Hydrogen and oxygen reaction equation: Johnstone's triangle

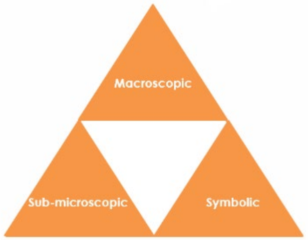
This resource is from the **Johnstone's triangle** series which can be viewed at: rsc.li/43jMfSn. It will help learners to understand the different ways you need to think in chemistry, and to build their mental models and understanding.

Learning objectives

1. Recognise the chemical formulas used in the equation.
2. Interpret the state symbols used in the equation.
3. Describe what is shown by the balanced chemical equation.

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 and introducing other levels, in turn, once secure.

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/4sCRfNI.

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 interpreting equations** worksheets (rsc.li/45CE5q6). These include icons in the margin referring to the conceptual level of thinking needed to answer the question.

Macroscopic – what we can see

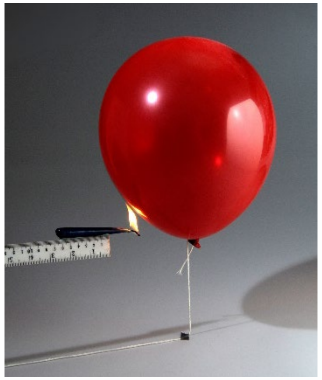
If a balloon of hydrogen is lit by a burning splint it will explode with a loud bang.

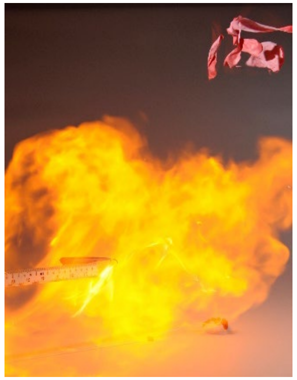
Name the gas in the air that reacts with the hydrogen.

oxygen

Suggest why no liquid water is observed after the reaction.

The water produced is in the gas state (because the reaction given is highly exothermic).





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Sub-microscopic – smaller than we can see

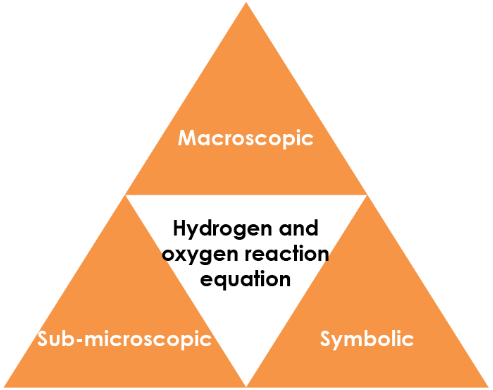
Add numbers to the sentence to describe what is shown by the balanced chemical equation.

Every two molecules of hydrogen react with one molecule of oxygen to produce two molecules of water.

Explain why the following equation cannot be correct.

$$H_2(g) + O_2(g) \rightarrow H_2O(g)$$

If each molecule of hydrogen reacted with one molecule of oxygen to form one molecule of water, there would be an atom of oxygen left over.



Symbolic – representations

Give the chemical formula of each reactant and product in the equation:

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$$

hydrogen

H_2

oxygen

O_2

water

H_2O

Give the state of both reactants and the product. gas state