Chapter 7 Problem 37 [†]

Given
$E = 7.50 \times 10^4\ V/m$
$\Delta x = 4.0\ cm = 0.040\ m$

Solution
a) Find the potential difference between the plates.

The voltage difference between the two plates is

$$\Delta V = -\int \vec{E} \cdot d\vec{l}$$

Since the electric field is uniform between two parallel plates, the integral simplifies to

$$\Delta V = -E\Delta x \qquad (Eq.1)$$

assuming the motion between the plates is in the x-direction. The voltage difference between the two plates is

$$\Delta V = -(7.50 \times 10^4\ V/m)(0.040\ m) = -3,000\ V$$

The negative occurs because you are losing potential energy as you move from the positive plate to the negative plate of the system. If you went from negative to positive, you would have $+3,000\ V$.

b) What is the potential at $x = 0.010\ m$ from the lowest potential plate?

The lowest potential plate is the negatively charged one. Setting this one equal to $0\ V$, the other plate will be at $3,000\ V$. As you go from one plate to the other, the potential increases linearly because the electric field is uniform between the plates. Since the location of interest is $1/4$ of the total distance between the plates, the potential level will be $1/4$ of the highest potential plate. Therefore, the potential at $x = 0.010\ m$ is $750\ V$.
Alternately, you could use Eq. 1 in part a) and use $0.010\ m$ instead of $0.040\ m$ and get the same answer.

$$\Delta V = (7.50 \times 10^4\ V/m)(0.010\ m) = 750\ V$$

Notice I dropped the negative sign. If I set up the integral correctly in light of part a), the negative sign will drop out.

[†] Problem from Univesity Physics by Ling, Sanny and Moebs (OpenStax)