Moles of xenon: Johnstone's triangle

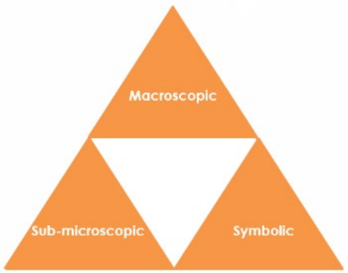
This resource is from the **Johnstone's triangle** series which can be viewed at: rsc.li/43jMfSn. It will help learners to understand the different ways you need to think in chemistry, and to build their mental models and understanding.

Learning objectives

1. Convert from cm^3 to dm^3.
2. Calculate the number of moles of xenon in a given volume of gas at room temperature and pressure.
3. Suggest how the number of atoms differs at a higher pressure.

How to use Johnstone's triangle

Use Johnstone's triangle to develop learners' thinking about scientific concepts at three different conceptual levels:



- Macroscopic – what we can see. Think about the properties you 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.

For learners to gain a deeper awareness of a topic, they need to understand it at all three levels.

When introducing a topic, don't introduce all three levels of thinking at once. This will overload working memory. Instead complete the triangle over a series of lessons, beginning with the macroscopic level, ideally followed by the symbolic and then sub-microscopic levels.

The levels are interrelated. For example, learners need visual representation of the sub-microscopic in order to develop mental models of the particle or atomic level.

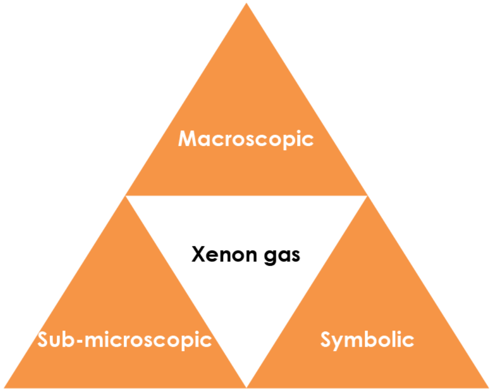
Find further reading about Johnstone's triangle and how to use it in your teaching at: rsc.li/3N8CFxx.

Scaffolding

Share the structure of the triangle with learners prior to use. Tell them why you are using it and how it will help them to develop their understanding. Use an 'I try, we try, you try' approach when introducing Johnstone's triangle for the first time.

More resources

To further develop learner's thinking in all areas of Johnstone's triangle, try our **Developing understanding of moles and volume** worksheet (rsc.li/4q4ZEI6). This includes icons in the margin referring to the conceptual level of thinking needed to answer the question.



Macroscopic – what we can see

The photo shows a car headlight bulb that contains xenon.

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Describe the appearance of xenon.

Xenon is a colourless gas

Suggest why it is safe to use xenon inside the bulb.

Xenon is very unreactive.

Sub-microscopic – smaller than we can see

One mole of any gas has a volume of 24 dm^3 at room temperature and pressure. One mole of xenon contains 6.02×10^{23} atoms of xenon.

Calculate the number of moles of xenon atoms in 1 cm^3.

$$\text{Number of moles} = \frac{\text{volume of gas in dm}^3}{24\ \text{dm}^3}$$

$= 0.001 / 24$

$= 0.00004$ moles

Calculate the number of atoms of Xe.

$0.00004 \times 6.02 \times 10^{23} = 2.5 \times 10^{19}$ atoms

The xenon used inside the bulb is at high pressure. Suggest whether the number of xenon atoms will be higher or lower than calculated.

The number of atoms of xenon per volume will be higher than calculated at a higher pressure.

Symbolic – representations

Give the element symbol of xenon.

Xe

The volume occupied by one mole of a gas is given in dm^3.

dm^3 and cm^3 are unit symbols for units of volume.

Give the number of centimetres that is equal to 1 decimetre?

10 cm

Show why 1 dm^3 is equal to1000 cm^3.

1 dm^3 = 10 cm x 10 cm x 10 cm

= 1000 cm^3

Give the volume of 1 cm^3 in dm^3.

1 / 1000 dm^3 or 0.001 dm^3