Question 1

In the figure, an electron e travels through a small hole in plate A and then toward plate B. A uniform electric field in the region between the plates then slows the electron down without deflecting it.

What is the direction of the field?

- Leftward
- Rightward

Four other particles similarly travel through small holes in either plate A or plate B and then into the region between the plates. Three have charges +q₁, +q₂, -q₃. The fourth (labeled n) is a neutron, which is electrically neutral. Does the speed of each of those four other particles increase, decrease, or remain the same in the region between the plates?

+q₁
+q₂
-q₃
n
1. Increase
2. Decrease
3. Remain the same

**Question 2**

The figure shows five protons that are launched in a uniform electric field \( \vec{E} \); the magnitude and direction of the launch velocities are indicated. Rank the protons according to the magnitude of their accelerations due to the field, greatest first.

\[ \begin{array}{cccc}
\text{c} & \text{b} & \text{d} & \text{a} & \text{e} \\
10 \text{ m/s} & 3 \text{ m/s} & 5 \text{ m/s} & 7 \text{ m/s} & 16 \text{ m/s} \\
\end{array} \]

- c>b=d>a=e
- e>d>c>b>a
- a=e>b=d>c
- a=b=c=d=e
- a>b>c>d>e

**Question 3**

An electron with a speed of \( 5.95 \times 10^8 \text{ cm/s} \) in the positive direction of an \( x \) axis enters an electric field of magnitude \( 1.21 \times 10^3 \text{ N/C} \), traveling along a field line in the direction that retards its motion. (a) How far will the electron travel in the field before stopping momentarily, and (b) how much time will have elapsed? (c) If the region containing the electric field is 5.66 mm long (too short for the electron to stop within it), what fraction of the electron’s initial kinetic energy will be lost in that region?

(a) Number *1 Units
(b) Number *2 Units
(c) Number *3 Units
Question 4

At some instant the velocity components of an electron moving between two charged parallel plates are $v_x = 1.6 \times 10^5$ m/s and $v_y = 3.1 \times 10^3$ m/s. Suppose the electric field between the plates is uniform and given by $\vec{E} = \left(120 \text{ N/C}\right) \hat{j}$. In unit-vector notation, what are (a) the electron’s acceleration in that field and (b) the electron’s velocity when its $x$ coordinate has changed by 2.1 cm?

(a) $\left(\boxed{\quad \text{significant digits are disabled; the tolerance is +/-1 in the 3rd significant digit}} \quad \right) \hat{j}$.

(b) $\left(\boxed{\quad \text{significant digits are disabled; the tolerance is +/-1 in the 2nd significant digit}} \quad \right) \hat{i} + \left(\boxed{\quad \text{significant digits are disabled; the tolerance is +/-1 in the 2nd significant digit}} \quad \right) \hat{j}$.

Question 5

Two large parallel copper plates are 6.84 cm apart and have a uniform electric field of magnitude $E = 3.22$ N/C between them (see the figure). An electron is released from the negative plate at the same time that a proton is released from the positive plate. Neglect the force of the particles on each other and find their distance from the positive plate when they pass each other.
**Question 6**

An electric dipole consists of charges +2e and -2e separated by 0.63 nm. It is in an electric field of strength \(3.7 \times 10^6\) N/C. Calculate the magnitude of the torque on the dipole when the dipole moment is (a) parallel to, (b) perpendicular to, and (c) antiparallel to the electric field.

(a) Number \[\text{Units}\] ^{1}

(b) Number \[\text{Units}\] ^{2}

(c) Number \[\text{Units}\] ^{3}

\(^{1}\) - significant digits are disabled; the tolerance is +/-2%

\(^{2}\) - significant digits are disabled; the tolerance is +/-1 in the 2nd significant digit

\(^{3}\) - significant digits are disabled; the tolerance is +/-2%

**Question 7**

The figure shows three paths along which we can move the positively charged sphere \(A\) closer to positively charged sphere \(B\), which is held fixed in place.

Would sphere \(A\) be moved to a higher or lower electric potential?
Is the work done by our force positive, negative, or zero?

- Zero
- Positive
- Negative

Is the work done by the electric field due to $B$ positive, negative, or zero?

- Positive
- Negative
- Zero

Rank the paths according to the work our force does, greatest first. If multiple paths rank equally, use the same rank for each, then exclude the intermediate ranking (i.e. if objects A, B, and C must be ranked, and A and B must both be ranked first, the ranking would be A:1, B:1, C:3). If all paths rank equally, rank each as '1'.

- Path 1
- Path 2
- Path 3

1. Greatest
2. Second greatest
3. Third greatest

Question 8

In the figure, a particle is to be released at rest at point $A$ and then is to be accelerated directly through point $B$ by an electric field. The potential difference between points $A$ and $B$ is 100 V. Which point should be at higher electric potential if the particle is (a) an electron, (b) a proton, and (c) an alpha particle (a nucleus of two protons and two neutrons)? (d) Rank the kinetic energies of the particles at point $B$, greatest first.
Question 9

The electric potential difference between the ground and a cloud in a particular thunderstorm is $1.3 \times 10^9$ V. What is the magnitude of the change in the electric potential energy of an electron that moves between the ground and the cloud?

Number ____________________________  *1 Units ________________

*Significant digits are disabled; the tolerance is +/-1 in the 2nd significant digit

Question 10

Suppose that in a lightning flash the potential difference between a cloud and the ground is $1.2 \times 10^9$ V and the quantity of charge transferred is 29 C. (a) What is the change in energy of that transferred charge? (b) If all the energy released could be used to accelerate a 950 kg car from rest, what would be its final speed?

(a) Number ____________________________  *1 Units ________________

(b) Number ____________________________  *2 Units ________________

*1 - significant digits are disabled; the tolerance is +/-1 in the 2nd significant digit
*2 - significant digits are disabled; the tolerance is +/-1 in the 2nd significant digit