

Chemistry

## Big idea (age 11-14)

# CSU: Substances and properties

### What's the big idea?

All materials are made up of either a single substance or a mixture of substances. These substances may be elements or compounds. Substances have distinctive properties that may be used to identify them or separate them from a mixture. A solution is a mixture of two (or more) substances, the solute(s) and the solvent.

### Topics

The big idea is developed through a series of key concepts at age 11-14, which have been organised into teaching topics as follows:

Topic CSU1

**Substances and mixtures**

Key concepts:

- CSU1.1 Substance
- CSU1.2 Solutions
- CSU1.3 Separating solutions

Topic CSU2

**Solubility**

Key concepts:

- CSU2.1 Comparing solubility

Topic CSU3

**Acids and alkalis**

Key concepts:

- CSU3.1 pH scale

Topic CSU4

**Periodic table**

Key concepts:

- CSU4.1 Trends in physical properties

The numbering gives some guidance about teaching order based on research into effective sequencing of key concepts. However, the teaching order can be tailored for different classes as appropriate.

### Guidance notes

As a subject, chemistry often requires an understanding of both macroscopic observations and a sub-microscopic (particulate) model that explains what is being observed. On other occasions an understanding of the substances involved and the reactions taking place is required. For this reason, several chemistry topics consist of key concepts from more than one big idea.

The 'Substances and mixtures' topic also includes key concepts from the 'Particles and structure' big idea (topic CPS1) and the 'Acids and alkalis' topic contains key concepts from the 'Chemical reactions' big idea (topic CCR 4).

The 'Periodic Table' topic spans three big ideas and includes key concepts from topics CPS5 and CCR5.

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## Learning progression

The science story associated with the big idea develops from age 5 to age 16, and could be summarised as follows:

### Science story at age 5-11

Objects are made of different materials. Materials may be grouped according to their different properties. It is important to make an object out of a material with the right properties for the use of that object.

Materials may be in the solid, liquid or gas state at room temperature. Some materials dissolve in water to form a solution. Some materials change state if they are heated or cooled.

Mixtures of materials (including solutions) can be separated using an appropriate technique.

### Science story at age 11-14

#### *Substances and mixtures*

All materials are made up of either a single substance, or a mixture of substances. A substance has a characteristic sharp melting and boiling point which determines its state at room temperature. One substance can exist in either the solid, liquid or gas state depending upon the temperature.

A pure sample of a substance consists of only that substance whereas an impure sample is a mixture containing one or more additional substances. An impure sample of a substance melts over a temperature range. Melting point can therefore be used to distinguish a pure sample of a substance from an impure sample.

Some substances dissolve in a particular solvent and some do not. A substance can be said to be soluble or insoluble in that solvent. The solution formed is a mixture of the solute and the solvent. Although the solute cannot be seen it is still present.

The properties of different substances may be used to separate a mixture using an appropriate practical technique.

#### *Solubility*

There is a maximum mass of a substance (solute) that will dissolve in any given volume of solvent. A solution in which no more solute will dissolve is called a saturated solution.

Solubility can change with temperature therefore the solubility of a particular substance is defined at a specific temperature.

Graphical data on solubility can be used to predict macroscopic observations of solutions in terms of whether the solute will appear fully dissolved.

#### *Acids and alkalis*

Acids and alkalis are both types of aqueous solution with specific chemical properties. They are indistinguishable by observation as they form colourless solutions. The colour change of litmus indicator may be used to find out whether a solution is acidic or alkaline.

The pH scale indicates how acid or alkaline a solution is.

*Periodic Table*

Within the Periodic Table there are both horizontal and vertical trends in physical properties of the elements. Metals are located on the left and non-metals on the right. Elements within the same vertical group may have similar physical properties (for example they may all conduct electricity) but also show differences including in melting and boiling point. Understanding of these trends allows predictions to be made about unfamiliar elements.

**Science story at age 14-16**

Groups of similar substances, including elements in the periodic table and organic compounds, may be understood in terms of similarities and trends in physical and chemical properties.

For example, crude oil is made up of a mixture of hydrocarbons. The alkanes are part a family of substances called hydrocarbons. They show trends in their properties (for example boiling point and viscosity) which make them suitable for different uses. These differences in properties allow the components of crude oil to be separated by fractional distillation.