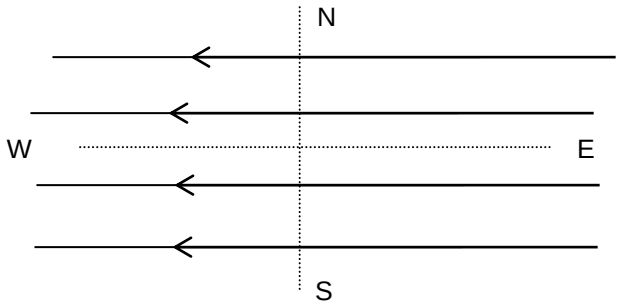
Practice Problems
Vectors, Chapters 21 and 22
Common Exam 1, Physics 121, Fall 2024

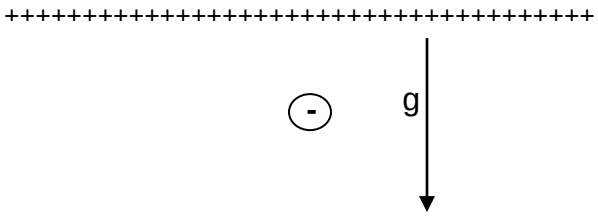
1. A negatively charged particle is placed in a uniform electric field directed West. What are the magnitude and direction of the particle's acceleration if its charge is q= -6 μC, its mass m = 2 grams, and the value of electric field E is 6 $x10^{-6}$ N/C? Select the closest answer:

A) West. a = 1.8 $x10^{-8}$ m/s^2
B) East. a = 1.8 $x10^{-3}$ m/s^2
C) West. a = 1.8 $x10^{+3}$ m/s^2
D) **East. a = 1.8 $x10^{-8}$ m/s^2**
E) East. a = 1.8 $x10^{-5}$ m/s^2

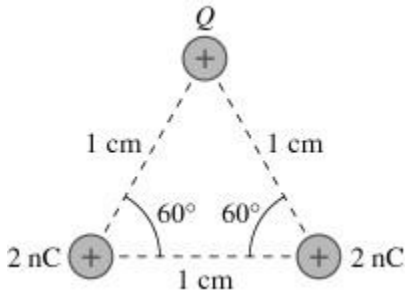


2. An electron with mass m = 9.11 x 10^{-31} kg is released at rest above very large positively charged non-conducting charged sheet lying horizontally as shown. What should the surface charge density σ on this sheet be to keep the electron balanced at rest above the ground?

A) 8.55 x 10^{-1} C/m^2
B) 2.35 x 10^{-6} C/m^2
C) 1.8 x 10^{-18} C/m^2
D) **9.88 x 10^{-22} C/m^2**
E) 1.84 C/m^2



3. In the figure $Q = 5.8$ nC. What is the magnitude and direction of the force on the charge Q? ($k = 1/4\pi\varepsilon_0 = 8.99 \times 10^9\ \mathrm{N \cdot m^2/C^2}$)



A) 1.8×10^{-3} N up
B) 9.0×10^{-4} N, up
C) 9.0×10^{-4} N, up
D) 9.0×10^{-4} N, down
E) 9.0×10^{-4} N, right

4. A large non-conducting disk with radius 5.0 m is negatively charged. The charge is uniformly distributed across the surface of the disk. The electric field, on the axis of the disk, 1 mm away from its surface is 10 N/C. Find the total charge on the disc?

A) 6nC
B) 9nC
C) 14nC
D) 22nC
E) 23nC

5. A very long uniform line of charge has charge per unit length $\lambda_1 = 4.78\ \mu$C/m and lies along the x-axis. A second-long uniform line of charge has charge per unit length $\lambda_2 = -2.46\ \mu$C/m and is parallel to the x-axis at $y_1 = 0.400$ m. What is the magnitude of the net electric field at point $y_2 = 0.200$ m on the y-axis?

A. 6.51×10^5 N/C

6. Determine the angle between $\underline{\mathbf{A}} = 3.00\underline{\mathbf{i}} + 1.00\underline{\mathbf{j}} + 0\underline{\mathbf{k}}$ and the $\underline{\mathbf{B}} = -3.00\underline{\mathbf{i}} + 3.00\underline{\mathbf{j}} + 0\underline{\mathbf{k}}$.

A) 26.6°
B) 30.0°
C) 88.1°
D) 117°
E) 45.2°

7. Vectors $\underline{\mathbf{A}} = 3.00\underline{\mathbf{i}} + 1.00\underline{\mathbf{j}} + 0.00\underline{\mathbf{k}}$ and the $\underline{\mathbf{B}} = -3.00\underline{\mathbf{i}} + 3.00\underline{\mathbf{j}} + 0.00\underline{\mathbf{k}}$. $\underline{\mathbf{C}} = \underline{\mathbf{A}} \times \underline{\mathbf{B}}$. What is the z-components of the vector $\underline{\mathbf{C}}$?

A) $12.00\underline{\mathbf{k}}$
B) $7.00\underline{\mathbf{k}}$
C) $-7\text{-}00\underline{\mathbf{k}}$
D) $1.00\underline{\mathbf{k}}$
E) $-1.00\underline{\mathbf{k}}$

8. The electrostatic force between two negatively charged cubes, 10 cm. on each side, with Q_1= -7 µC and Q_2= -4 µC is:

A) Attractive. The force on cube 1 is twice as large as the force on cube 2.
B) Attractive. The force on cube 1 is equal to the force on cube 2.
C) Zero.
D) Repulsive. The force on cube 1 is twice as large as the force on cube 2.
E) **Repulsive. The force on cube 1 is equal to the force on cube 2**.

9. A particle of charge $Q1 = +40.0\ \mu\ C$ is located on the x-axis at the point $x = 20.0\ cm$, and a second particle of charge $Q2 = -50.0\ \mu C$ is placed on the x-axis at $x = 30.0\ cm$. What is the magnitude of the total electrostatic force on a third particle of charge $Q3 = -4.0\ \mu C$ placed at the origin ($x = 0$)?

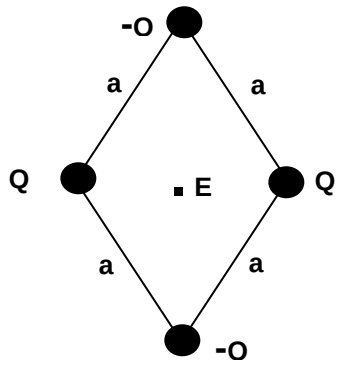
A) 16N i
B) 0N**i**
C) 10N**i** + 5N**j**
D) -16N**i**
E) -16N**j**

10. The force acting on an electron 100 cm from a positive 0.1 µC point charge in a vacuum is:

A) 2.81 x 10^{+10} N. Repulsive
B) 1.0 x 10^{-19} N. Attractive
C) 1.41 x 10^{-12} N. Repulsive
D) **1.44 x 10^{-16} N. Attractive**
E) 1.80 x 10^{-16} N. Attractive

11. The magnitude Q of the charge on four balls is 12 μC distributed uniformly on the surface of each one. Two are positive and two are negative as shown in the sketch. They are placed at the corners of the diamond as shown in the diagram. Each of the sides has length a = 3 cm. What is the magnitude and direction of the electric field at the center of the diamond shape?

A) 24.1×10^{13} N/C. Down
B) 1.6×10^{12} N/C. Up
C) 7.9×10^{19} N/C. Left
D) 1.4×10^{10} N/C. Right
E) **Zero**

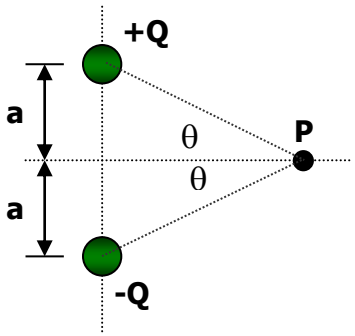


12. A proton is moving with constant acceleration east in a uniform electric field of 1.50 N/C directed to the west. At point *A*, the velocity of the proton is 1.90×10^4 m/s, east. What is the speed of the proton at point B which is a distance of 0.395 m east of point A?

A) 4.25×10^4 m/s
B) 7.32×10^3 m/s
C) 1.59×10^4 m/s
D) 8.35×10^8m/s
E) 1.09×10^3 m/s

13. An electric dipole consists of two equal and opposite charges located on the vertical axis, as shown in the figure. The direction of the electric field at point P is:

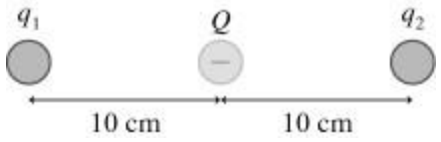
A) ↑
B) ↓
C) →
D) ←



E) The electric field is zero at point P.

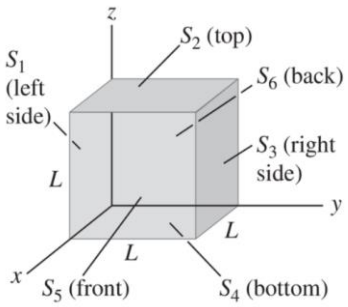
14. In the figure, all the charges are point charges and the charge in the middle is Q = -3.1 nC. For what charge q_1 will charge q_2 be in static equilibrium?

A) 12 nC
B) 6.2 nC
C) 3.1 nC
D) 25 nC
E) 6.0 nC



15. The cube in Fig. E22.6 has sides of length L=10.0 cm. The electric field is uniform, has magnitude $E=4.00\times10^3$ N/C, and is parallel to the xy-plane at an angle of 53.1° measured from the +x-axis toward the +y-axis. (a) What is the electric flux through each of the six cube faces S_1, S_2, S_3, S_4, S_5, and S_6? (b) What is the total electric flux through all faces of the cube?

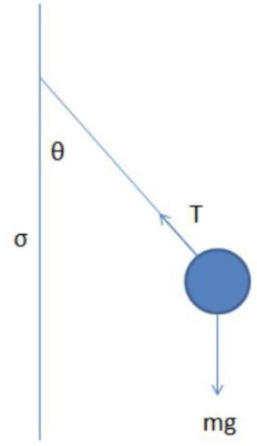
Figure E22.6



Ans.
a) S1: $-32\ \mathrm{N\cdot m^2/C}$
S2: 0
S3: $+\ 32\ \mathrm{N\cdot m^2/C}$
S4: 0
S5: $+\ 24\ \mathrm{N\cdot m^2/C}$.
S6: $-\ 24\ \mathrm{N\cdot m^2/C}$.

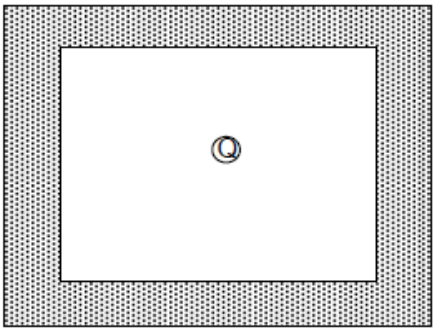
b) total flux will be zero

16. A small sphere with mass m carries a positive charge q and is attached to one end of a silk fiber of length L. The other end of the fiber is attached to a large vertical insulating sheet that has a positive surface charge density σ. Show that when the sphere is in equilibrium, the fiber makes an angle equal to arctan (qσ/2mgϵ0) with the vertical sheet.



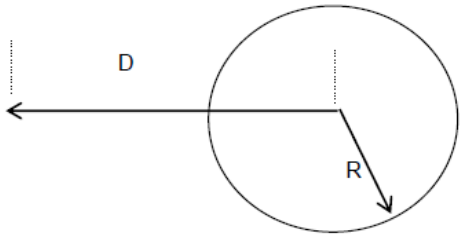
17. A negative charge Q = - 2 μC is placed inside a neutral cubical conducting box with a cavity in it. The length of the side of the inner cavity is a and the outer box's side length is b. What charges will be induced at the inner and outer surfaces of the box?

A) Inner charge = –2 μC. Outer charge = +2 μC
B**) Inner charge = +2 μC. Outer charge = -2 μC**
C) Inner charge = 0 μC. Outer charge = -2 μC
D) Inner charge = +2 μC. Outer charge = 0 μC
E) Inner charge = 0 μC. Outer charge = 0 μC



19. A solid, conducting sphere has a net positive charge of Q = 4.5 C on it. It's radius R is 3.0 m. What is the magitude of the electric field at a distance D of 9.0 m. from the center of the sphere.

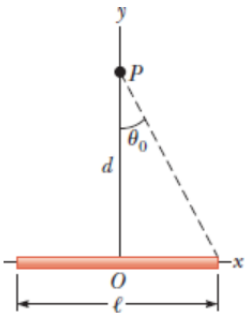
A) 9 x 10^9 N/C
B) 0.0 N/C
C) 1.0 x 10^9 N/C
D) **5 x 10^8 N/C**
E) 1.0 x 10^8 N/C



20. For same solid, charged conducting sphere of the problem above, find the magnitude of the electric field at a distance D = 0.5 m. from the center of the sphere.

A) 9.0 x 109 N/C
B) 0.0 N/C
C) 1.0 x 109 N/C
D) 0.5 x 109 N/C
E) 2.25 x 109 N/C

21.A thin rod of length *l* and uniform charge per unit length λ lies along the *x* axis as shown in Figure. Show that the electric field at *P*, a distance *y* from the rod along its perpendicular bisector, has no *x* component and is given by $\boldsymbol{E = 2k_e\lambda \sin \theta_0/d}$.



22. A flat sheet is in the shape of a rectangle with sides of lengths 0.400 m and 0.600 m. The sheet is immersed in a uniform electric field of magnitude 60.0 N/C that is directed at 20° from the plane of the sheet as it is shown in the figure. Find the magnitude of the electric flux through the sheet.

A) 9.2 N·m^2/C
B) 5.3 N·m^2/C
C) 2.3 N·m^2/C
D) 2.8 N·m^2/C
E) 4.9 N·m^2/C