This print-out should have 14 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering.

Negatively Charged Rod
001 10.0 points

If a negatively charged rod is held near an uncharged metal ball, the metal ball

1. becomes positively charged.

2. is unaffected.

3. Unable to determine.

4. becomes negatively charged.

5. becomes polar. **correct**

Explanation:

When the charged rod moves toward the metal ball, an electric field is created around the ball. Electrons inside the metal ball can move freely, and move away from the area where the negatively charged rod approaches, causing a positively charged area, creating a polar metal ball.

Charges 04
002 10.0 points

When the leaves of an electroscope are spread apart,

1. the leaves are neutral.

2. a negatively charged object must be touching the knob of the electroscope.

3. a positively charged object must be touching the knob of the electroscope.

4. the leaves have the same charge. **correct**

Explanation:

Acceleration of a Particle
003 10.0 points

A particle of mass 62 g and charge 58 μC is released from rest when it is 25 cm from a second particle of charge -18 μC.

Determine the magnitude of the initial acceleration of the 62 g particle.

Correct answer: 2421.41 m/s^2.

Explanation:

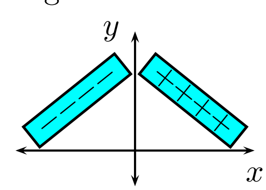
$$\begin{aligned}
\text{Let :}\quad m &= 62 \text{ g}\,,\\
q &= 58\ \mu\text{C} = 5.8\times10^{-5}\text{ C}\,,\\
d &= 25\text{ cm} = 0.25\text{ m}\,,\\
Q &= -18\ \mu\text{C} = -1.8\times10^{-5}\text{ C}\,,\quad\text{and}\\
k_e &= 8.9875\times10^{9}\text{ N}\cdot\text{m}^2/\text{C}^2\,.
\end{aligned}$$

The force exerted on the particle is

$$\begin{aligned}
F &= k_e\,\frac{|q|\,|Q|}{d^2} = m\,a\\
a &= k_e\,\frac{|q|\,|Q|}{m\,d^2}\\
&= (8.9875\times10^{9}\text{ N}\cdot\text{m}^2/\text{C}^2)\\
&\quad\times\frac{\left|5.8\times10^{-5}\text{ C}\right|\left|-1.8\times10^{-5}\text{ C}\right|}{(0.062\text{ kg})\,(0.25\text{ m}^2)}\\
&= \boxed{2421.41\text{ m/s}^2}\,.
\end{aligned}$$

Field Directions by Inspection
004 (part 1 of 5) 10.0 points

Consider symmetrically placed rectangular insulators with uniformly charged distributions of equal magnitude as shown.



What is the direction of the electric field at the origin?

1. Aligned with the negative y-axis

2. Zero with undefined direction

3. Aligned with the negative x-axis **correct**

4. Aligned with the positive y-axis

5. Aligned with the positive x-axis

6. Non-zero and not aligned with either the x- or the y-axis

Explanation:

At the origin, the positive slab of charge produces an electric field pointed into quadrant III (away from the positively charged slab). The negatively charged slab produces an electric field of equal magnitude (as the positively charged slab) but pointing into quadrant II (toward the negatively charged slab). The x-components of the two fields add (producing $E_x < 0$), while the y-components cancel, so the electric field is along the negative x-axis.

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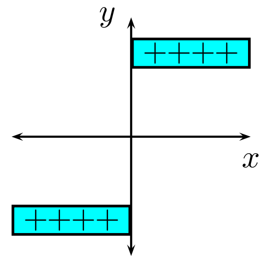
005 (part 2 of 5) 10.0 points



What is the direction of the electric field at the origin?

1. Non-zero and not aligned with either the x- or the y-axis

2. Aligned with the negative y-axis

3. Aligned with the positive y-axis

4. Aligned with the negative x-axis

5. Zero with undefined direction **correct**

6. Aligned with the positive x-axis

Explanation:

At the origin the upper slab produces an electric field that points into quadrant III (away from the positively charged slab) and the lower slab produces an electric field pointing into quadrant I (away from the positively charged slab). By symmetry, these two electric fields are equal in magnitude and opposite in direction, so the total electric field sums to zero.

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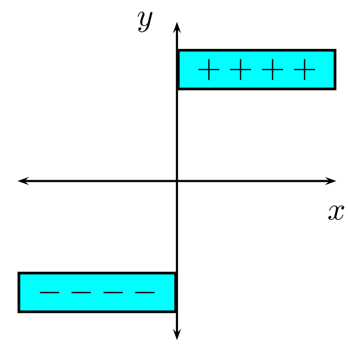
006 (part 3 of 5) 10.0 points



What is the direction of the net electric field at the origin?

1. Zero with undefined direction

2. Aligned with the negative x-axis

3. Aligned with the positive x-axis

4. Aligned with the positive y-axis

5. Aligned with the negative y-axis

6. Non-zero and not aligned with either the x- or the y-axis **correct**

Explanation:

At the origin, the upper slab produces an electric field pointing into quadrant III (away from the positively charged slab) while the lower slab produces an electric field also pointing into quadrant III (toward the negatively charged slab). By symmetry both slabs produce an electric field of the same magnitude and direction. The sum of these electric fields points into quadrant III which is neither aligned with the x nor y axis.

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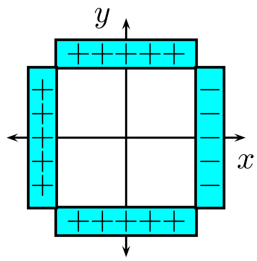
007 (part 4 of 5) 10.0 points



What is the direction of the net field at the origin?

1. Aligned with the positive y-axis

2. Zero with undefined direction

3. Non-zero and not aligned with either the x- or y-axis

4. Aligned with the positive x-axis **correct**

5. Aligned with the negative y-axis

6. Aligned with the negative x-axis

Explanation:

At the origin the fields from the top and bottom slabs cancel because they are equal and opposite. The field from the left slab points toward the positive x-axis (away from the positively charged slab) and the field from the right slab also points toward the positive x-axis (toward the negatively charged slab). This configuration is symmetric about the x-axis, so the y component of the total field must vanish, and the sum of the electric fields from all four slabs is aligned with the positive x-axis.

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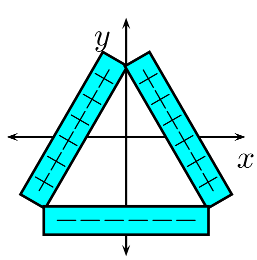
008 (part 5 of 5) 10.0 points



What is the direction of the net electric field at the origin?

1. Aligned with the positive x-axis

2. Aligned with the negative x-axis

3. Aligned with the negative y-axis **correct**

4. Non-zero and not aligned with either the x- or the y-axis

5. Aligned with the positive y-axis

6. Zero with undefined direction

Explanation:

At the origin the field from the bottom slab points toward the negative y axis (toward the negatively charged slab). The fields from the right and left slabs have equal magnitudes at the origin and are symmetric about the y axis, so their x components cancel at the origin. The net fields from the right and left slabs point toward the negative y axis (away from the positively charged slab). Thus the sum of the electric fields from all three slabs is aligned with the negative y-axis.

Electron in a Field 02
009 (part 1 of 2) 10.0 points

An electron with 9.109×10^{-31} kg is accelerated from rest for 1×10^{-9} s by a uniform electric field that exerts a force of 3.3×10^{-15} N on the electron.

What is the magnitude of the electric field? The fundamental charge is 1.602×10^{-19} C .

Correct answer: 20599.3 V/m.

Explanation:

$$\text{Let :} \quad q_e = -1.602 \times 10^{-19}\text{ C} \quad \text{and}$$
$$F = 3.3 \times 10^{-15}\text{ N}\,.$$

The magnitude of the force is

$$\begin{aligned} F &= |q_e|\,E \\ E &= \frac{F}{|q_e|} = \frac{3.3 \times 10^{-15}\text{ N}}{|-1.602 \times 10^{-19}\text{ C}|} \\ &= \boxed{20599.3\text{ V/m}}\,. \end{aligned}$$

010 (part 2 of 2) 10.0 points

What is the speed of the electron after it has accelerated for 1×10^{-9} s?

Correct answer: 3.62279×10^6 m/s.

Explanation:

$$\text{Let :} \quad m_e = 9.109 \times 10^{-31}\text{ kg} \quad \text{and}$$
$$t = 1 \times 10^{-9}\text{ s}\,.$$

The force on the electron is $F = m_e\, a$ and its acceleration is

$$\begin{aligned} a &= \frac{\Delta v}{\Delta t} = \frac{F}{m_e} \\ \Delta v &= \frac{F\,\Delta t}{m_e} = \frac{(3.3 \times 10^{-15}\text{ N})(1 \times 10^{-9}\text{ s})}{9.109 \times 10^{-31}\text{ kg}} \\ &= \boxed{3.62279 \times 10^6\text{ m/s}}\,. \end{aligned}$$

AP B 1998 MC 14num

011 10.0 points

Two parallel conducting plates are connected to a constant voltage source. The magnitude of the electric field between the plates is 1682 N/C.

If the voltage is doubled and the distance between the plates is reduced to $\frac{1}{5}$ the original distance, what is the magnitude of the new electric field?

Correct answer: 16820 N/C.

Explanation:

$$\begin{aligned} \text{Let :} \quad E &= 1682\text{ N/C}\,, \\ V' &= 2\,V\,, \quad \text{and} \\ d' &= \frac{1}{5}\,d\,. \end{aligned}$$

The magnitude of the electric field between two parallel conducting plates is $E = \dfrac{V}{d}$, where V is the voltage between the plates, and d is the distance between the plates, so the new electric field has a magnitude of

$$\begin{aligned} E' &= \frac{V'}{d'} = \frac{2\,V}{\dfrac{d}{5}} = 10\left(\frac{V}{d}\right) \\ &= 10\,E \\ &= 10\,(1682\text{ N/C}) \\ &= \boxed{16820\text{ N/C}}\,. \end{aligned}$$

Accelerating a Deuteron

012 (part 1 of 2) 10.0 points

A deuteron (a nucleus that consists of one proton and one neutron) is accelerated through a 1.58 kV potential difference.

How much kinetic energy does it gain? The mass of a proton is 1.6726×10^{-27} kg, the mass of a neutron 1.6749×10^{-27} kg and the elemental charge is 1.602×10^{-19} C.

Correct answer: 2.53116×10^{-16} J.

Explanation:

$$\text{Let :} \quad \Delta V = -1.58\text{ kV} = -1580\text{ V} \quad \text{and}$$
$$q = 1.602 \times 10^{-19}\text{ C}\,.$$

The neutron has no charge. By conservation of energy since there is a gain of kinetic energy, there must be a loss of potential energy ($\Delta V < 0$) and

$$\begin{aligned} \Delta K &= -\Delta U = -q\,\Delta V \\ &= -\left(1.602 \times 10^{-19}\text{ C}\right)(-1580\text{ V}) \\ &= \boxed{2.53116 \times 10^{-16}\text{ J}}\,. \end{aligned}$$

013 (part 2 of 2) 10.0 points

How fast is it going if it starts from rest?

Correct answer: 3.88879×10^5 m/s.

Explanation:

$$\text{Let :} \quad m_p = 1.6726 \times 10^{-27}\text{ kg} \quad \text{and}$$
$$m_n = 1.6749 \times 10^{-27}\text{ kg}\,.$$

The mass of the deuteron is

$$\begin{aligned} m &= m_p + m_n \\ &= 1.6726 \times 10^{-27}\text{ kg} \\ &\quad + 1.6749 \times 10^{-27}\text{ kg} \\ &= 3.3475 \times 10^{-27}\text{ kg}\,, \quad \text{so} \end{aligned}$$

$$\begin{aligned} \Delta K &= \frac{1}{2}\, m\, v^2 - 0 \\ v &= \sqrt{\frac{2\,(\Delta K)}{m}} \\ &= \sqrt{\frac{2\ (2.53116 \times 10^{-16}\text{ J})}{3.3475 \times 10^{-27}\text{ kg}}} \\ &= \boxed{3.88879 \times 10^{5}\text{ m/s}}\,. \end{aligned}$$

Hewitt CP9 22 E44
014 10.0 points

Would you feel any electrical effects if you were inside the charged sphere of a van de Graaff generator? Why or why not?

1. No; although there are charges inside the generator, the net charge is zero.

2. None of these

3. Yes; the electric field exists both inside and outside of the generator.

4. Yes; the electric field is very strong inside the van de Graff generator.

5. No; the inside of the generator has zero charge and thus no electric field. **correct**

6. More information is needed.

Explanation:

You would feel no electrical effects inside any statically charged conducting body. The distribution of mutually-repelling charges is such that the electric field inside the body is zero.