Chapter 5 Problem 66 [†]

Given
$E = 100\ N/C$
$m = 2.0 \times 10^{-15}\ g = 2.0 \times 10^{-18}\ kg$
$q_e = -1.60 \times 10^{-19}\ C$

Solution
What is the magnitude and direction of the graviational and electric force on a small dust particle? What is the acceleration of the dust particle?

The graviational force will be in the downward direction (negative) and has a magnitude of

$$\vec{F_g} = m\vec{g} = (2.0 \times 10^{-18}\ kg)(9.80\ m/s^2 - \hat{j}) = -1.96 \times 10^{-17}\ N\hat{j}$$

The electric force will be in the upward direction (negative charges feel a force opposite of the direction of the electric field, which is downward) with a magnitude of

$$\vec{F_e} = q\vec{E} = (-1.60 \times 10^{-19}\ C)(-100\ N/m\hat{j}) = 1.60 \times 10^{-17}\ N\hat{j}$$

From Newton's 2nd Law

$$\Sigma\vec{F} = m\vec{a}$$

$$\vec{F_g} + \vec{F_e} = m\vec{a}$$

$$\vec{a} = \frac{\vec{F_g} + \vec{F_e}}{m}$$

$$\vec{a} = \frac{(-1.96 \times 10^{-17}\ N\hat{j}) + (1.60 \times 10^{-17}\ N\hat{j})}{2.0 \times 10^{-18}\ kg} = \frac{-0.36 \times 10^{-17}\ N\hat{j}}{2.0 \times 10^{-18}\ kg}$$

$$\vec{a} = -1.8\ m/s^2\hat{j}$$

It accelerates downward with a magnitude of $1.8\ m/s^2$.

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