

Exercise walk-through

15.8

Types of Radioactive Decay

AP Physics 2

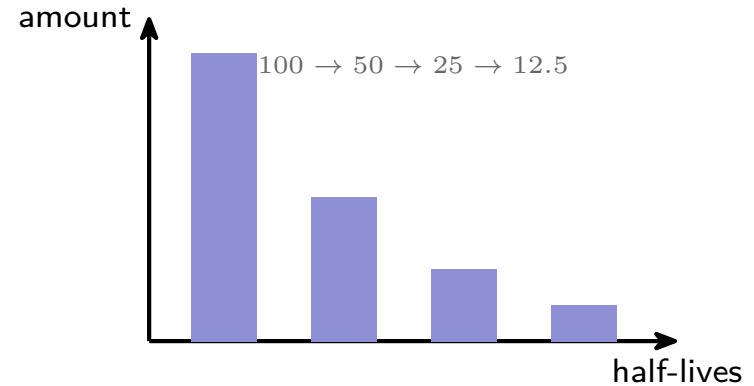
Nuclear physics

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.

Exam tips

- Photon energy is $E = hf$, below the **threshold frequency** no electrons are emitted **however bright** the light (the photoelectric effect).
- Use $K_{\max} = hf - \phi$ for the fastest photoelectrons (ϕ = work function).
- Electrons jump between **discrete energy levels** by absorbing/emitting a photon whose energy equals the level gap – the source of line spectra.
- In fission and fusion the small **mass lost** becomes energy via $E = mc^2$.
- Balance decay equations by conserving **mass number, charge, and lepton number** (write the antineutrino in β^- , the neutrino in β^+), and halve the sample every **half-life** ($(\frac{1}{2})^n$ after n half-lives).

Unit 15 – key takeaways

1

Duality

$E = hf$; matter has $\lambda = h/p$; wave and particle both

2

Atoms

quantized levels; a jump gives $hf = E_i - E_f$ – sharp lines

3

Photoelectric

$hf = \phi + KE_{max}$; a threshold frequency, not brightness

4

Nuclear

fission, fusion, decay; $E = mc^2$; half-life

Exercises 2.1-2.3

2.1 State what is emitted in alpha, beta, and gamma decay. [2]

2.2 State which type of radiation is the most penetrating. [1]

2.3 In alpha decay, state how the mass number and the atomic number change. [2]

Exercises 2.1-2.3

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2.1

- alpha: a helium nucleus; beta: a fast electron; gamma: a high-energy photon
-

2.2 State which type of radiation is the most penetrating. [1]

2.2

- gamma
-

2.3 In alpha decay, state how the mass number and the atomic number change. [2]

2.3

- the mass number decreases by 4 and the atomic number decreases by 2

Exercises 3.1-3.2

3.1 An alpha particle is a

[1]

☐

A helium nucleus

B fast-moving electron

C high-energy photon

D single proton

3.2 The most penetrating type of radiation is

[1]

☐

A alpha

B beta

C gamma

D all equally penetrating

Exercises 3.1-3.2

3.1 An alpha particle is a

[1]

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3.1 A

- helium nucleus.

3.2 The most penetrating type of radiation is

[1]

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A alpha

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C gamma

D all equally penetrating

3.2 C

- gamma.

Exercise 3.3 (a)

3.3 A nucleus ${}_{92}^{238}\text{U}$ emits an alpha particle.

(a) State the mass number of the new nucleus.

[1]

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[1]

(a)

- $238 - 4 = 234$

Exercise 3.3 (b)

3.3 A nucleus ${}_{92}^{238}\text{U}$ emits an alpha particle.

(b) State its atomic number.

[1]

Exercise 3.3 (b)

3.3 A nucleus ${}_{92}^{238}\text{U}$ emits an alpha particle.

(b) State its atomic number.

[1]

(b)

- $92 - 2 = 90$

Exercise 3.3 (c)

3.3 A nucleus ${}_{92}^{238}\text{U}$ emits an alpha particle.

(c) Name the two quantities that must be conserved in the equation.

[1]

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[1]

(c)

- nucleon number and charge