Atoms and isotopes

This resource is from the **Johnstone's triangle** series, which can be viewed at: rsc.li/43jMfSn. In this series you will also find our **Atoms and isotopes: Johnstone's triangle** worksheet which introduces the triangle in the context of hydrogen and deuterium and can be viewed at: rsc.li/45bB6pv

Learning objectives

LO	Objective	Where assessed
1	Recall the types of sub-atomic particle, their location in an atom and how to determine the number of each from the atomic number and mass number.	Q1
2	Determine the number of protons, neutrons and electrons in an atom from the atomic symbol.	Q2
3	Recognise similarities and differences in the number of protons, neutrons and electrons between atoms and their ions and different isotopes.	Q3
4	Determine the atomic symbol for different isotopes using information about the number of protons and neutrons.	Q4

How to use this resource

This resource aims to develop learners' understanding of isotopes and how they are represented. The questions encourage learners to think about similarities and differences in the number of different sub-atomic particles in a range of atoms, ions and isotopes. As a result, learners should develop more secure mental models to support their thinking about this topic.

When to use?	Introduce	**Develop**	**Revise**	Assess
	Use after initial teaching or discussion of this topic to develop ideas further. You can also use as a revision activity.			
Group size?	**Independent**	**Small group**	**Whole class**	**Homework**
	Suitable for independent work either in class or at home. Or use the questions for group or class discussions.			
How long?	→		15–30 mins	

Johnstone's triangle

Johnstone's triangle is a model of the three different conceptual levels in chemistry: macroscopic, sub-microscopic and symbolic. You can use Johnstone's triangle to build a secure understanding of chemical ideas for your learners.

Find further reading about Johnstone's triangle and how to use it in your teaching at rsc.li/43na3ov

Johnstone's triangle and this resource

The icons in the margin indicate which level of understanding each question is developing to help prompt learners in their thinking.

Macroscopic: what we can see. Think about the properties that we can observe, measure and record.

Sub-microscopic: smaller than we can see. Think about the particle or atomic level.

Symbolic: representations. Think about how we represent chemical ideas including symbols and diagrams.

The levels are interrelated, for example, learners need visual representation of the sub-microscopic to develop mental models of the particle or atomic level. Our approach has been to apply icons to questions based on what the learners should be thinking about.

Questions may be marked with two or all three icons, indicating that learners will be thinking at more than one level. However, individual parts of the question may require learners to think about only one or two specific levels at a time.

Support

This worksheet is ramped so that the earlier questions are more accessible. The activity becomes more challenging in the later questions. You can give extra explanations for the more challenging questions. If completing as an in-class activity it is best to pause and check understanding at intervals, as often one question builds on the previous one.

It is useful for learners to observe macroscopic properties first-hand. You could circulate examples of substances in the classroom, run a class practical of a chemical reaction or show a teacher demonstration of properties.

Additional support may be needed for any learners still lacking in confidence in the required symbolic representation, for example by sharing and explaining a diagram.

Answers

1. *Guidance note:* This question consolidates learners' understanding of the location and number of each type of sub-atomic particle in an atom (sub-microscopic understanding). This question assumes prior familiarity with the atomic model.

(a) protons and neutrons
(b) nucleus
(c) number of protons: 2
number of electrons: 2
(d) 4 – 2 = 2
(e) number of neutrons = mass number – atomic number

2. *Guidance note:* This question develops learners' ability to interpret atomic symbols (symbolic understanding) and to use the information to find the number of protons, neutrons and electrons in each atom (sub-microscopic understanding).

Atomic symbol	Mass number	Atomic number	Number of protons	Number of electrons	Number of neutrons
$^{19}_{9}F$	19	9	**9**	**9**	**10**
$^{16}_{8}O$	**16**	**8**	**8**	**8**	**8**
$^{23}_{11}Na$	**23**	**11**	**11**	**11**	**12**

3. *Guidance note:* This question develops learners' understanding of the similarities and differences in the number of protons, neutrons and electrons in atoms and their ions and in different isotopes (sub-microscopic understanding). This question assumes prior familiarity with the structure of atoms and ions.

(a) **A** protons = 3 electrons = 3 neutrons = 4
B protons = 3 electrons = 2 neutrons = 4

(b) **A** +3 –3 = 0
B +3 –2 = +1

(c) Diagram **B**

(d) **C** protons = 4 electrons = 4 neutrons = 3
D protons = 3 electrons = 3 neutrons = 3
E protons = 4 electrons = 4 neutrons = 2

(e) Diagram **D** is a diagram of an isotope of lithium because it has 3 protons which is equal to the atomic number of lithium.

4. *Guidance note:* The questions develop learners' understanding of how to distinguish isotopes of the same element from an isotope of a different element using information on the number of protons and neutrons (sub-microscopic understanding). This question also requires learners to construct atomic symbols (symbolic understanding).

(a) $^{14}_{6}C$

(b) $^{13}_{6}C$

(c) Atom Z is not an isotope of carbon because its atomic number (number of protons) is 7 not 6.

(d) Nitrogen

(e) $^{14}_{7}N$