Quiz 5 Phys. 2306 F09 Crn94823

You may use your text book, notes, and a calculator.

Two very large area parallel, conducting plates A,B are kept at a potential difference $\Delta V$ by a battery. The plates are separated by a distance $d$. Small holes are drilled in the plates so that particles traveling perpendicular to the plates can pass through the holes. Electron 1 traveling from A to B is accelerated from $3.00 \times 10^6$ m/s to $8.00 \times 10^6$ m/s. Electron 2 traveling from B to A is slowed from speed $v$ to zero. You may use $q_e = -1.60 \times 10^{-19}$ C and $m_e = 9.11 \times 10^{-31}$ kg.

1) The electric field between the plates points from?
   a) A to B b) B to A

The speed of electron 1 increases as it travels from A to B. Since electrons have negative charge, the electric field points from B to A, b.

2) Which plate is at the higher potential?
   a) A b) B

Pick $E = E_0 k$ so that $E_0$ is a positive constant and going from B to A means you are going in the direction of increasing $z$. Then, $V_A - V_B = - \int_B^A E \cdot dr = -E_0 \int_{z_B}^{z_A} dz = -E_0 (z_A - z_B) < 0$, b.

3) What is $\Delta V$ in volts?
   a) 7.42 b) 15.7 c) 157. d) 314. e) none of these

Note $q_e = -e$. Use conservation of energy on electron 1, so, $0.5m(v_B^2 - v_A^2) - e(V_B - V_A) = 0$. Thus, $\Delta V = (0.5m/e)(v_B^2 - v_A^2) = 157$ V, c.
4) What is the speed $v$ in $10^6$ m/s?
   a) 7.42 b) 5.26 c) 3.71 d) 2.14 e) none of these

From conservation of energy and the fact that the final KE = 0, one gets $0.5mv^2 = e\Delta V$. So $v = \sqrt{(2e/m)\Delta V} = 7.42 \times 10^6$ m/s, a.

5) What is the surface charge density on the surface of the positive plate closest to the negative plate in terms of $d, \varepsilon_0, \Delta V$?
   a) $\varepsilon_0 \Delta V/d$ b) $2\varepsilon_0 \Delta V/d$ c) $\varepsilon_0 \Delta V/2d$ d) $\Delta V/d\varepsilon_0$ e) none of these

$E_0 = \sigma/\varepsilon_0 = \Delta V/d$, so $\sigma = \varepsilon_0 \Delta V/d$, a.