746.

Problem 51.11 (RHK)

The lifetime of an electron in the state $n = 2$ *in hydrogen is about* 10 ns. *We have to calculate the uncertainty in the energy of the* $n = 2$ *state and compare it with the energy of this state.*

Solution:

According to the Heisenberg's uncertainty principle

$\Delta E \, \Delta T = \mathrm{h}$,

where ΔE is the uncertainty in energy and ΔT is the uncertainty in time that is the lifetime of a state. It is given that the lifetime of an electron in the state $n = 2$ in hydrogen is about 10 ns. Therefore, the uncertainty in the energy of the state will be

$$\Delta E = \frac{\mathrm{h}}{\Delta T} = \frac{1.05 \times 10^{-34}}{10 \times 10^{-9}} \text{ J}$$

$$= \frac{1.05 \times 10^{-26}}{1.6 \times 10^{-19}} \text{ eV} = 6.56 \times 10^{-8} \text{ eV}.$$

The energy of the state $n = 2$ is

$$E_2 = -\frac{13.58}{2^2} \text{ eV} = -3.39 \text{ eV}.$$

Ratio of the uncertainty in energy of the state and its energy will be

$$\frac{\Delta E}{|E_2|} = \frac{6.56 \times 10^{-8}}{3.39} = 1.9 \times 10^{-8} \ .$$