

Chemistry > Big idea CPS: Particles and structure > Topic CPS4: Understanding chemical reactions

Key concept (age 11-14)

CPS4.1 Representing reactions

What's the big idea?

A big idea in chemistry is that during a chemical reaction, atoms are rearranged to form a new substance (or substances).


How does this key concept develop understanding of the big idea?

This key concept develops the big idea by linking the symbolic representation of a chemical reaction (a chemical equation) with the rearrangement of atoms.

The conceptual progression starts by checking the interpretation and writing of word equations. It then supports the development of the ability to move between macroscopic and symbolic representational levels of substances and reactions in order to enable the categorisation of a reaction using a symbolic chemical equation alone.

Using the progression toolkit to support student learning

Use diagnostic questions to identify quickly where your students are in their conceptual progression. Then decide how to best focus and sequence your teaching. Use further diagnostic questions and response activities to move student understanding forwards.

Progression toolkit:	
Learning focus	What I am teaching
As students' conceptual understanding progresses they can:	
Diagnostic questions	<p>Observable learning outcomes to guide my teaching focus</p> <p>Questions to find out what my students know and understand</p>
Response activities	<p>Activities to move my students' understanding forwards</p>

Progression toolkit: Representing reactions

Learning focus	A chemical reaction can be summarised by a chemical equation.				
As students' conceptual understanding progresses they can:					
P Interpret the meaning of the symbols + and → in a word equation.	B Select the word equation that correctly represents the chemical reaction described.	B Match a chemical formula and state symbol with a macroscopic observation.	B Link a symbolic chemical equation to macroscopic observations of a reaction.	B Use a symbolic chemical equation to categorise a reaction as oxidation, decomposition or precipitation.	
Diagnostic questions	Word equation sentences	Writing word equations	State symbols	Reaction observations	Reaction type
Response activities		Product discussion	State symbol observations		Categorising reactions

Key:

P Prior understanding from earlier stages of learning

B Bridge to later stages of learning

What's the science story?

Chemical reactions are represented by chemical equations.

A word equation summarises the reactants and products of a reaction. A symbolic chemical equation provides not only qualitative information about the substances in the reaction, but also quantitative information relating to the both the substance and the ratio in which they react. State symbols are used to indicate whether substances are in the solid, liquid or gas state or if they are dissolved in water (aqueous).

What does the research say?

Research (Al-Kunifed, Good and Wandersee, 1993) found some confusion amongst students between the use of symbols such as + and \rightarrow in chemical equations and potentially more familiar mathematical equations. Other research (Taber and Bricheno, 2009) found that whilst word equations are often considered to be more straightforward, students may not have the conceptual framework needed to understand them when they are first introduced.

Johnstone (1991) used a triangle to summarise three levels of representation that he proposed are needed in order to understand chemistry.

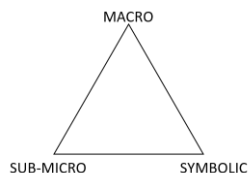


Figure 1 Johnstone's triangle

Jaber and BaJaoude (2012) propose that at an instrumental level of understanding (knowing how) students learn chemical concepts at the three levels separately. This may lead to fragmented and compartmentalised learning.

They suggest that in order to acquire a relational level of understanding (knowing why) students need to develop ways to move easily and skilfully within Johnstone's triangle.

The learning outcomes therefore start with the basic interpretation of chemical word equations, including the symbols used. Then links are developed between symbolic chemical equations and macroscopic observations.

Guidance notes

The representation of reactions is difficult to cover isolation. It is therefore important that students have been introduced to the types of reaction referred to in this key concept. For this reason, in the chemistry subject map, this key concept is placed after the topic 'Chemical Change' which includes oxidation and thermal decomposition reactions. This key concept also assumes familiarity with precipitation reactions and so should be used either after or alongside key concept CCR2.1: Reactions in solution.

References

- Al-Kunifed, A., Good, R. and Wandersee, J. (1993). Investigation of high school chemistry students' concepts of chemical symbol, formula and equations: Students' prescientific conceptions. ERIC Document ED376020.
- Jaber, L. Z. and BouJaoude, S. (2012). A macro-micro-symbolic teaching to promote relational understanding of chemical reactions. *International Journal of Science Education*, 34(7), 973-998.
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- Taber, K. S. and Bricheno, P. (2009). Coordinating procedural and conceptual knowledge to make sense of word equations: Understanding the complexity of a 'simple' completion task at the learner's resolution. *International Journal of Science Education*, 31(15), 2021-2055.