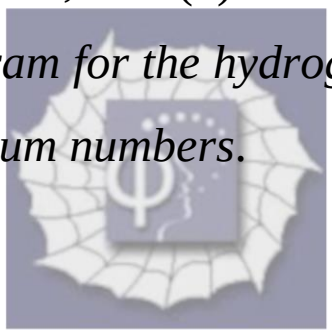
751.

Problem 51.18 (RHK)

A hydrogen atom in a state having a binding energy (*the energy required to remove an electron*) *of* 0.85 eV *makes a transition to a state with an excitation energy* (*the difference in energy between the state and the ground state*) *of* 10.2 eV. *We have to find* (a) *the energy of the emitted photon*; *and* (b) *show this transition on an energy-level diagram for the hydrogen, labelling with the appropriate quantum numbers.*



Solution:

(a)

The energy of the state which corresponds to a binding energy of 0.85 eV will be

$E_i = -0.85 \text{ eV}$.

As the states of the hydrogen atom, in the Bohr' model, have energies given by the relation

$$E_n = -\frac{13.6}{n^2} \text{ eV},$$

the state with energy E_i will correspond to the quantum number

$$n = \left(\frac{13.6}{0.85}\right)^{1/2} = 4.$$

It is given that the hydrogen atom makes a transition to the state with excitation energy of 10.2 eV. The energy of this state will therefore be

$$E_f = (-13.6 + 10.2)\ \text{eV} = -3.4\ \text{eV}.$$

The quantum number corresponding to this state is

$$n = \left(\frac{13.6}{3.4}\right)^{1/2} = 2.$$

The energy of the photon which is emitted when hydrogen atom makes a transition from the state with energy $0.85\ \text{eV}$ to the state with energy E_f will be

$$h\nu = E_i - E_f = (-0.85 + 3.4)\ \text{eV} = 2.55\ \text{eV}.$$

(b)