Useful Constants

$k_e = 1/4\pi\varepsilon_o = 9 \times 10^9$ N.m²/C²; $\varepsilon_o = 8.85\times10^{-12}$ C²/N.m²; $e = 1.6\times10^{-19}$ C; $m_{electron} = 9.11 \times 10^{-31}$ kg; $m_{proton} = 1.67 \times 10^{-27}$ kg; $g = 9.8$ m/s²

If the force between two charges has magnitude 3.36 N when the charges are separated by 8.0 mm, the magnitude of the force (in N) between these two charges when separated by 16 mm is

- a. 5.97
- b. 2.15
- c. 0.84
- d. 13.44
- e. 1.49

Clear my choice

Q1:

$$F_1 = K \frac{q_1 q_2}{(8 * 10^{-3})^2} = 3.36 \text{ N} \rightarrow (1)$$

$$F_2 = K \frac{q_1 q_2}{(16 * 10^{-3})^2} \rightarrow (2) \qquad K = \frac{1}{4\pi\epsilon_0}$$

eqn $2 \div 1$:

$$\frac{F_2}{3.36} = \frac{(8 * 10^{-3})^2}{(16 * 10^{-3})^2}$$

$$\frac{F_2}{3.36} = \frac{1}{4} \qquad \boxed{F_2 = 0.84 \text{ N}}$$

$\therefore$ the answer is $\boxed{C}$

$9.8\ m/s^2$

If $a = 60$ cm, $b = 80$ cm, $Q = -2.0$ nC, and $q = 1.5$ nC, what is the magnitude of the electric field (in N/C) at point P?

- a. 47
- b. 56
- c. 68
- d. 80
- e. 92

Clear my choice

Q2: $E_1 = K \frac{q_1}{r_1^2} = \frac{9 \times 10^9 \times 2 \times 10^{-9}}{(0.8)^2} = 28.13 \ N/C$

$E_2 = K \frac{q_2}{r_2^2} = \frac{9 \times 10^9 \times 1.5 \times 10^{-9}}{(0.6)^2} = 37.5 \ N/C$

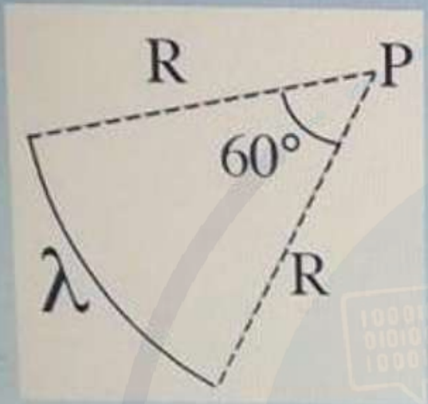
$|E| = \sqrt{E_1^2 + E_2^2}$

$= \sqrt{(28.13)^2 + (37.5)^2} = 46.88 \ N/C$

∴ the answer is $\boxed{a}$

9.8 m/s²

A charge of uniform density λ= 2 nC/m is distributed along the circular arc shown in the figure. Taking the electric potential to be zero at infinity, the electric potential (in V) at point *P* is



- a. 11.2
- b. 18.9
- c. 28.3
- d. 37.7

Q3: $\theta = \frac{60 * 2\pi}{360} = \frac{\pi}{3}$ rad

$\lambda = 2 * 10^{-9}$ C

$V = k\lambda\theta = 9 * 10^{9} * 2 * 10^{-9} * \frac{\pi}{3}$

$= 18.85$ V   the answer is **b**

$e = 1.6 \times 10^{-19}$ C; $m_{electron} = 9.11 \times 10^{-31}$ kg; $m_{proton} = 1.67 \times 10^{-27}$ kg;
$g = 9.8$ m/s^2

A proton accelerates from rest in a uniform electric field of 500 N/C. At one later moment, its speed is 1.30×10^6 m/s. Over what time interval (in μs) does the proton reach this speed?

- (•) a. 27
- ( ) b. 48
- ( ) c. 69
- ( ) d. 90
- ( ) e. 13

Clear my choice

$proton = 1.6 * 10^{-19}$

$E = 500\ N/C$

$V_1 = 0\ m/s$

$V_2 = 1.3 * 10^{6}\ m/s$

$t = ??$

1) $F = q.E = am$

$$= \frac{1.6 * 10^{-19} * 500}{1.67 * 10^{-27}} = \frac{1.67 * 10^{-27} * a}{1.67 * 10^{-27}}$$

$a = 4.79 * 10^{10}$

2) $V_2 = V_1 + at$

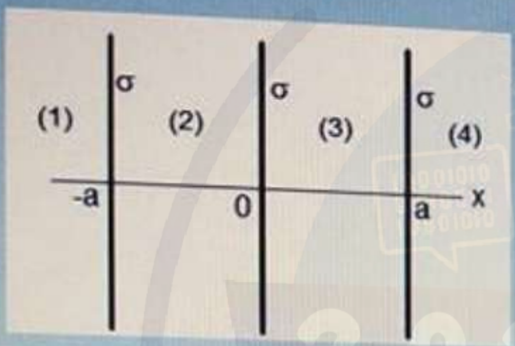
$1.3 * 10^{6} = 0 + 4.79 * 10^{10} * t$

$\boxed{t = 27}$ the answer is $\boxed{a}$

Useful Constants

$k_e = 1/4\pi\varepsilon_o = 9 \times 10^9$ N.m^2/C^2; $\varepsilon_o = 8.85\times10^{-12}$ C^2/N.m^2; $e = 1.6\times10^{-19}$ C; $m_{electron} = 9.11 \times 10^{-31}$ kg; $m_{proton} = 1.67 \times 10^{-27}$ kg; $g = 9.8$ m/s^2

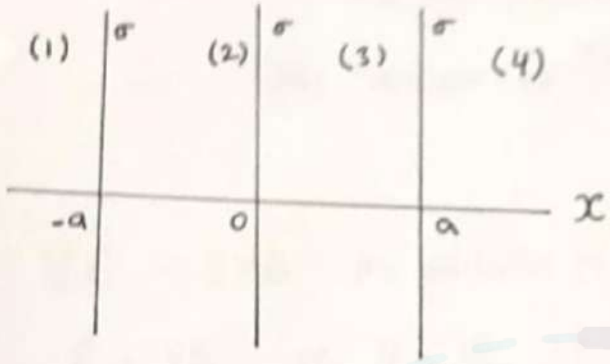
Three infinite, nonconducting parallel sheets carry equal uniform charge densities σ as shown in the figure. The electric field in region (3) is



- a. $(3\sigma/2\varepsilon_o)$ in the negative x-direction
- b. $(\sigma/2\varepsilon_o)$ in the negative x-direction
- c. Zero (selected)
- d. $(\sigma/2\varepsilon_o)$ in the positive x-direction
- e. $(3\sigma/2\varepsilon_o)$ in the positive x-direction

Clear my choice

Q5:



→ $\vec{E}$ due to infinite non conducting parallel sheets is given by:

$$E = \frac{\sigma}{2\epsilon_0}$$

→ $\vec{E}$ due to the sheet (a) at $x = -a$ is given by:

$$E_A = \frac{\sigma}{2\epsilon_0}$$ in positive x-direction

→ the same for the sheet B at $x = 0$:

$$E_B = \frac{\sigma}{2\epsilon_0}$$ in positive x-direction

→ for the sheet C at $x = a$:

$$E_C = -\frac{\sigma}{2\epsilon_0}$$ in negative x-direction

* The electric field in region (3) is:

$$E = E_A + E_B + E_C$$

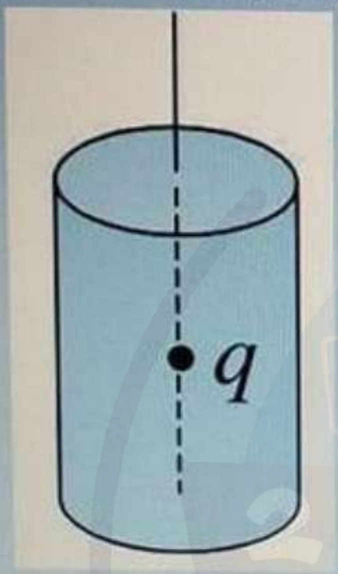
$$= \frac{\sigma}{2\epsilon_0} + \frac{\sigma}{2\epsilon_0} - \frac{\sigma}{2\epsilon_0} = \frac{\sigma}{2\epsilon_0}$$

$$E = \frac{\sigma}{2\epsilon_0}$$ in the positive x-direction

the answer is **d**

$k_e = 1/4\pi\varepsilon_o = 9 \times 10^9$ N.m^2/C^2; $\varepsilon_o = 8.85\times10^{-12}$ C^2/N.m^2; $e = 1.6\times10^{-19}$ C; $m_{electron} = 9.11 \times 10^{-31}$ kg; $m_{proton} = 1.67 \times 10^{-27}$ kg; $g = 9.8$ m/s^2

If a point charge is located at the center of a cylinder and the electric flux leaving one end of the cylinder is 15% of the total flux leaving the cylinder, the portion of the flux that leaves the curved surface of the cylinder is



- a. 80%
- b. 70%
- c. 85%

total flux = $\frac{q}{\varepsilon_0} = \phi$

~~Φ_1 = ...~~ $\Phi_1 = 15\%$ of ϕ fluxpassing through flatsurface 1

$\Phi_2 = 15\%$ of Φ " " " " 2

Φ_3 = Remaning fluxpassing through curved surface 3

$= (100 - 30)\%$ of Φ

$\Phi_3 = 70\%$ of Φ

(B)

A parallel plate capacitor stores a charge of 50 mC when a potential difference of 100 V exists between its plates. The charge (in mC) stored in a spherical capacitor with twice the capacitance of the parallel-plate capacitor when a potential difference of 200 V is applied to it is:

Select one:

- 150
- 200
- 25
- 100
- 50

Q7: $q = CV$

So: $C = \frac{q}{V} = \frac{50 * 10^{-3}}{100} = \frac{10^{-3}}{2}$ F

for spherical capasitor :

$q = 2CV$

$= 2 * \frac{10^{-3}}{2} * 200$

$= 200$ ms   the answer is [b]

proton moves in a circle due to the force of a uniform magnetic field of 0.835 T. If the magnitude of the linear momentum of the proton is 1.336×10^{-19} kg.m.s^{-1}, then the radius (in m) of the circle is:

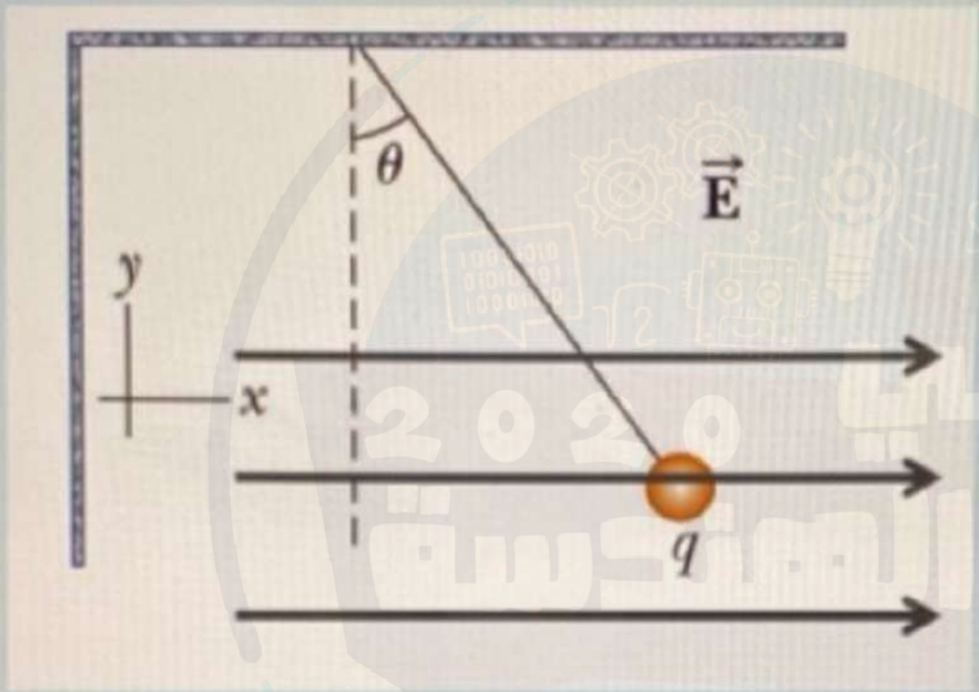
Select one:

- 1.198
- 0.697
- 1.0
- 1.785
- 0.835

Q8: $r = \frac{mv}{qB} = \frac{1.336 \times 10^{-19}}{1.6 \times 10^{-19} \times 0.835}$

$r = 1.0$ the answer is C

As shown in the figure, a small ball with charge *q and* a mass 3.80 grams is attached to a horizontal ceiling by a wire of length 130.0cm. When an electric field, E, of magnitude 3085 N/C is applied, the ball swings away from the vertical axis with an angle θ= 42°, therefore, *q* (in μC) is:



Select one:

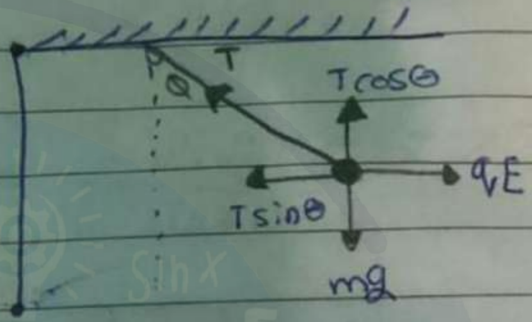
- 3.01
- 8.97
- 10.87
- 6.66
- 8.08

$m = 3.80\ g = 3.8 \times 10^{-3}\ kg$

$L = 130\ cm$

$E = 3085\ N/C$

$\theta = 42$



$T\cos\theta = mg \quad -(1)$

$T\sin(\theta) = qE \quad -(2)$

$2/1 \rightarrow \frac{T\sin\theta}{T\cos\theta} = \frac{qE}{mg} \Rightarrow \tan\theta = \frac{qE}{mg}$

$q = \frac{mg \cdot \tan\theta}{E}$

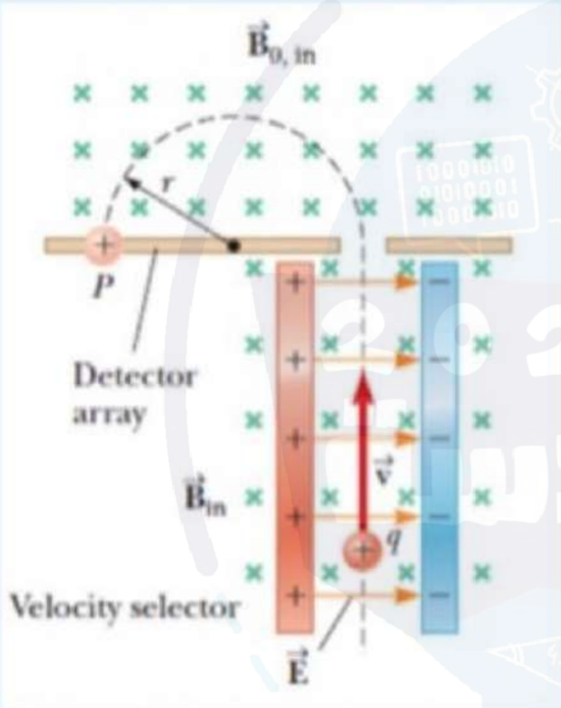
$= \frac{3.8 \times 10^{-3} \times 9.8 \times \tan(42)}{3085} = 10.8690 \times 10^{-6}\ C$

$= 10.8690\ MC$

$\approx 10.87\ MC$

the answer is C

In the mass spectrometer shown, a positive charge q of mass m is sent first through a velocity selector with a velocity **v** in the presence of a magnetic field **B** and an electric field **E**. Upon entering the second magnetic field $\mathbf{B_0}$, the charge q moves in a semicircle of radius r before striking a detector array at P, as shown. The radius r can be expressed as:



Select one:

- mBB_0/vE
- mE/qBB_0
- E/mBB_0

Q10: $qE = qvB$ as particle is going straight

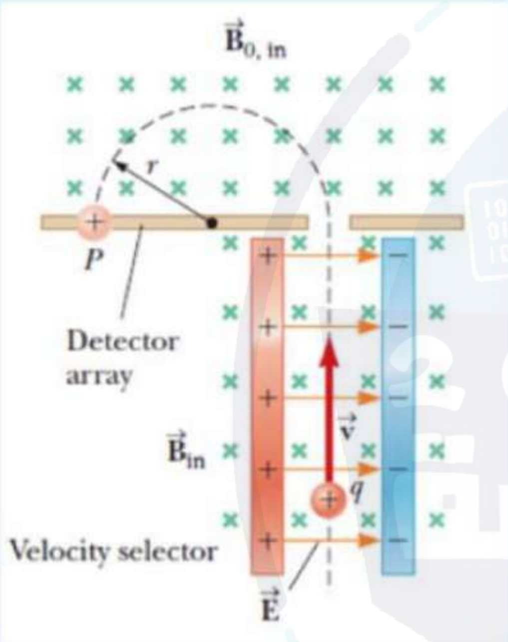
$E = vB \Rightarrow v = \frac{E}{B} = \frac{E}{B_{in}}$

After that it is going in a circular motion

$r = \frac{mv}{qB_0}$ and $v = \frac{E}{B_{in}}$

$r = \frac{mE}{qBB_0}$ the answer is $\boxed{B}$

In the mass spectrometer shown, a positive charge q of mass m is sent first through a velocity selector with a velocity **v** in the presence of a magnetic field **B** and an electric field **E**. Upon entering the second magnetic field $\mathbf{B_0}$, the charge q moves in a semicircle of radius r before striking a detector array at P, as shown. The strength of the second field B_0 can be expressed as:



Select one:

- mv/EB
- vE/mrB
- mE/qrB
- rmB/vE
- qE/vB

Q11: $F_{magnatic} = F_{electric}$

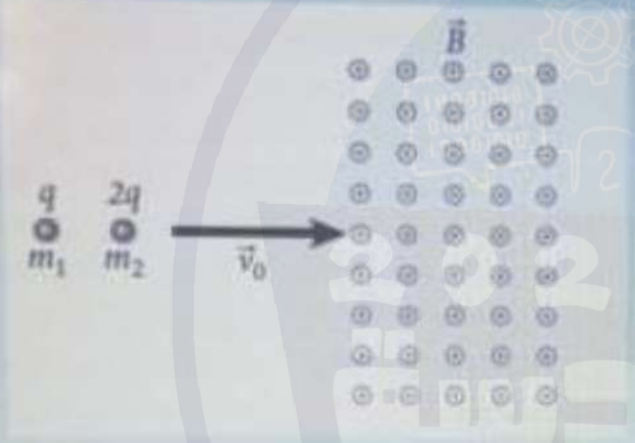
$Eq = Bvq \Rightarrow v = \frac{E}{B}$

$F_{magnatic} = F_{cunsipetal}$

$B_0 vq = \frac{mv^2}{r} \Rightarrow B_0 q = \frac{m}{r} v$

$B_0 = \frac{m}{qr}\left(\frac{E}{B}\right) = \frac{mE}{qrB}$ the answer is [C]

The two particles shown in the figure enter the magnetic field at the same point, with the same velocity. Accordingly, in the magnetic field, they move in circles with radii $r_1 = r$ and $r_2 = 2r$. The ratio of their masses, $[m_1/m_2]$, is:



Select one:

- 4
- 1
- 2
- 1/2
- 1/4

$$r_1 = \frac{mv}{qB}$$

$$r_1 \rightarrow \frac{m_1 \times v}{qB} \qquad r_2 = \frac{m_2 \times v}{2q \times B}$$

$$\frac{r_1}{r_2} \rightarrow \frac{\frac{m_1 v}{qB}}{\frac{m_2 v}{2qB}} \qquad \frac{r_1}{r_2} \rightarrow \frac{r}{2r} \rightarrow \frac{2m_1}{m_2}$$

$$\frac{m_1}{m_2} = \frac{1}{4}$$

D

Two identical conducting spheres (#1 and #2) carry charges Q and 3Q respectively. They are separated by a distance r much larger than their diameters. Another identical conducting sphere (#3) is uncharged. Sphere #3 is first touched to #1, then to #2, and finally removed. As a result, the Coulomb force between #1 and #2, which was originally F, becomes:

Select one:

- 9F
- 7F/8
- 3F/14
- 7F/24
- 6F/15

q_1 = charge on sphere 1 = Q

q_2 = charge on sphere 2 = 3Q

q_3 = charge on sphere 3 = 0

$$F = \frac{kQ \times 3Q}{r^2}$$

* when 3 touches 1, then new charge on 1 is Q/2 and 3 is also Q2. → Now 3 touches 2 → the new charge on 2 is

$$\frac{3Q + \frac{Q}{2}}{2} = \frac{7Q}{4}$$

Final charge on 1 is Q/2, on 2 is 7Q/4

$$F' = \frac{k \times \frac{Q}{2} \times \frac{7Q}{4}}{r^2} = \frac{k \times \frac{Q}{2} \times \frac{7Q}{4}}{r^2} \times \frac{3}{3} = \boxed{\frac{7F}{24}}$$

D

An infinite conducting cylinder has a radius of 12.0 mm. If the magnitude of the electric field 16.0 mm from the axis of the cylinder is 55 N/C, what is the charge density distributed over the surface of the cylinder (in nC/m^2)?

$K = 9 \times 10^{+9}\ N.m^2.C^{-2}$, $\varepsilon_0 = 8.85 \times 10^{-12}\ C^2.N^{-1}.m^{-2}$

Select one:

- (•) 4.87
- ( ) 0.89
- ( ) 0.70
- ( ) 0.65
- ( ) 0.07

Clear my choice

$R = 12\,mm$, $r = 16$ $E = 55\ N/C$ $\lambda = ?$

$$E = \frac{2k\lambda}{r}$$

$$55 = \frac{2 \times 9 \times 10^{9} \times \lambda}{16 \times 10^{-3}}$$

$\lambda = 4.889 \times 10^{-11}\ C/M$ **[A]**

A thin wire of length L has a uniform charge density λ. The wire is bent into a semicircle with its center at the origin. The magnitude of the electric field at the center of the semicircle is $1.5 \times 10^{+4}$ (in N/C). If $\lambda = 5.6 \times 10^{-8}$ C/m, what is the value of L (in cm)?

$K = 9 \times 10^{+9}\ N.m^2.C^{-2}$, $\varepsilon_0 = 8.85 \times 10^{-12}\ C^2.N^{-1}.m^{-2}$

Select one:

- 21.1
- 0.8
- 18.1
- 4.4
- 7.0

$\pi r = L$ or $r = L/\pi$

$$E = \frac{2k\lambda}{r} = \frac{2k\lambda}{L/\pi}$$

$$L = \frac{2\pi k\lambda}{E} = \frac{2\pi \times 9 \times 10^{9} \times 5.6 \times 10^{-8}}{1.5 \times 10^{4}} = 0.211\ m = 21.1\ cm$$

A

A total charge of 10.0 nC is distributed uniformly through an insulating sphere with a radius of 14.00 mm. The total electric flux (in $N.m^2/C$) through a concentric sphere with a radius of 7.00 mm is:

$K = 9 \times 10^{+9}\ N.m^2.C^{-2}$, $\varepsilon_0 = 8.85 \times 10^{-12}\ C^2.N^{-1}.m^{-2}$

Select one:

- 664.6
- 2101.4
- 748.4
- 141.2
- 34.7

The volume charge density $\rho = \frac{Q}{V}$ $\quad Q = 10\,nC = 10\times10^{-9}\,C$

$R = 14\,mm = 14\times10^{-3}\,m$

$$\rho = \frac{Q}{4/3\pi R^3} \qquad \rho = \frac{30\times10^{-9}}{(4\pi)(2744\times10^{-9})}\ \frac{C}{m^3}$$

$$\rho = 8.70016\times10^{-4}\ C/m^3$$

* according to gauss's law

$$\Phi = \frac{q}{\varepsilon_0} \qquad \varepsilon_0 = 8.85\times10^{-12}$$

$$q = (\rho)\left(\frac{4}{3}\pi r^3\right)$$

$$8.70016\times10^{-4}\left(\frac{C}{m^3}\right)\times\frac{4}{3}\pi\times(7\times10^{-3}\,m)^3$$

$$q = 1.25\times10^{-9}\,C$$

now $\Phi = \frac{q}{\varepsilon_0} = \frac{1.25\times10^{-9}\,C}{8.85\times10^{-12}\,C^2/Nm^2}$

$$\boxed{\Phi = 141.243\ \frac{Nm^2}{C}} \quad \boxed{D}$$

A total charge of 25.0 nC is distributed uniformly through an insulating sphere with a radius of 18.00 mm. The total electric flux (in N m^2/C) through a concentric sphere with a radius of 9.00 mm is:

$K = 9 \times 10^{+9}$ N.m^2.C^{-2}, $\varepsilon_0 = 8.85 \times 10^{-12}$ C^2.N^{-1}.m^{-2}

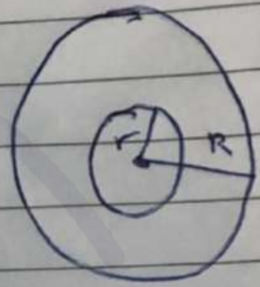
Select one:

- 7840.7
- 2040.8
- 12.2
- 4.2
- 353.1

$Q = 25\ nC = 25 \times 10^{-9}\ C$

$R = 18\ mm$

$\rho = \frac{q}{\text{volume}} = \frac{Q}{\frac{4}{3}\pi R^3}$



$r = 9\ mm$

$q = \rho\left(\frac{4}{3}\pi r^3\right)$ volume of sphere $= \frac{4}{3}\pi r^3$

$$q = \frac{Q}{\frac{4}{3}\pi R^3} \times \frac{4}{3}\pi r^3 = \frac{Q r^3}{R^3} = \frac{25 \times 10^{-9} \times (9)^3}{(18)^3}$$

$q = 3.125 \times 10^{-9}\ (C)$

now $\Phi = \frac{q}{\varepsilon_0} = \frac{3.125 \times 10^{-9}}{8.85 \times 10^{-12}} = \boxed{353.11\ Nm^2/C}$

E

The point charge q_1 (+4 μC) is located at x_1= -5.7m, and the point charge q_2 (+9 μC) is located at x_2 = +14.1m, as shown in the figure. The net electric force on a point charge q_3 (+5 μC) is zero at the x-coordinate (in m):

$K = 9 \times 10^{+9}\ N.m^2.C^{-2}$, $\varepsilon_0 = 8.85 \times 10^{-12}\ C^2.N^{-1}.m^{-2}$

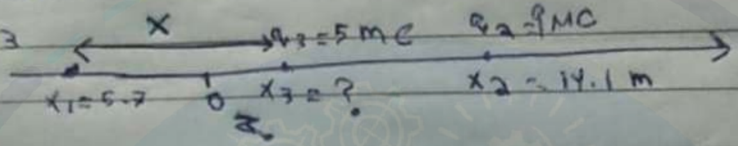
Select one:

- +11.0
- -3.1
- +2.2
- -1.2
- +15.7

Force on q_3 due to q_1 and q_2

$\vec{F}_3 = \vec{F}_{13} + \vec{F}_{23}$

$\vec{F}_{13} = \frac{q_1 q_3}{4\pi \varepsilon_0 x^2}$



d between q_1 and q_2 = 19.8 m

d between q_1 and q_3 = x

" " q_2 " q_3 = d − x

$F_{13} = \frac{(4\times10^{-6}C)(5\times10^{-6}C)}{4\pi\varepsilon_0 x^2} = \frac{0.18}{x^2}$ (along + x-axis)

$F_{32} = \frac{q_2 q_3}{4\pi\varepsilon_0 (d-x)^2} = \frac{0.405}{(d-x)^2}$ along −x axis)

net force = 0 $\quad F_{13} = F_{23}$

$\frac{0.18}{x^2} = \frac{0.405}{(d-x)^2} \Rightarrow 0.18(d^2 + x^2 - 2dx) = 0.405x^2$

$\Rightarrow 0.225x^2 + 7.128x - 70.57 = 0 \quad x = 7.92\text{ m or } -39.6\text{ m}$ (impossible)

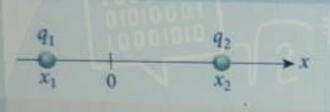
$q_3 = 7.92\text{ m} - 5.7\text{ m} = \boxed{+2.2\text{ m}}$ (C)

A conducting sphere of radius R carries a net positive charge Q, uniformly distributed over the surface of the sphere. Assuming that the electric potential is zero at an infinite distance, what is the electric potential at a distance r = R/8 from the center of the sphere?

Select one:

- 8kQ/R
- kQ/8R
- kQ/R
- zero
- 64kQ/R

The point charge q_1 (+5 μC) is located at x_1= -3.6m, and the point charge q_2 (+7 μC) is located at x_2, as shown in the figure. The net electric force on a point charge q_3 (-1 μC) is zero at the x-coordinate +4.6m. The value of x_2 (in m) is:



$K = 9 \times 10^{+9}\ N.m^2.C^{-2}$, $\varepsilon_0 = 8.85 \times 10^{-12}\ C^2.N^{-1}.m^{-2}$

Select one:

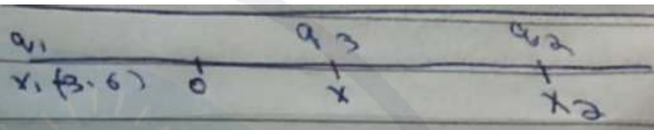
- + 11.0
- +8.2
- +14.3
- +0.7
- +3.6

$q_1 = 5\,\mu C = 5\times10^{-6}$

$q_2 = 7\,\mu C = 7\times10^{-6}$

$q_3 = -\,\mu C = 1\times10^{-6}\,C$

$x_1 = -3.6 \quad x_2 = 4.6 \qquad X_2 = ?$



$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{x^2}$ F net in q_3 is zero

$F_{13} = F_{32}$

$$\frac{1}{4\pi\varepsilon_0}\frac{q_1 q_3}{(x_1+x)^2} = \frac{1}{4\pi\varepsilon_0}\frac{q_2 q_3}{(x_2-x)^2}$$

$$\frac{5\times10^{-6}}{(-3.6+4.6)^2} = \frac{7\times10^{-6}}{(x_2-4.6)^2} = 94.136$$

$(x_2 - 4.6)^2 = 9.7$

$x_2 = 9.7 + 4.6$

$x_2 = 14.3$ (C)

A thin wire of length L has a uniform charge density λ. The wire is bent into a semicircle with its center at the origin. The magnitude of the electric field at the center of the semicircle is $2 \times 10^{+4}$ (in N/C). If $\lambda = 6.1 \times 10^{-8}$ C/m, what is the value of L (in cm)?

$K = 9 \times 10^{+9}\ N.m^2.C^{-2}$, $\varepsilon_0 = 8.85 \times 10^{-12}\ C^2.N^{-1}.m^{-2}$

Select one:

- ○ 9.0
- ◉ 17.2
- ○ 3.4
- ○ 5.4
- ○ 14.2

$E = 2\times10^{4}\ N/C$

$f = 6.1\times10^{-6}\ C/m$

$E = \dfrac{2kf}{R}$ $\quad R = \dfrac{2kf}{E} = \dfrac{2\times9\times10^{9}\times6.1\times10^{-6}}{2\times10^{4}}$

$R = 5.49\ m$

the length of wire $L = \pi R = \pi \times 5.49$

$\boxed{L = 17.25\ m}$ $\boxed{B}$

The potential along the *y*-axis is given by $V(y) = -8y+3y^2$ in units of V. At what value(s) of *y* (in m) is (are) the electric field equal to zero?

Select one:

- +4/3
- 0 or +4
- 0 or +8/3
- +8/3
- 0

$$V(y) = -8y + 3y^2$$

$$E = \frac{-dV}{dy} = \frac{-d}{dy}\left(-8y + 3y^2\right)$$

$$\rightarrow E = -(-8 + 6y)$$

$$E = 0 \qquad -(-8 + 6y) = 0$$

$$6y = 8 \qquad \boxed{y = +\frac{4}{3}}$$

A

A thin wire of length L has a uniform charge density λ. The wire is bent into a semicircle with its center at the origin. The magnitude of the electric field at the center of the semicircle is $3 \times 10^{+4}$ (in N/C). If L = 10.55 cm, what is the value of λ (in C/m)?

$K = 9 \times 10^{+9}\ N.m^2.C^{-2}$, $\varepsilon_0 = 8.85 \times 10^{-12}\ C^2.N^{-1}.m^{-2}$

Select one:

- 7.4×10^{-6}
- 4.4×10^{-7}
- 8.2×10^{-7}
- 5.6×10^{-8}
- 8.2×10^{-8}

An infinite conducting cylinder has a radius of 7.0 cm. If the magnitude of the electric field 11.0 cm from the axis of the cylinder is 23 N/C, what is the charge density distributed over the surface of the cylinder (in nC/m^2)?

$K = 9 \times 10^{+9}$ N.m^2.C^{-2} , $\varepsilon_0 = 8.85 \times 10^{-12}$ C^2.N^{-1}.m^{-2}

Select one:

- 0.06
- 0.47
- 0.89
- 6.04
- 0.32

A proton ($m = 1.67 \times 10^{-27}$ kg) is placed a distance y above a long, horizontal wire of linear charge density λ. The proton is then released from rest. Determine the magnitude of the initial acceleration of the proton (in m/s^2). Take $\lambda = 2.8 \times 10^{-12}$ C/m and y = 70cm.

$K = 9 \times 10^{+9}\ N.m^2.C^{-2}$, $\varepsilon_0 = 8.85 \times 10^{-12}\ C^2.N^{-1}.m^{-2}$

Select one:

- $1.9 \times 10^{+7}$
- $6.9 \times 10^{+6}$
- $8.8 \times 10^{+6}$
- $4.4 \times 10^{+7}$
- $7.4 \times 10^{+6}$

Particle A (of mass m and charge q) and particle B (of mass 4m and charge 2q) are each accelerated from rest through the same potential difference of 4000 V. Which one of the following statements regarding their resulting speeds is TRUE:

Select one:

- Particle A has twice the speed of particle B.
- The speed of particle A is $\sqrt{2}$ times the speed of particle B.
- Particle A has the same speed as particle B.
- Particle A has half the speed of particle B.
- The speed of particle B is $\sqrt{2}$ times the speed of particle A.

For A : Electrostatic potential Energy = EPE = qV

Kinetic Energy (K.E) = $\frac{1}{2} m V_a^2$

EPE = K.E

$qV = \frac{1}{2} m V_a^2$ V ≡ potential

$V_a = \sqrt{\frac{2qV}{m}}$

For B: EPE = 2qV

$K.E = \frac{1}{2}(4m)V_B^2$

EPE = K.E

$2qV = \frac{1}{2} * 4 m V_B^2$

$V_B = \sqrt{\frac{qV}{m}}$

$\therefore V_a = \sqrt{2}\, V_B$

the answer is [D]

Useful Constants

$k_e = 1/4\pi\varepsilon_o = 9 \times 10^9$ N.m^2/C^2; $\varepsilon_o = 8.85 \times 10^{-12}$ C^2/N.m^2;

e = 1.6×10^{-19} C; $m_{electron} = 9.11 \times 10^{-31}$ kg; $m_{proton} = 1.67 \times 10^{-27}$ kg;

g = 9.8 m/s^2

The magnitude of the acceleration (in m/s^2) of a proton in a uniform electric field of magnitude 3×10^4 N/C is

- a. 1.9×10^{12}
- b. 3.5×10^{12}
- c. 2.9×10^{12}
- d. 4.8×10^{12}
- e. 6.7×10^{12}

Next page

of

Useful Constants

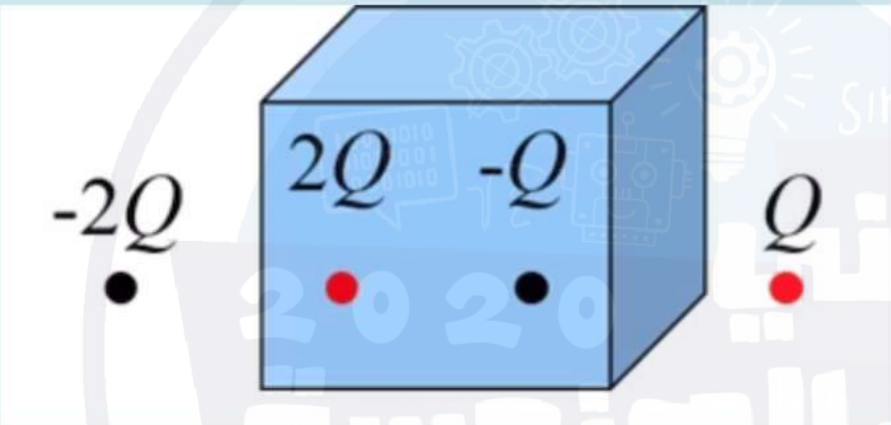
$k_e = 1/4\pi\varepsilon_o = 9 \times 10^9$ N.m^2/C^2; $\varepsilon_o = 8.85\times10^{-12}$ C^2/N.m^2; e = 1.6x10^{-19} C; $m_{electron} = 9.11 \times 10^{-31}$ kg; $m_{proton} = 1.67 \times 10^{-27}$ kg; g = 9.8 m/s^2

The magnitude of the electric potential (in V) at a point that is 3.0 m away from a 1.5 nC point charge is

- a. 3.0
- b. 4.5
- c. 5.2
- d. 6.0
- e. 9.6

Next page

The figure shows a closed cubical surface with the charges $2Q$ and $-Q$ inside the cube and the charges $-2Q$ and Q outside the cube. If $Q = 4$ nC the net electric flux (in $N.m^2/C$) through the surface of the cube is



- a. 282
- b. 0
- c. 452
- d. 734
- e. 565

Next page

Useful Constants

$k_e = 1/4\pi\varepsilon_o = 9 \times 10^9$ N.m^2/C^2; $\varepsilon_o = 8.85\times10^{-12}$ C^2/N.m^2; e = 1.6×10^{-19} C; $m_{electron} = 9.11 \times 10^{-31}$ kg; $m_{proton} = 1.67 \times 10^{-27}$ kg; g = 9.8 m/s^2

The surface charge density on the surface of a conducting sphere is 4 nC/m^2. The magnitude of the electric field at the surface of the sphere (in N/C) is:

- a. 226
- b. 452
- c. 678
- d. 930
- e. 1130

Next page

Useful Constants

$k_e = 1/4\pi\varepsilon_o = 9 \times 10^9$ N.m^2/C^2; $\varepsilon_o = 8.85\times10^{-12}$ C^2/N.m^2; e = 1.6×10^{-19} C; $m_{electron} = 9.11 \times 10^{-31}$ kg; $m_{proton} = 1.67 \times 10^{-27}$ kg; g = 9.8 m/s^2

Over a certain region of space, the electric potential is $V = 5x - 3x^2y + 2yz^2$ volts. The magnitude of the electric field (in N/C) at the point P that has coordinates (1, 0, 1) m is

- a. 5.1
- b. 5.6
- c. 10.7
- d. 15.8
- e. 18.6

Useful Constants

$k_e = 1/4\pi\varepsilon_o = 9 \times 10^9$ N.m^2/C^2; $\varepsilon_o = 8.85\text{x}10^{-12}$ C^2/N.m^2; e = 1.6x10^{-19} C; $m_{electron} = 9.11 \times 10^{-31}$ kg; $m_{proton} = 1.67 \times 10^{-27}$ kg; g = 9.8 m/s^2

A charged nonconducting ball with a mass of 0.0300 kg and a total charge of +50.0 μC is hung from a ceiling by a light nonconducting string of length 15.0 cm. The ball is subjected to a uniform, downward electric field of magnitude 2000 N/C. The tension (in N) in the string is:

- a. 0.394
- b. 0.194
- c. 0
- d. 0.294
- e. 0.100

Useful Constants

$k_e = 1/4\pi\varepsilon_o = 9 \times 10^9$ N.m^2/C^2; $\varepsilon_o = 8.85\text{x}10^{-12}$ C^2/N.m^2; e = $1.6\text{x}10^{-19}$ C; $m_{electron} = 9.11 \times 10^{-31}$ kg; $m_{proton} = 1.67 \times 10^{-27}$ kg; g = 9.8 m/s^2

There is a 1.5×10^{-3} N electric force in the negative y-direction on a -3.00 nC point charge at the point with coordinates (-1.00 m, 0.00 m, 0.00 m). The electric field (in N/C) at this point is given by:

- a. 5.0×10^5 in the positive y-direction
- b. 5.0×10^5 in the negative y-direction
- c. 5.0×10^5 in the positive x-direction
- d. 5.0×10^5 in the negative x-direction
- e. 1.5×10^5 in the positive y-direction

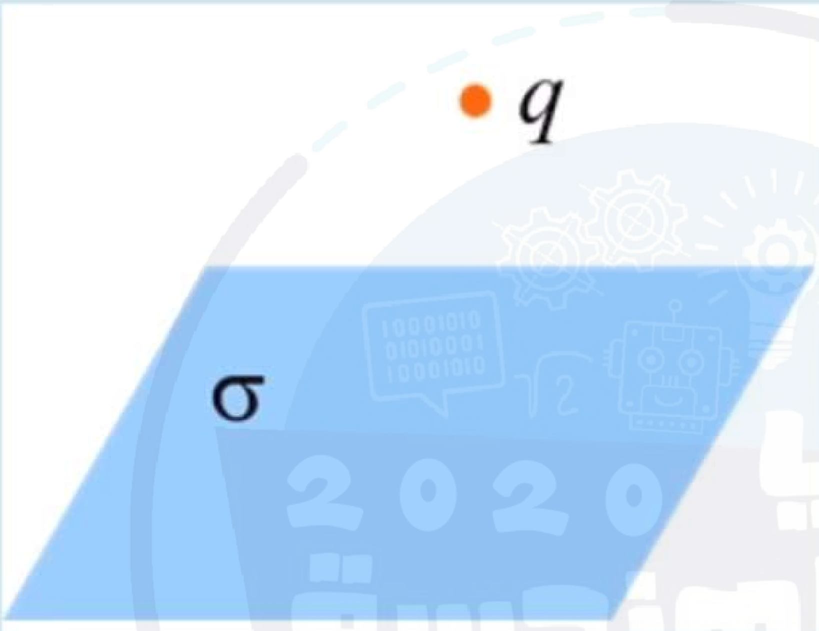
Useful Constants

$k_e = 1/4\pi\varepsilon_o = 9 \times 10^9$ N.m^2/C^2; $\varepsilon_o = 8.85\text{x}10^{-12}$ C^2/N.m^2; e = $1.6\text{x}10^{-19}$ C; $m_{electron} = 9.11 \times 10^{-31}$ kg; $m_{proton} = 1.67 \times 10^{-27}$ kg; g = 9.8 m/s^2

A solid conducting sphere of radius R carries a net positive charge $2Q$. The electric potential V at a distance $r = R/2$ from the center of the sphere is

- a. $5k_eQ/R$
- b. $4k_eQ/R$
- c. $3k_eQ/R$
- d. $2k_eQ/R$
- e. k_eQ/R

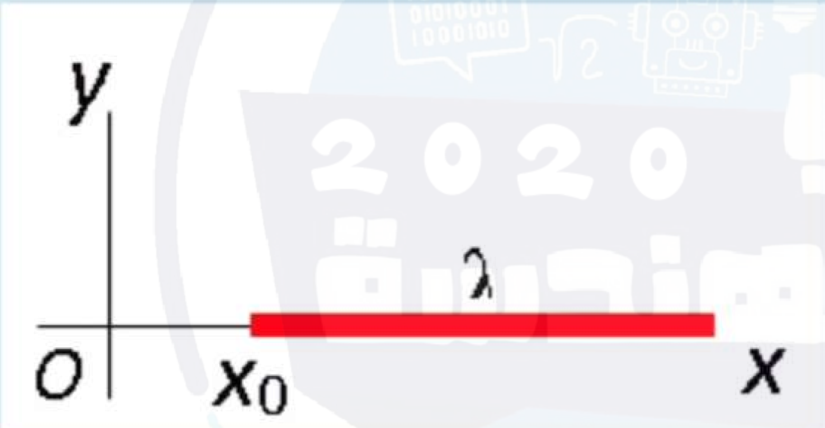
A 10.0-g small plastic ball carries a net charge $q = 0.70\ \mu C$ and floats (تطفو) at rest above an infinite horizontal sheet of plastic that has a uniform surface charge density σ on its surface. The surface charge density σ (in $\mu C/m^2$) on the plastic sheet is



- a. −2.5
- b. 2.5
- c. −4.3
- d. 4.3
- e. 0.7

$k_e = 1/4\pi\varepsilon_o = 9 \times 10^9\ N.m^2/C^2$; $\varepsilon_o = 8.85 \times 10^{-12}\ C^2/N.m^2$; $e = 1.6 \times 10^{-19}\ C$; $m_{electron} = 9.11 \times 10^{-31}\ kg$; $m_{proton} = 1.67 \times 10^{-27}\ kg$; $g = 9.8\ m/s^2$

A line of charge lying along the x-axis starts at $x=+x_0$ and extends to positive infinity. It has a nonuniform linear charge density $\lambda=\lambda_0 x_0/x$, where λ_0 is a positive constant. The magnitude of the electric field at the origin O is



- a. $4k_e\lambda_0$
- b. $4k_e\lambda_0/x_0$
- c. $2k_e\lambda_0/x_0$
- d. $k_e\lambda_0/x_0$
- e. $k_e\lambda_0/2\ x_0$

2. Charges q1 and q2 are on the x axis, with q1 at x = a and q2 at x = 2a. For the net force on another charge at the origin to be zero q1 and q2 must be related by q2=: *
(3 Points)

- 2q1
- 4q1
- -2q1
- -4q1
- -q1/4

Useful Constants

$k_e = 1/4\pi\varepsilon_o = 9 \times 10^9\ N.m^2/C^2$; $\varepsilon_o = 8.85 \times 10^{-12}\ C^2/N.m^2$; $e = 1.6 \times 10^{-19}\ C$; $m_{electron} = 9.11 \times 10^{-31}$ kg; $m_{proton} = 1.67 \times 10^{-27}$ kg; $g = 9.8\ m/s^2$

Consider an insulating solid sphere of radius $R = 0.1$ m and uniform volume charge density $\rho = 2.4 \times 10^{-4}\ C/m^3$. The magnitude of the electric field a distance $r = 0.15$ m from the center of the sphere (in N/C) is

- a. 4.0×10^5
- b. 2.3×10^5
- c. 1.8×10^5
- d. 1.4×10^5
- e. 1.0×10^5

Next page

Useful Constants

$k_e = 1/4\pi\varepsilon_o = 9 \times 10^9$ N.m²/C²; $\varepsilon_o = 8.85\times10^{-12}$ C²/N.m²; e = 1.6x10⁻¹⁹ C; $m_{electron} = 9.11 \times 10^{-31}$ kg; $m_{proton} = 1.67 \times 10^{-27}$ kg; g = 9.8 m/s²

A proton released from rest in a region of a uniform electric field undergoes a displacement through a potential difference of -150 V. The change in its kinetic energy (in eV) is

- a. -150
- b. 150

5. 10 C of charge are placed on a spherical conducting shell. A −3-C point charge is placed at the center of the cavity. The net charge in coulombs on the inner surface of the shell is: *
(3 Points)

- −7
- −3
- 0
- +3
- +7

8. Three charges lie on the x axis: 1 × 10–8 C at x = 1 cm, 2 × 10–8 C at x = 2 cm, and 3 × 10–8 C at x = 3 cm. The potential energy (in J) of this arrangement, relative to the potential energy for infinite separation, is: *
(3 Points)

- 7.9×10^{-2}
- 8.5×10^{-4}
- 1.7×10^{-3}
- 0.16
- 0

6. Charge Q is distributed uniformly throughout a spherical insulating shell. The net electric flux in N × m2/C through the outer surface of the shell is: *
(3 Points)

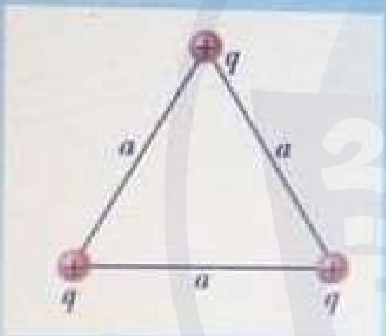
- 0
- Q/ε
- $2Q/\varepsilon$
- $Q/4\varepsilon$
- $Q/2\pi\varepsilon$

7. A conducting sphere of radius 0.01 m has a charge of 1.0 × 10–9 C deposited on it. The magnitude of the electric field in N/C just outside the surface of the sphere is: *
(3 Points)

- 0
- 450
- 900
- 4500
- 90000

$k_e = 1/4\pi\varepsilon_o = 9 \times 10^9$ N.m^2/C^2; $\varepsilon_o = 8.85\times10^{-12}$ C^2/N.m^2; e = 1.6×10^{-19} C; $m_{electron} = 9.11 \times 10^{-31}$ kg; $m_{proton} = 1.67 \times 10^{-27}$ kg; g = 9.8 m/s^2

Three particles with equal positive charges q = 10.0 μC are at the corners of an equilateral triangle of side a = 3.0 cm as shown in the figure. What is the electric potential energy (in J) of the system of three particles?



a. 270

b. 90

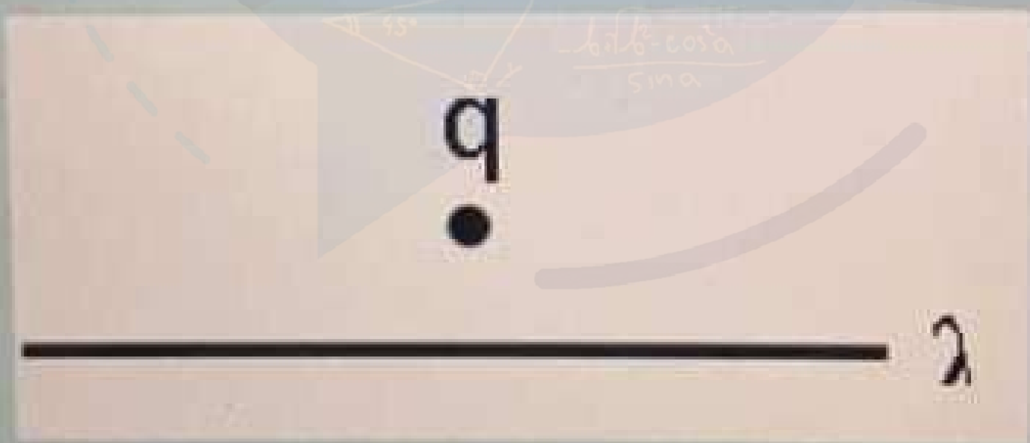
Useful Constants

$k_e = 1/4\pi\varepsilon_o = 9 \times 10^9$ N.m^2/C^2; $\varepsilon_o = 8.85\text{x}10^{-12}$ C^2/N.m^2; e = 1.6x10^{-19} C; $m_{electron} = 9.11 \times 10^{-31}$ kg; $m_{proton} = 1.67 \times 10^{-27}$ kg; g = 9.8 m/s^2

If a charge of 30 μC is located 5.0 cm from a charge of 6.5 μC, the electric potential energy (in J) of this arrangement is

- a. 35
- b. 14
- c. 21
- d. 28
- e. 7

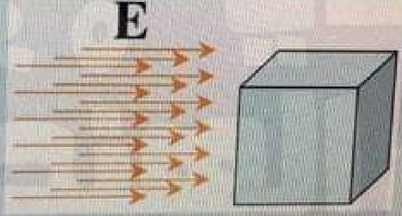
A 2.0-g small plastic ball carries a net positive charge at (تطفو) of 5.0 μC and floats rest 1.0 mm directly above an infinitely long horizontal line of positive charge having a uniform charge per unit length λ as shown. The magnitude of λ (in nC/m) is



Useful Constants

$k_e = 1/4\pi\varepsilon_o = 9 \times 10^9$ N.m^2/C^2; $\varepsilon_o = 8.85\times10^{-12}$ C^2/N.m^2; e = 1.6×10^{-19} C; $m_{electron} = 9.11 \times 10^{-31}$ kg; $m_{proton} = 1.67 \times 10^{-27}$ kg; g = 9.8 m/s^2

A closed cube of edge length L = 0.5 m is resting within a horizontal electric field of magnitude $E = 3.2 \times 10^2$ N/C as shown in the figure. The electric flux through the left face (in N.m^2/C) is:



- a. 0
- b. -145
- c. 145
- d. -80
- e. 80

Useful Constants

$k_e = 1/4\pi\varepsilon_o = 9 \times 10^9$ N.m^2/C^2; $\varepsilon_o = 8.85\times10^{-12}$ C^2/N.m^2; e = 1.6×10^{-19} C; $m_{electron} = 9.11 \times 10^{-31}$ kg; $m_{proton} = 1.67 \times 10^{-27}$ kg; g = 9.8 m/s^2

If a charge of 12 μC is located 5.0 cm from a charge of 6.5 μC, the electric potential energy (in J) of this arrangement is

- a. 35
- b. 14
- c. 21
- d. 28
- e. 7

9. The potential difference between two points is 100 V. If 2 C is transported from one of these points to the other, the magnitude of the work done is: *
(3 Points)

- 200 J
- 100 J
- 50 J
- 100 V
- 2 J

Useful Constants

$k_e = 1/4\pi\varepsilon_o = 9 \times 10^9$ N.m²/C²; $\varepsilon_o = 8.85 \times 10^{-12}$ C²/N.m²; $e = 1.6 \times 10^{-19}$ C; $m_{electron} = 9.11 \times 10^{-31}$ kg; $m_{proton} = 1.67 \times 10^{-27}$ kg; $g = 9.8$ m/s²

If the electric flux through a closed surface is 565 N.m²/C, the net charge (in nC) inside the closed surface is:

- a. 0
- b. 5
- c. 4
- d. 2.5
- e. 6.5

Clear my choice

Next page

Useful Constants

$k_e = 1/4\pi\varepsilon_o = 9 \times 10^9$ N.m^2/C^2; $\varepsilon_o = 8.85\text{x}10^{-12}$ C^2/N.m^2; $e = 1.6\text{x}10^{-19}$ C; $m_{electron} = 9.11 \times 10^{-31}$ kg; $m_{proton} = 1.67 \times 10^{-27}$ kg; $g = 9.8$ m/s^2

Three point charges lie along a straight line as shown in the figure below, where $q_1 = 6.36$ μC, $q_2 = 1.49$ μC, and $q_3 = -2.16$ μC. The separation distances are $d_1 = 3.00$ cm and $d_2 = 2.00$ cm. The net electric force (in N) on q_2 is

- a. 167.2 to the right
- b. 334.4 to the right
- c. 0
- d. 167.2 to the left

3. The magnitude of the force (in N) of a 400-N/C electric field on a 0.02-C point charge is: *
(3 Points)

- 8
- 0.08
- 8000
- 2×10^{11}
- 8×10^{-5}

1. Two small charged objects repel 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: *
(3 Points)

- F/16
- F/8
- F/4
- F/2
- F

10. A 5-cm radius conducting sphere is charged until the electric field just outside its surface is 2000 V/m. The electric potential of the sphere (in V), relative to the potential far away, is: *
(3 Points)

- 0
- 5
- 100
- 4×10^4
- 8×10^5

4. A spherical shell has an inner radius of 3.7 cm and an outer radius of 4.5 cm. If charge is distributed uniformly throughout the shell with a volume density of 6.1 × 10^{-4} C/m3 the total charge (in C) is: *
(3 Points)

- 1.0×10^{-7}
- 1.3×10^{-7}
- 2.0×10^{-7}
- 2.3×10^{-7}
- 4.0×10^{-7}

(1) $ma = Eq$

$(1.67\times10^{-27})\,a = (3\times10^{4})(1.6\times10^{-19})$

$a = 2.87\times10^{12} \approx 2.9\times10^{12}\ m/s^2$

(c)

(2) $V = \frac{kq_1}{r} = \frac{(9\times10^{9})(1.5\times10^{-9})}{3} = 4.5\,V$

(b)

(3) $\phi = \frac{\sum q_{in}}{\varepsilon_0} = \frac{2Q+(-Q)}{\varepsilon_0}$

$= \frac{Q}{\varepsilon_0} = \frac{4\times10^{-9}}{8.85\times10^{-12}} = 451.97$

≈ 452 (c)

(4) $E = \frac{\sigma}{\varepsilon_0} = \frac{4\times10^{-9}}{8.85\times10^{-12}} = 451.97$

≈ 452

(b)

(5) $V = 5x - 3x^2y + 2yz^2$

$E = -\frac{\partial V}{\partial r}$ at $(1,0,1)$

$\vec{E} = -(5-6xy)\hat{i} - (-3x^2+2z^2)\hat{j} - (4yz)\hat{k}$

$= -(5)\hat{i} - (-1)\hat{j} - 0\hat{k}$

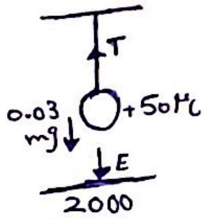
$\vec{E} = -5\hat{i} + 1\hat{j}$

$|\vec{E}| = \sqrt{(-5)^2 + (1)^2} = 5.099 \approx 5.1$

(a)

*(6) $m = 0.03$ $q = +50\times10^{-6}$

$E = 2000$ $g = 9.8$

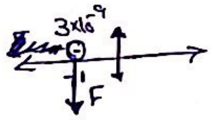


$T = mg + Eq$

$T = (0.03)(9.8) + (2000)(50\times10^{-6})$

$= 0.394$ (a)

(7) $E = \frac{F}{q}$



$E = \frac{1.5\times10^{-3}}{3\times10^{-9}} = 5\times10^{5}\,N/C$

in the positive y-direction

(a)

(8) $r = \frac{R}{2} < R$ $V = \frac{kq}{R}$

$V = \frac{2kQ}{R}$ (d)

(9) $E = \frac{\sigma}{2\varepsilon_0}$ $E = \frac{F}{q}$ $F = mg$

$\frac{mg}{q} = \frac{\sigma}{2\varepsilon_0} \Rightarrow \sigma = \frac{2mg\varepsilon_0}{q}$

$\sigma = \frac{2(10\times10^{-3})(9.8)(8.85\times10^{-12})}{0.7\times10^{-6}} = 2.478\times10^{-6}\,C/m^2$

$\approx 2.5\times10^{-6}\,C/m^2 \approx 2.5\,\mu C/m^2$

(b)

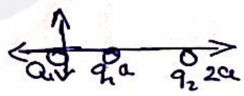
*(10) $E = \frac{k\lambda L}{D^2+DL}$ $L = \infty$

$D = x_0$ $\lambda = \frac{\lambda_0 x_0}{x}$

$L=\infty \Rightarrow E = \frac{k\lambda}{D}$

$E = \frac{k\lambda_0 x_0}{x_0 x} = \frac{k\lambda_0}{x}$ (d)

(11)



$F = 0 = \frac{kQ|q_1|}{a^2} = \frac{kQ|q_2|}{4a^2}$

$|q_2| = 4|q_1|$

بما أنه نقطة الاتزان خارج الشحنتين إذاً

هما معاكستان الإشارة

$q_2 = -4q_1$

(d)

Scanned with CamScanner

(12)* $r > R$

$E = \frac{\rho R^2}{3\varepsilon_0 r^2} = \frac{(2.4\times10^{-4})(0.10)^2}{3(8.85\times10^{-12})(0.15)^2}$

$= 4.017\times10^6 \approx 4\times10^6$

(a) but there is something wrong

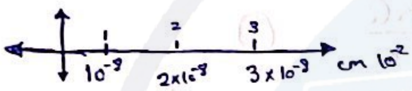
(13)* $\Delta KE = -\Delta U = \frac{q\Delta V}{e} = -\frac{e\Delta V}{e} = -\Delta V$

$= 150$

(b)

(14) +3 (d)

(15)



$U = \frac{kq_1q_2}{r_{12}} + \frac{kq_1q_3}{r_{13}} + \frac{kq_2q_3}{r_{23}}$

$= 8.55\times10^{-4} \approx 8.5\times10^{-4}$

(b)

(16) (b) $\frac{Q}{\varepsilon_0}$

(17) $E = \frac{kq}{R^2}$

$= \frac{9\times10^9(10^{-9})}{(0.01)^2} = 90000$

(E)

(18) $U = \frac{3kq^2}{r}$

$= 90$

(b)

(19) $U = \frac{kq_1q_2}{r}$

(22) $= \frac{(9\times10^9)(30\times10^{-6})(6.5\times10^{-6})}{5\times10^{-2}} = 35.1$

≈ 35 (a)

(20)* $mg - Eq = 0$

$mg = Eq$

$E = \frac{mg}{q} \Rightarrow \frac{2k\lambda}{y} = \frac{mg}{q}$ ✓

$\lambda = \frac{mgy}{2qk} = 2.2\times10^{-10}$ C/m

(21) $\phi = EA\cos\theta$ $\theta = 180$

$\phi = -EA = -(3.2\times10^3)(0.5)^2 = -80$

(d)

(23) $w = U = Vq = 100(2) = 200$

(a)

(24) $q = \varepsilon_0\phi = (8.85\times10^{-12})(565)$

$= 5\times10^{-9}C = 5nC$ (b)

(25) $F_{net} = \frac{kq_1q_2}{r_{12}^2} + \frac{kq_2q_3}{r_{23}^2}$

(a) 167.2 N to right

(26) $F = Eq = 400(0.02) = 8$ (a)

(27) $F_1 = \frac{kq_1q_2}{r^2}$ $F_2 = \frac{k\frac{1}{4}q_1\frac{1}{4}q_2}{\left(\frac{r}{4}\right)^2} = \frac{1}{4}F_1$

(C)

(28) $V = \frac{E}{R} = \frac{2000}{5\times10^{-2}} = 4\times10^4$ (d)

(29) $q = \rho V = 6.1\times10^{-4}\left(\frac{4}{3}\pi\left((4.5\times10^{-2})^3 - (3.7\times10^{-2})^3\right)\right)$

~~$(6.1\times10^{-4})\left(\frac{4}{3}\pi(0.8\times10^{-2})^3\right)$ 1.309×10~~

$(6.1\times10^{-4})\left(\frac{4}{3}\pi(4.5\times10^{-2})^3 - \frac{4}{3}\pi(3.7\times10^{-2})^3\right)$

$= 1.03\times10^{-7} \approx 1\times10^{-7}$ (a)