Question #60942, Physics / Other | for completion.

A certain atom has an energy level of 2.58 eV above the ground level. Once excited to this level, the atom remains in this level for 1.64×10^{-7} s before emitting a photon and returning to the ground level.

1) What is its wavelength? What is the color of this light?
2) What is the smallest possible uncertainty in energy (in eV) of the photon?
3) Find the width L of a one-dimensional box that would correspond to the absolute value of the ground state of a hydrogen atom. What is your observation?

Solution

1) The excitation energy is the energy that must be transferred to the electron, so that he went into an excited state. According to Bohr's postulate, the transition of an electron from one state (higher energy) to another (lower energy) emitted photon; find its wavelength by the formula:

$$\boldsymbol{h\frac{c}{\lambda} = E_{n_2} - E_{n_1}}$$

$$\boldsymbol{\lambda = \frac{hc}{\Delta E_{n_{2-1}}} = \frac{6,63 \cdot 10^{-34} J \cdot s \cdot 3 \cdot 10^{8} m/s}{2,58 eV \cdot 1,6 \cdot 10^{-19} C} = 4,818 \cdot 10^{-7} m \approx 482\ nm}$$

Light wavelength corresponds to **blue color**.

2) The possible uncertainty in energy of the photon:
$$\boldsymbol{\Delta E \cdot \Delta t \geq \hbar}$$
$$\boldsymbol{\Delta E \geq \frac{\hbar}{\Delta t} = \frac{1,05 \cdot 10^{-34} J \cdot s}{1,64 \cdot 10^{-7} s} \geq 0,64 \cdot 10^{-27} J \geq 4 \cdot 10^{-9} eV}$$
3) The solution of the Schrödinger equation for the one-dimensional potential box gives energy eigenvalue.
$$E_n = \frac{n^2 h^2}{8mL^2};$$
$$L = nh\sqrt{\frac{1}{8mE}} = 1 \cdot 6{,}63 \cdot 10^{-34} \mathrm{J} \sqrt{\frac{1}{8 \cdot 9{,}11 \cdot 10^{-31} kg \cdot 13{,}6 eV \cdot 1{,}6 \cdot 10^{-19} C}}$$
$$= 1{,}665 \cdot 10^{-10} m$$

Answer the questions:

1) $\boldsymbol{\lambda \approx 482\ nm}$ **- blue color**
2) $\boldsymbol{\Delta E \geq 4 \cdot 10^{-9} eV}$
3) $\boldsymbol{L = 1,665 \cdot 10^{-10} m}$