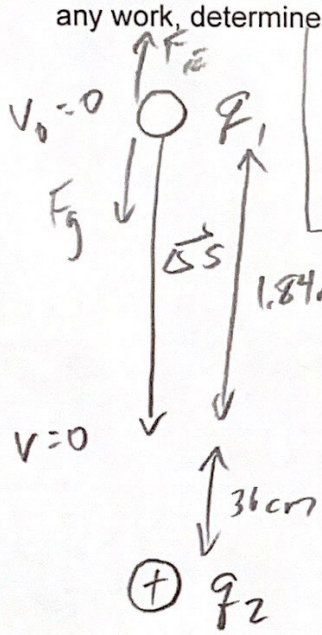
Quiz 19.3A

A 375 gram ball carrying an unknown charge q1 is initially at rest 2.20 meters above ground level. Directly below the ball is a fixed charge of value q2 = 45.0 μC.

When the ball is released, it falls toward the fixed charge, reaching a minimum distance of 36.0 cm before briefly coming to a stop.

Assuming that gravity and the electric force are the only forces in this problem that do any work, determine the value of the unknown charge q1.



$\vec{F}_E$ must point ↑ since q_1 slows down as it approaches q_2, so q_1 +

$$\Sigma W_F = W_g + W_E = \Delta K$$

$$W_g = +mg\Delta y$$

$$= (.375)(9.8)(1.84) = 6.762\ J$$

$$\Delta K = 0$$

$$\Rightarrow W_E = -6.762\ J$$

$$V_F = \frac{k_c q_2}{r_f} = \frac{(9\times10^9)(45\times10^{-6})}{.36} = 1.125\times10^6\ \text{Volts}$$

$$V_I = \frac{k_c q_2}{r_i} = \frac{(9\times10^9)(45\times10^{-6})}{2.2} = 1.841\times10^5\ \text{Volts}$$

$$\Delta V = 9.41\times10^5\ \text{Volts}$$

$$-6.762 = -q_1(9.41\times10^5) \Rightarrow \boxed{q_1 = 7.19\times10^{-6}\ C}$$