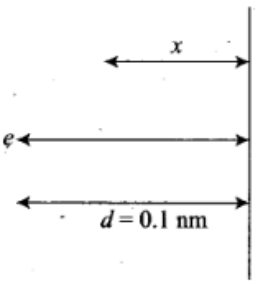
Question 26. Consider an electron in front of metallic surface of a distance d.Assume the force of attraction by the plate is given as . Calculate work in taking the to an infinite distance from the plate .Taking d=0.1 nm. find the work done in electron volts?

Solution:

Consider the figure in which an electron is displaced slowly by a distance x by the means of an external force which is,

$$F = \frac{q^2}{4 \times 4\pi\varepsilon_0 d^2}$$



where, $d = 0.1 \text{ nm} = 10^{-10} \text{ m}$

Let the electron be at distance x from metallic surface. Then, force of attraction on it is

$$F_x = \frac{q^2}{4 \times 4\pi\varepsilon_0 d^2}$$

Work done by external agency in taking the electron from distance d to infinity is

$$W = \int_d^\infty F_x dx = \int_d^\infty \frac{q^2 dx}{4 \times 4\pi\varepsilon_0} \frac{1}{x^2}$$

$$= \frac{q^2}{4 \times 4\pi\varepsilon_0}\left[\frac{1}{d}\right]$$

$$= \frac{(1.6 \times 10^{-19})^2 \times 9 \times 10^9}{4 \times 10^{-10}} \text{J}$$

$$= \frac{(1.6 \times 10^{-19})^2 \times (9 \times 10^9)}{(4 \times 10^{-10}) \times (1.6 \times 10^{-19})} \text{eV} = 3.6 \text{ eV}$$