734.

Problem 50.24 (RHK)

An atom in an excited state has a lifetime of 12 ns; *in a second excited state the lifetime is* 23 ns. *We have to find the uncertainty in energy for a photon emitted when an atom makes a transition between the two states*.

Solution:

The lifetime of the first excited state is 12 ns. Therefore, uncertainty in the energy of this level will be

$$\Delta E_1 = \frac{6.63\times10^{-34}\ \text{J s}}{2\pi\times12\times10^{-9}\ \text{s}} = 8.79\times10^{-27}\ \text{J}$$

$$= \frac{8.79\times10^{-27}}{1.6\times10^{-19}}\ \text{eV}$$

$$= 5.5\times10^{-8}\ \text{eV}.$$

The lifetime of the second excited state is 23 ns.

Therefore, uncertainty in the energy of this level will be

$$\Delta E_2 = \frac{6.63\times10^{-34}\ \text{J s}}{2\pi\times25\times10^{-9}\ \text{s}} = 4.22\times10^{-27}\ \text{J}$$

$$= \frac{4.22\times10^{-27}}{1.6\times10^{-19}}\ \text{eV}$$

$$= 2.6\times10^{-8}\ \text{eV}.$$

Therefore, the uncertainty in energy for a photon emitted when an atom makes a transition between the two states will be

$\Delta E_1 + \Delta E_2 = 8.1 \times 10^{-8}$ eV.