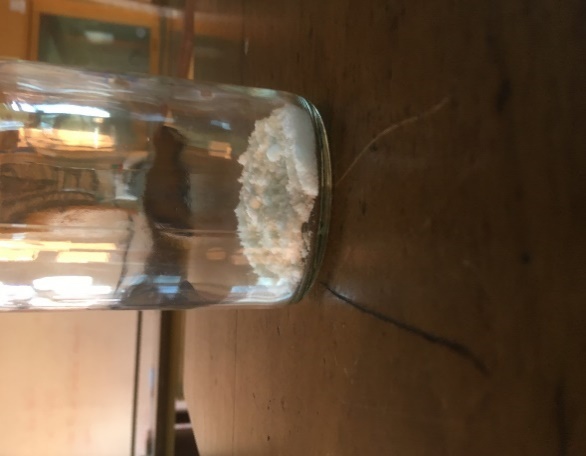
**Counter arguments**

Some students carry out an experiment in front of their class and teacher.

Substance A is white. Alia places it into a small glass jar.

Substance B is also white. Daniel places this compound into the same jar.



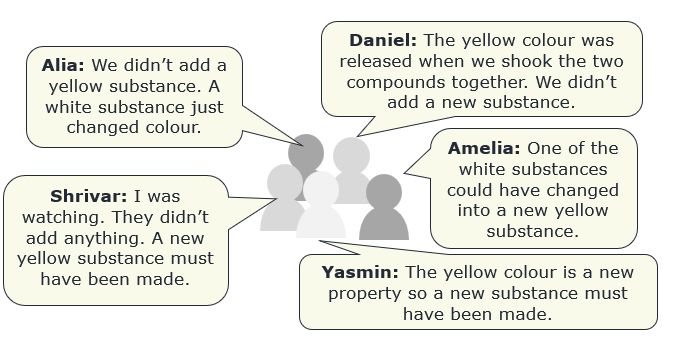
Alia places a lid on the jar and shakes it.

After 6 shakes, a yellow colour appears.



The teacher asks the students “Which of you has added a yellow substance to the test tube?”

Look at the students’ replies.



1. Who do you think gives a scientifically correct argument, and why?
2. For each of the other ideas create a counter argument. Your argument should explain to the student why their reply is not scientifically correct.

*Chemistry > Big idea CCR: Chemical reactions > Topic CCR1: Chemical change > Key concept CCR1.1: Formation of new substances*

|  |
| --- |
| **Response activity** |
| **Counter arguments** |

**Overview**

|  |  |
| --- | --- |
| Learning objective: | During a chemical reaction a new substance (or substances) are formed with different properties. |
| Observable learning outcome: | Explain observations of a chemical reaction in terms of the formation of a new substance or substances. |
| Activity type: | talking heads |
| Key words: | substance |

This activity can help develop students’ understanding by addressing the misunderstandings revealed by the following diagnostic question:

* Colour change

**What does the research say?**

This activity was inspired by an article from the Journal of Chemical Education (de Vos and Verdonk, 1985). The spectacular nature of some chemical reactions (for example burning magnesium) were thought to ‘distract’ students from observations relating to the formation of a new substance. The solid-solid reaction between lead nitrate and potassium iodide was chosen because it results in the appearance of a yellow colour and does not display any other ‘distracting’ phenomena. The research found that students were often very reluctant to attribute the colour change to the formation of a new substance. Instead they created other explanations to account for this observation.

A summary of research into students’ conceptions of matter (Andersson, 1990) developed five categories of the types of answers students gave when explaining chemical reactions, only the last is scientifically correct. Many of the explanations provided by students attempting to explain the appearance of the yellow colour fall into one of these categories.

|  |  |  |
| --- | --- | --- |
| **Category of explanation** | **Description** | **Example** |
| disappearance | The substance has simply gone. | Petrol is ‘used up’. |
| Displacement  (movement) | The new product has moved from somewhere else. | When solid lead nitrate and potassium iodide are mixed the yellow colour (lead iodide) comes out of the white grains of powder. |
| modification | The original substance keeps its identity, but its properties change. | When alcohol burns it turns into alcohol vapour. |
| transmutation | A substance changes into another substance or a substance is changed (partly) into energy. | When magnesium burns it turns into energy. |
| chemical interactions | Substances combine to form a new substance (or split up to create two or more substances). | Magnesium reacts with oxygen forming magnesium oxide. |

**Ways to use this activity**

Students should complete this activity in pairs or small groups, and the focus should be on the discussions and counter arguments developed.

If there is disagreement when you take feedback, a good way to progress might be through structured class discussion. Ask one student to give one of their counter arguments; ask another student to explain why they agree with them; ask another to explain why they disagree, and so on. This sort of discussion gives students the opportunity to explore their thinking and for you to really understand their learning needs. You may wish to use the outcomes of the whole class discussion to devise whole class versions.

*Differentiation*

It may help some students if you model an example counter argument or provide a talking frame as additional support.

**Expected answers**

Shrivar and Yasmin give a scientifically correct arguments.

Example counter arguments for the remaining students:

Alia - What colour is sodium chloride (table salt)? Have you ever seen different coloured version of sodium chloride? Why not? You cannot have yellow sodium chloride because sodium chloride is white.

Daniel - Try shaking the white substances separately. Does a yellow colour appear?

Amelia - Suppose it was compound A that changed into a different substance. What happened to compound B? Could A change without adding compound B? Can one substance change into a new one? What else could have happened? (There was a chemical reaction between compound A and compound B and new substances were formed).

**Acknowledgments**

Developed by Helen Harden (UYSEG), from an idea by de Vos and Verdonk (Utrecht University, Netherlands)

Images: Sarah Longshaw

**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.