**Chapter 7 Problem 50** [†]

**Given**
$D = 0.200\ m$
$V = 25.0\ kV = 2.50 \times 10^4\ V$
$k = 8.99 \times 10^9\ Nm^2/C^2$
$m = 0.100\ mg = 1.00 \times 10^{-4}\ kg$
$v = 10.0\ m/s$

**Solution**
a) Find the charge on the sphere.

The diameter is given, so the radius is

$$r = \frac{D}{2} = \frac{0.200\ m}{2} = 0.100\ m$$

For a spherically shaped object, the voltage is

$$V = \frac{kq}{r}$$

Solving for charge gives

$$q = \frac{rV}{k}$$

Substituting in the appropriate values gives

$$q = \frac{(0.100\ m)(2.50 \times 10^4\ V)}{8.99 \times 10^9\ Nm^2/C^2} = 2.78 \times 10^{-7}\ C$$

This is $0.278\ \mu C$.

b) Find the charge on a $0.100\ mg$ paint drop to arrive with a speed of $10.0\ m/s$.

Voltage is related to potential energy by the relationship

$$\Delta U = q\Delta V$$

Since the object to be painted is grounded, or at $0\ V$, the potential difference is just the voltage of the sprayer's sphere. All of the energy is converted to kinetic energy, so

$$U = K$$

$$qV = \tfrac{1}{2}mv^2$$

Solving for q gives

$$q = \frac{mv^2}{qV} = \frac{(1.00 \times 10^{-4}\ kg)(10.0\ m/s)^2}{2(2.50 \times 10^4\ V)} = 2.00 \times 10^{-7}\ C$$

This is $0.200\ \mu C$.

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