

43. We use the conservation of energy principle. The initial potential energy is $U_i = q^2/4\pi\epsilon_0 r_1$, the initial kinetic energy is $K_i = 0$, the final potential energy is $U_f = q^2/4\pi\epsilon_0 r_2$, and the final kinetic energy is $K_f = \frac{1}{2}mv^2$, where v is the final speed of the particle. Conservation of energy yields

$$\frac{q^2}{4\pi\epsilon_0 r_1} = \frac{q^2}{4\pi\epsilon_0 r_2} + \frac{1}{2}mv^2 .$$

The solution for v is

$$\begin{aligned} v &= \sqrt{\frac{2q^2}{4\pi\epsilon_0 m} \left(\frac{1}{r_1} - \frac{1}{r_2} \right)} \\ &= \sqrt{\frac{(8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2)(2)(3.1 \times 10^{-6} \text{ C})^2}{20 \times 10^{-6} \text{ kg}} \left(\frac{1}{0.90 \times 10^{-3} \text{ m}} - \frac{1}{2.5 \times 10^{-3} \text{ m}} \right)} \\ &= 2.5 \times 10^3 \text{ m/s} . \end{aligned}$$