

Chapter 21: ELECTRIC CHARGE

1. A coulomb is the same as:
 - A. an ampere/second
 - B. half an ampere-second²
 - C. an ampere/meter²
 - D. an ampere-second
 - E. a newton·meter²ans: D
2. A kiloampere-hour is a unit of:
 - A. current
 - B. charge per time
 - C. power
 - D. charge
 - E. energyans: 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 Cans: 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 Cans: 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 Cans: 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

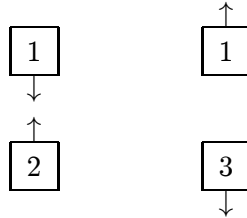
9. To make an uncharged object have a negative charge we must:
- A. add some atoms
 - B. remove some atoms
 - C. add some electrons
 - D. remove some electrons
 - E. write down a negative sign

ans: C

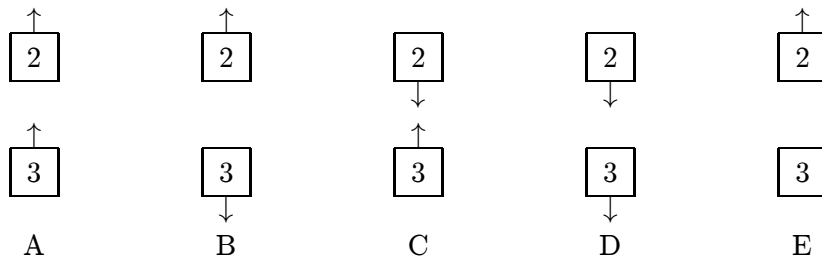
10. To make an uncharged object have a positive charge:
- A. remove some neutrons
 - B. add some neutrons
 - C. add some electrons
 - D. remove some electrons
 - E. heat it to cause a change of phase

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?

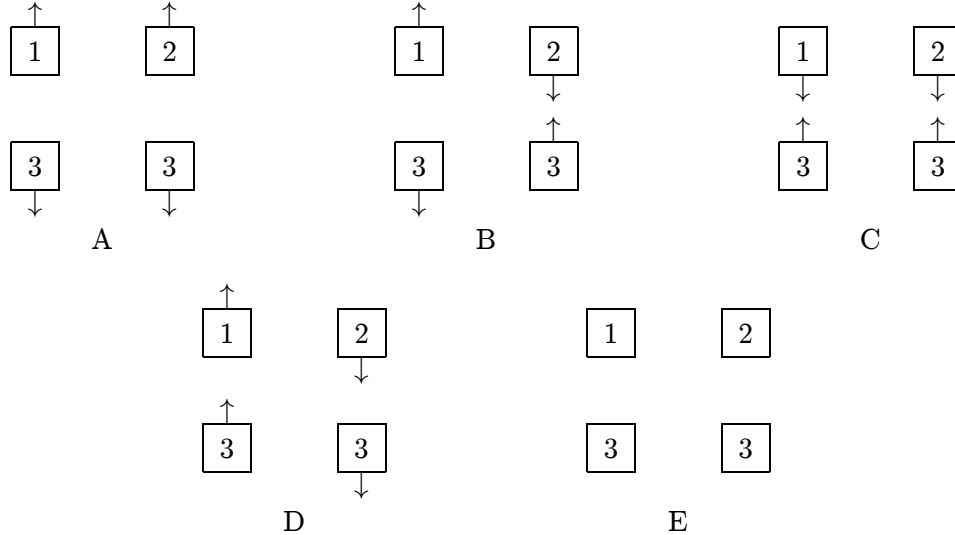


ans: C

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:
- the ball becomes positively charged by induction
 - the ball becomes negatively charged by induction
 - the number of electrons in the ball is more than the number in the rod
 - the string is not a perfect insulator
 - there is a rearrangement of the electrons in the ball

ans: E

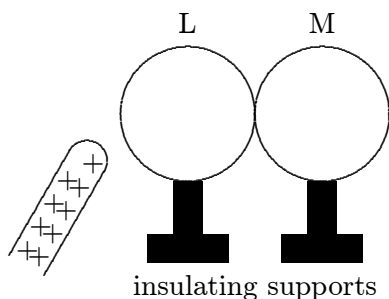
17. A positively charged insulating rod is brought close to an object that is suspended by a string. If the object is attracted toward the rod we can conclude:
- the object is positively charged
 - the object is negatively charged
 - the object is an insulator
 - the object is a conductor
 - none of 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. N^2C^2
 - B. $N \cdot m/C$
 - C. $N^2 \cdot m^2/C^2$
 - D. $N \cdot m^2/C^2$
 - E. m^2/C^2

ans: D

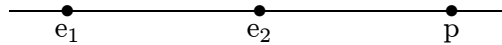
31. A 5.0-C charge is 10 m from a -2.0-C charge. The electrostatic force on the positive charge is:
- $9.0 \times 10^8 \text{ N}$ toward the negative charge
 - $9.0 \times 10^8 \text{ N}$ away from the negative charge
 - $9.0 \times 10^9 \text{ N}$ toward the negative charge
 - $9.0 \times 10^9 \text{ N}$ away from the negative charge
 - 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:
- $1.8 \times 10^{-9} \text{ C}$
 - $2.1 \times 10^{-5} \text{ C}$
 - $4.2 \times 10^{-5} \text{ C}$
 - $1.9 \times 10^5 \text{ C}$
 - $3.8 \times 10^5 \text{ C}$

ans: C

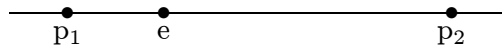
33. Two electrons (e_1 and e_2) and a proton (p) lie on a straight line, as shown. The directions of the force of e_2 on e_1 , the force of p on e_1 , and the total force on e_1 , respectively, are:



- $\rightarrow, \leftarrow, \rightarrow$
- $\leftarrow, \rightarrow, \rightarrow$
- $\rightarrow, \leftarrow, \leftarrow$
- $\leftarrow, \rightarrow, \leftarrow$
- $\leftarrow, \leftarrow, \leftarrow$

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:

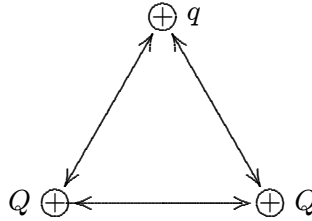


- $\rightarrow, \leftarrow, \rightarrow$
- $\leftarrow, \rightarrow, \rightarrow$
- $\rightarrow, \leftarrow, \leftarrow$
- $\leftarrow, \rightarrow, \leftarrow$
- $\leftarrow, \leftarrow, \leftarrow$

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:
- midway between Q and $-Q$
 - on the perpendicular bisector of the line joining Q and $-Q$, but not on that line itself
 - on the line joining Q and $-Q$, to the side of Q opposite $-Q$
 - on the line joining Q and $-Q$, to the side of $-Q$ opposite Q
 - 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 $q_2 =$:
- $2q_1$
 - $4q_1$
 - $-2q_1$
 - $-4q_1$
 - $-q_1/4$
- 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:
- midway between A and B
 - on the perpendicular bisector of the line joining A and B but away from the line
 - on the line joining A and B, not between the particles
 - on the line joining A and B, closer to one of them than the other
 - at none of these places (there is no place)
- ans: A
38. A particle with charge $2\text{-}\mu\text{C}$ 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:
- $9.0 \times 10^{-3} \text{ N}$
 - $6.4 \times 10^{-3} \text{ N}$
 - $1.3 \times 10^{-2} \text{ N}$
 - $1.8 \times 10^{-2} \text{ N}$
 - $3.6 \times 10^{-2} \text{ N}$
- 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:
- just use R for the distance
 - just use $2R$ for the distance
 - just use $2\pi R$ for the distance
 - the result of the calculation is zero
 - 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