

Exercise walk-through

15.7

Fission, Fusion, and Nuclear Decay

AP Physics 2

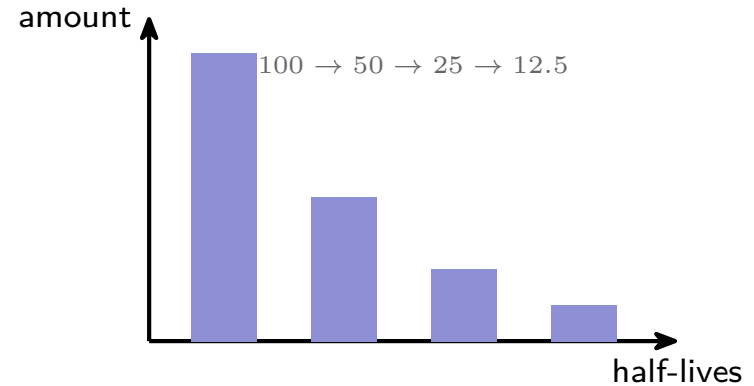
Nuclear physics

The nucleus releases huge energy when it changes – the lost **mass** becomes energy:

Mass-energy

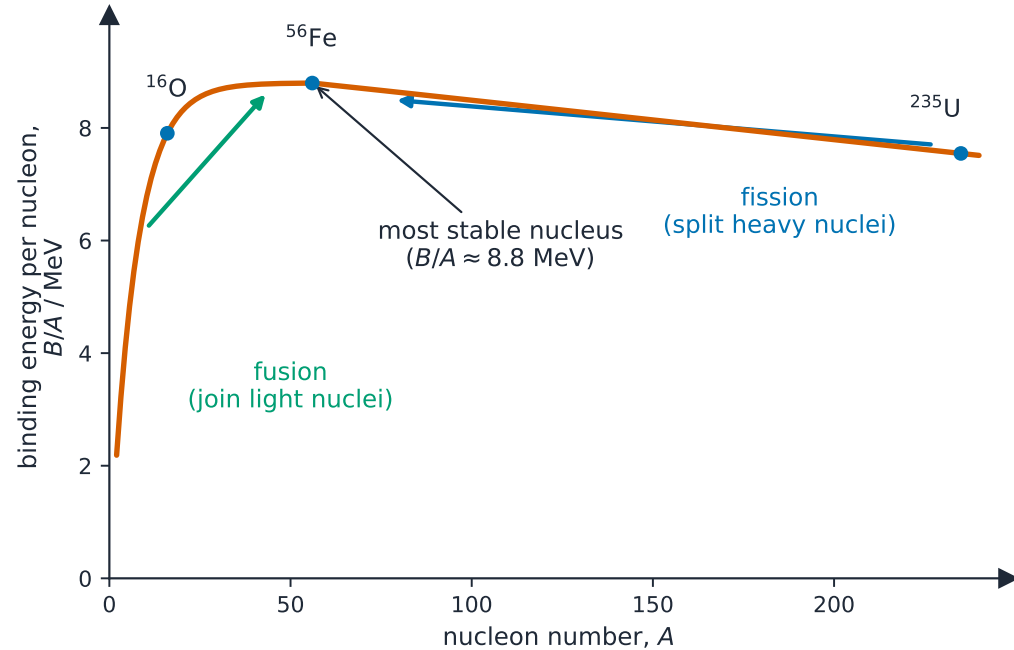
$$E = mc^2$$

- **fission** : split a heavy nucleus
- **fusion** : join light nuclei (the Sun)
- **alpha** / **beta** / **gamma** decay – conserve nucleons & charge



Half-life : time for half to decay.

Binding energy per nucleon peaks near iron



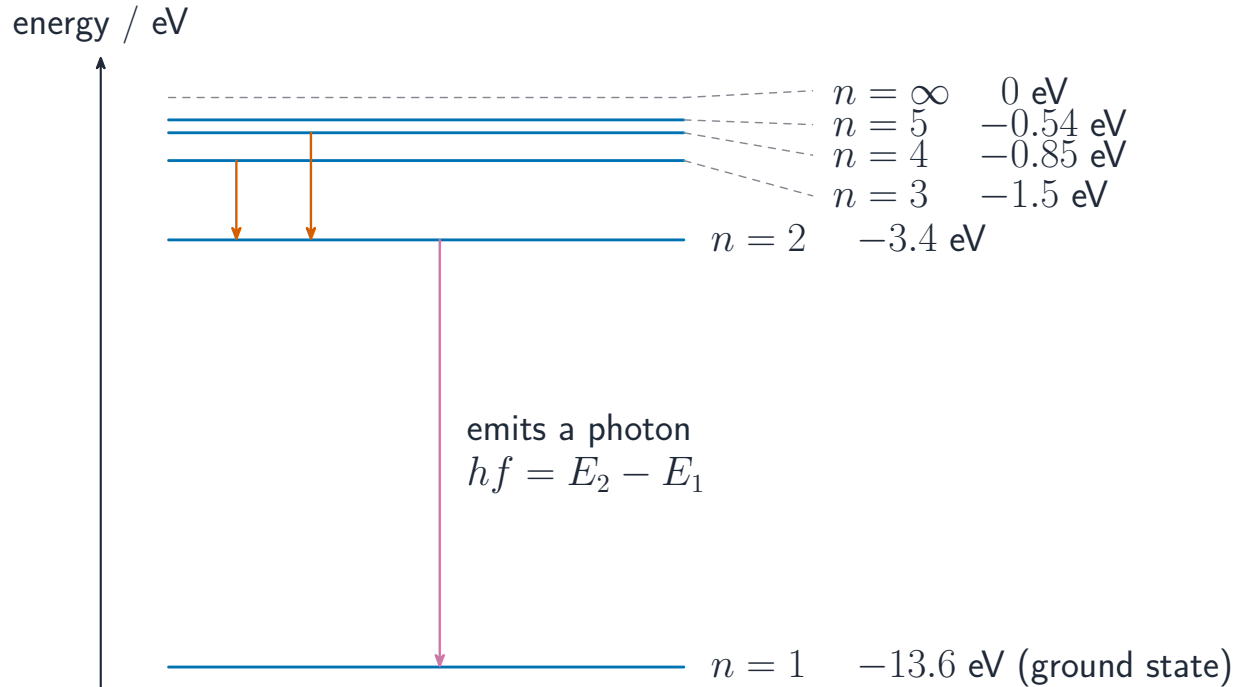
Binding energy per nucleon peaks near iron, so both fusion and fission can release energy

Emission and Absorption Spectra



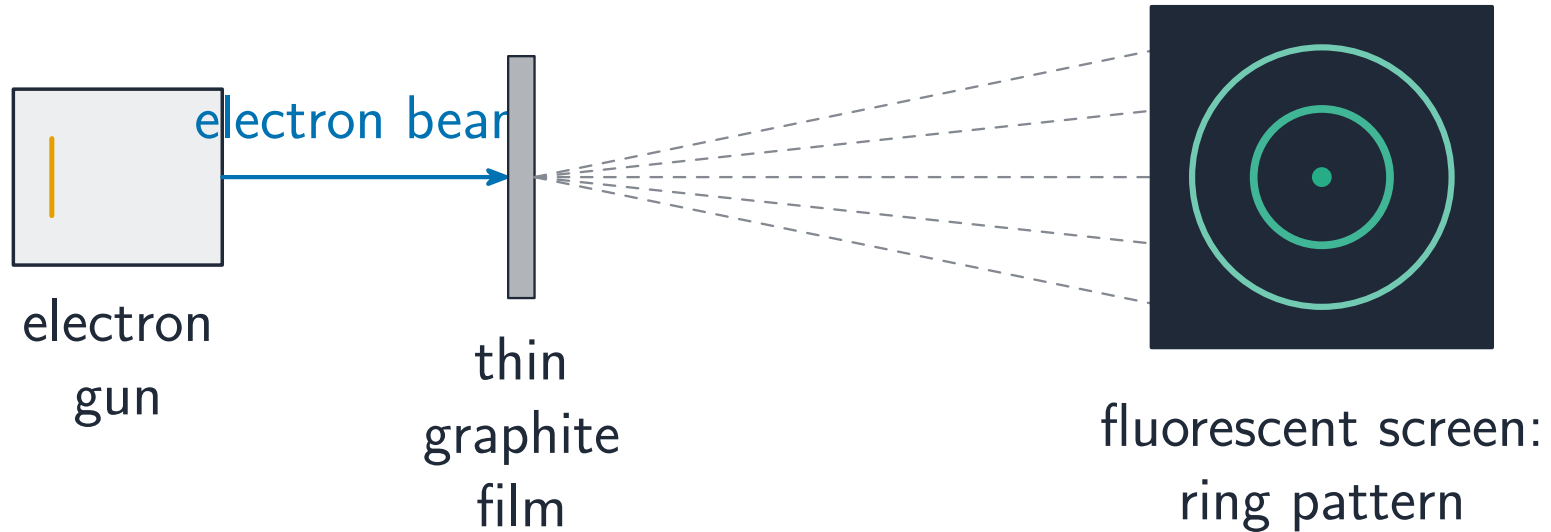
Hydrogen's emission spectrum: each bright line is light from an electron dropping between fixed energy levels

The discrete energy levels of hydrogen produce



The discrete energy levels of hydrogen produce a line spectrum

Quantum Theory and Wave-Particle Duality



Electrons form a diffraction pattern, showing that particles have a wave nature

Exercises 2.1-2.3

2.1 State the difference between nuclear fission and fusion. [2]

2.2 State what the half-life of a radioactive substance means. [1]

2.3 A mass of 2.0×10^{-3} kg is converted entirely to energy ($c = 3.0 \times 10^8$). Find the energy released. [2]

Exercises 2.1-2.3

2.1 State the difference between nuclear fission and fusion.

[2]

2.1

- fission is the splitting of a heavy nucleus; fusion is the joining of light nuclei

2.2 State what the half-life of a radioactive substance means.

[1]

2.2

- the time taken for half of the radioactive nuclei to decay

2.3 A mass of 2.0×10^{-3} kg is converted entirely to energy ($c = 3.0 \times 10^8$). Find the energy released.

[2]

2.3

- $E = mc^2 = (2.0 \times 10^{-3})(3.0 \times 10^8)^2 = 1.8 \times 10^{14}$ J

Exercises 3.1-3.2

3.1 Joining two light nuclei into a heavier one is called

[1]

☐

A fission

B fusion

C decay

D ionization

3.2 The energy released in a nuclear reaction comes from a change in

[1]

☐

A charge

B mass

C volume

D temperature

Exercises 3.1-3.2

3.1 Joining two light nuclei into a heavier one is called

[1]

☐

A fission

B fusion

C decay

D ionization

3.1 B

- fusion.

3.2 The energy released in a nuclear reaction comes from a change in

[1]

☐

A charge

B mass

C volume

D temperature

3.2 B

- mass.

Exercise 3.3 (a)

3.3 A radioactive sample has a half-life of 8 days, starting with 80 g.

(a) Find the mass remaining after 16 days.

[2]

Exercise 3.3 (a)

3.3 A radioactive sample has a half-life of 8 days, starting with 80 g.

(a) Find the mass remaining after 16 days.

[2]

(a)

- after two half-lives: $80 \rightarrow 40 \rightarrow 20$ g

Exercise 3.3 (b)

3.3 A radioactive sample has a half-life of 8 days, starting with 80 g.

(b) Explain why radioactive decay is described as random.

[1]

Exercise 3.3 (b)

3.3 A radioactive sample has a half-life of 8 days, starting with 80 g.

(b) Explain why radioactive decay is described as random.

[1]

(b)

- you cannot predict which nucleus will decay or when – only the probability