

Atomic energy levels and line spectra

Physics grades 11-12 (A Level · IB · Class 11-12) · Test

Name: _____ Date: _____ Class: _____ Mark: ____ / 20

Answer all the questions. Show each step of a calculation, give units, and use $h = 6.63 \times 10^{-34} \text{ J s}$, $c = 3.00 \times 10^8 \text{ m/s}$, $1 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$ and $\lambda \text{ (nm)} = 1240 / E \text{ (eV)}$. A calculator is allowed.

Level: Physics grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** IB E.1

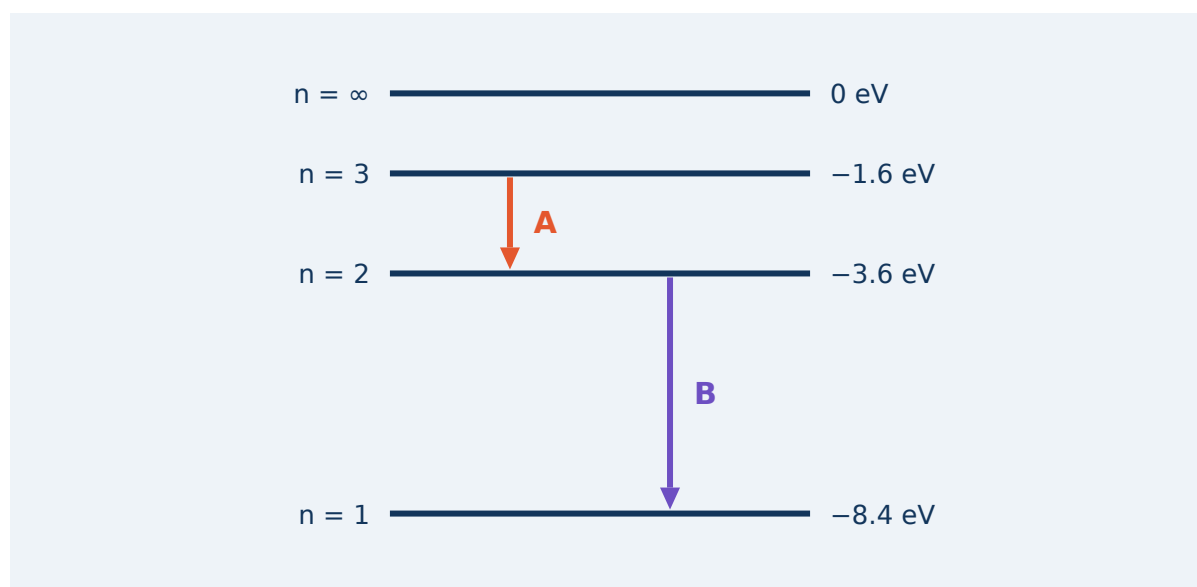
Time: 45 minutes · 8 questions · Total: 20 marks · Calculator allowed

Question 1 The electronvolt (2 marks)

- Define the electronvolt. (1 mark)
- Calculate 2.5 eV in joules. (1 mark)

Question 2 Reading a level diagram (3 marks)

The diagram shows some energy levels of an atom, and two transitions A and B.



Energy levels of the atom.

- Calculate the energy of the photon emitted in transition A. (1 mark)
- Calculate the wavelength of that photon. (1 mark)
- Calculate the energy of the photon in transition B and state whether it is visible. (1 mark)

Question 3 Discrete emission (2 marks)

Explain why an atom of a gas emits light only at certain wavelengths.

Question 4 Dark lines in starlight (3 marks)

Explain how the dark lines in the spectrum of a star show which elements are present in its atmosphere.

Question 5 Hydrogen $n = 5$ to $n = 2$ (3 marks)

In hydrogen, level $n = 5$ is at -0.54 eV and level $n = 2$ is at -3.40 eV.

- Calculate the energy of the photon emitted in the transition $n = 5 \rightarrow n = 2$. (1 mark)
- Calculate its wavelength. (1 mark)
- State the region of the spectrum. (1 mark)

Question 6 Electron collision (2 marks)

An electron of kinetic energy 9.0 eV hits a hydrogen atom in the ground state. The smallest energy needed to excite the atom is 10.2 eV. Explain what happens.

Question 7 A 100 nm photon (3 marks)

A photon of wavelength 100 nm meets a hydrogen atom in the ground state (-13.6 eV). The next levels are at -3.40 eV, -1.51 eV and -0.85 eV.

- Calculate the energy of the photon. (1 mark)
- Deduce whether the atom can absorb the photon. (2 marks)

Question 8 Photons from a laser pointer (2 marks)

A laser pointer emits 5.0 mW of green light of wavelength 532 nm. Use $h = 6.63 \times 10^{-34}$ J s and $c = 3.00 \times 10^8$ m/s.

- Calculate the energy of one photon. (1 mark)
- Calculate the number of photons emitted per second. (1 mark)