Seminar 5: Lectures 9-10

Print and answer all questions found below.
Please bring your completed worksheet to the Seminar Class. [1]

Question 1

A system consists of three-point charges, $q_1 = +5\mu C$, $q_2 = -3\mu C$ and $q_3 = +3\mu C$ placed at the vertices of an equilateral triangle with each side measuring $0.1\ m$.

(a) Calculate the force exerted on q_1 by q_2 using Coulomb's Law.

(b) Calculate the force exerted on q_1 by q_3 .

(c) Determine the net force on q_1 by combining the forces from q_2 and q_3.

(d) Sketch a diagram showing the arrangement of the charges and the forces acting on q_1.

[1] It is assumed that you have access to the standard physical constants.

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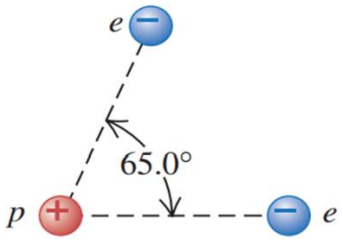
Question 2

If two electrons are each $1.5 \times 10^{-10}\ m$ from a proton, as shown in Figure below, find the magnitude and direction of the net electrical force they will exert on the proton. The charge of an electron is 1.6×10^{-19}C.



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Question 3

A plastic rod is rubbed with wool, making the rod negatively charged by 6.0 μC. The rod is then brought close to a neutral metal sphere on an insulating stand.

(a) Describe the process of charging the rod by friction.

(b) Explain the process of inducing charge on the metal sphere when the rod is brought close.

(c) If the sphere is grounded while the rod is nearby, describe what happens to the sphere. Subsequently we remove the grounding and then the rod. What is the charge of the sphere now?

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Question 4

Two charges, $q_1 = +3\mu C$, and $q_2 = -2\mu C$ are separated by 0.2 m.

(a) Calculate the electric field at a point midway between the two charges.
(b) Determine the direction of the electric field at this point.
(c) If a third charge $q_3 = +1\mu C$ is placed at this midpoint, calculate the force on q_3.
(d) Sketch the electric field lines around the two charges (in the original setup).

Question 5

Two small spheres spaced 20.0 cm apart have equal negative charge. How many excess electrons must be present on each sphere if the magnitude of the force of repulsion between them is $4.57 \times 10^{-21} N$

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Question 6

A small object carrying a charge of $-5 \times 10^{-9} C$ is acted upon by a downward force of 20.0 nN when placed at a certain point in an electric field.

(a) What is the magnitude and direction of the electric field at the point in question?

(b) What would be the magnitude and direction of the force acting on a proton placed at this same point in the electric field?

Question 7

An electron is released from rest in a uniform electric field. The electron accelerates vertically upward, traveling 4.5 m in the first $3\mu s$ after it is released.

(a) What is the magnitude and direction of the electric field?

(b) Are we justified in ignoring the effects of gravity? Justify your answer quantitatively.

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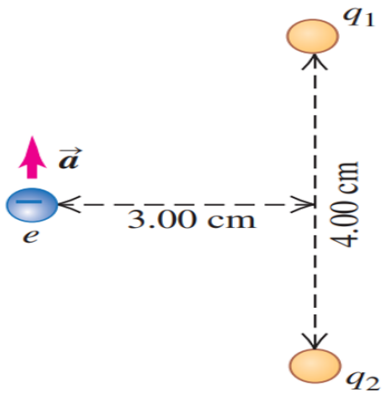
Question 8

Two-point charges $q_1 \; and \; q_2$ and are held 4.00 cm apart. An electron released at a point that is equidistant from both charges (see Figure 17.59) undergoes an initial acceleration of $8.25 \times 10^{18} \; m/s^2$directly upward as shown in the figure, parallel to the line connecting $q_1 \; and \; q_2$. Find the magnitude and sign $q_1 \; and \; q_2$.



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Extension Questions

Question 9

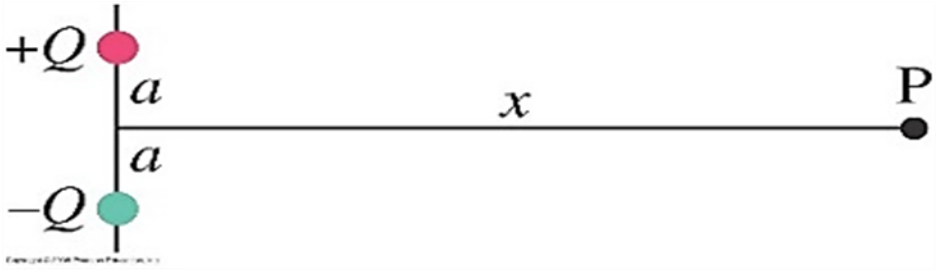
An electron moving to the right at $7.5 \times 10^5\ m/s$ enters a uniform electric field parallel to its direction of motion. If the electron is to be brought to rest in the space of 4.0 cm;

(a) what direction is required for the electric field and

(b) what is the strength of the field?

Question 10

Determine the direction and magnitude of the electric field at the point P shown in the figure. The two charges are separated by a distance, $2a$. Point P is on the perpendicular bisector of the line joining the charges, a distance, x, from the midpoint between them. Express your answer in terms of Q, x, a, and k.



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Question 11

Two charges, $-Q_0$ and $-4Q_0$, are a distance, l, apart. These two charges are free to move, but do not because there is a third charge nearby. What must be the magnitude of the third charge and its placement in order for the first two to be in equilibrium?