Chapter 21: ELECTRIC CHARGE

1. A coulomb is the same as:
   A. an ampere/second
   B. half an ampere·second^2
   C. an ampere/meter^2
   D. an ampere·second
   E. a newton·meter^2

   ans: D

2. A kiloampere·hour is a unit of:
   A. current
   B. charge per time
   C. power
   D. charge
   E. energy

   ans: D

3. The magnitude of the charge on an electron is approximately:
   A. 10^{23} C
   B. 10^{-23} C
   C. 10^{19} C
   D. 10^{-19} C
   E. 10^{9} C

   ans: D

4. The total negative charge on the electrons in 1 mol of helium (atomic number 2, molar mass 4) is:
   A. 4.8×10^4 C
   B. 9.6×10^4 C
   C. 1.9×10^5 C
   D. 3.8×10^5 C
   E. 7.7×10^5 C

   ans: C

5. The total negative charge on the electrons in 1 kg of helium (atomic number 2, molar mass 4) is:
   A. 48 C
   B. 2.4×10^7 C
   C. 4.8×10^7 C
   D. 9.6×10^8 C
   E. 1.9×10^8 C

   ans: C

6. A wire carries a steady current of 2 A. The charge that passes a cross section in 2 s is:
   A. 3.2×10^{-19} C
   B. 6.4×10^{-19} C
   C. 1 C
   D. 2 C
   E. 4 C

   ans: E

7. A wire contains a steady current of 2 A. The number of electrons that pass a cross section in 2 s is:
   A. 2
   B. 4
   C. 6.3×10^{18}
   D. 1.3×10^{19}
   E. 2.5×10^{19}

   ans: E

8. The charge on a glass rod that has been rubbed with silk is called positive:
   A. by arbitrary convention
   B. so that the proton charge will be positive
   C. to conform to the conventions adopted for G and m in Newton's law of gravitation
   D. because like charges repel
   E. because glass is an insulator

   ans: A

9. To make an uncharged object have a negative charge we must:
   A. add some atoms
   B. remove some atoms
   C. add some electrons
   D. remove some electrons
   E. write down a negative sign

   ans: C

10. To make an uncharged object have a positive charge:
   A. remove some neutrons
   B. add some neutrons
   C. add some electrons
   D. remove some electrons
   E. heat it to cause a change of phase

   ans: D

11. When a hard rubber rod is given a negative charge by rubbing it with wool:
    A. positive charges are transferred from rod to wool
    B. negative charges are transferred from rod to wool
    C. positive charges are transferred from wool to rod
    D. negative charges are transferred from wool to rod
    E. negative charges are created and stored on the rod

    ans: D

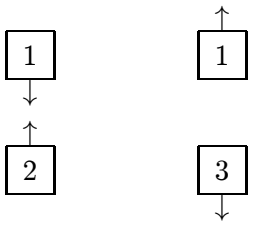
12. An electrical insulator is a material:
    A. containing no electrons
    B. through which electrons do not flow easily
    C. that has more electrons than protons on its surface
    D. cannot be a pure chemical element
    E. must be a crystal

    ans: B

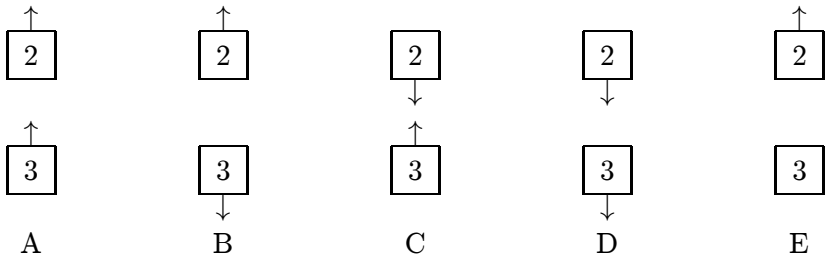
13. A conductor is distinguished from an insulator with the same number of atoms by the number of:
    A. nearly free atoms
    B. electrons
    C. nearly free electrons
    D. protons
    E. molecules

    ans: C

14. The diagram shows two pairs of heavily charged plastic cubes. Cubes 1 and 2 attract each other and cubes 1 and 3 repel each other.

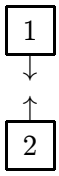


Which of the following illustrates the forces of cube 2 on cube 3 and cube 3 on cube 2?

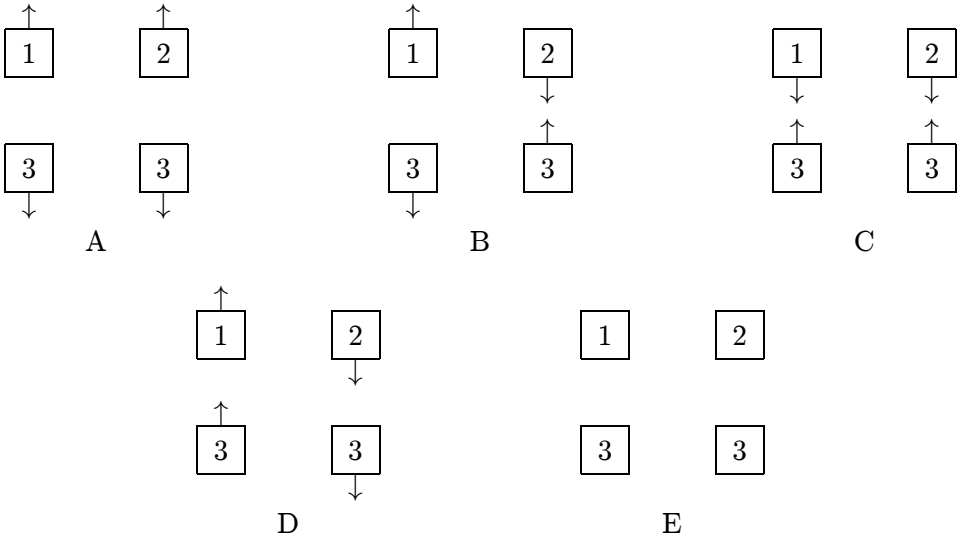


ans: C

15. The diagram shows a pair of heavily charged plastic cubes that attract each other.



Cube 3 is a conductor and is uncharged. Which of the following illustrates the forces between cubes 1 and 3 and between cubes 2 and 3?



ans: C

16. 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. the string is not a perfect insulator
E. there is a rearrangement of the electrons in the ball

ans: E

17. A positively charged insulating rod is brought close to an object that is suspended by a string. If the object is attracted toward the rod we can conclude:

A. the object is positively charged
B. the object is negatively charged
C. the object is an insulator
D. the object is a conductor
E. none of the above

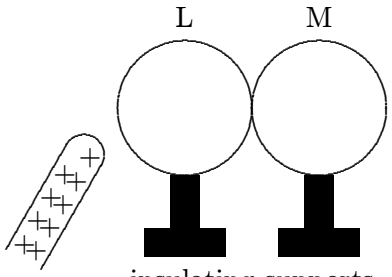
ans: E

18. A positively charged insulating rod is brought close to an object that is suspended by a string. If the object is repelled away from the rod we can conclude:

A. the object is positively charged
B. the object is negatively charged
C. the object is an insulator
D. the object is a conductor
E. none of the above

ans: A

19. Two uncharged metal spheres, L and M, are in contact. A negatively charged rod is brought close to L, but not touching it, as shown. The two spheres are slightly separated and the rod is then withdrawn. As a result:



A. both spheres are neutral
B. both spheres are positive
C. both spheres are negative
D. L is negative and M is positive
E. L is positive and M is negative

ans: D

20. A positively charged metal sphere A is brought into contact with an uncharged metal sphere B. As a result:

A. both spheres are positively charged
B. A is positively charged and B is neutral
C. A is positively charged and B is negatively charged
D. A is neutral and B is positively charged
E. A is neutral and B is negatively charged

ans: A

21. 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
E. uncharged

ans: C

22. A negatively charged rubber rod is brought near the knob of a positively charged electroscope. The result is that:

A. the electroscope leaves will move farther apart
B. the rod will lose its charge
C. the electroscope leaves will tend to collapse
D. the electroscope will become discharged
E. nothing noticeable will happen

ans: C

23. An electroscope is charged by induction using a glass rod that has been made positive by rubbing it with silk. The electroscope leaves:

A. gain electrons
B. gain protons
C. lose electrons
D. lose protons
E. gain an equal number of protons and electrons

ans: A

24. Consider the following procedural steps:

1. ground an electroscope
2. remove the ground from the electroscope
3. touch a charged rod to the electroscope
4. bring a charged rod near, but not touching, the electroscope
5. remove the charged rod

To charge an electroscope by induction, use the sequence:

A. 1, 4, 5, 2
B. 4, 1, 2, 5
C. 3, 1, 2, 5
D. 4, 1, 5, 2
E. 3, 5

ans: B

25. A charged insulator can be discharged by passing it just above a flame. This is because the flame:

A. warms it
B. dries it
C. contains carbon dioxide
D. contains ions
E. contains more rapidly moving atoms

ans: D

26. A small object has charge Q. Charge q is removed from it and placed on a second small object. The two objects are placed 1 m apart. For the force that each object exerts on the other to be a maximum. q should be:

A. $2Q$
B. Q
C. $Q/2$
D. $Q/4$
E. 0

ans: C

27. Two small charged objects attract each other with a force F when separated by a distance d. If the charge on each object is reduced to one-fourth of its original value and the distance between them is reduced to $d/2$ the force becomes:

A. $F/16$
B. $F/8$
C. $F/4$
D. $F/2$
E. F

ans: C

28. Two identical conducting spheres A and B carry equal charge. They are separated by a distance much larger than their diameters. A third identical conducting sphere C is uncharged. Sphere C is first touched to A, then to B, and finally removed. As a result, the electrostatic force between A and B, which was originally F, becomes:

A. $F/2$
B. $F/4$
C. $3F/8$
D. $F/16$
E. 0

ans: C

29. Two particles, X and Y, are 4 m apart. X has a charge of $2Q$ and Y has a charge of Q. The force of X on Y:

A. has twice the magnitude of the force of Y on X
B. has half the magnitude of the force of Y on X
C. has four times the magnitude of the force of Y on X
D. has one-fourth the magnitude of the force of Y on X
E. has the same magnitude as the force of Y on X

ans: E

30. The units of $1/4\pi\epsilon_0$ are:

A. $\mathrm{N^2C^2}$
B. $\mathrm{N \cdot m/C}$
C. $\mathrm{N^2 \cdot m^2/C^2}$
D. $\mathrm{N \cdot m^2/C^2}$
E. $\mathrm{m^2/C^2}$

ans: D

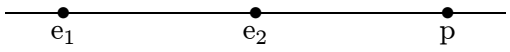
31. A 5.0-C charge is 10 m from a −2.0-C charge. The electrostatic force on the positive charge is:
A. 9.0×10^8 N toward the negative charge
B. 9.0×10^8 N away from the negative charge
C. 9.0×10^9 N toward the negative charge
D. 9.0×10^9 N away from the negative charge
E. none of these

ans: A

32. Two identical charges, 2.0 m apart, exert forces of magnitude 4.0 N on each other. The value of either charge is:
A. 1.8×10^{-9} C
B. 2.1×10^{-5} C
C. 4.2×10^{-5} C
D. 1.9×10^5 C
E. 3.8×10^5 C

ans: C

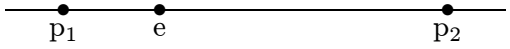
33. Two electrons (e_1 and e_2) and a proton (p) lie on a straight line, as shown. The directions of the force of e_2 on e_1, the force of p on e_1, and the total force on e_1, respectively, are:



A. $\longrightarrow, \longleftarrow, \longrightarrow$
B. $\longleftarrow, \longrightarrow, \longrightarrow$
C. $\longrightarrow, \longleftarrow, \longleftarrow$
D. $\longleftarrow, \longrightarrow, \longleftarrow$
E. $\longleftarrow, \longleftarrow, \longleftarrow$

ans: D

34. Two protons (p_1 and p_2) and an electron (e) lie on a straight line, as shown. The directions of the force of p_1 on e, the force of p_2 on e, and the total force on e, respectively, are:



A. $\longrightarrow, \longleftarrow, \longrightarrow$
B. $\longleftarrow, \longrightarrow, \longrightarrow$
C. $\longrightarrow, \longleftarrow, \longleftarrow$
D. $\longleftarrow, \longrightarrow, \longleftarrow$
E. $\longleftarrow, \longleftarrow, \longleftarrow$

ans: D

35. Two particles have charges Q and $-Q$ (equal magnitude and opposite sign). For a net force of zero to be exerted on a third charge it must be placed:

A. midway between Q and $-Q$
B. on the perpendicular bisector of the line joining Q and $-Q$, but not on that line itself
C. on the line joining Q and $-Q$, to the side of Q opposite $-Q$
D. on the line joining Q and $-Q$, to the side of $-Q$ opposite Q
E. at none of these places (there is no place)

ans: E

36. Particles 1, with charge q_1, and 2, with charge q_2, are on the x axis, with particle 1 at $x = a$ and particle 2 at $x = -2a$. For the net force on a third charged particle, at the origin, to be zero, q_1 and q_2 must be related by $q_2 =$:

A. $2q_1$
B. $4q_1$
C. $-2q_1$
D. $-4q_1$
E. $-q_1/4$

ans: B

37. Two particles A and B have identical charge Q. For a net force of zero to be exerted on a third charged particle it must be placed:

A. midway between A and B
B. on the perpendicular bisector of the line joining A and B but away from the line
C. on the line joining A and B, not between the particles
D. on the line joining A and B, closer to one of them than the other
E. at none of these places (there is no place)

ans: A

38. A particle with charge 2-μC is placed at the origin, an identical particle, with the same charge, is placed 2 m from the origin on the x axis, and a third identical particle, with the same charge, is placed 2 m from the origin on the y axis. The magnitude of the force on the particle at the origin is:

A. 9.0×10^{-3} N
B. 6.4×10^{-3} N
C. 1.3×10^{-2} N
D. 1.8×10^{-2} N
E. 3.6×10^{-2} N

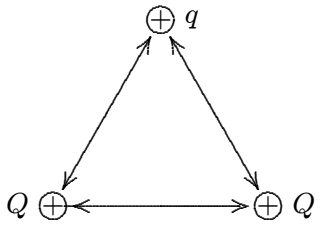
ans: C

39. Charge Q is spread uniformly along the circumference of a circle of radius R. A point particle with charge q is placed at the center of this circle. The total force exerted on the particle can be calculated by Coulomb's law:

A. just use R for the distance
B. just use $2R$ for the distance
C. just use $2\pi R$ for the distance
D. the result of the calculation is zero
E. none of the above

ans: D

40. Two particles, each with charge Q, and a third particle, with charge q, are placed at the vertices of an equilateral triangle as shown. The total force on the particle with charge q is:



A. parallel to the left side of the triangle
B. parallel to the right side of the triangle
C. parallel to the bottom side of the triangle
D. perpendicular to the bottom side of the triangle
E. perpendicular to the left side of the triangle

ans: D

41. A particle with charge Q is on the y axis a distance a from the origin and a particle with charge q is on the x axis a distance d from the origin. The value of d for which the x component of the force on the second particle is the greatest is:

A. 0
B. a
C. $\sqrt{2}a$
D. $a/2$
E. $a/\sqrt{2}$

ans: E

42. In the Rutherford model of the hydrogen atom, a proton (mass M, charge Q) is the nucleus and an electron (mass m, charge q) moves around the proton in a circle of radius r. Let k denote the Coulomb force constant $(1/4\pi\epsilon_0)$ and G the universal gravitational constant. The ratio of the electrostatic force to the gravitational force between electron and proton is:

A. $kQq/GMmr^2$
B. GQq/kMm
C. kMm/GQq
D. GMm/kQq
E. kQq/GMm

ans: E

43. A particle with a charge of 5×10^{-6} C and a mass of 20 g moves uniformly with a speed of 7 m/s in a circular orbit around a stationary particle with a charge of -5×10^{-6} C. The radius of the orbit is:

A. 0
B. 0.23 m
C. 0.62 m
D. 1.6
E. 4.4 m

ans: B

44. Charge is distributed uniformly on the surface of a spherical balloon (an insulator). A point particle with charge q is inside. The electrical force on the particle is greatest when:

A. it is near the inside surface of the balloon
B. it is at the center of the balloon
C. it is halfway between the balloon center and the inside surface
D. it is anywhere inside (the force is same everywhere and is not zero)
E. it is anywhere inside (the force is zero everywhere)

ans: E

45. Charge is distributed on the surface of a spherical conducting shell. A point particle with charge q is inside. If polarization effects are negligible the electrical force on the particle is greatest when:

A. it is near the inside surface of the balloon
B. it is at the center of the balloon
C. it is halfway between the balloon center and the inside surface
D. it is anywhere inside (the force is same everywhere and is not zero)
E. it is anywhere inside (the force is zero everywhere)

ans: A