Find the wavelengths present in the radiation emitted when hydrogen atoms excited to $n = 3$ states return to their ground states.

Solution : A hydrogen atom may return directly to the ground state or it may go to $n = 2$ and from there to the ground state. Thus, wavelengths corresponding to $n = 3 \rightarrow n = 1$, $n = 3 \rightarrow n = 2$ and $n = 2 \rightarrow n = 1$ are present in the radiation.

The energies in $n = 1$, 2 and 3 states are

$$E_1 = -13{\cdot}6 \text{ eV}$$

$$E_2 = -\frac{13{\cdot}6}{4} \text{ eV} = -3{\cdot}4 \text{ eV}$$

and
$$E_3 = -\frac{13{\cdot}6}{9} \text{ eV} = -1{\cdot}5 \text{ eV}.$$

The wavelength emitted in the transition $n = 3$ to the ground state is

$$\lambda = \frac{hc}{\Delta E}$$

$$= \frac{1242 \text{ eV nm}}{13{\cdot}6 \text{ eV} - 1{\cdot}5 \text{ eV}} = 103 \text{ nm}.$$