CHAPTER REVIEW

Concept Items

18.2 Coulomb's law

4. Two plastic spheres with uniform charge repel each other with a force of 10 N . If you remove the charge from one sphere, what will be the force between the spheres?

a. The force will be 15 N.
b. The force will be 10 N.
c. The force will be 5 N.
d. The force will be zero.

5. What creates a greater magnitude of force, two charges $+q$ a distance r apart or two charges $-q$ the same distance apart?

a. Two charges $+q$ a distance r away
b. Two charges $-q$ a distance r away
c. The magnitudes of forces are equal.

6. In Newton's law of universal gravitation, the force between two masses is proportional to the product of the two masses. What plays the role of mass in Coulomb's law?

a. the electric charge
b. the electric dipole
c. the electric monopole
d. the electric quadruple

18.3 Electric Field

7. Why can electric fields not cross each other?

a. Many electric-field lines can exist at any given point in space.
b. No electric-field lines can exist at any given point in space.
c. Only a single electric-field line can exist at any given point in space.
d. Two electric-field lines can exist at the same point in space.

8. A constant electric field is $(4.5 \times 10^5\ \text{N/C})\hat{y}$. In which direction is the force on a –20 nC charge placed in this field?

a. The direction of the force is in the $+\hat{x}$ direction.
b. The direction of the force is in the $+\hat{x}$ direction.
c. The direction of the force is in the $-\hat{y}$ direction.
d. The direction of the force is in the $+\hat{y}$ direction.

18.4 Electric Potential

9. True or false—The potential from a group of charges is the sum of the potentials from each individual charge.

a. false
b. true

10. True or false—The characteristics of an electric field make it analogous to the gravitational field near the surface of Earth.

a. false
b. true

11. An electron moves in an electric field. Does it move toward regions of higher potential or lower potential? Explain.

a. It moves toward regions of higher potential because its charge is negative.
b. It moves toward regions of lower potential because its charge is negative
c. It moves toward regions of higher potential because its charge is positive.
d. It moves toward regions of lower potential because its charge is positive.

Critical Thinking Items

18.2 Coulomb's law

18. In terms of Coulomb's law, why are water molecules attracted by positive and negative charges?

a. Water molecules are neutral.
b. Water molecules have a third type of charge that is attracted by positive as well as negative charges.
c. Water molecules are polar.
d. Water molecule have either an excess of electrons or an excess of protons.

19. A negative lightning strike occurs when a negatively charged cloud discharges its excess electrons to the positively charged ground. If you observe a cloud-to-cloud lightning strike, what can you say about the charge on the area of the cloud struck by lightning?

a. The area of the cloud that was struck by lightning had a positive charge.
b. The area of the cloud that was struck by lightning had a negative charge.
c. The area of the cloud that was struck by lightning is neutral.
d. The area of the cloud that was struck by lightning had a third type of charge.

18.3 Electric Field

20. An arbitrary electric field passes through a box-shaped volume. There are no charges in the box. If 11 electric-field lines enter the box, how many electric-field lines must exit the box?

a. nine electric field lines
b. 10 electric field lines
c. 11 electric field lines
d. 12 electric field lines

21. In a science-fiction movie, a villain emits a radial electric field to repulse the hero. Knowing that the hero is electrically neutral, is this possible? Explain your reasoning.

a. No, because an electrically neutral body cannot be repelled or attracted.
b. No, because an electrically neutral body can be attracted but not repelled.
c. Yes, because an electrically neutral body can be repelled or attracted.
d. Yes, because an electrically neutral body can be repelled.

18.4 Electric Potential

22. What is the relationship between voltage and energy? More precisely, what is the relationship between potential difference and electric potential?

a. Voltage is the energy per unit mass at some point in space.
b. Voltage is the energy per unit length in space.
c. Voltage is the energy per unit charge at some point in space.
d. Voltage is the energy per unit area in space.

23. Three parallel plates are stacked above each other, with a separation between each plate. If the potential difference between the first two plates is ΔV_1 and the potential between the second two plates is ΔV_2, what is the potential difference between the first and the third plates?

a. $\Delta V_3 = \Delta V_2 + \Delta V_1$
b. $\Delta V_3 = \Delta V_2 - \Delta V_1$
c. $\Delta V_3 = \Delta V_2 / \Delta V_1$
d. $\Delta V_3 = \Delta V_2 \times \Delta V_1$

Problems

18.2 Coulomb's law

27. Two particles with equal charge experience a force of 10 nN when they are 30 cm apart. What is the magnitude of the charge on each particle?

a. -5.8×10^{-10} C
b. -3.2×10^{-10} C
c. $+3.2 \times 10^{-10}$ C
d. $+1.4 \times 10^{-5}$ C

28. Three charges are on a line. The left charge is $q_1 = 2.0$ nC . The middle charge is $q_2 = 5.0$ nC . The right charge is $q_3 = -3.0$ nC . The left and right charges are 2.0 cm from the middle charge. What is the force on the middle charge?

a. -5.6×10^{-4} N to the left
b. -1.12×10^{-4} N to the left
c. $+1.12 \times 10^{-4}$ N to the right
d. 5.6×10^{-4} N to the right

18.3 Electric Field

29. An electric field $(15\ \text{N/C})\hat{z}$ applies a force $(-3 \times 10^{-6}\ \text{N})\hat{z}$ on a particle. What is the charge on the particle?

a. -2.0×10^{-7} C
b. 2.0×10^{-7} C
c. 2.0×10^{-8} C
d. 2.0×10^{-9} C

30. Two uniform electric fields are superimposed. The first electric field is $\vec{E}_1 = (14\ \text{N/C})\hat{x}$. The second electric field is $\vec{E}_2 = (7.0\ \text{N/C})\hat{y}$. With respect to the positive x axis, at which angle will a positive test charge accelerate in this combined field?

a. 27°
b. 54°
c. 90°
d. 108°

18.4 Electric Potential

31. You move a charge q from $r_i = 20$ cm to $r_f = 40$ cm from a fixed charge $Q = 10$ nC. What is the difference in potential for these two positions?

a. -2.2×10^2 V
b. -1.7×10^3 V
c. -2.2×10^4 V
d. -1.7×10^2 V

32. How much work is required from an outside agent to move an electron from $x_i = 0$ to $x_f = 20$ cm in an electric field $(50\text{N/C})\hat{x}$?

a. 1.6×10^{-15} J
b. 1.6×10^{-16} J
c. 1.6×10^{-20} J
d. 1.6×10^{-18} J

TEST PREP

Multiple Choice

18.2 Coulomb's law

41. If you double the distance between two point charges, by which factor does the force between the particles change?
a. 1/2
b. 2
c. 4
d. 1/4

42. The combined charge of all the electrons in a dime is hundreds of thousands of coulombs. Because like charges repel, what keeps the dime from exploding?
a. The dime has an equal number of protons, with positive charge.
b. The dime has more protons than electrons, with positive charge.
c. The dime has fewer protons than electrons, with positive charge.
d. The dime is polarized, with electrons on one side and protons on the other side.

43. How can you modify the charges on two particles to quadruple the force between them without moving them?
a. Increase the distance between the charges by a factor of two.
b. Increase the distance between the charges by a factor of four.
c. Increase the product of the charges by a factor of two
d. Increase the product of the charges by a factor of four.

18.3 Electric Field

44. What is the magnitude of the electric field 12 cm from a charge of 1.5 nC ?
a. 9.4×10^{7} N/ C
b. 1.1×10^{2} N/C
c. 9.4×10^{2} N/C
d. 9.4×10^{-2} N/C

45. A charge distribution has electric field lines pointing into it. What sign is the net charge?
a. positive
b. neutral
c. final
d. negative

46. If five electric field lines come out of point charge q_1 and 10 electric-field lines go into point charge q_2, what is the ratio q_1/q_2?
a. −2
b. −1
c. −1/2
d. 0

47. True or false—The electric-field lines from a positive point charge spread out radially and point outward.
a. false
b. true

18.4 Electric Potential

48. What is the potential at 1.0 m from a point charge $Q = -25$ nC?
a. 6.6×10^{2} V
b. -2.3×10^{2} V
c. -6.6×10^{2} V
d. 2.3×10^{2} V

49. Increasing the distance by a factor of two from a point charge will change the potential by a factor of how much?
a. 2
b. 4
c. 1/2
d. 1/4

50. True or false—*Voltage* is the common word for potential difference, because this term is more descriptive than potential difference.
a. false
b. true

Short Answer

18.2 Coulomb's law

62. Why does dust stick to the computer screen?
a. The dust is neutral.
b. The dust is polarized.
c. The dust is positively charged.
d. The dust is negatively charged.

63. The force between two charges is 4×10^{-9} N . If the magnitude of one charge is reduced by a factor of two and the distance between the charges is reduced by a factor of two, what is the new force between the charges?
a. 2×10^{-9} N
b. 4×10^{-9} N
c. 6×10^{-9} N
d. 8×10^{-9} N

64. True or false—Coulomb's constant is $k = 8.99 \times 10^9$ N·m^2/C^2. Newton's gravitational constant is $G = 6.67 \times 10^{-11}$ m^3/kg·s^2. This tells you about the relative strength of the electrostatic force versus that of gravity.
a. true
b. false

65. An atomic nucleus contains 56 protons, for iron. Which force would this nucleus apply on an electron at a distance of 10×10^{-12} m?
a. 0.65×10^{-4} N
b. 0.02×10^{-4} N
c. 1.3×10^{-4} N
d. 72.8×10^{-4} N

18.3 Electric Field

66. The electric field a distance of 10 km from a storm cloud is 1,000 N/C . What is the approximate charge in the cloud?
a. 0.0011 C
b. 11 C
c. 110 C
d. 1,100 C

67. Which electric field would produce a 10 N force in the $+x$- direction on a charge of – 10 nC ?
a. -1.0×10^9 N/C
b. 1.0×10^9 N/C
c. 1.0×10^{10} N/C
d. 1.0×10^{11} N/C

68. A positive charge is located at $x = 0$. When a negative charge is placed at $x = 10$ cm, what happens to the electric field lines between the charges?
a. The electric field lines become denser between the charges.
b. The electric field lines become denser between the charges.
c. The electric field lines remains same between the charges.
d. The electric field lines will be zero between the charges.

18.4 Electric Potential

69. The energy required to bring a charge $q = -8.8$ nC from far away to 5.5 cm from a point charge Q is 13 mJ. What is the potential at the final position of q?
a. –112 MV
b. –1.5 MV
c. –0.66 MV
d. +1.5 MV

70. How is electric potential related to electric potential energy?
a. Electric potential is the electric potential energy per unit mass at a given position in space.
b. Electric potential is the electric potential energy per unit length at a given position in space. This relation is not dimensionally correct.
c. Electric potential is the electric potential energy per unit area in space.
d. Electric potential is the electric potential energy per unit charge at a given position in space.

71. If it takes 10 mJ to move a charge q from $x_i = 25$ cm to $x_f = -25$ cm in an electric field of $(-20\text{N/C})\hat{x}$, what is the charge q?
a. –1.0 mC
b. +0.25 mC
c. + 1.0 mC
d. +400 mC

72. Given the potential difference between two points and the distance between the points, explain how to obtain the electric field between the points.
a. Add the electric potential to the distance to obtain the electric field.
b. Divide the electric potential by the distance to obtain the electric field.
c. Multiply the electric potential and the distance to obtain the electric field.
d. Subtract the electric potential from the distance to obtain the electric field.

Extended Response

18.2 Coulomb's law

81. Electrostatic forces are enormous compared to gravitational force. Why do you not notice electrostatic forces in everyday life, whereas you do notice the force due to gravity?

a. Because there are two types of charge, but only one type of mass exists.
b. Because there is only one type of charge, but two types of mass exist.
c. Because opposite charges cancel each other, while gravity does not cancel out.
d. Because opposite charges do not cancel each other, while gravity cancels out.

82. A small metal sphere with a net charge of 3.0 nC is touched to a second small metal sphere that is initially neutral. The spheres are then placed 20 cm apart. What is the force between the spheres?

a. 1.02×10^{-7} N
b. 2.55×10^{-7} N
c. 5.1×10^{-7} N
d. 20.4×10^{-7} N

18.3 Electric Field

83. Point charges are located at each corner of a square with sides of 5.0 cm . The top-left charge is $q_1 = 8.0$ nC The top right charge is $q_2 = 4.0$ nC. The bottom-right charge is $q_3 = 4.0$ nC. The bottom-left charge is $q_4 = 8.0$ nC. What is the electric field at the point midway between charges q_2 and q_3?

a. $(-2.1 \times 10^4 \text{ N/C})\hat{x}$
b. $(2.3 \times 10^4 \text{ N/C})\hat{x}$
c. $(4.1 \times 10^4 \text{ N/C})\hat{x}$
d. $(4.6 \times 10^4 \text{ N/C})\hat{x}$

18.4 Electric Potential

85. A square grid has charges of $Q = 10$ nC are each corner. The sides of the square at 10 cm . How much energy does it require to bring a $q = 1.0$ nC charge from very far away to the point at the center of this square?

a. 1.3×10^{-6} J
b. 2.5×10^{-6} J
c. 3.8×10^{-6} J
d. 5.1×10^{-6} J

86. How are potential difference and electric-field strength related for a constant electric field?

a. The magnitude of electric-field strength is equivalent to the potential divided by the distance.
b. The magnitude of electric-field strength is equivalent to the product of the electric potential and the distance.
c. The magnitude of electric-field strength is equivalent to the difference between magnitude of the electric potential and the distance.
d. The magnitude of electric-field strength is equivalent to the sum of the magnitude of the electric potential and the distance.