Atoms, Radioactivity and Chemical Reactions! Year 9 Science at Home

You can help! Your child is learning about what atoms are made of, how some atoms are unstable and decay (radioactivity), and how atoms rearrange in chemical reactions — always conserving total mass. This is the science underpinning both nuclear medicine and everyday chemistry!

Why are we learning this? Atoms and chemistry in daily life

Atomic science seems abstract but has direct relevance to life in remote communities. Carbon-14 dating, which uses the radioactive decay of carbon atoms, has been used to prove that First Peoples have lived on the Australian continent for more than 60,000 years — some of the most important evidence validating Aboriginal and Torres Strait Islander history. Nuclear medicine uses radioactive isotopes to diagnose and treat cancer — relevant to the clinic and hospital services accessed by remote communities. And everyday chemical reactions — from cooking to cleaning to traditional food processing — all follow the same laws of conservation of mass that your child is learning.

My child will learn to:

✓ Describe atomic structure
Name the three subatomic particles (proton, neutron, electron) and describe how they are arranged in an atom.

✓ Understand isotopes and radioactivity
Explain that atoms of the same element can have different numbers of neutrons (isotopes) and that some are unstable and decay.

✓ Understand conservation of mass
Demonstrate that in a chemical reaction, the total mass of reactants equals the total mass of products — atoms are rearranged, not created or destroyed.

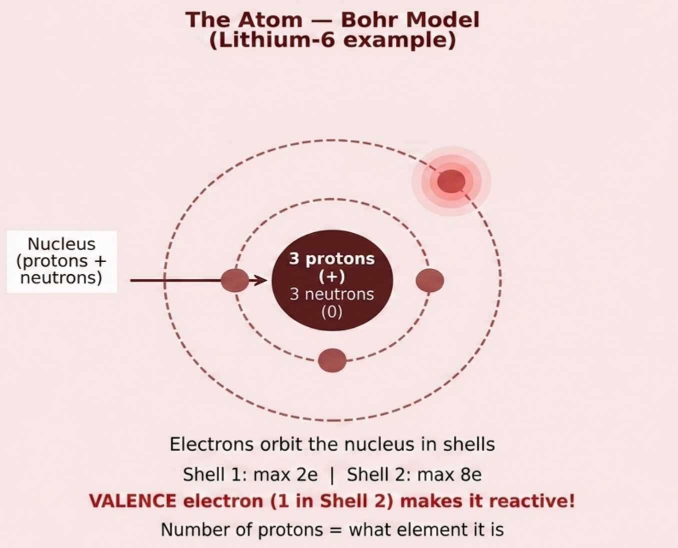
✓ Write and balance equations
Write simple word equations for chemical reactions and understand what a balanced equation means.

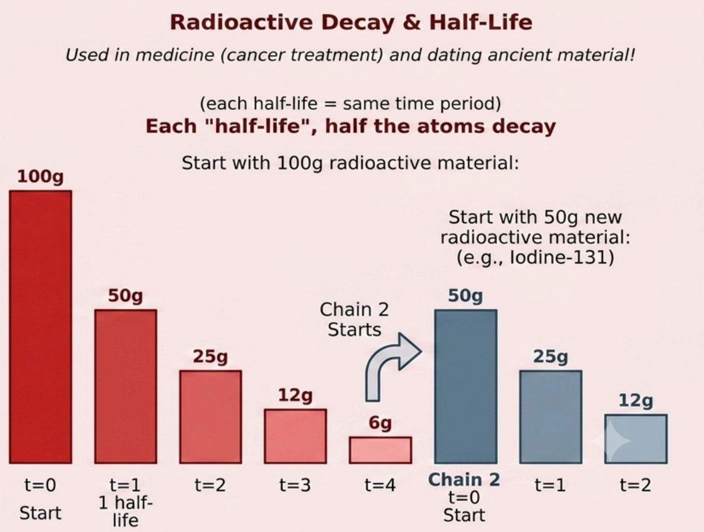
Big ideas to know:

Inside the atom
Every atom has a nucleus at its centre containing positively charged protons and neutral neutrons. Negatively charged electrons orbit the nucleus in shells. The number of protons determines what element it is (e.g. every oxygen atom has 8 protons). The number of neutrons can vary — atoms of the same element with different numbers of neutrons are called isotopes. Most isotopes are stable, but some are unstable and break down over time — this is radioactivity.

Radioactive decay and half-life
Unstable atoms (radioactive isotopes) release radiation as they decay into more stable atoms. The rate of decay is measured by "half-life" — the time it takes for half the atoms in a sample to decay. Carbon-14 has a half-life of about 5,730 years. By measuring how much C-14 is left in an ancient object, scientists can calculate how old it is. This is radiocarbon dating — the technique that has dated human remains in Australia to over 60,000 years ago.

Conservation of mass in reactions
In a chemical reaction, atoms rearrange — existing bonds between atoms break and new bonds form, creating new substances. But no atoms are created or destroyed. This means the total mass of the starting materials (reactants) always equals the total mass of the products. This is the Law of Conservation of Mass, discovered by Antoine Lavoisier in the 18th century. This is why we must balance chemical equations — to show that the same atoms are present on both sides.





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Types of radioactive decay and their uses

Type	What is released	Penetrating power	Uses
Alpha decay	2 protons + 2 neutrons (alpha particle)	Low — stopped by skin or paper	Smoke detectors, some cancer treatments
Beta decay	High-speed electron (beta particle)	Medium — stopped by aluminium	Medical tracers, treating thyroid conditions
Gamma radiation	High-energy electromagnetic wave	High — needs thick lead or concrete	Sterilising medical equipment, cancer radiotherapy
Radiocarbon dating (C-14)	Beta decay used to date organic material	N/A — measurement technique	Dating ancient artefacts and human remains

Think Like a Scientist — Conservation of Mass

Dissolve a teaspoon of salt in a glass of water. Weigh the glass before and after. Has the mass changed? Now mix bicarb soda and vinegar in a sealed bag. Has the mass changed? (If gas escapes, you might see a difference — that is why chemists work in sealed systems!)

Ask: "If the salt seems to have disappeared, where has it gone? Has it lost mass? What would happen if we boiled away the water — would we see the salt again?" The mass never changes — it is just rearranged!

Conservation of mass experiments:

1. Weigh salt + water separately, then mix and weigh together — same mass!
2. Weigh bicarb + vinegar, mix in sealed bag, reweigh — should be same mass
3. Burn a candle carefully — the wax seems to disappear. Where does the mass go? (CO2 + water vapour escape!)
4. Grow a seedling — where does the mass of the new leaves come from? (Carbon from air!)
5. Dissolve aspirin in water — has the mass changed? Try to recover the aspirin (evaporation)

Questions to ask your child

1. What determines which element an atom is — the number of protons, neutrons or electrons?
2. Carbon-12 and carbon-14 are both carbon atoms — what is different about them?
3. Why does a radioactive substance get less radioactive over time?
4. If you have 100g of a radioactive substance with a half-life of 10 years, how much radioactive material will be left after 30 years?
5. Why do chemical equations need to be balanced — what principle does this represent?
6. How does radiocarbon dating prove that First Peoples have been in Australia for over 60,000 years?
7. Why are gamma rays more dangerous to human tissue than alpha particles, even though alpha particles have more mass?

The conservation of mass can be demonstrated with a simple sealed container: mix bicarb soda and vinegar inside a ziplock bag that you close before mixing (squeeze to mix). The bag will inflate with CO2 gas — but if you weigh it before and after, the mass is exactly the same! The gas is still inside the system.

Key words to know:

Atom	The smallest unit of an element that retains the properties of that element
Proton	A positively charged subatomic particle found in the nucleus — determines the element type
Neutron	A neutral (no charge) subatomic particle in the nucleus — same mass as a proton
Isotope	Atoms of the same element with different numbers of neutrons — same chemical behaviour, different mass
Radioactive decay	The process by which an unstable nucleus loses energy by emitting radiation, becoming more stable
Half-life	The time it takes for half the atoms in a radioactive sample to decay
Conservation of mass	In a chemical reaction, total mass of reactants = total mass of products — atoms are rearranged, not created or destroyed

Key words to look up

Atom · Proton · Neutron · Isotope · Radioactive decay · Half-life · Conservation of mass

What school will check

By the end of Year 9, your child needs to explain how the model of the atom changed following discoveries of electrons, protons and neutrons; describe radioactive decay; and model the rearrangement of atoms in chemical reactions using the law of conservation of mass.

Try it at home!

Search 'radiocarbon dating Australia First Peoples' online. Find out how old the oldest confirmed human occupation sites in Australia are, and how scientists used carbon-14 to determine those dates. This is real chemistry making history!