1) A proton with a speed of 2×10^5 m/s falls through a potential difference V and thereby increases its speed to 4×10^5 m/s. Through what potential difference did the proton fall?

A) 1540 V B) 144V C) 626 V D) 258 V E) 835 V

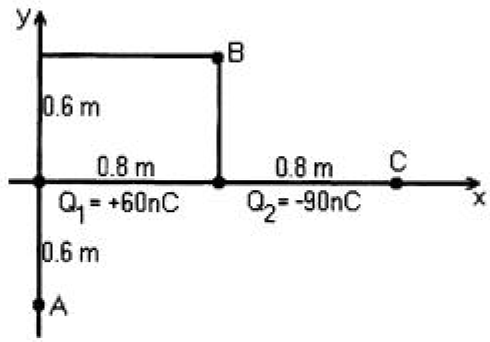
$$\Delta E = \frac{1}{2} m_p v_f^2 - \frac{1}{2} m_p v_i^2 = q \Delta V$$

$$\frac{1}{2} m_p (v_f^2 - v_i^2) = e \, \Delta V$$

$$\Delta V = \frac{m_p (v_f^2 - v_i^2)}{2e} = \frac{1.67 \times 10^{-27} \text{kg} \cdot [(4 \times 10^5 \text{m/s})^2 - (2 \times 10^5 \text{m/s})^2]}{2 \cdot 1.60 \times 10^{-19} \text{C}}$$

$$= 626 \text{ V}$$

Figure 24.1



Point charges, $Q_1 = +60$ nC and $Q_2 = -90$ nC, are placed as shown.

2) In Figure 24.1, a point on the positive y-axis lies on the V = 0 equipotential surface. The y-coordinate of the point, in SI units, is closest to:

A) 0.74 B) 0.70 C) 0.72 D) 0.78 E) 0.76

3) In Figure 24.1, an electron is released from rest at point C. The speed of the electron as it arrives at infinity is closest to:

A) 1.3×10^7 B) 1.1×10^7 C) 1.7×10^7 D) 1.5×10^7 E) 1.9×10^7

2) $V = k_e \left(\frac{Q_1}{r_1} + \frac{Q_2}{r_2} \right) = 0 \quad r_1 = y \quad r_2 = \sqrt{y^2 + 0.8_m^2}$

$$k_e \left(\frac{60 nC}{y} + \frac{-90 nC}{\sqrt{y^2 + 0.8_m^2}} \right) = 0$$

$$60 nC \cdot \sqrt{y^2 + (0.8m)^2} = 90 nC \cdot y$$

$$2 \cdot \sqrt{y^2 + (0.8m)^2} = 3 \cdot y$$

$$4 (y^2 + 0.64 m^2) = 9 y^2$$

$$5 y^2 = 2.56 m^2 \rightarrow y^2 = \frac{2.56 m^2}{5} \rightarrow y = 0.716 m \sim 0.72 m$$

3) $\frac{1}{2} m v_f^2 = PE_f + PE_i + \frac{1}{2} m v_i^2 \to 0 = -e V_f - e V_i$

$\frac{1}{2} m v_f^2 = (-e) k_e \left[\left(\frac{60nC}{\infty} - \frac{90nC}{\infty} \right) \to 0 - \left(\frac{60nC}{1.6m} - \frac{90nC}{0.8m} \right) \right]$

$\frac{1}{2} m v_f^2 = (-e) k_e (-75 nV)$

$v_f = \sqrt{\frac{2(e) k_e}{m} (-75nV)} = 1.5e^7 \, m/s$

Situation 25.1

Each plate of a parallel-plate air capacitor has an area of 0.0040 m^2, and the separation of the plates is 0.030 mm. An electric field of 1.5×10^6 V/m is present between the plates.

4) In Situation 25.1, the potential difference across the capacitor is closest to:
A) 45 V B) 75 V C) 30 V D) 90 V E) 60 V

5) In Situation 25.1, the surface charge density on the plates, in $\mu C/m^2$, is closest to:
A) 11 B) 13 C) 9 D) 7 E) 15

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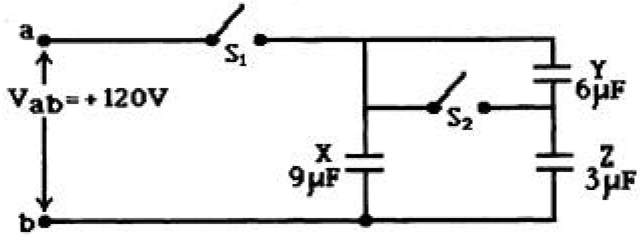
4) $V = E_x \Delta x = 1.5 \times 10^6 \frac{V}{m} \cdot 0.030mm \cdot \frac{1m}{10^3 mm} = 45V$

5) $Q = V \cdot C \qquad C = \epsilon_0 \frac{A}{d} \qquad \sigma = \frac{Q}{A}$

$\sigma = \frac{VC}{A} = \epsilon_0 \frac{VA}{dA} = \epsilon_0 \frac{V}{d} = 1.3 \times 10^{-5} C = 13 \mu C$

Figure 25.3



The network shown is assembled with uncharged capacitors X, Y, and Z, and open switches, S_1 and S_2. A potential difference V_{ab} = +120 V is applied between points a and b. After the network is assembled, switch S1 is closed, but swi S_2 is kept open.

6) In Figure 25.3, the voltage across capacitor Z, in SI units, is closest to:
A) 80 B) 20 C) 100 D) 40 E) 60

7) A 5.0-μF capacitor has a potential difference of 5.0 V applied across its plates. If the potential difference across its plates is increased to 9.0 V, how much additional energy does the capacitor store?
A) 280 μJ B) 80 μJ C) 40 μJ D) 140 μJ

$$C_{eq} = \frac{6\mu F \cdot 3\mu F}{(6+3)\mu F} = 2\mu F \qquad Q = C_{eq} \cdot V = 2\mu F\, 120V = 240\mu C$$

$$V_z = \frac{Q}{C} = \frac{240\mu C}{3\mu F} = 80\ V$$

7) $E = \frac{1}{2}CV^2$

$$\Delta E = \frac{1}{2}C(9.0V^2 - 5.0V^2) = \frac{1}{2}C(81V^2 - 25V^2)$$

$$= \frac{1}{2}\, 5\mu F \cdot 56V^2 = 140\mu J$$