text{ C}$$

$$q_\alpha = +2e = +3.20 \times 10^{-19} \text{ C}$$

$$r = 4.5 \times 10^{-6} \text{ m}$$

$$k_C = 8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$$

Solution

$$F_{\text{electric}} = k_C \frac{q_p q_\alpha}{r^2} = \left(8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2 \right) \left(\frac{(+1.60 \times 10^{-19} \text{ C})(+3.20 \times 10^{-19} \text{ C})}{(4.5 \times 10^{-6} \text{ m})^2} \right)$$

$$F_{\text{electric}} = 2.3 \times 10^{-17} \text{ N}$$

PTS: 1

DIF: IIIA

OBJ: 16-2.1

3. ANS: $-1.3 \times 10^{-8} \text{ N}$

Given

$$q_e = -e = -1.60 \times 10^{-19} \text{ C}$$

$$q_{\text{nucleus}} = +19e = +3.04 \times 10^{-18} \text{ C}$$

$$r = 5.7 \times 10^{-10} \text{ m}$$

$$k_C = 8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$$

Solution

$$F_{electric} = k_C \frac{q_e q_{nucleus}}{r^2} = \left(8.99 \times 10^9 \text{ N} \cdot \text{m}^2 / \text{C}^2 \right) \left(\frac{(-1.60 \times 10^{-19} \text{ C})(+3.04 \times 10^{-18} \text{ C})}{(5.7 \times 10^{-10} \text{ m})^2} \right)$$

$$F_{electric} = -1.3 \times 10^{-8} \text{ N}$$

PTS: 1 DIF: IIIA OBJ: 16-2.1

4. ANS: $\pm 2.5 \times 10^{-16} \text{ C}$

Given

$$q_1 = q_2$$

$$F_{electric} = 8.51 \times 10^{-3} \text{ N}$$

$$r = 2.6 \times 10^{-10} \text{ m}$$

$$k_C = 8.99 \times 10^9 \text{ N} \cdot \text{m}^2 / \text{C}^2$$

Solution

$$F_{electric} = k_C \frac{q_1 q_2}{r^2} = \frac{k_C q^2}{r^2}$$

$$q = \sqrt{\frac{F_{electric} r^2}{k_C}} = \sqrt{\frac{(8.51 \times 10^{-3} \text{ N})(2.6 \times 10^{-10} \text{ m})^2}{8.99 \times 10^9 \text{ N} \cdot \text{m}^2 / \text{C}^2}}$$

$$q = \pm 2.5 \times 10^{-16} \text{ C}$$

PTS: 1 DIF: IIIB OBJ: 16-2.1

5. ANS: 91e

Given

$$e = 1.60 \times 10^{-19} \text{ C}$$

$$q_\alpha = 2e = 3.20 \times 10^{-19} \text{ C}$$

$$F_{electric} = 79.8 \text{ N}$$

$$r = 2.29 \times 10^{-14} \text{ m}$$

$$k_C = 8.99 \times 10^9 \text{ N} \cdot \text{m}^2 / \text{C}^2$$

Solution

$$F_{electric} = k_C \frac{q_\alpha q_{nucleus}}{r^2}$$

Rearrange to solve for $q_{nucleus}$.

$$q_{nucleus} = \frac{(F_{electric}) r^2}{(k_C) q_\alpha} = \frac{(79.8 \text{ N})(2.29 \times 10^{-14} \text{ m})^2}{(8.99 \times 10^9 \text{ N} \cdot \text{m}^2 / \text{C}^2)(3.20 \times 10^{-19} \text{ C})} = 1.45 \times 10^{-17} \text{ C}$$

$$\frac{q_{\text{nucleus}}}{q_e} = \frac{1.45 \times 10^{-17} \text{ C}}{1.60 \times 10^{-19} \text{ C}} = 90.6$$

The charge on the gold nucleus must be an integer multiple of e . Integer $(90.6)e = 91e$

PTS: 1 DIF: III B OBJ: 16-2.1

6. ANS: $3.6 \times 10^{-4} \text{ N}$

Given

$$q_1 = 6.26 \times 10^{-9} \text{ C}$$

$$q_2 = -3.17 \times 10^{-9} \text{ C}$$

$$q_3 = 5.33 \times 10^{-9} \text{ C}$$

$$r_{31} = 0.026 \text{ m} = 2.6 \times 10^{-2} \text{ m}$$

$$r_{32} = 0.043 \text{ m} = 4.3 \times 10^{-2} \text{ m}$$

$$k_C = 8.99 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2$$

Solution

$$F_{31} = k_C \frac{q_3 q_1}{(r_{31})^2} = \left(8.99 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2 \right) \frac{(5.33 \times 10^{-9} \text{ C})(6.26 \times 10^{-9} \text{ C})}{(2.6 \times 10^{-2} \text{ m})^2} = 4.4 \times 10^{-4} \text{ N}$$

$$F_{32} = k_C \frac{q_3 q_2}{(r_{32})^2} = \left(8.99 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2 \right) \frac{(5.33 \times 10^{-9} \text{ C})(-3.17 \times 10^{-9} \text{ C})}{(4.3 \times 10^{-2} \text{ m})^2} = -8.2 \times 10^{-5} \text{ N}$$

$$F_3 = F_{31} + F_{32} = 4.4 \times 10^{-4} \text{ N} + (-8.2 \times 10^{-5} \text{ N}) = 3.6 \times 10^{-4} \text{ N}$$

PTS: 1 DIF: III C OBJ: 16-2.3

7. ANS: 0.46 N

Given

$$q_1 = 2.0 \times 10^{-6} \text{ C}$$

$$q_2 = 2.0 \times 10^{-6} \text{ C}$$

$$Q = 4.0 \times 10^{-6} \text{ C}$$

$$r_{q_1, Q} = r_{q_2, Q} = 0.50 \text{ m}$$

$$\theta = \tan^{-1}(0.30 \text{ m}/0.40 \text{ m}) = 37^\circ$$

$$k_C = 8.99 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2$$

Solution

$$F_{q_1, Q} = F_{q_2, Q} = k_C \frac{qQ}{(r_{q, Q})^2} = \left(8.99 \times 10^9 \text{ N} \cdot \text{m}^2 / \text{C}^2 \right) \left(\frac{(2.0 \times 10^{-6} \text{ C})(4.0 \times 10^{-6} \text{ C})}{(0.50 \text{ m})^2} \right) = 0.29 \text{ N}$$

$$\text{For } F_{q_1, Q} : F_{x, q_1, Q} = (F_{q_1, Q})(\cos 37^\circ) = (0.29 \text{ N})(\cos 37^\circ) = 0.23 \text{ N}$$

$$F_{y, q_1, Q} = -(F_{q_1, Q})(\sin 37^\circ) = -(0.29 \text{ N})(\sin 37^\circ) = -0.17 \text{ N}$$

$$\text{For } F_{q_2, Q} : F_{x, q_2, Q} = (F_{q_2, Q})(\cos 37^\circ) = (0.29 \text{ N})(\cos 37^\circ) = 0.23 \text{ N}$$

$$F_{y, q_2, Q} = (F_{q_2, Q})(\sin 37^\circ) = (0.29 \text{ N})(\sin 37^\circ) = 0.17 \text{ N}$$

$$F_{x, \text{tot}} = F_{x, q_1, Q} + F_{x, q_2, Q} = 0.23 \text{ N} + 0.23 \text{ N} = 0.46 \text{ N}$$

$$F_{y, \text{tot}} = F_{y, q_1, Q} + F_{y, q_2, Q} = -0.17 \text{ N} + 0.17 \text{ N} = 0 \text{ N}$$

$$F_{Q, \text{tot}} = \sqrt{(F_{x, \text{tot}})^2 + (F_{y, \text{tot}})^2} = \sqrt{(0.46 \text{ N})^2 + 0} = 0.46 \text{ N}$$

$$F_{Q, \text{tot}} = 0.46 \text{ N}$$

PTS: 1

DIF: IIC

OBJ: 16-2.3

8. ANS:

-0.35 C

Given

$$r_{A, B} = r_{B, D} = r_{D, C} = r_{C, A}$$

$$q_A = q_D$$

$$q_B = q_C = +1.0 \text{ C}$$

$$F_B = 0 \text{ N}$$

$$\theta_{ABC} = \theta_{DBC} = 45.0^\circ$$

Solution

Because charge B is in equilibrium and the charges are along the same line, the force exerted on charge B by charge A in the y-direction is zero, and only the force exerted on charge B by charge A in the x-direction is needed.

In the x-direction, $F_{A, B} = -F_{C, B}$, which gives $F_B = 0$.

$$F_B = F_{A, B} + F_{C, B}(\cos \theta_{ABC}) = 0$$

$$F_{A, B} = -F_{C, B}(\cos \theta_{ABC})$$

$$k_C \frac{q_A q_B}{(r_{A, B})^2} = - \left(k_C \frac{q_C q_B}{(r_{C, B})^2} \right) (\cos \theta_{ABC})$$

$$\frac{q_A}{(r_{A, B})^2} = - \frac{q_C}{(r_{C, B})^2} (\cos \theta_{ABC})$$

The relative distances between charges A and B and charges C and B are

$$r_{A, B} = r_{C, B}(\cos \theta_{ABC})$$

so,

$$\frac{q_A}{(r_{C,B})^2 (\cos \theta_{ABC})^2} = -\frac{q_C}{(r_{C,B})^2} (\cos \theta_{ABC})$$

$$q_A = -q_C (\cos \theta_{ABC})^3 = -(1.0 \text{ C})(\cos 45.0^\circ)^3 = -(1.0 \text{ C})(0.707)^3 = -0.35 \text{ C}$$

PTS: 1 DIF: IIC OBJ: 16-2.3

9. ANS: $1.52 \times 10^7 \text{ N/C}$

Given

$$q_1 = 4.9 \times 10^{-6} \text{ C}$$

$$q_2 = -4.9 \times 10^{-6} \text{ C}$$

$$\theta_1 = 0.0^\circ$$

$$\theta_2 = 180^\circ$$

$$r_{\text{total}} = 15.2 \text{ cm} = 0.152 \text{ m}$$

$$r_1 = r_2 = 7.6 \text{ cm} = 0.076 \text{ m}$$

$$k_C = 8.99 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2$$

Solution

$$E_1 = E_{x1} = k_C \frac{q_1}{r_1^2} = \left(8.99 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2\right) \frac{(4.9 \times 10^{-6} \text{ C})}{(0.076 \text{ m})^2} = 7.6 \times 10^6 \text{ N/C}$$

$$E_2 = E_{x2} = k_C \frac{q_2}{r_2^2} = \left(8.99 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2\right) \frac{(-4.9 \times 10^{-6} \text{ C})}{(0.076 \text{ m})^2} = -7.6 \times 10^6 \text{ N/C}$$

$$E_{x,\text{total}} = (\cos 0.0^\circ)E_{x1} + (\cos 180^\circ)E_{x2} = (1.0)(7.6 \times 10^6 \text{ N/C}) + (-1.0)(-7.6 \times 10^6 \text{ N/C})$$

$$E_{x,\text{total}} = 1.52 \times 10^7 \text{ N/C}$$

PTS: 1 DIF: IIIB OBJ: 16-3.1

10. ANS: $1.76 \times 10^9 \text{ N/C}$

Given

$$r_1 = r_2 = \frac{4.8 \text{ cm}}{2} = 2.4 \text{ cm} = 2.4 \times 10^{-2} \text{ m}$$

$$\theta_1 = 0.0^\circ$$

$$\theta_2 = 180^\circ$$

$$q_1 = 56.5 \text{ } \mu\text{C} = 5.65 \times 10^{-5} \text{ C}$$

$$q_2 = -56.5 \mu\text{C} = -5.65 \times 10^{-5} \text{ C}$$

$$k_C = 8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$$

Solution

$$E_1 = k_C \frac{q_1}{r_1^2} = \left(8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2\right) \frac{\left(5.65 \times 10^{-5} \text{ C}\right)}{\left(2.4 \times 10^{-2} \text{ m}\right)^2} = 8.8 \times 10^8 \text{ N/C}$$

$$E_2 = k_C \frac{q_2}{r_2^2} = \left(8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2\right) \frac{\left(-5.65 \times 10^{-5} \text{ C}\right)}{\left(2.4 \times 10^{-2} \text{ m}\right)^2} = -8.8 \times 10^8 \text{ N/C}$$

$$\text{For } E_1 : \quad E_{x,1} = (E_1)(\cos 0.0^\circ) = (8.8 \times 10^8 \text{ N/C})(\cos 0.0^\circ) = 8.8 \times 10^8 \text{ N/C}$$

$$E_{y,1} = 0 \text{ N/C}$$

$$\text{For } E_2 : \quad E_{x,2} = (E_2)(\cos 180^\circ) = (-8.8 \times 10^8 \text{ N/C})(\cos 180^\circ) = 8.8 \times 10^8 \text{ N/C}$$

$$E_{y,2} = 0 \text{ N/C}$$

$$E_{x,tot} = E_{x,1} + E_{x,2} = 8.8 \times 10^8 \text{ N/C} + 8.8 \times 10^8 \text{ N/C} = 1.76 \times 10^9 \text{ N/C}$$

$$E_{y,tot} = E_{y,1} + E_{y,2} = 0 \text{ N/C} + 0 \text{ N/C} = 0 \text{ N/C}$$

$$E_{tot} = \sqrt{\left(E_{x,tot}\right)^2 + \left(E_{y,tot}\right)^2} = \sqrt{\left(1.76 \times 10^9 \text{ N/C}\right)^2 + 0} = 1.76 \times 10^9 \text{ N/C}$$

$$E_{tot} = 1.76 \times 10^9 \text{ N/C}$$

PTS: 1

DIF: III B

OBJ: 16-3.1

11. ANS:

$$4.7 \times 10^6 \text{ N/C}$$

Given

$$q_1 = 5.2 \times 10^{-6} \text{ C}$$

$$q_2 = -8.7 \times 10^{-6} \text{ C}$$

$$\theta = 60.0^\circ$$

$$r_1 = 0.12 \text{ m} = 1.2 \times 10^{-1} \text{ m}$$

$$r_2 = 0.12 \text{ m} = 1.2 \times 10^{-1} \text{ m}$$

$$k_C = 8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$$

Solution

$$E_1 = k_C \frac{q_1}{r_1^2} = \left(8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2\right) \frac{\left(5.2 \times 10^{-6} \text{ C}\right)}{\left(1.2 \times 10^{-1} \text{ m}\right)^2} = 3.2 \times 10^6 \text{ N/C}$$

$$E_2 = k_C \frac{q_2}{r_2^2} = \left(8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2\right) \frac{\left(-8.7 \times 10^{-6} \text{ C}\right)}{\left(1.2 \times 10^{-1} \text{ m}\right)^2} = -5.4 \times 10^6 \text{ N/C}$$

For E_1 : $E_{x1} = (E_1)(\cos 60.0^\circ) = (3.2 \times 10^6 \text{ N/C})(0.500) = 1.6 \times 10^6 \text{ N/C}$

$$E_{y1} = (E_1)(\sin 60.0^\circ) = (3.2 \times 10^6 \text{ N/C})(0.866) = 2.8 \times 10^6 \text{ N/C}$$

For E_2 : $E_{x2} = -(E_2)(\cos 60.0^\circ) = -(-5.4 \times 10^6 \text{ N/C})(0.500) = 2.7 \times 10^6 \text{ N/C}$

$$E_{y2} = (E_2)(\sin 60.0^\circ) = (-5.4 \times 10^6 \text{ N/C})(0.866) = -4.7 \times 10^6 \text{ N/C}$$

$$E_{x,tot} = E_{x1} + E_{x2} = 1.6 \times 10^6 \text{ N/C} + 2.7 \times 10^6 \text{ N/C} = 4.3 \times 10^6 \text{ N/C}$$

$$E_{y,tot} = E_{y1} + E_{y2} = 2.8 \times 10^6 \text{ N/C} + (-4.7 \times 10^6 \text{ N/C}) = -1.9 \times 10^6 \text{ N/C}$$

$$E_{tot} = \sqrt{(E_{x,tot})^2 + (E_{y,tot})^2} = \sqrt{(4.3 \times 10^6 \text{ N/C})^2 + (-1.9 \times 10^6 \text{ N/C})^2}$$

$$E_{tot} = \sqrt{1.8 \times 10^{13} \text{ N}^2/\text{C}^2 + 3.6 \times 10^{12} \text{ N}^2/\text{C}^2}$$

$$E_{tot} = \sqrt{2.2 \times 10^{13} \text{ N}^2/\text{C}^2}$$

$$E_{tot} = 4.7 \times 10^6 \text{ N/C}$$

PTS: 1 DIF: IIC OBJ: 16-3.1

12. ANS: 10^{-2}
 $1.24 \times 10^{-2} \text{ m}$

Given

$$E = 2715 \text{ N/C}$$

$$q = 4.68 \times 10^{-11} \text{ C}$$

$$k_C = 8.99 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2$$

Solution

$$E = k_C \frac{q}{r^2}$$

Rearrange to solve for r .

$$r = \sqrt{k_C \frac{q}{E}} = \sqrt{\left(8.99 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2\right) \frac{\left(4.68 \times 10^{-11} \text{ C}\right)}{\left(2715 \text{ N/C}\right)}} = 1.24 \times 10^{-2} \text{ m}$$

PTS: 1 DIF: IIIB OBJ: 16-3.1

13. ANS: 10^{-6}
 $9.6 \times 10^{-6} \text{ C} = 9.6 \mu\text{C}$

Given

$$q_1 = q_2$$

$$r_{total} = 1.2 \text{ m}$$

$$r_1 = r_2 = \frac{r_{total}}{2} = 0.60 \text{ m}$$

$$E_{total} = 4.8 \times 10^5 \text{ N/C}$$

$$k_C = 8.99 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2$$

Solution

$$E_1 = E_2 = \frac{E_{total}}{2} = \frac{4.8 \times 10^5 \text{ N/C}}{2} = 2.4 \times 10^5 \text{ N/C}$$

$$E_1 = k_C \frac{q_1}{r_1^2}$$

Rearrange to solve for q_1 .

$$q_1 = \frac{E_1 r_1^2}{k_C} = \frac{(2.4 \times 10^5 \text{ N/C})(0.60 \text{ m})^2}{8.99 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2} = 9.6 \times 10^{-6} \text{ C}$$

$$q_1 = q_2 = 9.6 \times 10^{-6} \text{ C} = 9.6 \mu\text{C}$$

PTS: 1 DIF: IIB OBJ: 16-3.2

14. ANS:
 $2.3 \times 10^{-8} \text{ N}$; attractive

Given

$$q_e = -e = -1.60 \times 10^{-19} \text{ C}$$

$$q_p = +e = +1.60 \times 10^{-19} \text{ C}$$

$$r = 1.0 \times 10^{-10} \text{ m}$$

$$k_C = 8.99 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2$$

Solution

$$F_{electric} = k_C \frac{q_e q_p}{r} = (8.99 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2)$$

$$\left(\frac{(-1.60 \times 10^{-19} \text{ C})(+1.60 \times 10^{-19} \text{ C})}{(1.0 \times 10^{-10} \text{ m})^2} \right)$$

$$F_{electric} = 2.3 \times 10^{-8} \text{ N}$$

PTS: 1 TOP: Chapter 16 Test A

15. ANS:
 $1.6 \times 10^{-8} \text{ N}$

Given

$$q_e = -e = -1.60 \times 10^{-19} \text{ C}$$

$$q_{nucleus} = +19e = +3.04 \times 10^{-18} \text{ C}$$

$$r = 5.2 \times 10^{-10} \text{ m}$$

$$k_C = 8.99 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2$$

Solution

$$F_{electric} = k_C \frac{q_e q_{nucleus}}{r^2} = (8.99 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2)$$

$$\left(\frac{(-1.60 \times 10^{-19} \text{ C})(+3.04 \times 10^{-18} \text{ C})}{(5.2 \times 10^{-10} \text{ m})^2} \right)$$

$$F_{electric} = 1.6 \times 10^{-8} \text{ N}$$

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