Chapter 18: Electric Fields and Forces

Section 18.1 The Origin of Electricity
Section 18.2 Charged Objects and the Electric Force
Section 18.3 Conductors and Insulators
Section 18.4 Charging by Contact and by Induction

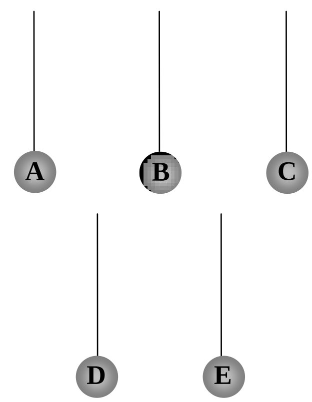
☐ 1. Which one of the following statements *best* explains why tiny bits of paper are attracted to a charged rubber rod?

(a) Paper is naturally a positive material.
(b) Paper is naturally a negative material.
(c) The paper becomes polarized by induction.
(d) Rubber and paper always attract each other.
(e) The paper acquires a net positive charge by induction.

◘ 2. Five styrofoam balls are suspended from insulating threads. Several experiments are performed on the balls; and the following observations are made:

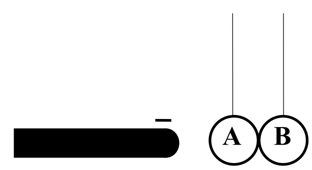
I. Ball A attracts B and A repels C.
II. Ball D attracts B and D has no effect on E.
III. A negatively charged rod attracts both A and E.

What are the charges, *if any*, on *each* ball?



	A	**B**	**C**	**D**	**E**
(a)	+	–	+	0	+
(b)	+	–	+	+	0
(c)	+	–	+	0	0
(d)	–	+	–	0	0
(e)	+	0	–	+	0

◘ 3. Two uncharged conducting spheres, **A** and **B**, are suspended from insulating threads so that they touch each other. While a negatively charged rod is held *near*, *but not touching* sphere **A**, someone moves ball B away from A. How will the spheres be charged, *if at all*?



	Sphere **A**	*Sphere* **B**
(a)	0	+
(b)	–	+
(c)	0	0
(d)	–	0
(e)	+	–

☐ 4. Each of three objects has a net charge. Objects **A** and **B** attract one another. Objects **B** and **C** also attract one another, but objects **A** and **C** repel one another. Which one of the following table entries is a possible combination of the signs of the net charges on these three objects?

	A	**B**	**C**
(a)	+	+	–
(b)	–	+	+
(c)	+	–	–
(d)	–	+	–
(e)	–	–	+

◘ 5. A conducting sphere has a net charge of -4.8×10^{-17} C. What is the approximate number of excess electrons on the sphere?
(a) 100
(b) 200
(c) 300
(d) 400
(e) 500

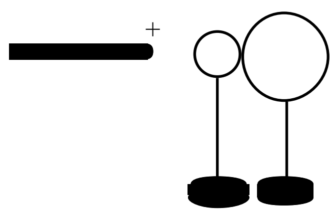
☐ 6. Complete the following statement: When an ebonite rod is rubbed with animal fur, the rod becomes negatively charged as
(a) positive charges are transferred from the fur to the rod.
(b) negative charges are transferred from the rod to the fur.
(c) negative charges are created on the surface of the rod.
(d) negative charges are transferred from the fur to the rod.
(e) positive charges are transferred from the rod to the fur.

☐ 7. Complete the following statement: When a glass rod is rubbed with silk cloth, the rod becomes positively charged as
(a) positive charges are transferred from the silk to the rod.
(b) negative charges are transferred from the rod to the silk.
(c) positive charges are created on the surface of the rod.
(d) negative charges are transferred from the silk to the rod.
(e) positive charges are transferred from the rod to the silk.

☐ 8. A charged conductor is brought near an uncharged insulator. Which one of the following statements is true?
(a) Both objects will repel each other.
(b) Both objects will attract each other.
(c) Neither object exerts an electrical force on the other.
(d) The objects will repel each other only if the conductor has a negative charge.
(e) The objects will attract each other only if the conductor has a positive charge.

◘ 9. An aluminum nail has an excess charge of +3.2 μC. How many electrons must be added to the nail to make it electrically neutral?
(a) 2.0×10^{13}
(b) 2.0×10^{19}
(c) 3.2×10^{16}
(d) 3.2×10^{6}
(e) 5.0×10^{-14}

◘ 10. Two uncharged, conducting spheres, **A** and **B**, are held at rest on insulating stands and are in contact. A positively charged rod is brought near sphere **A** as suggested in the figure. While the rod is in place, someone moves sphere **B** away from **A**. How will the spheres be charged, *if at all*?



	Sphere **A**	*Sphere* **B**
(a)	positive	positive
(b)	positive	negative
(c)	negative	positive
(d)	negative	negative
(e)	zero	zero

◘ 11. Consider three identical metal spheres, **A**, **B**, and **C**. Sphere **A** carries a charge of −2.0 μC; sphere **B** carries a charge of −6.0 μC; and sphere **C** carries a charge of +5.0 μC. Spheres **A** and **B** are touched together and then separated. Spheres **B** and **C** are then touched and separated. Does sphere **C** end up with an excess or a deficiency of electrons and how many electrons is it?
(a) deficiency, 6×10^{13}
(c) excess, 2×10^{13}
(e) deficiency, 1×10^{12}

(b) excess, 3×10^{13} (d) deficiency, 3×10^{12}

Section 18.5 Coulomb's Law

☐ 12. Three charged particles **A**, **B**, and **C** are located near one another. Both the *magnitude* and *direction* of the force that particle **A** exerts on particle **B** is *independent* of
(a) the sign of charge **B**.
(b) the sign of charge **A**.
(c) the distance between **C** and **B**.
(d) the distance between **A** and **B**.
(e) the magnitude of the charge on **B**.

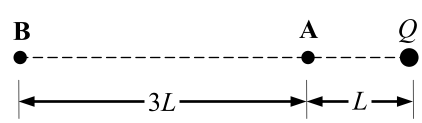
◘ 14. Two positive point charges Q and $2Q$ are separated by a distance R. If the charge Q experiences a force of magnitude F when the separation is R, what is the magnitude of the force on the charge $2Q$ when the separation is $2R$?
(a) $F/4$
(b) $F/2$
(c) F
(d) $2F$
(e) $4F$

◘ 15. A charge Q exerts a 12 N force on another charge q. If the distance between the charges is doubled, what is the magnitude of the force exerted on Q by q?
(a) 3 N
(b) 6 N
(c) 24 N
(d) 36 N
(e) 48 N

Section 18.6 The Electric Field
Section 18.7 Electric Field Lines
Section 18.8 The Electric Field Inside a Conductor: Shielding

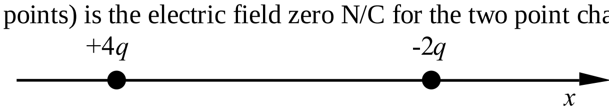
☐ 27. Which one of the following statements is true concerning the magnitude of the electric field at a point in space?
(a) It is a measure of the total charge on the object.
(b) It is a measure of the electric force on any charged object.
(c) It is a measure of the ratio of the charge on an object to its mass.
(d) It is a measure of the electric force per unit mass on a test charge.
(e) It is a measure of the electric force per unit charge on a test charge.

◘ 28. In the figure, point **A** is a distance L away from a point charge Q. Point **B** is a distance $4L$ away from Q. What is the ratio of the electric field at **B** to that at **A**, $E_{\mathbf{B}}/E_{\mathbf{A}}$?



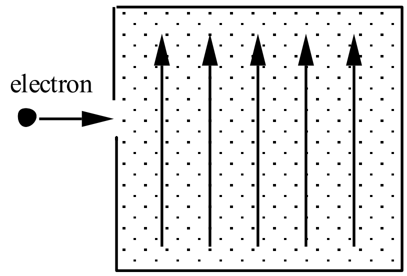
(a) 1/16
(b) 1/9
(c) 1/4
(d) 1/3
(e) This cannot be determined since neither the value of Q nor the length L is specified.

◘ 29. At which point (or points) is the electric field zero N/C for the two point charges shown on the x axis?



(a) The electric field is never zero in the vicinity of these charges.
(b) The electric field is zero somewhere on the x axis to the left of the $+4q$ charge.
(c) The electric field is zero somewhere on the x axis to the right of the $-2q$ charge.
(d) The electric field is zero somewhere on the x axis between the two charges, but this point is nearer to the $-2q$ charge.
(e) The electric field is zero at two points along the x axis; one such point is to the right of the $-2q$ charge and the other is to the left of the $+4q$ charge.

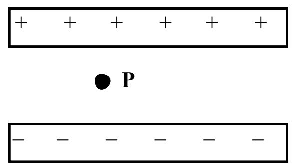
■ 30. An electron traveling horizontally enters a region where a uniform electric field is directed upward. What is the direction of the force exerted on the electron once it has entered the field?
(a) to the left
(b) to the right
(c) upward
(d) downward
(e) out of the page, toward the reader



■ 31. Which one of the following statements is true concerning the strength of the electric field between two oppositely charged parallel plates?
(a) It is zero midway between the plates.
(b) It is a maximum midway between the plates.
(c) It is a maximum near the positively charged plate.
(d) It is a maximum near the negatively charged plate.
(e) It is constant between the plates except near the edges.

Questions 37 through 39 pertain to the statement and diagram below:

The figure shows a parallel plate capacitor. The surface charge density on each plate is 8.8×10^{-8} C/m^2. The point **P** is located 1.0×10^{-5} m away from the positive plate.



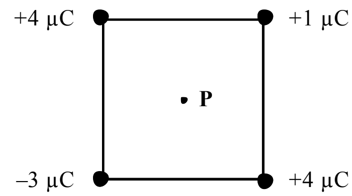
□ 37. Which one of the following statements concerning the direction of the electric field between the plates is true?
(a) It points to the left.
(b) It points to the right.
(c) It points toward the negative plate.
(d) It points toward the positive plate.
(e) It points up out of the plane of the page.

■ 38. What is the magnitude of the electric field at the point **P**?
(a) 8.8 N/C
(b) 88 N/C
(c) 1.0×10^2 N/C
(d) 8.8×10^2 N/C
(e) 9.9×10^3 N/C

■ 39. If a $+2.0 \times 10^{-5}$ C point charge is placed at **P**, what is the force exerted on it?
(a) 0.2 N, toward the negative plate
(b) 0.2 N, toward the positive plate
(c) 5×10^4 N, toward the positive plate
(d) 5×10^4 N, toward the negative plate
(e) 5×10^4 N, into the plane of the page

□ 41. Complete the following statement: The magnitude of the electric field at a point in space does *not* depend upon
(a) the distance from the charge causing the field.
(b) the sign of the charge causing the field.
(c) the magnitude of the charge causing the field.
(d) the force that a unit positive charge will experience at that point.
(e) the force that a unit negative charge will experience at that point.

■ 42. Four point charges are placed at the corners of a square as shown in the figure. Each side of the square has length 2.0 m. Determine the magnitude of the electric field at the point **P**, the center of the square.



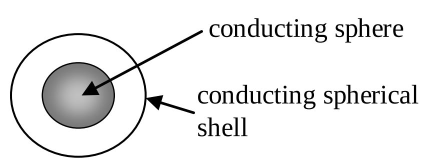
(a) 2.0×10^{-6} N/C
(b) 3.0×10^{-6} N/C
(c) 9.0×10^{3} N/C
(d) 1.8×10^{4} N/C
(e) 2.7×10^{4} N/C

□ 46. Which one of the following statements is true concerning the *spacing* of the electric field lines in the vicinity of two point charges of equal magnitude and opposite sign?
(a) It indicates the direction of the electric field.
(b) It does not depend on the magnitude of the charges.
(c) It is large when the magnitude of the charges is large.
(d) It indicates the relative magnitude of the electric field.
(e) It is small when the magnitude of the charges is small.

□ 47. Which one of the following statements is true concerning the electrostatic charge on a conductor?
(a) The charge is uniformly distributed throughout the volume.
(b) The charge is confined to the surface and is uniformly distributed.
(c) Most of the charge is on the outer surface, but it is not uniformly distributed.
(d) The charge is entirely on the surface and it is distributed according to the shape of the object.
(e) The charge is dispersed throughout the volume of the object and distributed according to the object's shape.

◘ 49. What is the magnitude and direction of the electric force on a –1.2 μC charge at a point where the electric field is 2500 N/C and is directed along the +*y* axis.
(a) 0.15 N, –*y* direction
(b) 0.15 N, +*y* direction
(c) 0.0030 N, –*y* direction
(d) 0.0030 N, +*y* direction
(e) 4.3 N, +*x* direction

◘ 50. A conducting sphere carries a net charge of –6 μC. The sphere is located at the center of a conducting spherical shell that carries a net charge of +2 μC. Determine the excess charge on the outer surface of the spherical shell.



(a) –4 μC
(b) +4 μC
(c) –8 μC
(d) +8 μC
(e) +6 μC