PHYS 102: General Physics 2 **KOÇ UNIVERSITY** **Spring Semester 2010**

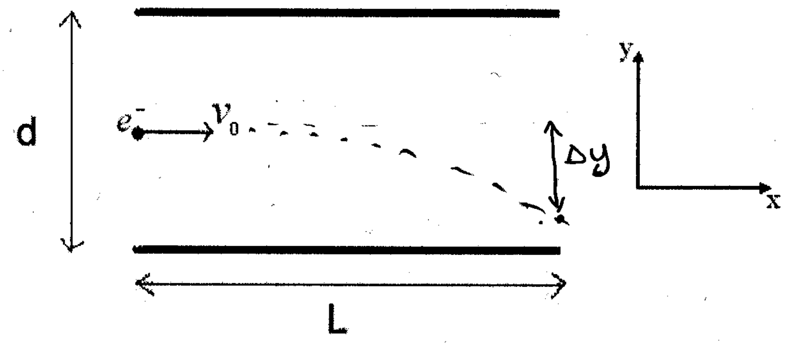
College of Sciences

Section 1 **Quiz 3** **11 March 2010**

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

An electron (charge $-e$ and mass m_e) with an initial speed v_0 is projected along the axis midway between the conducting plates of length L. Assume that the upper plate has negative and the lower plate has positive charge distribution, and that the resultant electric field is uniform. How far below the axis has the electron moved when it reaches the end of the plates, Δy, assuming $|\Delta y| < \frac{d}{2}$? What would happen if the particle had been a positron (charge e and mass $m_p = m_e$)? (effects of gravity is negligible, and you can ignore it)



$$\vec{F} = -e\vec{E} \Rightarrow -eE\hat{j} = m_e\vec{a}$$

$$\vec{a} = -\frac{eE}{m_e}\hat{j} = a_y\hat{j}$$

$$x - x_0 = v_{0x}t + \frac{1}{2}a_x t^2 \Rightarrow L = v_0 t^* \Rightarrow t^* = \frac{L}{v_0}$$

$$y - y_0 = v_{0y}t + \frac{1}{2}a_y t^2$$

$$\Delta y = \frac{1}{2}\left(-e\frac{E}{m_e}\right)t^{*2} = -\frac{e}{2}\frac{E}{m_e}\left(\frac{L}{v_0}\right)^2$$

$$\Delta y = -\frac{eEL^2}{2m_e v_0^2}$$

For Positron (e^+);

$$\Delta y = \frac{eEL^2}{2m_e v_0^2}$$

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Section 2 Quiz 3 11 March 2010

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Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

In a certain region of space, the electric potential is;

$$V(x,y,z) = Axy - Bx^2 + Cy,$$

where A, B and C are positive constants. Determine the units of A, B and C, and find the point where the electric field is zero.

$$A \equiv \frac{\text{Volt}}{m^2}, \quad B \equiv \frac{\text{Volt}}{m^2}, \quad C \equiv \frac{\text{Volt}}{m}$$

$$\vec{E} = -\vec{\nabla} V = -(Ay - 2Bx)\hat{i} - (Ax + C)\hat{j}$$

$$\vec{E} = 0 \Rightarrow x = -\frac{C}{A}$$

$$y = \frac{2B}{A}x = -\frac{2BC}{A^2}$$

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Section 3 **Quiz 3** **11 March 2010**

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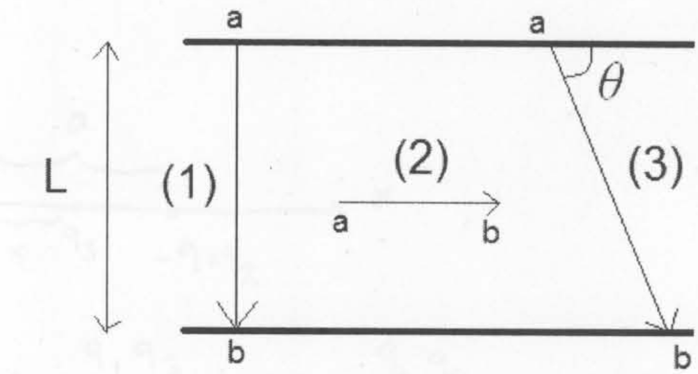
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

Using the definition of the electric potential;

$$V_{ab} = V_a - V_b = \int_a^b \vec{E} \cdot d\vec{l}$$

calculate V_{ab} for the trajectories shown in the figure. Assume that the upper plate has positive and the lower plate has negative surface charge density σ, and that the resultant electric field is uniform.



$$V_{ab} = \int_a^b \vec{E} \cdot d\vec{l}$$

$$\vec{E} = -\frac{\sigma}{\varepsilon_0}\hat{j}, \quad d\vec{l} = dx\,\hat{i} + dy\,\hat{j}$$

$$\vec{E} \cdot d\vec{l} = -\frac{\sigma}{\varepsilon_0} dy$$

$$V_{ab} = -\frac{\sigma}{\varepsilon_0}\int_a^b dy$$

$\Rightarrow \quad V_{ab} = -\dfrac{\sigma L}{\varepsilon_0}$ for (1) and (3)

$V_{ab} = 0$ for (2)

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Section 4 **Quiz 3** **11 March 2010**

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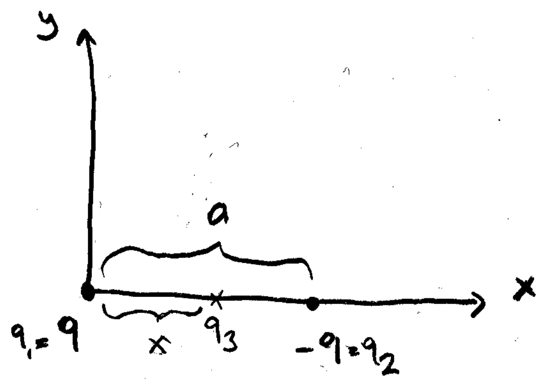
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

A point charge $q_1 = q > 0$ is placed at the origin and a second point charge $q_2 = -q$ is placed on the x-axis at $x = a$. A third particle $q_3 = q$ is placed on the x-axis between q_1 and q_2. Where should q_3 be placed to make the potential energy of the system equal to zero?



$$U = \frac{q_1 q_2}{4\pi\varepsilon_0 a} + \frac{q_1 q_3}{4\pi\varepsilon_0 x} + \frac{q_2 q_3}{4\pi\varepsilon_0 (a-x)} = 0$$

$$\Rightarrow \frac{q_1 q_2}{a} + \frac{q_1 q_3}{x} + \frac{q_2 q_3}{a-x} = 0$$

$$q_1 q_3 (a-x) + q_2 q_3 x = -\frac{q_1 q_2}{a} x (a-x)$$

$$-\frac{q_1 q_2}{a} x^2 + (-q_1 q_3 + q_2 q_3 + q_1 q_2) x + q_1 q_3 a = 0$$

$$\Rightarrow \frac{q^2}{a} x^2 - 3q^2 x + q^2 a = 0$$

$$\alpha x^2 + \beta x + c = 0$$

$$\Rightarrow x = -\frac{\beta}{2\alpha} \pm \sqrt{\left(\frac{\beta}{2\alpha}\right)^2 - \frac{c}{\alpha}}$$

$\alpha < 0$, $\beta > 0$, $c < 0$

since, $\frac{c}{\alpha} = a^2 > 0$ and $\frac{\beta}{2\alpha} < 0$

$$\boxed{x = \frac{3}{2} a \pm \sqrt{\left(\frac{3}{2} a\right)^2 - a}}$$

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Section 5

Quiz 3

11 March 2010

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Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

A small particle has charge $q < 0$ and mass m. It moves from point A where the electric potential is $V_A > 0$ to point B where the electric potential is $V_B > V_A$. If the particle has speed v_A at point A, what is its speed at point B? Is it moving faster or slower at B than at A? (assume there is only electrostatic forces)

$$K_A + U_A = K_B + U_B$$

$$U = qV$$

$$\frac{1}{2} m v_A^2 + qV_A = \frac{1}{2} m v_B^2 + qV_B$$

$$v_B = \sqrt{v_A^2 + \frac{2q}{m}(V_A - V_B)}$$

Since $V_B > V_A$, but $q < 0$

$$v_A < v_B$$