345.

Problem 30.22 (RHK)

We have to compute the escape speed for an electron from the surface of a uniformly charged sphere of radius 1.22 cm *and total charge* 1.76×10^{-15} C. *We may neglect gravitational forces.*

Solution:

Potential energy of an electron at the surface of a uniformly charged sphere of radius $R = 1.22$ cm and total charge $q = 1.76\times10^{-15}$ C is

$$V = -\frac{1}{4\pi\varepsilon_0}\times\frac{qe}{R} = -\frac{8.99\times10^{9}\times1.76\times10^{-15}\times1.6\times10^{-19}}{1.22\times10^{-2}}\ \text{J}$$

$$= -2.075\times10^{-20}\ \text{J}.$$

Its potential energy at $r = \infty$ will be zero.

Escape speed is defined as the minimum speed that a particle must have so that it may escape to ∞. It implies that the sum of the kinetic energy and the potential energy of the electron on the surface of the charged sphere should be zero. That is

$$\frac{mv^2}{2} = 2.075\times10^{-20}\ \text{J},$$

or

$$v = \sqrt{\frac{2\times2.075\times10^{-20}}{9.11\times10^{-31}}} = 21.3\ \text{km s}^{-1}.$$