A Guide to Comparing Physical and Chemical Change

Teaching Approach

In this series of five lessons, we investigate different types of change happening all around us and we include many simple, practical experiments. We use the evidence gathered from these experiments to build our knowledge about change. We make careful observations of macroscopic changes and use microscopic models to explain these observations. The macroscopic changes refer to the changes that are observable and the microscopic changes refer to what happens to the particles of substances. The microscopic model must explain the macroscopic nature of substances for chemistry to make sense. This series therefore ensures that macroscopic observations from the practical activities are explained at a microscopic level.

The series addresses all the specific aims in Physical Sciences which promotes knowledge and skills in scientific inquiry and problem solving; the construction and application of scientific and technological knowledge; an understanding of the nature of science and its relationships to technology and society.

During the course of these lessons we will investigate these physical and chemical changes and some types of chemical change. We will refer briefly to the energy changes that occur during these changes and how we use them in our everyday lives. An inquiry-based approach should motivate learners to observe objects around them more carefully and learners will be given the opportunity to observe and discuss the changes in the world surrounding them on both microscopic and macroscopic levels.

Video Summaries

Some videos have a 'PAUSE' moment, at which point the teacher or learner can choose to pause the video and try to answer the question posed or calculate the answer to the problem under discussion. Once the video starts again, the answer to the question or the right answer to the calculation is given

Mindset suggests a number of ways to use the video lessons. These include:

- Watch or show a lesson as an introduction to a lesson
- Watch or show a lesson after a lesson, as a summary or as a way of adding in some interesting real-life applications or practical aspects
- Design a worksheet or set of questions about one video lesson. Then ask learners to watch a video related to the lesson and to complete the worksheet or questions, either in groups or individually
- Worksheets and questions based on video lessons can be used as short assessments or exercises
- Ask learners to watch a particular video lesson for homework (in the school library or on the website, depending on how the material is available) as preparation for the next day's lesson; if desired, learners can be given specific questions to answer in preparation for the next day's lesson

1. How to Identify a Physical Change

This lesson investigates what happens when we heat substances. We also show how water changes phases and these changes are explained by looking at the particle model of matter.

2. How to Identify a Chemical Change

In this lesson we investigate chemical change when iron and sulfur are mixed and heated and the chemical changes that take place when a candle burns.

3. Types of Chemical Change

In this lesson we find out how copper can be recovered from its ore through a series of decomposition reactions. We also show that copper reacts with oxygen in a synthesis reaction.

4. Law of Constant Composition

The reactions of copper in oxygen are revisited and looked at from a historical context in which Proust noted that compounds react in fixed proportions.

5. Law of Conservation of Mass

This lesson looks at another very important law - the Law of Conservation of Mass. We make careful measurements to show that the mass of a closed system does not change during either a physical or a chemical change.

Resource Material

1 How to Identify a Physical Change	http://www.personal.psu.edu/faculty/r/j/rjp4/change.htm	An outline of the macroscopic and microscopic changes that occur when charcoal burns in oxygen to outline the difference between physical and chemical change.
	http://www.bbc.co.uk/bitesize/ks3/science/chemical_material_behaviour/compounds_mixtures/revision/2/slideshow-1/3/#bs-slideshow-1	A definition of compounds and an animation to show the formation of iron sulfide
2 How to Identify a Chemical Change	http://www.bgfl.org/bgfl/custom/resources_ftp/client_ftp/ks3/science/changing_matter/index.htm	An animation to show a particle view of what happens to water as it is heated and the temperature increases.
	http://www.youtube.com/watch?v=hKcT5nxIANc&list=PLB5D259E8067AA940	Video to show the difference between mixtures and compounds looking at a mixture of iron and sulfur and the formation of the compound iron sulfide.
3 Types of Chemical Change	http://www.youtube.com/watch?v=FiwpSUHyGOI	Video of the decomposition reaction of hydrogen peroxide into oxygen and water.
	http://www.youtube.com/watch?v=-j1eU8-49wc	Video demonstration of the synthesis of water from burning hydrogen and oxygen.
4 Law of Constant Composition	http://www.youtube.com/watch?v=ithQj7XehW8	Video that outlines the law of definite and multiple proportions.
5 Law of Conservation of Mass	http://www.youtube.com/watch?v=dExpJAECSL8	Video that explains the law of conservation of mass in chemical change.
	http://www.youtube.com/watch?v=zOZK8BcddT0	Video of demonstration of conservation of mass in reaction between baking soda and vinegar.
	http://www.learner.org/courses/essential/physicalsci/session3/	Video on Law of Conservation of Mass in various examples of physical change and use of particle model of matter to explain phase changes.

Task

Question 1

Consider the following two examples: water in a river that freezes in winter and a candle burning.

1.1 Decide whether each change is a physical change or not.
1.2 Give both macroscopic and microscopic explanations to justify each decision.

Question 2

Octane (C_8H_{10}) burns in oxygen in motor car engines to produce carbon dioxide gas and water vapour. The energy released is used to power the motor.

2.1 Write a word equation to represent this change.
2.2 Is this a physical or chemical change? Give a reason for your answer?

Question 3

Consider the following example of chemical change. Hydrogen burns in air, which contains oxygen, with a blue flame and forms water.

3.1 Write a word equation to represent this change.
3.2 Is this a decomposition or a synthesis reaction? Give a reason for your answer.

Question 4

Various samples of calcium carbonate are heated and decompose into calcium oxide. The mass of each sample of calcium oxide is measured and recorded in a table.

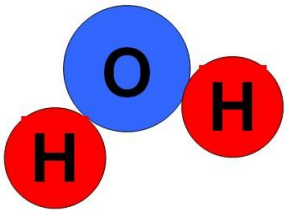
Mass of calcium carbonate decomposed	Mass of calcium oxide formed	Mass Calcium oxide / Mass calcium carbonate
100 g	56 g	0,56
200 g	112 g	0,56
300 g		

4.1 What is the mass of calcium carbonate divided by the mass of calcium oxide for the 300 gram sample?

4.2 What mass of calcium oxide forms for the 300 gram sample?

Question 5

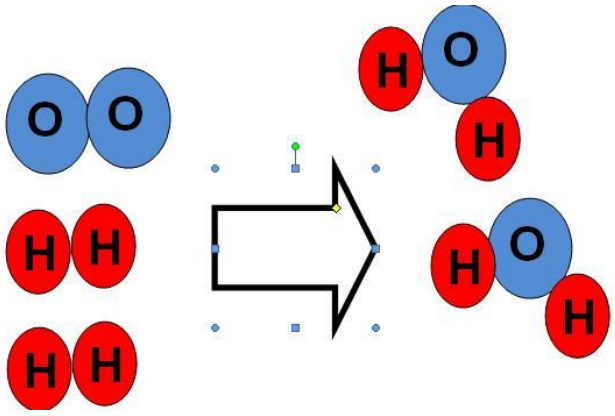
Any water molecule is always made up of two hydrogen atoms and one oxygen atom in a two to one ratio.



Use the relative atomic mass of hydrogen and oxygen to determine the percentage mass of the water accounted for by the oxygen and hydrogen atoms.

Question 6

Hydrogen gas reacts with oxygen gas to form water. Here is a microscopic representation of this reaction.



Complete the table for the number of molecules, relative mass and number of atoms for the reactants and the products of this reaction.

	Reactants	Products
Number of molecules		
Mass		
Number of atoms		

Question 7

When 247 g copper carbonate is heated it forms 159 g copper oxide.

7.1 Write a word equation to represent this change.

7.2 Use the Law of Conservation of Mass to work out the mass of carbon dioxide that forms during the reaction.

Task Answers

Question 1

1.1 Physical changes mean new substances do not form; they happen as a result of the transfer of relatively small quantities of energy and they are often reversible.
Water freezing is a physical change.
The candle burning is a chemical change.

1.2 When water freezes no new substance forms, little energy is released from the water and ice can be heated to melt. The particles of water change the way they are arranged. In the solid the particles are all close together, have strong inter-molecular forces and move slowly over very short distances.

When the candle burns new products form and the process is not reversible. Larger amount of energy is released. The chemical bonds within the molecules in candle wax are broken and reform in different combinations when new substances form.

Question 2

2.1 Candle wax + oxygen → carbon dioxide + water

2.2 Chemical Change
For burning petrol new products form and the process is not reversible. The chemical bonds within the molecules in petrol are broken and reform in different combinations when new substances form.

Question 3

3.1 Hydrogen + oxygen → water

3.2 Synthesis reaction. Simpler substances join together to form a more complex substance

Question 4

4.1 By the Law of definite proportions it must be the same as for the other samples. So, 0,56.

4.2 Mass of calcium oxide / Mass of calcium carbonate = 0,56
x / 300 = 0,56
x = 0,56 x300
x = 168 g

Question 5

Relative mass of water molecule =16 + (2 x 1) = 180 amu.
% Oxygen = 16 / 18 x 100
= 88,89% oxygen
% Hydrogen = 2/ 18 x 100
= 11,11 % hydrogen

Question 6

	Reactants	Products
Number of molecules	3 molecules (2 hydrogen molecules, one oxygen molecule)	2 molecules of water
Mass	Oxygen: (16 x 2) = 32 amu Hydrogen: 2 x (2 x 1) = 4 amu 36 amu	Water 2 x (16 + 2) = 36 am

Number of atoms	Two oxygen atoms Four hydrogen atoms	Two oxygen atoms Four hydrogen atoms

Question 7

7.1 Copper carbonate (s) → Copper oxide (s) + carbon dioxide (g)

7.2 From the law of conservation of mass

247 = 159 + x

X = 88 g of carbon dioxide.

Acknowledgements

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