Week 25

IGCSE Physics

Homework bundle for this week

本周作业合集

exercises.lol

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IGCSE Physics Name: ______________ Score: ______

1. Where is almost all of an atom's mass?
   - ☐ in the tiny central nucleus
   - ☐ spread evenly through the atom
   - ☐ in the electrons
   - ☐ in the empty space
2. Nuclear fission is when:
   - ☐ a heavy nucleus splits into two smaller nuclei, releasing neutrons and energy
   - ☐ two light nuclei join together
   - ☐ an atom gains an electron
   - ☐ a nucleus gives out a gamma ray only
3. Radioactive decay is spontaneous and random. This means:
   - ☐ you cannot predict when a particular nucleus will decay, or speed it up
   - ☐ it can be sped up by heating
   - ☐ every nucleus decays at the same instant
   - ☐ it only happens in a laboratory
4. The half-life of a radioactive isotope is the time taken for:
   - ☐ half the unstable nuclei in a sample to decay
   - ☐ all the nuclei to decay
   - ☐ the sample to double
   - ☐ the radiation to travel 1 metre
5. An atom that loses an electron becomes a positive ion.

   ☐ True ☐ False
6. Nuclear fusion is when:
   - ☐ two light nuclei join to make a heavier one, releasing energy
   - ☐ a heavy nucleus splits
   - ☐ a neutron turns into a proton
   - ☐ electrons jump between orbits

7. A source reads 250 counts/min. The background is 30 counts/min. What is the corrected count rate, in counts/min?

_________________ counts/min

8. A source reads 800 counts/min and has a half-life of 3 hours. What is the count rate after 6 hours, in counts/min?

_________________ counts/min

9. What fraction of the unstable nuclei remain after 3 half-lives? (Give a decimal.)

____

10. In ${}^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \to {}^{141}_{56}\mathrm{Ba} + {}^{92}_{36}\mathrm{Kr} + x\,{}^{1}_{0}\mathrm{n}$, how many neutrons x are released?

____

IGCSE Physics

1. **in the tiny central nucleus**

   Almost all the mass is concentrated in the tiny, dense nucleus; the rest of the atom is mostly empty space.

2. **a heavy nucleus splits into two smaller nuclei, releasing neutrons and energy**

   Fission = splitting a heavy nucleus (after it absorbs a neutron) into two smaller nuclei, plus 2–3 neutrons and energy.

3. **you cannot predict when a particular nucleus will decay, or speed it up**

   Spontaneous = not triggered and not controllable; random = you cannot say which nucleus decays next or exactly when.

4. **half the unstable nuclei in a sample to decay**

   Each half-life, half of the remaining unstable nuclei decay, so the count rate halves.

5. **True**

   Losing a negative electron leaves the atom with more positive charge — a positive ion.

6. **two light nuclei join to make a heavier one, releasing energy**

   Fusion = joining two light nuclei into a heavier one, releasing energy. It powers the Sun.

7. **220 counts/min**

   Corrected = measured − background = 250 − 30 = 220 counts/min.

8. **200 counts/min**

   6 hours is two half-lives: 800 → 400 → 200 counts/min.

9. **0.125**

   Each half-life halves the number: $\left(\frac{1}{2}\right)^3 = \frac{1}{8} = 0.125$.

10. **3**

    Nucleon numbers must balance: $235 + 1 = 141 + 92 + x$, so $236 = 233 + x$ and $x = 3$.

5.1 The nuclear model of the atom

Name: ______________ Class: __________ Date: ____________ **Total: 10 marks**

KEY WORDS neutron 中子 • proton 质子 • electron 电子 • nucleus 原子核 • isotope 同位素

Objective

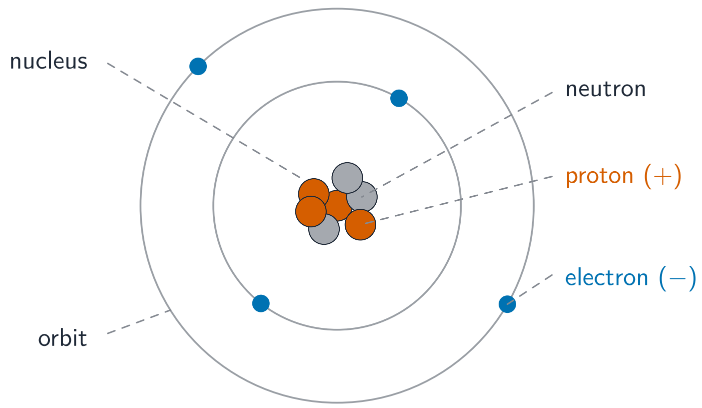
Build the skills to answer exam questions on the **nuclear model of the atom** 原子核模型 — atomic structure, the **alpha-scattering** α 散射 evidence, **nuclide notation** 核素符号, and **isotopes** 同位素.

You must be able to:

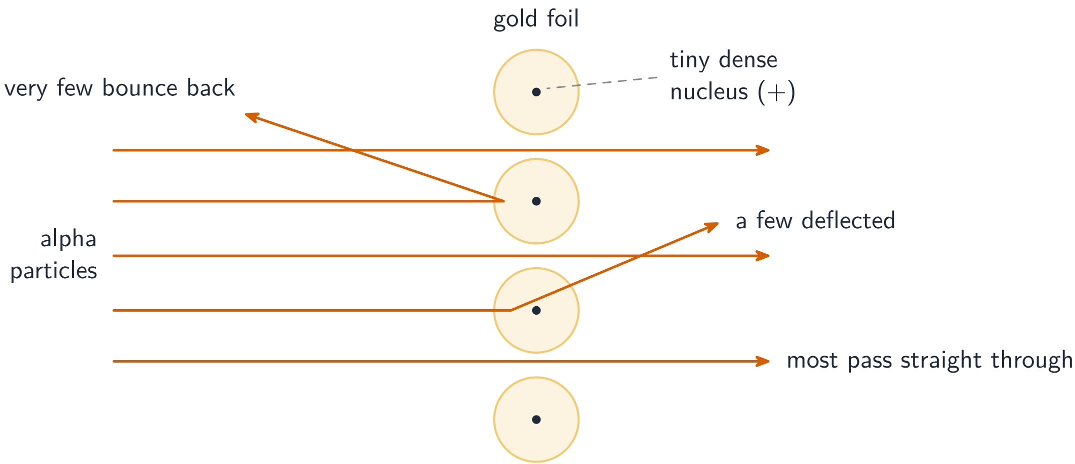
- describe the nuclear atom (tiny dense nucleus, electrons in orbits)
- interpret the alpha-scattering results
- use ${}^{A}_{Z}\mathrm{X}$ to find protons, neutrons and electrons; define isotopes

1 Worked examples

■ Nuclide notation & scattering



Almost all the mass is in the tiny nucleus; the atom is mostly empty space



Most pass straight through (empty space); a few bounce back (small, heavy, positive nucleus)

$^{197}_{79}$**Au:** 79 protons, $197 - 79 = 118$ neutrons, 79 electrons (neutral atom).

2 Practice

2.1 State what is meant by an isotope. [1]

2.2 For $^{23}_{11}$Na, write down the number of protons and the number of neutrons. [2]

3 Exam-style questions

3.1 In the alpha-scattering experiment, most alpha particles pass straight through the foil. This shows the atom is: [1]

- **A** solid throughout
- **B** mostly empty space
- **C** negatively charged
- **D** very large

3.2 The nuclide $^{40}_{19}K$ is given.

(a) State the number of protons, neutrons and electrons in a neutral atom. [3]

(b) An isotope of potassium is $^{39}_{19}K$. State how its nucleus differs from $^{40}_{19}K$. [1]

3.3 Explain why a very few alpha particles bounce almost straight back off the gold foil. [2]

Solutions

2.1 atoms of the same element (same proton number) with different numbers of neutrons.

2.2 protons = 11; neutrons = $23 - 11 = 12$.

3.1 B. Most passing straight through shows the atom is mostly empty space.

3.2 (a) protons = 19; neutrons = $40 - 19 = 21$; electrons = 19.
(b) it has one fewer neutron (20 instead of 21).

3.3 the nucleus is very small, very dense and positively charged; a head-on approach is strongly repelled, so the positive alpha particle bounces back.

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5.2 Radioactivity

Name: ______________ Class: __________ Date: ____________ **Total: 12 marks**

KEY WORDS decay 衰变 • half-life 半衰期 • radiation 辐射 • decay equations 衰变方程 • background radiation 背

Objective

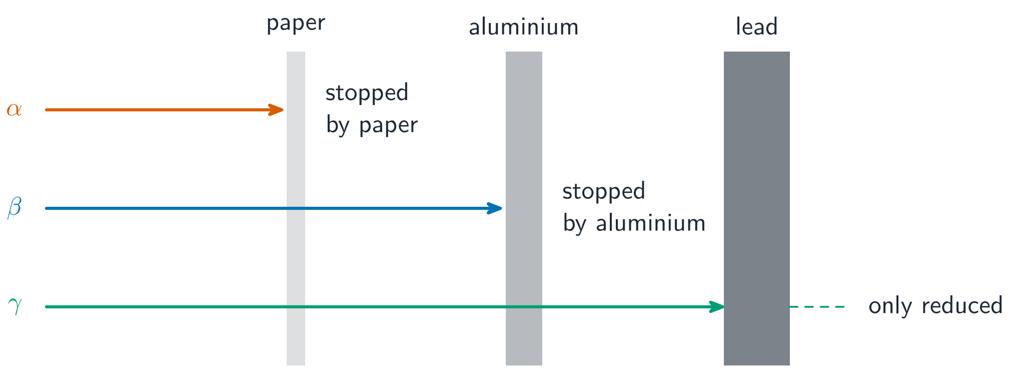
Build the skills to answer exam questions on **radioactivity** 放射性 — the three types of radiation, **decay equations** 衰变方程, **half-life** 半衰期, and safety.

You must be able to:

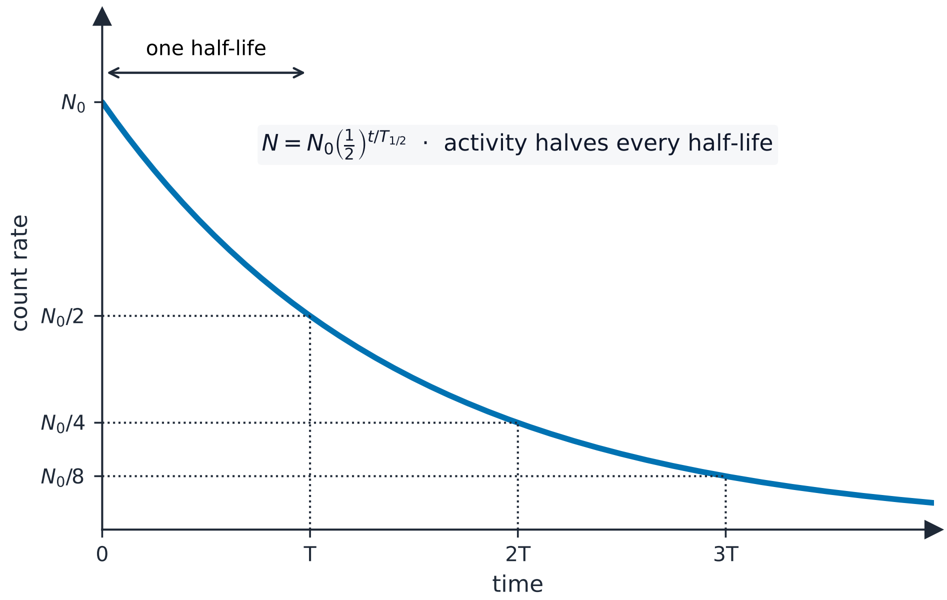
- compare alpha, beta and gamma (ionising, penetrating, stopped by)
- balance alpha and beta decay equations
- use half-life and correct for background radiation

1 Worked examples

■ Penetration & half-life



Alpha = most ionising, least penetrating; gamma = least ionising, most penetrating



Each half-life the count rate halves: $N_0 \to N_0/2 \to N_0/4$

Alpha decay: ${}^{226}_{88}\mathrm{Ra} \to {}^{222}_{86}\mathrm{Rn} + {}^{4}_{2}\alpha$ $(A-4,\ Z-2)$.

2 Practice

2.1 State what material stops beta radiation. [1]

2.2 A detector reads 250 counts/min; the background is 30 counts/min. Find the corrected count rate. [2]

3 Exam-style questions

3.1 Which radiation is the most penetrating? [1]

- **A** alpha
- **B** beta
- **C** gamma
- **D** they are equal

3.2 A nucleus ${}^{24}_{11}\mathrm{Na}$ undergoes beta decay.

(a) Write the decay equation, giving the new nuclide. [3]

(b) State what happens inside the nucleus during beta decay. [1]

3.3 A source has a count rate of 800 counts/min and a half-life of 5 days.

(a) Find the count rate after 15 days. [3]

(b) Explain why the count rate never quite reaches zero. [1]

Solutions

2.1 a few millimetres of aluminium.

2.2 corrected $= 250 - 30 = 220$ counts/min.

3.1 **C**. Gamma radiation is the most penetrating.

3.2 (a) ${}^{24}_{11}\mathrm{Na} \rightarrow {}^{24}_{12}\mathrm{Mg} + {}^{0}_{-1}\beta$.
(b) a neutron changes into a proton (and an electron, which leaves as the beta particle).

3.3 (a) $15 \div 5 = 3$ half-lives; $800 \rightarrow 400 \rightarrow 200 \rightarrow 100$; $= 100$ counts/min.
(b) decay is random; there is always a chance some nuclei have not yet decayed.