

Energy levels, radioactive decay and binding energy

AP Physics 2 (algebra-based) · Test

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

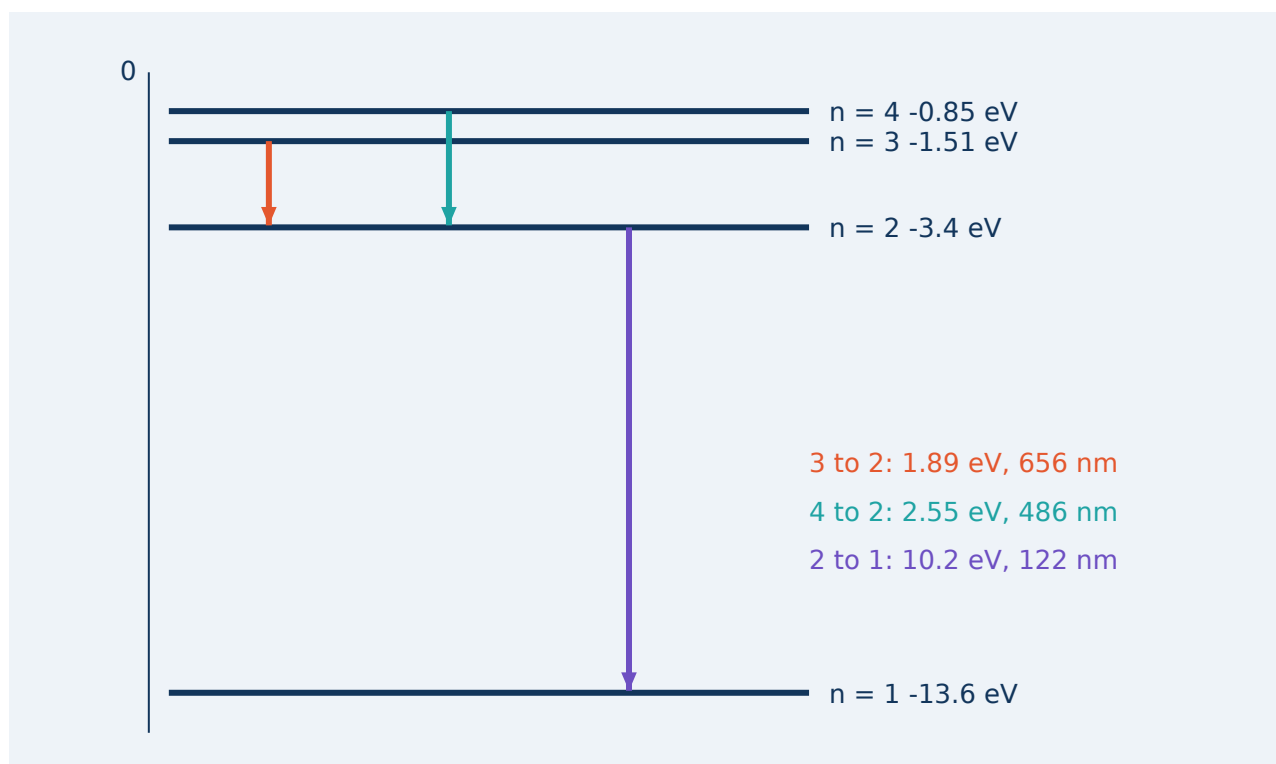
This test covers energy levels, nuclear equations, half-life and binding energy with calculations and short explanations. Use $1 \text{ u} = 931.5 \text{ MeV}$ and $hc = 1240 \text{ eV}\cdot\text{nm}$ where needed. Show each step.

Level: AP Physics 2 (algebra-based) · **Curriculum:** AP P2 Unit 15

Time: 40 minutes · 8 questions · Total: 20 marks · Calculator allowed

Question 1 Hydrogen transition (3 marks)

The diagram shows hydrogen levels.



Hydrogen energy levels with three emission transitions.

An electron falls from $n = 3$ to $n = 1$. Use $hc = 1240 \text{ eV}\cdot\text{nm}$.

- Calculate the photon energy. (1 mark)
- Calculate the wavelength. (1 mark)
- State the region of the spectrum. (1 mark)

Question 2 Absorption (2 marks)

A hydrogen atom in the ground state is hit by photons of energy 10.2 eV and 10.0 eV.

- State which photon is absorbed. (1 mark)
- Explain your choice. (1 mark)

Question 3 Alpha decay (2 marks)

Polonium-210 ($Z = 84$) emits an alpha particle and becomes lead ($Z = 82$).

- Write the nuclear equation. (1 mark)
- Name the two quantities that are conserved in the equation. (1 mark)

Question 4 Beta decay (2 marks)

Iodine-131 ($Z = 53$) decays by beta minus emission to xenon.

- State the mass number and atomic number of xenon. (1 mark)
- Describe what happens inside the nucleus. (1 mark)

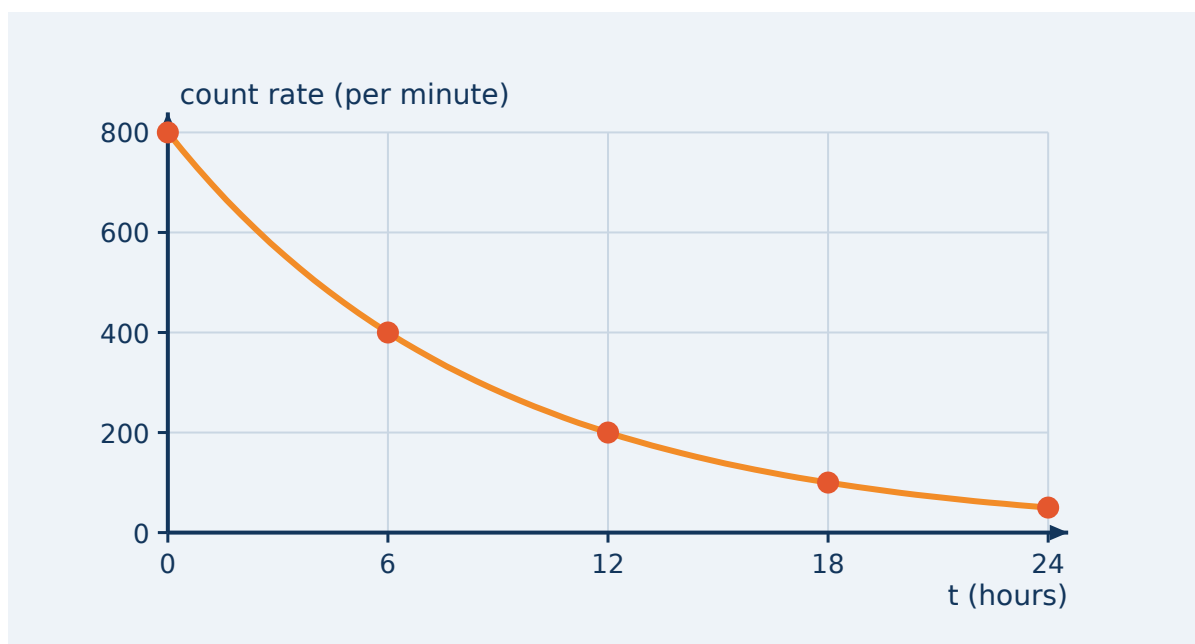
Question 5 Half-life calculation (3 marks)

A sample contains 40 mg of an isotope with half-life 12 hours.

- Calculate the mass left after 36 hours. (2 marks)
- Calculate the time for the mass to fall to 2.5 mg. (1 mark)

Question 6 Decay graph (3 marks)

The graph shows the count rate of a source.



Count rate against time.

- Read the half-life. (1 mark)
- Predict the count rate at 18 hours. (1 mark)
- Explain why the rate at 12 hours is not zero. (1 mark)

Question 7 Mass defect (3 marks)

In a nuclear reaction the total mass decreases by 0.0150 u. Use $1 \text{ u} = 931.5 \text{ MeV}$.

- Calculate the energy released in MeV. (1 mark)
- Convert this to joules, given that $1 \text{ MeV} = 1.60 \times 10^{-13} \text{ J}$. (1 mark)
- State the relationship used. (1 mark)

Question 8 Fusion and fission (2 marks)

Binding energy per nucleon peaks near iron-56.

- Explain why fusing light nuclei releases energy. (1 mark)
- Explain why splitting very heavy nuclei releases energy. (1 mark)