CAMBRIDGE IGCSE™ PHYSICS 0625 | TOPICS 5.1 · 5.2

FREE SAMPLE

Nuclear Physics

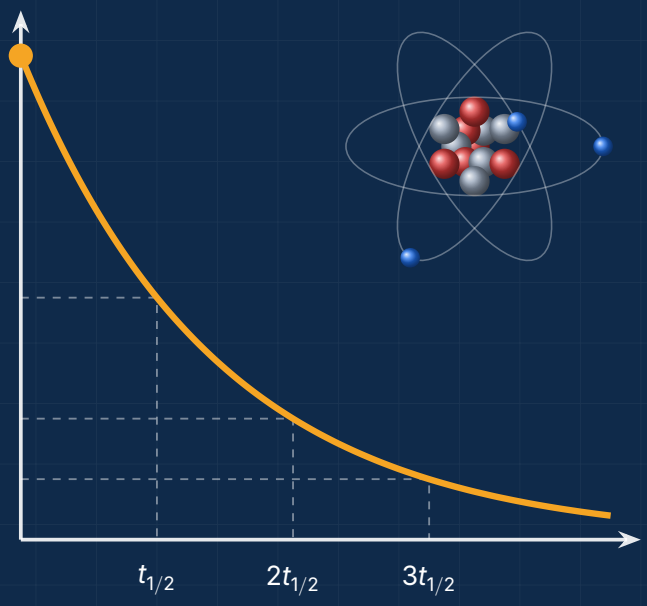
Free sample: knowledge organiser and Worksheet 1 with answers

Atoms & nuclei | Isotopes | Alpha, beta & gamma | Decay equations | Half-life

Uses & safety | Exam-style questions

$$^{238}_{92}U \rightarrow {}^{234}_{90}Th + {}^{4}_{2}\alpha$$

$$n \rightarrow p + e^{-}$$



I Can't Do Physics

Physics that finally makes sense.

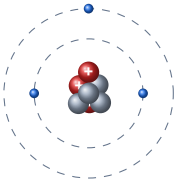
Free sample

Full pack: worksheets, exam paper, answers

Cambridge IGCSE is a trademark of Cambridge University Press & Assessment, which has not reviewed or endorsed this resource.

Knowledge organiser

The atom and the nucleus



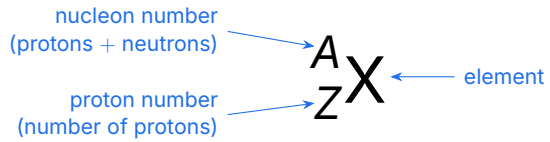
Small, positive **nucleus** (protons + neutrons); negative **electrons** orbit it.

Charges: p +1, n 0, e −1.

Lose electrons: **positive ion**.
Gain electrons: **negative ion**.

SUPPLEMENT α-scattering: most go straight through (**empty space**); a few deflected (**positive** nucleus); very few bounce back (**tiny** nucleus with most of the **mass**).

Nuclide notation and isotopes



number of neutrons $= A - Z$

Isotopes: same number of protons, different number of neutrons.

SUPPLEMENT Nuclear charge depends on Z, nuclear mass on A.

SUPPLEMENT **Fission**: a large nucleus splits. **Fusion**: small nuclei join. Mass decreases slightly; energy is released.

The three types of nuclear emission (spontaneous and random in direction)

	alpha α	**beta** β	**gamma** γ
what it is	helium nucleus (2p + 2n), charge +2	fast electron from the nucleus, charge −1	electromagnetic wave, no charge
ionising	strongly	moderately	weakly
stopped by	paper, a few cm of air	a few mm of aluminium	reduced by thick lead or concrete
SUPPLEMENT **in fields**	slightly deflected	strongly deflected, opposite way to α	not deflected

Radioactive decay

An **unstable** nucleus emits α, β and/or γ, **spontaneously** and **randomly**. α- and β-decay make a **new element**.

SUPPLEMENT α: $A - 4$, $Z - 2$. β: A same, $Z + 1$. γ: no change.

$^{238}_{92}\text{U} \rightarrow {}^{234}_{90}\text{Th} + {}^{4}_{2}\alpha$ $\quad$ $^{14}_{6}\text{C} \rightarrow {}^{14}_{7}\text{N} + {}^{0}_{-1}\beta$

SUPPLEMENT In β-decay n → p + e. Unstable nuclei have too many neutrons or are too heavy.

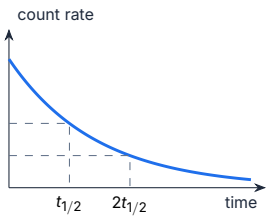
Safety

Effects on living things: cell death, mutations, cancer.

Safe handling: lead-lined box in a locked cupboard; long tongs; never point a source at anyone; out of its box for the shortest possible time.

SUPPLEMENT Reduce **time**, increase **distance**, use **shielding**.

Half-life



Half-life: the time for half the nuclei of an isotope in a sample to decay.

After n half-lives, $\left(\frac{1}{2}\right)^n$ is left.

Background: radon, rocks and buildings, food and drink, cosmic rays. **Detector and counter**: counts/s or counts/minute.

SUPPLEMENT corrected count rate = measured − background

SUPPLEMENT Choosing an isotope

Long half-life: smoke alarm α; paper thickness β; sterilising and irradiating food γ.
Short half-life (hours): medical tracer γ. Cancer treatment: γ beam.

© I Can't Do Physics. Free sample: you may print and share this file unchanged.

The nuclear atom

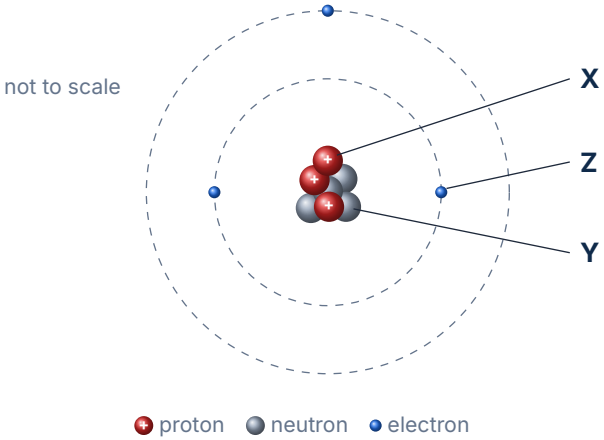
WORKSHEET 1

CORE SUPPLEMENT

You will: describe the structure of the atom and its nucleus, explain how ions form, use proton number, nucleon number and nuclide notation, and explain what isotopes are. Extended: use the alpha-particle scattering experiment as evidence for the nucleus, and describe fission and fusion.

CORE all students SUPPLEMENT Extended (Supplement) students CHALLENGE stretch question

1 CORE The diagram shows a simple model of an atom of lithium.



(a) Name the particles X, Y and Z. [3]

X _____ Y _____ Z _____

(b) Complete the table. [3]

particle	relative charge	where it is found in the atom
proton	_____	_____
neutron	0	_____
electron	_____	orbiting the nucleus

(c) The lithium atom has no overall charge. Explain why. [1]

.....

2 CORE Atoms can become ions.

(a) A sodium atom loses one electron. State whether the ion formed is positive or negative. [1]

.....

(b) An oxygen atom gains two electrons. State the charge on the ion formed, relative to the charge on a proton. [1]

.....

© I Can't Do Physics. Free sample: you may print and share this file unchanged.

(c) Explain why the number of protons in an atom does not change when the atom becomes an ion. [1]

.....

3 CORE Complete the table. The first row has been done for you. [6]

nuclide	proton number Z	nucleon number A	number of electrons in the neutral atom	number of neutrons
$^{12}_{6}C$	6	12	6	6
$^{23}_{11}Na$				
$^{56}_{26}Fe$				
$^{238}_{92}U$				

4 CORE Write each nucleus in nuclide notation, $^{A}_{Z}X$.

(a) A chlorine (Cl) nucleus with 17 protons and 18 neutrons. [1]

.....

(b) A potassium (K) nucleus with 19 protons and 21 neutrons. [1]

.....

(c) A gold (Au) nucleus with a nucleon number of 197 and 118 neutrons. [1]

.....

5 CORE Here are five nuclei.

$^{14}_{6}C$ $^{14}_{7}N$ $^{12}_{6}C$ $^{16}_{8}O$ $^{13}_{6}C$

(a) Explain what is meant by *isotopes*. [2]

.....

.....

(b) Identify all the nuclei above that are isotopes of the same element. [1]

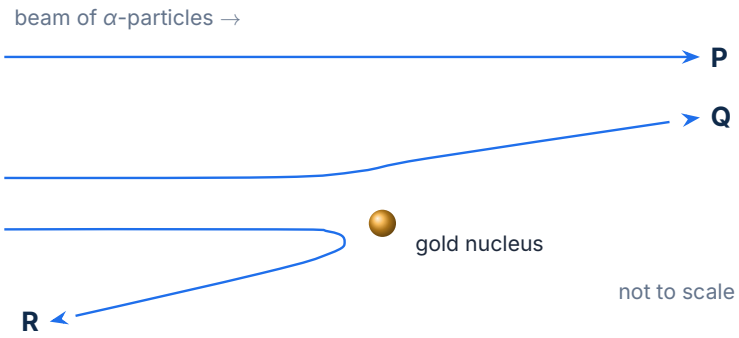
.....

(c) $^{14}_{6}C$ and $^{14}_{7}N$ have the same nucleon number. Explain why they are **not** isotopes. [1]

.....

© I Can't Do Physics. Free sample: you may print and share this file unchanged.

6 SUPPLEMENT In the alpha-particle scattering experiment, a beam of α-particles is aimed at a very thin sheet of gold. A detector records how many α-particles are scattered through different angles. The diagram shows three paths, P, Q and R, near one gold nucleus.



(a) Most α-particles follow a path like P. State what this shows about the atom. [1]

.....

(b) A few α-particles are deflected through small angles, like Q. State what this shows about the charge of the nucleus. [1]

.....

(c) A very small number of α-particles bounce back, like R. Explain what this shows about the nucleus. [2]

.....

.....

7 SUPPLEMENT The table shows two nuclei.

nucleus X	nucleus Y
$^{16}_{8}O$	$^{32}_{16}S$

(a) State the charge of nucleus X, relative to the charge on a proton. [1]

charge = _____

(b) Explain how the charge of nucleus Y compares with the charge of nucleus X. [1]

.....

(c) Explain how the mass of nucleus Y compares with the mass of nucleus X. [1]

.....

© I Can't Do Physics. Free sample: you may print and share this file unchanged.

8 SUPPLEMENT The equations show two nuclear reactions that release energy.

reaction 1 $^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{141}_{56}Ba + {}^{92}_{\square}Kr + 3\,{}^{1}_{0}n$

reaction 2 $^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He + {}^{1}_{0}n$

(a) State which reaction is fission and which is fusion. Give a reason for each answer. [2]

.....

.....

(b) Calculate the missing proton number of krypton (Kr) in reaction 1. [1]

proton number = _____

(c) State what happens to the total mass of the particles and to the energy in both reactions. [2]

.....

.....

© I Can't Do Physics. Free sample: you may print and share this file unchanged.

Answers: Worksheet 1

Mark codes: B1 independent mark C1 method mark, implied by a correct final answer A1 correct answer with unit. Accept answers that round correctly; allow error carried forward from earlier parts.

Worksheet 1 – The nuclear atom

1 **(a)** X proton B1; Y neutron B1; Z electron B1
(b) proton: $+1$, in the nucleus B1; neutron: in the nucleus B1; electron: -1 B1
(c) It has equal numbers of protons and electrons (3 of each), so the charges cancel. B1

2 **(a)** positive B1
(b) -2 B1
(c) Only electrons are lost or gained; the nucleus does not change. B1

3 Na: 11, 23, 11, 12 B2; Fe: 26, 56, 26, 30 B2; U: 92, 238, 92, 146 B2 (columns: Z, A, electrons, neutrons; one mark for each two correct cells)

4 **(a)** $^{35}_{17}\mathrm{Cl}$ B1
(b) $^{40}_{19}\mathrm{K}$ B1
(c) $Z = 197 - 118 = 79$: $^{197}_{79}\mathrm{Au}$ B1

5 **(a)** Nuclei of the same element (same number of protons) B1 with different numbers of neutrons. B1
(b) $^{12}_{6}\mathrm{C}$, $^{13}_{6}\mathrm{C}$ and $^{14}_{6}\mathrm{C}$ B1
(c) They have different proton numbers (6 and 7), so they are different elements. B1

6 **(a)** Most of the atom is empty space. B1
(b) The nucleus is positively charged (it repels the positive α-particles). B1
(c) The nucleus is very small (very few α-particles come close enough) B1; it contains most of the mass of the atom (it can turn a fast α-particle back). B1

7 **(a)** $+8$ B1
(b) Y has twice the charge of X, because it has twice as many protons (16 and 8). B1
(c) Y has about twice the mass of X, because it has twice as many nucleons (32 and 16). B1

8 **(a)** Reaction 1 is fission: a large nucleus splits into two smaller nuclei B1; reaction 2 is fusion: two small nuclei join to make a larger nucleus. B1
(b) $92 - 56 = 36$ B1
(c) The total mass decreases slightly B1; energy is released. B1

© I Can't Do Physics. Free sample: you may print and share this file unchanged.

Get the full pack

You have just used Worksheet 1. The full Nuclear Physics pack contains:

- **Worksheet 1:** The nuclear atom
- **Worksheet 2:** Alpha, beta and gamma
- **Worksheet 3:** Radioactive decay
- **Worksheet 4:** Half-life
- **Worksheet 5:** Uses of radioactivity and safety
- **Multiple-choice practice:** 10 Paper 1/2-style questions
- **Practical skills:** an Alternative to Practical (Paper 6) question
- **Exam-style questions:** a 40-mark paper
- **Revision checklist** and knowledge organiser

3 files in every pack

Teacher edition PDF with fully worked answers and a Cambridge-style mark scheme (B1/C1/A1)

Fillable student PDF: type answers and tick boxes on any device

Editable Word version to adapt for your classes

Full pack £4 **Bundles save up to 25 %**

Find it on **Tes**: search for **I Can't Do Physics** or **IGCSE Physics 0625 Nuclear Physics**.

Every question is labelled CORE or SUPPLEMENT. Written for the Cambridge IGCSE Physics (0625) syllabus for exams in 2026, 2027 and 2028. Cambridge IGCSE is a trademark of Cambridge University Press & Assessment, which has not reviewed or endorsed this resource.

© I Can't Do Physics. Free sample: you may print and share this file unchanged.