

Activity H

Changes in Matter

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Introduction

This activity uses “competing theories”, where alternative explanations about a particular phenomenon are evaluated. This activity requires pupils to evaluate two competing theories, in this case, explanations about the differences between chemical and physical changes. Pupils are presented with two alternative theories and they are asked to evaluate a list of evidence that can support one theory, the other or both theories. They are expected to provide justifications for their choice of theory as well as evidence.

Objectives

Pupils will learn:

- about the nature of science by exploring and debating alternative theories for the similarities and differences between physical and chemical change;
- to construct an argument using evidence to support a theory and will explain why these statements justify the theory supported.

Outcomes

By the end of the lesson, pupils will be able to:

- evaluate statements and justify why a particular statement supports or does not support a theory;
- generate criteria for evaluating the statements e.g. relevance of the evidence;
- oppose the counter theory by constructing counter arguments and providing an explanation for why the other theory is not plausible.

Notes for Teachers

It is counter intuitive to many pupils that boiling water and burning paper are fundamentally different kinds of change, because in both cases the substances are being heated and there is observable change in the reactants. One of the observable similarities is that gases are released in both situations. However pupils do not have any observable evidence that these two processes should involve different mechanisms. The only

observable difference is that ash is left behind when paper is burned and nothing or very little is left behind when water is boiled away.

Teaching Sequence

- Distribute the pupil activity sheet and explain the task. It may be useful to draw a simple diagram on the blackboard to illustrate how the two theories are the opposite of each other. Tell the pupils that the activity requires them to work in small groups to discuss the theories and the evidence statements.

- Ask the pupils to discuss the ideas on the activity sheet for about 10 minutes. Tell them that it is acceptable if they do not agree, but that they should be able to justify their point of view. Emphasise that they need to justify their reasons why they think any particular evidence statement is relevant or not.

- There are two ways of managing the next stage.
 - **A** Once each group has finished discussing the sheet, ask one person from each group to report back to the whole class. Ask this pupil to explain who agreed with which theory and why and whether the group has come to some consensus or not. In other words, ask the groups to report back the substance of the discussion and the arguments and the reasons for picking one theory over another.

 - **B** Use an ‘envoy’ arrangement. One person from each group is delegated to go to the next group as an ‘envoy’ and report on the discussion that they had and which theory they have chosen. In turn the group has to explain to the ‘envoy’ which theory they chose and why. Allow 5 minutes maximum for this. Then ask the envoys to return to their groups and share what they found out with the others in their group.

- Whichever option is used, finish by making a record of the pupils’ choices on the board once all groups have presented or shared them using envoys. If there are major disagreements (for instance, if there are groups who think that Theory 1 is correct) ask the groups who support Theory 2 how they would convince other groups that their theory is wrong. Ensure that the full scientific argument is provided at some stage in the final discussion.

Changes in Matter!

Theory 1: Burning a piece of paper is like boiling water. Both paper and water change in their compositions in the same way.

Theory 2: Burning a piece of paper is very different from boiling water. Paper changes its composition, but water does not.

Evidence Statements:

Heat is needed to burn paper and boil water.	Gas is released when water boils and paper burns.
When paper burns ash is left, but when pure water boils away nothing is left behind.	A chemical reaction occurs when reactants change into new products.
As a liquid is heated, its molecules gain energy and move more and more quickly. Eventually, the bonds between molecules are no longer strong enough to keep the molecules close together.	It is possible to get the liquid water back by condensing the water vapour, but it is not possible to get the paper back after it has been burned.
Burning happens when an element or a compound reacts very vigorously with oxygen.	When matter undergoes phase transitions, it changes its state from solid to liquid to gas.