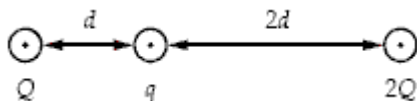


MULTIPLE CHOICE

1. In the figure, if $Q = 30 \mu\text{C}$, $q = 5.0 \mu\text{C}$, and $d = 30 \text{ cm}$, what is the magnitude of the electrostatic force on q ?



- a. 15 N
- b. 23 N
- c. zero
- d. 7.5 N
- e. 38 N

ANS: D

PTS: 2

DIF: Average

2. A particle ($m = 50 \text{ g}$, $q = 5.0 \mu\text{C}$) is released from rest when it is 50 cm from a second particle ($Q = -20 \mu\text{C}$). Determine the magnitude of the initial acceleration of the 50-g particle.
- a. 54 m/s^2
 - b. 90 m/s^2
 - c. 72 m/s^2
 - d. 65 m/s^2
 - e. 36 m/s^2

ANS: C

PTS: 2

DIF: Average

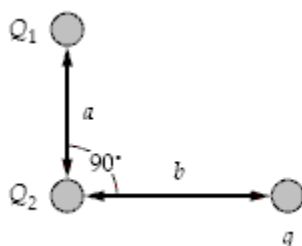
3. A point charge Q is placed on the x axis at $x = -2.0 \text{ m}$. A second point charge, $-Q$, is placed at $x = 1.0 \text{ m}$. If $Q = 60 \mu\text{C}$, what is the magnitude of the electrostatic force on a $40\text{-}\mu\text{C}$ charge placed at the origin?
- a. 16 N
 - b. 27 N
 - c. 32 N
 - d. 11 N
 - e. 3.0 N

ANS: B

PTS: 2

DIF: Average

4. If $a = 3.0 \text{ mm}$, $b = 4.0 \text{ mm}$, $Q_1 = 60 \text{ nC}$, $Q_2 = 80 \text{ nC}$, and $q = 24 \text{ nC}$ in the figure, what is the magnitude of the electric force on q ?



- a. 2.7 N
- b. 1.9 N
- c. 2.3 N
- d. 1.5 N
- e. 0.52 N

ANS: D

PTS: 2

DIF: Average

5. Identical point charges Q are placed at each of the four corners of a $3.0 \text{ m} \times 4.0 \text{ m}$ rectangle. If $Q = 40 \text{ } \mu\text{C}$, what is the magnitude of the electrostatic force on any one of the charges?
- a. 3.0 N
 - b. 2.4 N
 - c. 1.8 N
 - d. 3.7 N
 - e. 2.0 N

ANS: B

PTS: 3

DIF: Challenging

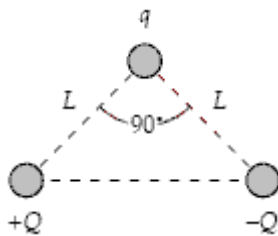
6. A point charge $(-5.0 \text{ } \mu\text{C})$ is placed on the x axis at $x = 4.0 \text{ cm}$, and a second charge $(+5.0 \text{ } \mu\text{C})$ is placed on the x axis at $x = -4.0 \text{ cm}$. What is the magnitude of the electric force on a third charge $(+2.5 \text{ } \mu\text{C})$ placed on the y axis at $y = 3.0 \text{ cm}$?
- a. 90 N
 - b. 45 N
 - c. 54 N
 - d. 72 N
 - e. 36 N

ANS: D

PTS: 2

DIF: Average

7. If $Q = 25 \text{ } \mu\text{C}$, $q = 10 \text{ } \mu\text{C}$, and $L = 40 \text{ cm}$ in the figure, what is the magnitude of the electrostatic force on q ?



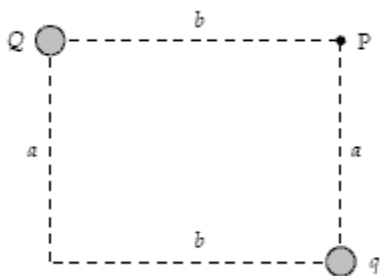
- a. 28 N
- b. 22 N
- c. 20 N
- d. 14 N
- e. 10 N

ANS: C

PTS: 2

DIF: Average

8. If $a = 60 \text{ cm}$, $b = 80 \text{ cm}$, $Q = -4.0 \text{ nC}$, and $q = 1.5 \text{ nC}$, what is the magnitude of the electric field at point P?



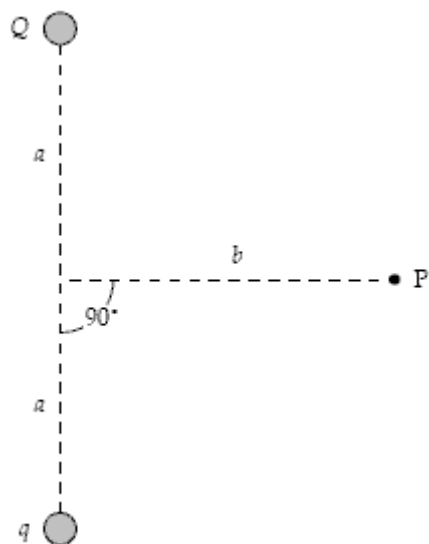
- a. 68 N/C
- b. 72 N/C
- c. 77 N/C
- d. 82 N/C
- e. 120 N/C

ANS: A

PTS: 2

DIF: Average

9. If $a = 60$ cm, $b = 80$ cm, $Q = -6.0$ nC, and $q = 3.0$ nC in the figure, what is the magnitude of the electric field at point P?



- a. 71 N/C
- b. 56 N/C
- c. 60 N/C
- d. 53 N/C
- e. 67 N/C

ANS: D

PTS: 2

DIF: Average

10. A $+2.0$ -nC point charge is placed at one corner of a square (1.5 m on a side), and a -3.0 -nC charge is placed on a corner diagonally away from the first charge. What is the magnitude of the electric field at either of the two unoccupied corners?
- a. 20 N/C
 - b. 14 N/C
 - c. 4.0 N/C
 - d. 12 N/C
 - e. 8.0 N/C

ANS: B

PTS: 2

DIF: Average

11. A $40\text{-}\mu\text{C}$ charge is positioned on the x axis at $x = 4.0$ cm. Where should a $-60\text{-}\mu\text{C}$ charge be placed to produce a net electric field of zero at the origin?
- -5.3 cm
 - 5.7 cm
 - 4.9 cm
 - -6.0 cm
 - $+6.0$ cm

ANS: C

PTS: 2

DIF: Average

12. A charge of 25 nC is uniformly distributed along a circular arc (radius = 2.0 m) that is subtended by a 90 -degree angle. What is the magnitude of the electric field at the centre of the circle along which the arc lies?
- 81 N/C
 - 61 N/C
 - 71 N/C
 - 51 N/C
 - 25 N/C

ANS: D

PTS: 3

DIF: Challenging

13. Charge of uniform density 4.0 nC/m is distributed along the x axis from $x = -2.0$ m to $x = +3.0$ m. What is the magnitude of the electric field at the point $x = +5.0$ m on the x axis?
- 16 N/C
 - 13 N/C
 - 19 N/C
 - 26 N/C
 - 5.0 N/C

ANS: B

PTS: 2

DIF: Average

14. A 16-nC charge is distributed uniformly along the x axis from $x = 0$ to $x = 4$ m. Which of the following integrals is correct for the magnitude (in N/C) of the electric field at $x = +10$ m on the x axis?
- $\int_0^4 \frac{36dx}{(10-x)^2}$
 - $\int_0^4 \frac{154dx}{(10-x)^2}$
 - $\int_0^4 \frac{36dx}{x^2}$
 - $\int_6^{10} \frac{154dx}{x^2}$
 - none of these

ANS: A

PTS: 2

DIF: Average

15. A 12-nC charge is distributed uniformly along the y axis from $y = 0$ to $y = 4$ m. Which of the following integrals is correct for the x component of the electric field at $x = 2$ m on the x axis?

- a. $\int_0^4 \frac{216dy}{(4+y^2)^{3/2}}$
- b. $\int_0^4 \frac{54dy}{(4+y^2)^{3/2}}$
- c. $\int_0^4 \frac{108dy}{4+y^2}$
- d. $\int_0^4 \frac{27dy}{4+y^2}$
- e. none of these

ANS: B

PTS: 2

DIF: Average

16. A uniform linear charge of 2.0 nC/m is distributed along the x axis from $x = 0$ to $x = 3$ m. Which of the following integrals is correct for the x component of the electric field at $y = 2$ m on the y axis?

- a. $\int_0^3 \frac{-18xdx}{(4+x^2)^{3/2}}$
- b. $\int_0^3 \frac{-18dx}{(2+x)^2}$
- c. $\int_0^3 \frac{-18dx}{4+x^2}$
- d. $\int_0^3 \frac{-18xdx}{(2+x)^3}$
- e. none of these

ANS: A

PTS: 3

DIF: Challenging

17. A rod (length = 2.0 m) is uniformly charged and has a total charge of 40 nC. What is the magnitude of the electric field at a point which lies along the axis of the rod and is 3.0 m from the centre of the rod?

- a. 40 N/C
- b. 45 N/C
- c. 24 N/C
- d. 90 N/C
- e. 36 N/C

ANS: B

PTS: 2

DIF: Average

18. A 24-nC charge is distributed uniformly along the x axis from $x = 2$ m to $x = 6$ m. Which of the following integrals is correct for the magnitude (in N/C) of the electric field at $x = +8$ m on the x axis?

- a. $\int_2^6 \frac{54dx}{(8-x)^2}$
- b. $\int_2^6 \frac{216dx}{(8-x)^2}$
- c. $\int_2^6 \frac{54dx}{x^2}$

d. $\int_2^6 \frac{216dx}{x^2}$

e. none of these

ANS: A

PTS: 2

DIF: Average

19. A uniform linear charge density of 7.0 nC/m is distributed along the y axis from $y = 2$ m to $y = 5$ m. Which of the following integrals is correct for the magnitude (in N/C) of the electric field at $y = 0$ on the y axis?

a. $\int_2^5 \frac{63dy}{y^2}$

b. $\int_2^5 \frac{21dy}{y^2}$

c. $\int_2^5 \frac{63dy}{(5-y)^2}$

d. $\int_2^5 \frac{21dy}{(5-y)^2}$

e. none of these

ANS: A

PTS: 2

DIF: Average

20. A uniform linear charge of 2.0 nC/m is distributed along the x axis from $x = 0$ to $x = 3$ m. What is the x component of the electric field at $y = 2$ m on the y axis?

a. -5.0 N/C

b. -4.0 N/C

c. -5.7 N/C

d. -6.2 N/C

e. -9.0 N/C

ANS: B

PTS: 3

DIF: Challenging

21. A particle (mass = 4.0 g, charge = 80 mC) moves in a region of space where the electric field is uniform and is given by $E_x = -2.5$ N/C, $E_y = E_z = 0$. If the velocity of the particle at $t = 0$ is given by $v_x = 80$ m/s, $v_y = v_z = 0$, what is the speed of the particle at $t = 2.0$ s?

a. 40 m/s

b. 20 m/s

c. 60 m/s

d. 80 m/s

e. 180 m/s

ANS: B

PTS: 2

DIF: Average

22. A particle (mass = 5.0 g, charge = 40 mC) moves in a region of space where the electric field is uniform and is given by $E_x = 2.5$ N/C, $E_y = E_z = 0$. If the velocity of the particle at $t = 0$ is given by $v_y = 50$ m/s, $v_x = v_z = 0$, what is the speed of the particle at $t = 2.0$ s?

a. 81 m/s

b. 72 m/s

c. 64 m/s

d. 89 m/s

e. 25 m/s

ANS: C

PTS: 2

DIF: Average

23. A particle (mass = 5.0 g, charge = 40 mC) moves in a region of space where the electric field is uniform and is given by $E_x = -5.5 \text{ N/C}$, $E_y = E_z = 0$. If the position and velocity of the particle at $t = 0$ are given by $x = y = z = 0$ and $v_x = 50 \text{ m/s}$, $v_y = v_z = 0$, what is the distance from the origin to the particle at $t = 2.0 \text{ s}$?
- 60 m
 - 28 m
 - 44 m
 - 12 m
 - 88 m

ANS: D

PTS: 2

DIF: Average

24. A particle ($q = 4.0 \text{ mC}$, $m = 50 \text{ g}$) has a velocity of 25 m/s in the positive x direction when it first enters a region where the electric field is uniform (60 N/C in the positive y direction). What is the speed of the particle 5.0 s after it enters this region?
- 49 m/s
 - 35 m/s
 - 32 m/s
 - 44 m/s
 - 24 m/s

ANS: B

PTS: 2

DIF: Average

25. A charge of $50\text{-}\mu\text{C}$ is placed on the y axis at $y = 3.0 \text{ cm}$ and a $77\text{-}\mu\text{C}$ charge is placed on the x axis at $x = 4.0 \text{ cm}$. If both charges are held fixed, what is the magnitude of the initial acceleration of an electron released from rest at the origin?
- $1.2 \times 10^{20} \text{ m/s}^2$
 - $1.5 \times 10^{20} \text{ m/s}^2$
 - $1.0 \times 10^{20} \text{ m/s}^2$
 - $1.8 \times 10^{20} \text{ m/s}^2$
 - $2.0 \times 10^{20} \text{ m/s}^2$

ANS: A

PTS: 3

DIF: Challenging

26. A particle ($m = 20 \text{ mg}$, $q = -5.0 \text{ }\mu\text{C}$) moves in a uniform electric field of 60 N/C in the positive x direction. At $t = 0$, the particle is moving 25 m/s in the positive x direction and is passing through the origin. How far is the particle from the origin at $t = 2.0 \text{ s}$?
- 80 m
 - 20 m
 - 58 m
 - 10 m
 - 30 m

ANS: B

PTS: 2

DIF: Average

27. A particle ($m = 20 \text{ mg}$, $q = -5.0 \text{ }\mu\text{C}$) moves in a uniform electric field of 60 N/C in the positive x direction. At $t = 0$, the particle is moving 30 m/s in the positive x direction and is passing through the origin. Determine the maximum distance beyond $x = 0$ the particle travels in the positive x direction.
- 25 m
 - 20 m
 - 15 m

- d. 30 m
- e. 60 m

ANS: D

PTS: 2

DIF: Average

28. Charge Q is distributed uniformly along a semicircle of radius a . Which formula below gives the correct magnitude of the force on a particle of charge q located at the centre of the circle?

a. $F = \frac{1}{4\pi\epsilon_0} \frac{qQ}{\pi a}$

b. $F = \frac{1}{4\pi\epsilon_0} \frac{qQ}{\pi a^2}$

c. $F = \frac{1}{4\pi\epsilon_0} \frac{2qQ}{\pi a}$

d. $F = \frac{1}{4\pi\epsilon_0} \frac{2qQ}{\pi a^2}$

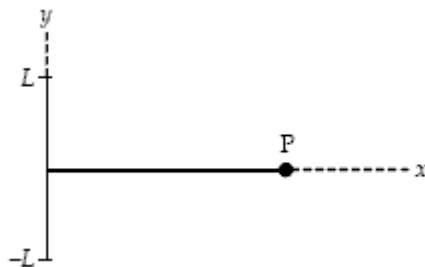
e. $F = \frac{1}{4\pi\epsilon_0} \frac{2qQ}{a^2}$

ANS: D

PTS: 2

DIF: Average

29. Charge Q is uniformly distributed over a line segment of length $2L$, as shown below. When the x -coordinate of point P is x , the magnitude of the y -component of the electric field at point P is:



a. 0.

b. $\frac{1}{4\pi\epsilon_0} \frac{Q}{2\sqrt{L^2 + x^2}}$

c. $\frac{1}{4\pi\epsilon_0} \frac{Q}{\sqrt{L^2 + x^2}}$

d. $\frac{1}{4\pi\epsilon_0} \frac{Q}{x\sqrt{L^2 + x^2}}$

e. $\frac{1}{4\pi\epsilon_0} \frac{Q}{2x\sqrt{L^2 + x^2}}$

ANS: A

PTS: 1

DIF: Easy

30. When gravitational, magnetic and any forces other than static electric forces are not present, electric field lines in the space surrounding a charge distribution show:

- a. the directions of the forces that exist in space at all times.

- ANS: D PTS: 1 DIF: Easy

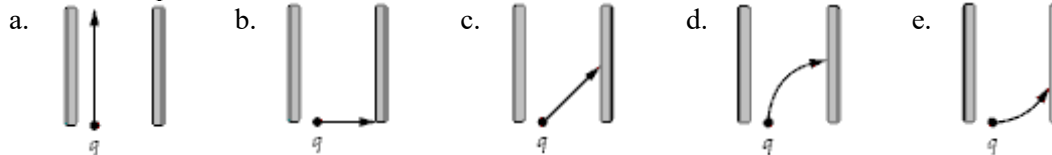
- ANS: E PTS: 1 DIF: Easy

- ANS: D PTS: 1 DIF: Easy

- ANS: C PTS: 1 DIF: Easy

- ANS: D PTS: 1 DIF: Easy

35. A positively charged particle is moving in the $+y$ -direction when it enters a region with a uniform electric field pointing in the $+x$ -direction. Which of the diagrams below shows its path while it is in the region where the electric field exists. The region with the field is the region between the plates bounding each figure. The field lines always point to the right. The x -direction is to the right; the y -direction is up.

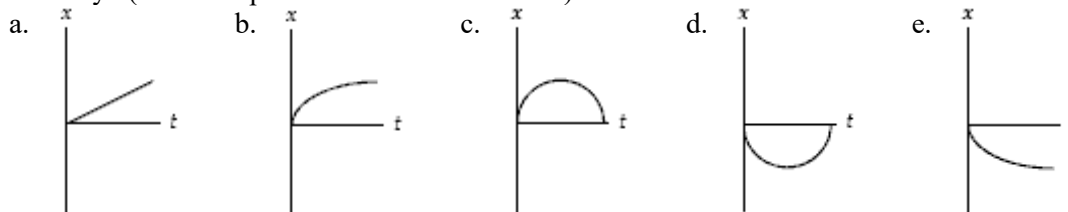


ANS: D

PTS: 1

DIF: Easy

36. A negatively charged particle is moving in the $+x$ -direction when it enters a region with a uniform electric field pointing in the $+x$ -direction. Which graph gives its position as a function of time correctly? (Its initial position is $x = 0$ at $t = 0$.)



ANS: C

PTS: 1

DIF: Easy

37. The symbol $\frac{1}{4\pi\epsilon_0}$ appears in Coulomb's law because we use independently defined units for:
- force and distance.
 - charge and distance.
 - distance and force.
 - force, distance and electric charge.
 - charge.

ANS: D

PTS: 1

DIF: Easy

38. Three pith balls supported by insulating threads hang from a support. We know that ball X is positively charged. When ball X is brought near balls Y and Z without touching them, it attracts Y and repels Z. Since pith is an insulating material, we can conclude that:
- Y has a negative charge.
 - Z has a negative charge.
 - Y has a positive charge.
 - Z has a positive charge.
 - Z is neutral (has no net charge.)

ANS: D

PTS: 1

DIF: Easy

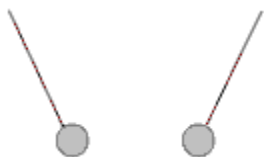
39. Three pith balls supported by insulating threads hang from a support. We know that ball X is positively charged. When ball X is brought near balls Y and Z without touching them, it attracts Y and repels Z. Since pith is an insulating material, we can conclude that:
- Y has a negative charge.
 - Z has a negative charge.
 - Y has a positive charge.
 - Z is neutral (has no net charge.)
 - Y is negatively charged or neutral (has no net charge.)

ANS: E

PTS: 1

DIF: Easy

40. Two identical pith balls supported by insulating threads hang side by side and close together, as shown below.



One is positively charged; the other is neutral. We can conclude that

- all field lines leaving the positively charged pith ball end on the neutral pith ball.
- some of the field lines leaving the positively charged pith ball end on the neutral pith ball.
- none of the field lines leaving the positively charged pith ball end on the neutral pith ball.
- positive charge is transferred along the field lines until both balls have equal charges.
- positive charge is transferred along the field lines until both balls hang along vertical lines.

ANS: B

PTS: 1

DIF: Easy

41. Two imaginary spherical surfaces of radius R and $2R$ respectively surround a positive point charge Q located at the centre of the concentric spheres. When compared to the number of field lines N_1 going through the sphere of radius R , the number of electric field lines N_2 going through the sphere of radius $2R$ is:

- $N_2 = \frac{1}{4}N_1$.
- $N_2 = \frac{1}{2}N_1$.
- $N_2 = N_1$.
- $N_2 = 2N_1$.
- $N_2 = 4N_1$.

ANS: C

PTS: 1

DIF: Easy

42. Two tiny metal spheres are fixed to the ends of a non-conducting string of length ℓ . Equal charges, $+q$, are placed on the metal spheres. Randall says that the force on the string has magnitude $\frac{1}{2\pi\epsilon_0} \frac{q^2}{\ell^2}$.

Tilden says that the tension in the string has magnitude $\frac{1}{2\pi\epsilon_0} \frac{q^2}{\ell^2}$. Which one, if either, is correct?

- Randall, because both charges exert forces on the string, but the tension is $\frac{1}{4\pi\epsilon_0} \frac{q^2}{\ell^2}$.
- Tilden, because both charges exert forces on the string, but the net force is $\frac{1}{4\pi\epsilon_0} \frac{q^2}{\ell^2}$.
- Both are correct, because both charges exert forces on the string.
- Neither is correct, because both the tension and the force have magnitude $\frac{1}{4\pi\epsilon_0} \frac{q^2}{\ell^2}$.
- Neither is correct, because the tension is $\frac{1}{4\pi\epsilon_0} \frac{q^2}{\ell^2}$, but the net force is 0.

ANS: E

PTS: 1

DIF: Easy

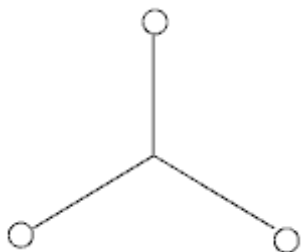
43. Enrico says that positive charge is created when you rub a glass rod with silk, and that negative charge is simply the absence of positive charge. Rosetta says that negative charge is created and that positive charge is the absence of negative charge. (She has heard that Ben Franklin should have reversed the signs he associated with the charges.) Which one, if either, is correct?
- Enrico, because there really is only one kind of charge.
 - Rosetta, because there really is only one kind of charge.
 - Neither: although no charge is present originally, both types of charge are created through friction.
 - Both: only one type of charge is created by friction at any one time.
 - Neither: both negative and positive charge are present simultaneously in all solid materials on Earth and the process described involves a transfer of charge, not the creation of charge.

ANS: E

PTS: 1

DIF: Easy

44. Three $2.50 \mu\text{C}$ charges are placed on tiny conducting spheres at the ends of 1.00 m-long strings that are connected at 120° angles as shown below. The magnitude, in N, of the tension in any one of the strings is:



- 1.88×10^{-2} .
- 3.25×10^{-2} .
- 3.75×10^{-2} .
- 6.50×10^{-2} .
- 7.50×10^{-2} .

ANS: B

PTS: 3

DIF: Challenging

PROBLEM

45. The electron gun in a television tube accelerates electrons (mass = 9.11×10^{-31} kg, charge = 1.60×10^{-19} C) from rest to 3.00×10^7 m/s within a distance of 2.00 cm. What electric field is required?

ANS:

128 000 N/C

PTS: 2

DIF: Average

46. An alpha particle (charge = $+2e$) is sent at high speed toward a gold nucleus (charge $+79e$). What is the electrical force acting on the alpha particle when it is at a distance of 2×10^{-14} m away from the gold nucleus? ($e = 1.6 \times 10^{-19}$ C)

ANS:
91 N

PTS: 2 DIF: Average

47. A proton moving at 3×10^4 m/s is projected at an angle of 30° above a horizontal plane. If an electric field of 400 N/C is directed downwards, how long does it take the proton to return to the horizontal plane? (HINT: Ignore gravity.) [$m_{\text{Proton}} = 1.67 \times 10^{-27}$ kg, $q_{\text{Proton}} = +1.6 \times 10^{-19}$ C.]

ANS:
 7.8×10^{-7} s

PTS: 2 DIF: Average

48. Imagine for a minute that the Moon is held in its orbit about the Earth by electrical forces rather than by gravitation. What electrical charges $-Q$ on the Earth and $+Q$ on the Moon are necessary to hold the Moon in a circular orbit with a period of 27.3 days? The Earth–Moon distance is 384 000 km and the mass of the Moon is 7.35×10^{22} kg.

ANS:
 $Q = 5.73 \times 10^{13}$ C

PTS: 3 DIF: Challenging