

Q1.

Three point charges are arranged along the x -axis. Charge $q_1 = +3.00 \mu\text{C}$ is at the origin, and charge $q_2 = -5.00 \mu\text{C}$ is at $x = 0.200 \text{ m}$. Where should a third charge $q_3 = -8.00 \mu\text{C}$ be located if the net force on q_1 is 7.00 N in the negative x -direction?

- A) -0.144 m
- B) -0.211 m
- C) $+0.412 \text{ m}$
- D) $+0.211 \text{ m}$
- E) -0.520 m

Q2.

Two identical small conducting spheres are separated by 0.6 m center to center. The spheres carry different amounts of charge with a total charge of $+4 \mu\text{C}$. The two spheres are now connected by a very thin conducting wire and then disconnected. The new electric force on each sphere is

- A) 0.1 N , repulsive
- B) 0.1 N , attractive
- C) 0.4 N , attractive
- D) zero
- E) 0.4 N , repulsive

Q3.

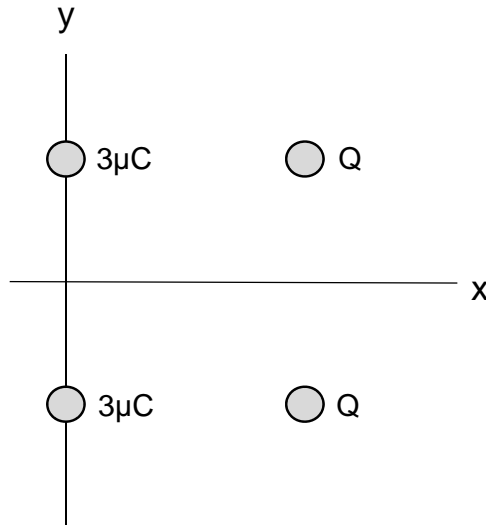
An electric dipole consists of a charge of $+1.0 \mu\text{C}$ located at the point $(0, 1.0) \text{ cm}$ and a charge of $-1 \mu\text{C}$ located at the point $(0, -1.0) \text{ cm}$. How much work must be done by an electric field $\vec{E} = 3.0 \times 10^6 \hat{i} \text{ (N/C)}$ to align the dipole with the field?

- A) 0.060 J
 - B) 0.030 J
 - C) zero
 - D) 0.020 J
 - E) 0.12 J
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Q4.

Charges of $3.0 \mu\text{C}$ are located at $(0, 2.0) \text{ m}$ and at $(0, -2.0) \text{ m}$, as shown in **FIGURE 1**. Charges Q are located at $(4.0, 2.0) \text{ m}$ and at $(4.0, -2.0) \text{ m}$. The net electric field at the origin is equal to $+4.0 \times 10^3 \hat{i} \text{ (N/C)}$. Determine Q .

Figure 1

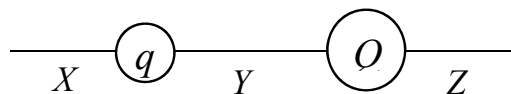


- A) $-5.0 \mu\text{C}$
- B) $+3.1 \mu\text{C}$
- C) $-3.1 \mu\text{C}$
- D) $-6.4 \mu\text{C}$
- E) $+5.0 \mu\text{C}$

Q5.

FIGURE 2 shows two unequal point charges, q and Q , of opposite sign. Charge Q has greater magnitude than charge q . In which of the regions X , Y , Z will there be a point at which the net electric field due to these two charges is zero?

Figure 2

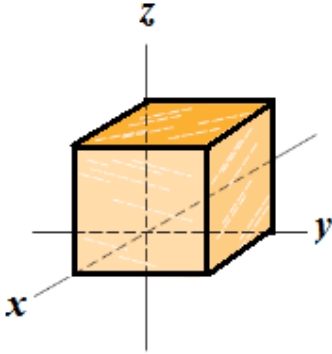


- A) only region X
- B) only regions X and Z
- C) only region Y
- D) only region Z
- E) all three regions

Q6.

At each point on the surface of the cube shown in **FIGURE 3**, the electric field is parallel to the z axis. The length of each edge of the cube is 3.0 m. On the top face of the cube, the electric field is $\vec{E} = -20\hat{\mathbf{k}}$ (N/C), and on the bottom face $\vec{E} = +20\hat{\mathbf{k}}$ (N/C). Determine the net charge contained within the cube.

Figure 3

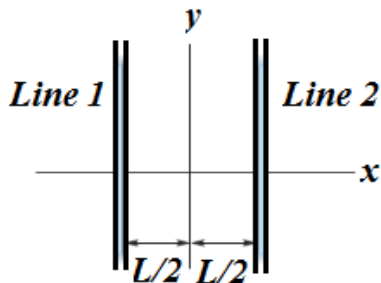


- A) -3.2×10^{-9} C
- B) $+3.2 \times 10^{-9}$ C
- C) -1.9×10^{-10} C
- D) $+1.9 \times 10^{-10}$ C
- E) $+0.90 \times 10^{-9}$ C

Q7.

In **FIGURE 4**, short sections of two very long parallel lines of charge are shown, fixed in place, and separated by $L = 8.0$ cm. The uniform linear charge densities are $+6.0 \mu\text{C/m}$ for line 1 and $-2.0 \mu\text{C/m}$ for line 2. Where along the x -axis (from the origin) is the net electric field due the two lines zero?

Figure 4



- A) 8.0 cm
- B) 4.0 cm
- C) 2.0 cm
- D) 6.0 cm

E) 0.0 cm

Q8.

An electron is shot directly toward the center of a large metal plate that has a surface charge density of $-2.0 \mu\text{C}/\text{m}^2$. If the initial kinetic energy of the electron is $1.6 \times 10^{-17} \text{ J}$ and if the electron is to stop (due to electrostatic repulsion from the plate) just as it reaches the plate, how far from the plate must the launch point of the electron be?

- A) 0.44 mm
- B) 3.3 mm
- C) 25 mm
- D) 14 mm
- E) 6.4 mm

Q9.

Charge Q is uniformly distributed in a sphere of radius R . Find the ratio of the magnitude of the electric field at $r = R/2$ to that on the surface of the sphere. (r is the distance from the center of the sphere)

- A) 1/2
- B) 1/4
- C) 2
- D) 4
- E) 1/3

Q10.

An electron and a proton are accelerated from rest through the same potential difference. Which of the following statements is **CORRECT**?

- A) The electron has greater speed.
- B) The proton has greater speed.
- C) They have the same speed.
- D) The electron has greater kinetic energy.
- E) The proton has greater kinetic energy.

Q11.

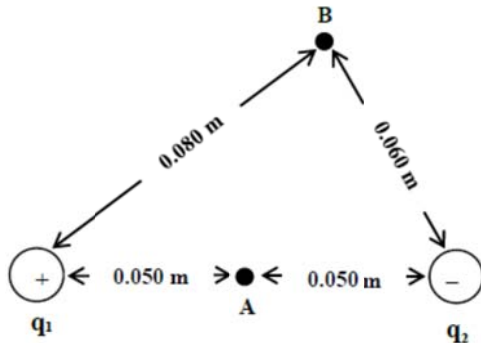
The electric potential at the surface of a conducting sphere is 200 V. At a point that is 10.0 cm from the surface, the electric potential is 150 V. What is the radius of the sphere?

- A) 30 cm
- B) 33 cm
- C) 25 cm
- D) 14 cm
- E) 28 cm

Q12.

Two stationary point charges $q_1 = +2.0 \text{ nC}$ and $q_2 = -2.0 \text{ nC}$ are 0.10 m apart, as shown in **FIGURE 5**. Calculate the work done by the electric field on a charge of $+2.0 \text{ nC}$ that moves from point B to point A.

Figure 5



- A) $-0.15 \mu\text{J}$
- B) $+0.15 \mu\text{J}$
- C) $-1.1 \mu\text{J}$
- D) $+1.1 \mu\text{J}$
- E) zero

Q13.

A particle with a charge of $+5.0 \text{ nC}$ is in a uniform electric field. It is released from rest. Its kinetic energy is found to be $1.5 \times 10^{-6} \text{ J}$ after it has moved 5.0 cm . What is the magnitude of the electric field?

- A) 6.0 kV/m
- B) 1.5 kV/m
- C) 3.0 kV/m
- D) 4.5 kV/m
- E) 7.5 kV/m

Q14.

The electric potential V (in volts) at points in the xyz space is given by:

$$V = -xz^2 + y^2z + 4.0$$

where x , y , and z are in meters. Find the electric field (in V/m) at the point $(2.0, 4.0, -1.0) \text{ m}$.

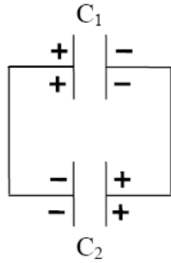
- A) $+1.0\hat{i} + 8.0\hat{j} - 20\hat{k}$
- B) $+2.0\hat{i} + 3.0\hat{j} - 1.0\hat{k}$
- C) $+1.0\hat{i} + 4.0\hat{j} + 2.0\hat{k}$
- D) $+4.0\hat{i} - 14\hat{j} + 2.0\hat{k}$

E) $+5.0\hat{i} + 3.0\hat{j} + 6.0\hat{k}$

Q15.

Two capacitors C_1 and C_2 are each charged to 60 V, and then disconnected from the battery. They store charges of $100 \mu\text{C}$ and $300 \mu\text{C}$. The two capacitors are then connected with opposite polarity as shown in **FIGURE 7**. What then is the potential difference across the capacitors?

Figure 7



- A) 30 V
- B) 120 V
- C) 40 V
- D) 20 V
- E) 50 V

Q16.

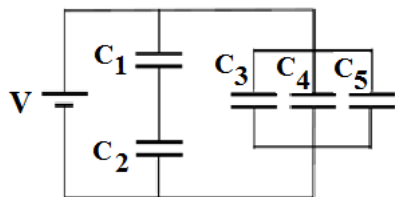
A charged isolated capacitor stores an energy of U . It is connected in parallel to an identical uncharged capacitor. After the combination, the total energy stored in the two capacitors is

- A) $U/2$
- B) U
- C) $U/4$
- D) $2U$
- E) $4U$

Q17.

In the capacitor circuit shown in **FIGURE 6**, the capacitance of each capacitor is C . Find the ratio of Q_3/Q_2 .

Figure 6



- A) 2
- B) $1/2$
- C) 3
- D) $1/3$

E) 2/3

Q18.

A 500-pF capacitor consists of two circular plates 15 cm in radius, separated by a sheet of polystyrene ($\kappa = 2.6$). What is the thickness of the sheet?

- A) 3.3 mm
- B) 3.7 mm
- C) 4.5 mm
- D) 5.1 mm
- E) 4.2 mm

Q19.

A light bulb has a tungsten filament and is powered by a battery. When the bulb is turned ON, its temperature is 20.0 °C and the current passing through it is 0.850 A. After 60.0 s, the current is 0.220 A. What then is the temperature of the filament? Tungsten has a temperature coefficient of resistivity of $4.50 \times 10^{-3} \text{ (}^\circ\text{C)}^{-1}$. Assume the filament's dimensions did not change.

- A) 656 °C
- B) 561 °C
- C) 415 °C
- D) 280 °C
- E) 300 °C

Q20.

Two points in a conducting wire are 75 cm apart and the potential difference between them is 0.95 V. If the current density is $4.5 \times 10^7 \text{ A/m}^2$, what is the resistivity of the wire?

- A) $2.8 \times 10^{-8} \text{ } \Omega \cdot \text{m}$
 - B) $1.5 \times 10^{-8} \text{ } \Omega \cdot \text{m}$
 - C) $1.7 \times 10^{-8} \text{ } \Omega \cdot \text{m}$
 - D) $2.4 \times 10^{-8} \text{ } \Omega \cdot \text{m}$
 - E) $5.3 \times 10^{-8} \text{ } \Omega \cdot \text{m}$
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