Atomic Energy Levels & Spectra

Modern physics · 4 questions · step-by-step answers at the end

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USEFUL EQUATIONS

$E_n = -13.6\ \text{eV}/n^2$ $E_{\text{photon}} = |E_i - E_f|$ $\lambda = 1240/|\Delta E|\ \text{nm}$ $E = hf$

Questions

Show your working in the space under each question.

1. Find the wavelength of the photon emitted in the n = 2 → 1 transition.

2. An electron in hydrogen drops from n = 3 to n = 2. Find the photon energy and wavelength, and name the colour.

3. How many different emission lines can hydrogen atoms excited to n = 5 produce?

4. What is the shortest wavelength in hydrogen's Balmer series (drops to n = 2)?

Step-by-step answers

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1. $\Delta E = 13.6(1 - \frac{1}{4}) = 10.2$ eV; $\lambda = 1240/10.2 \approx$ **122 nm** (ultraviolet, Lyman series).

2. 1. $E_3 = -13.6/9 = -1.51$ eV; $E_2 = -13.6/4 = -3.40$ eV.
2. $\Delta E = 3.40 - 1.51 =$ **1.89 eV**.
3. $\lambda = 1240/1.89 =$ **656 nm**.
4. That's **red**, the famous H-alpha line in the Balmer series.

Answer: 1.89 eV, 656 nm (red, Balmer H-α)

3. $5 \times 4/2 =$ **10**.

4. From $n = \infty$: $\Delta E = 3.4$ eV, so $\lambda =$ **365 nm** (just into the UV).