

Chemistry > Big idea CCR: Chemical reactions > Topic CCR2: Understanding reactions

Key concept (age 11-14)

CCR2.1 Reactions in solution

What's the big idea?

A big idea in chemistry is that during a chemical reaction, atoms are rearranged resulting in the formation of a new substance or substances.

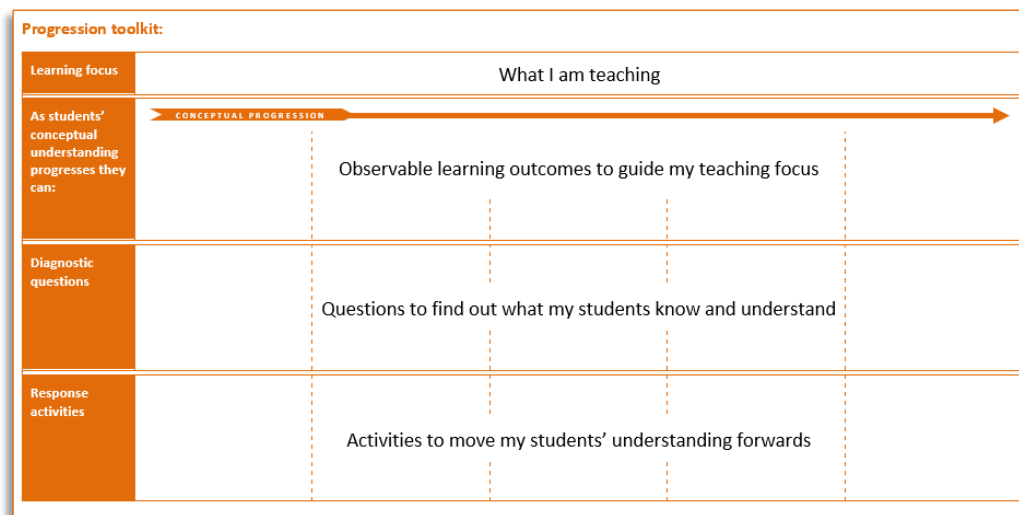
How does this key concept develop understanding of the big idea?

This key concept develops the big idea by introducing the reaction of substances that are in solution.


The conceptual progression starts by checking understanding of solubility both macroscopically and in terms of the difference in properties between a compound and its constituent elements. It then supports the development of understanding of the appearance of an insoluble product in order to enable explanation of the formation of a precipitate.

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: Reactions in solution

Learning focus	When two solutions react, a product may be insoluble, resulting in the formation of a precipitate.				
As students' conceptual understanding progresses they can:					
Diagnostic questions	Solution?	Is copper soluble?	Making silver?	Precipitate	Mass change?
Response activities	Dissolving discussion (key concept CSU1.2 Solutions)	Explaining differences	Copper discussion	Solubility sentences	Predicting mass

Key:

P Prior understanding from earlier stages of learning

B Bridge to later stages of learning

What's the science story?

Observed changes in reactions can be explained by differences in the properties of the reactants and products. Chemical reactions can also take place in solution. A precipitate is formed when an insoluble product is formed from soluble reactants.

What does the research say?

Anderson (1990) found that student answers to a research question asking students to predict the mass after a chemical change was influenced by students' understanding of chemical change. A student who observes a substance to 'disappear' may predict that the mass will decrease. A student who correctly predicts that mass will remain the same, may do so for the incorrect reason if they explain an observation in terms of substance always being present but just becoming visible.

Research (Stavridou and Solomonidou, 1998) based on a data analysis of students' definitions of chemical reaction combined with their identification of chemical reactions distinguished three main stages in the development of the concept of chemical reaction.

Students at the initial stage did not link a chemical reaction to the formation of a new substance. They focused instead upon a noticeable event such as the formation of a gas or a colour change. During the intermediate stage in their development of understanding students did recognise the formation of a new substance which they could then, at a more advanced stage, explain at a sub-microscopic level.

The reaction of substances in solution presents additional challenges to students in progressing through these stages of understanding. It requires students to combine their understanding of dissolving (so that students understand that a substance is present even if it cannot be seen in solution) with the concept of chemical change (so that students recognise that a new substance or substances can be formed with different properties to the reactants). This key concept is therefore introduced after key concepts CSU1.3: Solutions, CPS1.2 Particles in solution and CCR1.1: Formation of new substances. Example reactions in the latter deliberately avoid the use of substances in solutions.

Displacement and precipitation reactions result in very clear macroscopic observations during which a solid metal or suspension of an insoluble product are formed. Without making clear links to the concept of chemical change students may revert to the earlier stage of learning in which the macroscopic observations are simply regarded as an event. An article by de Vos and Verdonk (1985) suggested that more spectacular reactions can distract students from focusing on evidence for chemical change. Students may benefit from a reminder to link observations of chemical reactions with evidence for the formation of new substances.

Understanding of these reactions at the sub-microscopic scale requires an understanding of ions and so is usually studied at age 14-16.

Guidance notes

At this stage the focus is on macroscopic observations of reactions between solutions, including conservation of mass and the formation of insoluble products such as a metal during a displacement reaction or a precipitate from a reaction between two solutions. Student understanding of reactivity is explored in a later key concept.

However, students could start to make links between macroscopic observations and symbolic representation. See key concept CPS4.1: Representing reactions.

References

Andersson, B. (1990). Pupils' conceptions of matter and its transformations (age 12-16). *Studies in Science Education*, 18, 53-85.

de Vos, W. and Verdonk, A. H. (1985). A new road to reactions (part 1). *Journal of Chemical Education*, 62(3), 238-240.

Stavridou, H. and Solomonidou, C. (1998). Conceptual reorganization and the construction of the chemical reaction concept during secondary education. *International Journal of Science Education*, 20(2), 205-221.