

Multiple Choice. For all questions/problems, choose the one alternative that BEST completes the statement or answers the question, and code your choice, A, B, C, D, or E on your scan sheet. For numerical answers, BEST means the closest to what you calculated. Each question is equally weighted.

1) A flat 1.0 m^2 surface is vertical at $x = 2.0 \text{ m}$ and parallel to the yz -plane. What is the flux through the surface if it is located in a uniform electric field given by $\vec{E} = 28.0 \hat{i} + 73.0 \hat{j} + 55.0 \hat{k} \text{ N/C}$?

- A) $28 \text{ N}\cdot\text{m}^2/\text{C}$
- B) $65 \text{ N}\cdot\text{m}^2/\text{C}$
- C) $0 \text{ N}\cdot\text{m}^2/\text{C}$
- D) $110 \text{ N}\cdot\text{m}^2/\text{C}$
- E) $47 \text{ N}\cdot\text{m}^2/\text{C}$

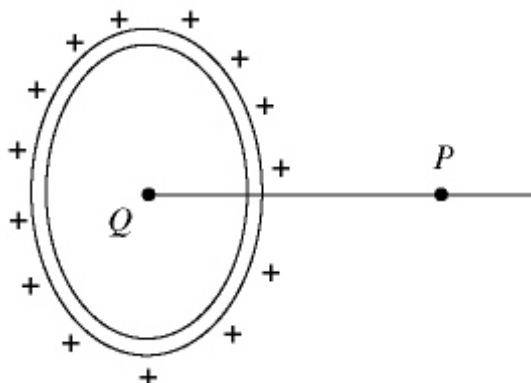
Answer: A

2) A dipole with a positive charge of $2.0 \mu\text{C}$ and a negative charge of $-2.0 \mu\text{C}$ is centered at the origin and oriented along the x -axis with the positive charge located to the right of the origin. The charge separation is 0.0010 m . Find the electric field due to this dipole at the point $x = 4.0 \text{ m}$, $y = 0.0 \text{ m}$.

- A) $-0.28 \hat{i} \text{ N/C}$
- B) $0.56 \hat{i} \text{ N/C}$
- C) $-0.56 \hat{i} \text{ N/C}$
- D) 0.0 N/C
- E) $0.28 \hat{i} \text{ N/C}$

Answer: B

- 3) In the figure, a ring 0.71 m in radius carries a charge of + 580 nC uniformly distributed over it. A point charge Q is placed at the center of the ring. The electric field is equal to zero at field point P , which is on the axis of the ring, and 0.73 m from its center. The point charge Q is closest to



- A) -420.
- B) -210.
- C) 210.
- D) 300.
- E) -300.

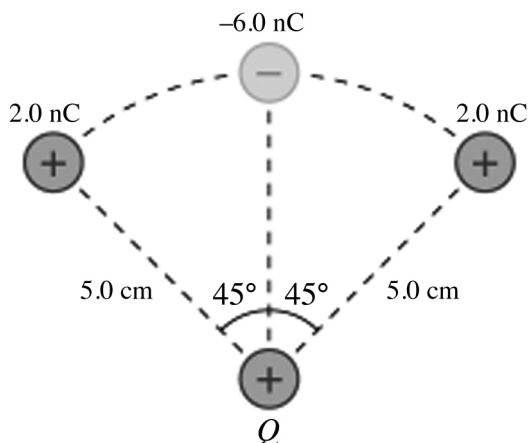
Answer: B

- 4) A positive point charge Q is fixed on a very large horizontal frictionless tabletop. A second positive point charge q is released from rest near the stationary charge and is free to move. Which statement best describes the motion of q after it is released?

- A) As it moves farther and farther from Q , its acceleration will keep increasing.
- B) Its acceleration is zero just after it is released.
- C) As it moves farther and farther from Q , its speed will keep increasing.
- D) As it moves farther and farther from Q , its speed will decrease.
- E) Its speed will be greatest just after it is released.

Answer: C

5) The point charge at the bottom of the figure is $Q = +23 \text{ nC}$, and the curve is a circular arc. What is the magnitude of the force on the charge Q due to the other point charges shown?



- A) $2.6 \times 10^{-4} \text{ N}$
- B) $3.1 \times 10^{-4} \text{ N}$
- C) $3.3 \times 10^{-5} \text{ N}$
- D) $2.1 \times 10^{-4} \text{ N}$
- E) $1.7 \times 10^{-4} \text{ N}$

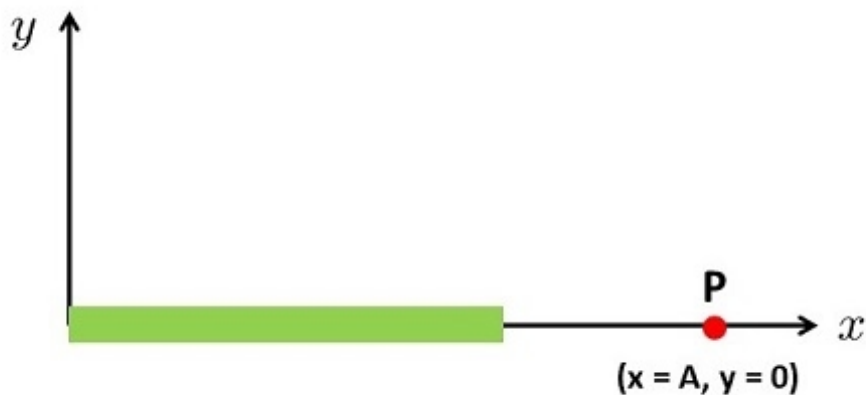
Answer: A

6) A spherical shell of inner radius a and outer radius b carries a charge Q that is uniformly distributed through its volume. The electric field magnitude at a distance r where $a < r < b$ from the center of the shell can be written as $Y(KQ/r^2)$ where K is the Coulomb constant and the factor Y is given by:

- A) $r/(b - a)$
- B) $(r^2 - a^2)/(b^2 - a^2)$
- C) $(r - a)/(b - a)$
- D) $(r^3 - a^3)/(b^3 - a^3)$
- E) $r^3/(b^3 - a^3)$

Answer: D

7) A uniformly charged rod with total charge Q and total length L ($\lambda = Q/L = \text{constant}$) is oriented as shown. Which expression, when integrated, will yield the x-component of the electric field at the field point $(x=A, y=0)$?



A) $\int_0^L \frac{K\lambda dx}{\sqrt{(A^2-x^2)^3}}$

B) $\int_0^L \frac{K\lambda dx}{Ax}$

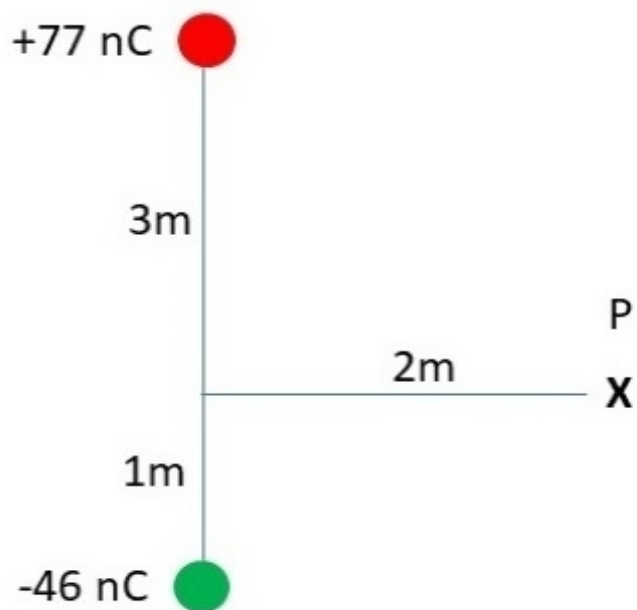
C) $\int_0^L \frac{K\lambda dx}{x(A-x)}$

D) $\int_0^L \frac{K\lambda dx}{A(A-x)}$

E) $\int_0^L \frac{K\lambda dx}{(A-x)^2}$

Answer: E

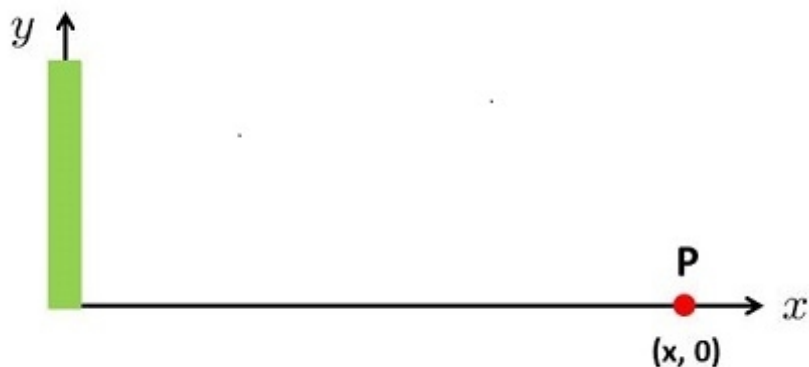
8) What is the magnitude of the total electric field at the point P?



- A) 93 N/C
- B) 136 N/C
- C) 30 N/C
- D) 108 N/C
- E) 74 N/C

Answer: A

- 9) A uniformly charged rod with total charge Q and total length L ($\lambda = Q/L = \text{constant}$) is oriented as shown. Which expression, when integrated, will yield the y-component of the electric field at the field point $(x,0)$?



- A) $-\int_0^L \frac{K\lambda dx}{x^2}$
- B) $-\int_0^L \frac{K\lambda y dy}{\sqrt{(x^2+y^2)^3}}$
- C) $-\int_0^L \frac{K\lambda x dy}{\sqrt{(x^2+y^2)^3}}$
- D) $-\int_0^L \frac{K\lambda dy}{(x^2+y^2)}$
- E) $-\int_0^L \frac{K\lambda dy}{x^2}$

Answer: B

- 10) Four equal positive point charges are located at the corners of a square, their positions in the xy -plane being $(1, 1)$, $(-1, 1)$, $(-1, -1)$, $(1, -1)$. The electric field on the x -axis at $(1, 0)$ points in the same direction as

- A) \hat{j} .
- B) $-\hat{j}$.
- C) \hat{i} .
- D) $-\hat{i}$.
- E) \hat{k} .

Answer: C

11) What is the minimum magnitude of an electric field that balances the weight of a plastic sphere of mass 2.8 g that has been charged to -3.0 nC?

- A) 2.8×10^6 N/C
- B) 9.1×10^6 N/C
- C) 1.0×10^6 N/C
- D) 2.0×10^6 N/C
- E) It is not possible for a negative charge to be in balance.

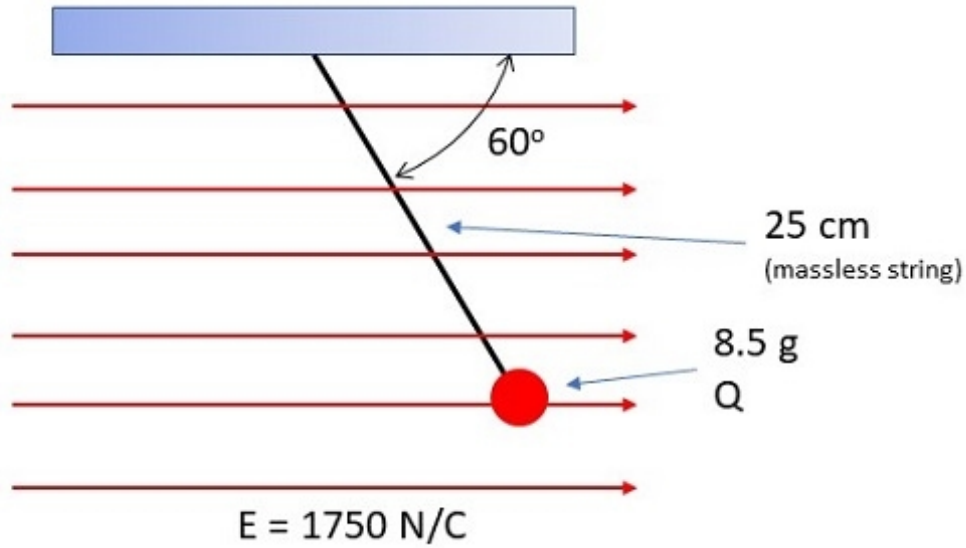
Answer: B

12) A charge $q = 2.00 \mu\text{C}$ is placed at the origin in a region where there is already a uniform electric field $\vec{E} = (100 \text{ N/C}) \hat{i}$. Calculate the flux of the net electric field through a Gaussian sphere of radius $R = 10.0 \text{ cm}$ centered at the origin.

- A) $2.26 \times 10^5 \text{ N} \cdot \text{m}^2/\text{C}$
- B) $5.52 \times 10^5 \text{ N} \cdot \text{m}^2/\text{C}$
- C) $1.13 \times 10^5 \text{ N} \cdot \text{m}^2/\text{C}$
- D) zero
- E) $7.73 \times 10^5 \text{ N} \cdot \text{m}^2/\text{C}$

Answer: A

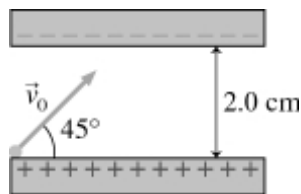
13) The red ball shown in the sketch is in equilibrium. What is the charge, Q , on the ball?



- A) $9.8 \mu\text{C}$
- B) $73.3 \mu\text{C}$
- C) $43.2 \mu\text{C}$
- D) $59.8 \mu\text{C}$
- E) $27.5 \mu\text{C}$

Answer: E

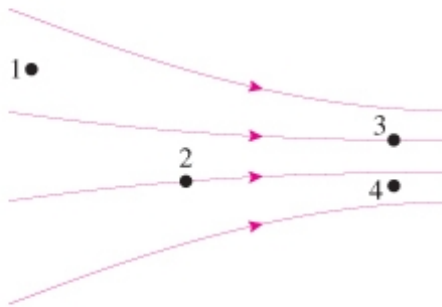
14) The figure shows two parallel plates that are 2.0 cm apart. The electric field between them is $4.8 \times 10^4 \text{ N/C}$. An electron is launched at a 45° angle and with initial speed v_0 from the positive plate. What is the maximum v_0 such that the electron won't hit the negative plate?



- A) $1.6 \times 10^7 \text{ m/s}$
- B) $1.3 \times 10^7 \text{ m/s}$
- C) $2.6 \times 10^7 \text{ m/s}$
- D) $2.0 \times 10^7 \text{ m/s}$
- E) the electron will hit the negative plate for any speed.

Answer: C

15) Below are shown four points in an electric field. Which statement is true about the electric field strength at each point, E_1 to E_4 ?



- A) $E_1 > E_2 > E_3 > E_4$
- B) $E_1 = E_2 = E_3 = E_4$
- C) $E_1 < E_2 < E_3 = E_4$
- D) $E_1 < E_2 < E_3 < E_4$
- E) $E_1 > E_2 > E_3 = E_4$

Answer: C

16) A proton and an electron are released from rest in the center of a capacitor. The magnitude of the forces on each are F_p and F_e , respectively, and the magnitude of the the accelerations are a_p and a_e . Choose the true statement.

- A) $\frac{F_p}{F_e} = 1$ and $\frac{a_p}{a_e} < 1$
- B) $\frac{F_p}{F_e} > 1$ and $\frac{a_p}{a_e} > 1$
- C) $\frac{F_p}{F_e} > 1$ and $\frac{a_p}{a_e} = 1$
- D) $\frac{F_p}{F_e} = 1$ and $\frac{a_p}{a_e} > 1$
- E) $\frac{F_p}{F_e} = 1$ and $\frac{a_p}{a_e} = 1$

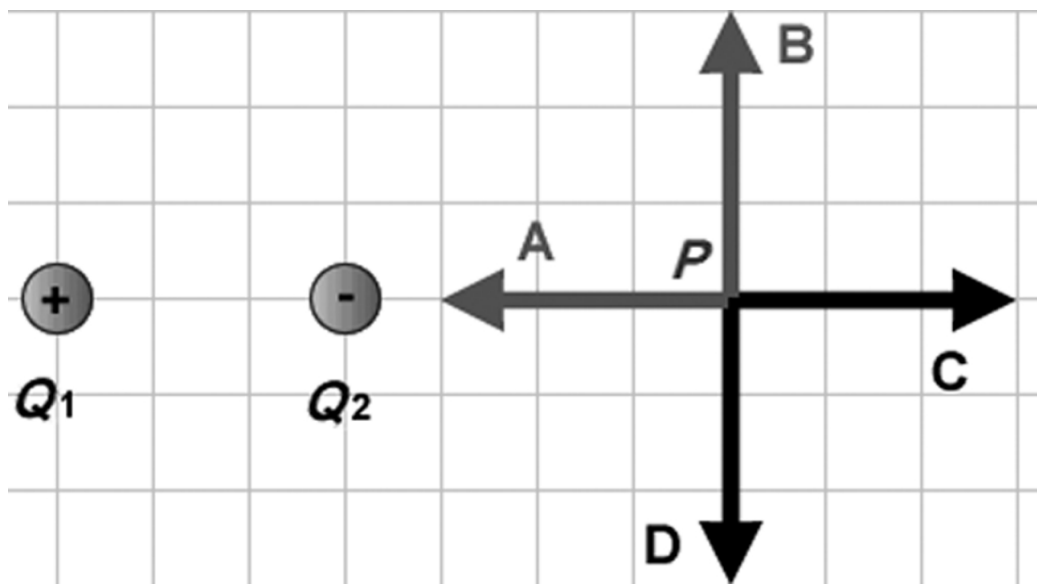
Answer: A

17) In the late 18th century, the invention of the "Leyden Jar" revolutionized our understanding of electricity. Today, such a device is known as a

- A) transistor
- B) resistor
- C) battery
- D) capacitor
- E) generator

Answer: D

18) Two point charges Q_1 and Q_2 of equal magnitudes and opposite signs are positioned as shown in the figure. Which of the arrows best represents the net electric field at point P due to these two charges?



- A) A
- B) B
- C) C
- D) D
- E) The field is equal to zero at point P .

Answer: A

19) A $+6.00 \mu\text{C}$ point charge and $-8.00 \mu\text{C}$ point charge are placed along the x -axis at $x = 0.000 \text{ cm}$ and $x = 40.0 \text{ cm}$, respectively. Where must a third charge, q , be placed along the x -axis so that it does not experience any net electric force due to the other two charges?

- A) -0.186 m
- B) 2.59 m
- C) -0.200 m
- D) -2.59 m
- E) 0.186 m

Answer: D

20) An irregularly shaped solid with a volume of 3.0 mm^3 carries a 2.0 nC charge that is uniformly distributed throughout the solid. If the farthest extent of the solid is 9.0 mm from the origin, what is the approximate electric field strength at 9.0 m from the origin?

- A) 0.074 N/C
- B) 0.22 N/C
- C) 0.67 N/C
- D) 1.7 N/C
- E) 0.025 N/C

Answer: B