



Isotopes

Topic Summary

- Every atom has a tiny, dense nucleus made of protons and neutrons.
- • The number of protons tells you which element it is (e.g., 6 protons = carbon).
- • But the number of neutrons can vary — and this gives us isotopes.
- An isotope is, “An atom of the same element with the same number of protons but a different number of neutrons.”
- Most elements have at least two naturally occurring isotopes. Most of these isotopes are stable but some will undergo radioactive decay. We identify an isotope by writing its mass number after its name like this Carbon-12 or Carbon-13. We can also write it with its symbol like this ^{12}C or ^{13}C .
- Remember that the proton number and element name are linked so we don't need to remind chemists that carbon has 6 protons (it always will have!).
- The relative atomic mass of an element is a weighted average taking into account the abundance of all naturally occurring isotopes of that element and measured relative to 1/12th of the mass of an atom of carbon-12.
- Isotopes of an element are chemically identical to each other; they all react in exactly the same way, because reactions are controlled by protons and electrons, not neutrons.
- Elements usually have non-integer relative atomic masses because of their isotopes, but individual isotopes will have integer (whole number) relative masses because they have whole numbers of protons and neutrons in their nuclei.



Quick Checks to Build Recall

What is an isotope? - Write a one sentence definition

.Atom of the same element with the **same number of protons** (1) but a
different number of neutrons. (1).

How many protons are in an atom of chlorine?

.....(1 mark)

Chlorine has two main isotopes: chlorine-35 and chlorine-37. How many neutrons are in each?

Neutrons in an atom of chlorine-3518.....

Neutrons in an atom of chlorine-3720..... (2 marks)

Define the term 'relative atomic mass' of an element

A weighted average (1) taking into account the abundance of all naturally occurring isotopes (1) of that element and measured relative to 1/12th of the mass of an atom of carbon-12 (1).



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Counting neutrons and identifying isotopes

The table below contains data on a range of atoms. Fill in the gaps to show mass numbers, proton numbers and neutron numbers

Atom	Proton Number	No. of Neutrons	Mass Number
Atom 1	6	6	12
Atom 2	7	7	14
Atom 3	17	20	37
Atom 4	6	8	14
Atom 5	35	46	81
Atom 6	3	3	6

Using the table above, identify which 2 atoms are isotopes of carbon. Explain how you know they are carbon atoms.

.....Atoms 1 and 4 (1) both have 6 protons in their nucleus (1).....(2 marks)

Which element is 'Atom 6' an isotope of, how do you know?

.....Lithium, it has 3 protons in its nucleus.....(2 marks)



Calculating relative atomic masses of elements

Carbon has 2 common isotopes, carbon-12 (98.9% abundance) and carbon-13 (1.1% abundance). Calculate the relative atomic mass of carbon based on the data given above, give your answer to 3d.p.

$$\text{Relative atomic mass} = \frac{(M_r \text{ isotope 1} \times \text{abundance of isotope 1}) + (M_r \text{ isotope 2} \times \text{abundance of isotope 2})}{100}$$

1 mark for correct substitution, 1 mark for calculating each correct (mass x abundance) bracket, 1 mark for answer and 1 for correct rounding.

Relative atomic mass =12.011.... (4 marks)



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Exam Style Questions

Bromine has 2 common, naturally occurring isotopes - bromine-79 and bromine-81. The table below shows their natural abundance on Earth. Use this information to find the average relative mass of a bromine atom.

Bromine isotope	Natural Abundance
Bromine-79	50.7%
Bromine-81	49.3%

1 mark for correct substitution, 1 mark for calculating each correct (mass x abundance) bracket, 1 mark for answer and 1 for correct rounding.

Relative atomic mass = (4 marks)

Copper has 2 common, naturally occurring isotopes - copper-63 and copper-65. The table below shows their natural abundance on Earth. Use this information to find copper's relative atomic mass.

Copper isotope	Natural Abundance
Copper-63	69.2%
Copper-65	30.8%

1 mark for correct substitution, 1 mark for calculating each correct (mass x abundance) bracket, 1 mark for answer and 1 for correct rounding.

Relative atomic mass = (4 marks)



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Exam Style Questions

Magnesium has 3 common, naturally occurring isotopes - magnesium-24, magnesium-25 and magnesium-26. The table below shows their natural abundance on Earth. Use this information to find magnesium's relative atomic mass.

Magnesium isotope	Natural Abundance
Magnesium-24	79.0%
Magnesium-25	10.0%
Magnesium-26	11.0%

Yes, there's 3 isotopes this time, but the method is exactly the same - have a go.
I bet you can do it!

1 mark for correct substitution, 1 mark for calculating each correct (mass x abundance) bracket, 1 mark for answer and 1 for correct rounding.

Relative atomic mass = (5 marks)



Do this later...

Give your brain a break and come back to these questions later. Cover the rest of the sheet while you have a go. By doing this 24-48 hours after watching the video you will boost your chances of remembering the key points in an exam. If you struggle with these questions, re-watch the video and then try again.

1. Lithium-6 and Lithium-7 are two isotopes of the element lithium. Define what is meant by the term 'isotope'. Atoms of the same element with the same number of protons but different numbers of neutrons
2. How many neutrons will an atom of Carbon-13 have in its nucleus? 7
3. Lithium has two, stable, naturally occurring isotopes. Lithium-7 is the most common with a natural abundance of 92.4%. What is the abundance of its only other naturally occurring isotope, Lithium-6?

7.6% (must add up to 100%)
4. Carbon has 2 common isotopes, carbon-12 (98.9% abundance) and carbon-13 (1.1% abundance) Calculate the relative atomic mass of carbon based on the data given above, give your answer to 3d.p.

See answer on page 1