Chemistry

Big idea (age 11-14)
CPS: Particles and structure

What's the big idea?

All matter is made up of atoms. The collective, structural arrangement and behaviour of the atoms explains the properties of different substances.

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 CPS1
Substances and mixtures

Key concepts:

- CPS1.1 Particle model for the solid, liquid and gas states
- CPS1.2 Particles in solutions

Topic CPS2
Elements and compounds

Key concepts:

- CPS2.1 Atoms and molecules
- CPS2.2 Symbols and formulae

Topic CPS3
Chemical change

Key concepts:

- CPS3.1 Rearrangement of atoms

Topic CPS4
Understanding chemical reactions

Key concepts:

- CPS4.1 Representing reactions
- CPS4.2 Conservation of mass

Topic CPS5
Evaporation

Key concepts:

- CPS5.1 Explaining evaporation

Topic CPS6
Periodic table

Key concepts:

- CPS6.1 Atomic model

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.

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Guidance notes

Please note that some substances are made up of ions but at this point the word 'atoms' has been used for simplicity as the concept of a charged atom requires understanding of atomic structure which is one of the last key concepts to be introduced. The concept of ions could be introduced from age 14-16.

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 'Substances and properties' big idea (topic CSU1) and the 'Understanding chemical reactions' topic contains key concepts from the 'Chemical reactions' big idea (topic CCR2). The 'Periodic Table' topic spans three big ideas and includes key concepts in topics CPS5 and CCR5.

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

When a material is looked at it seems to be continuous. Air cannot be seen but it can be felt as wind. Air is a material but cannot be seen because it is made of parts that are too small to be seen, even with a microscope. In fact, all materials are made of parts that are too small to be seen but which can join to create the materials that are visible.

Science story at age 11-14

Particle model

All matter is made up of particles. The arrangement and movement of these particles is described by the particle model. This model can be used to explain observed changes of state. In order to account for differences between the melting and boiling point of substances the particle model must be extended to include consideration of the attractive forces between the particles. The particle model can also explain why a clear solution is formed when a substance dissolves.

Elements and compounds

All matter is made up of atoms. Each element is made up of a different type of atom. A single atom does not have the properties of that element. The properties of an element arise due to the arrangement and behaviour of the atoms collectively. A compound is made up of two or more types of atom joined together. As different atoms are joined than in the separate elements, the compound has properties that are distinct from the elements that are made up of its constituent atoms.

Elements and compounds have one of two types of basic structure. Some are made up of separate groups of two or more atoms (molecules) whereas the atoms in others are joined to make one giant structure. These structures influence properties such as melting and boiling points because there are weaker forces between molecules than within molecules.

The element symbols that form part of a chemical formula represent the types of atom that make up that particular compound. The numbers in a chemical formula show the ratio of these different types of atom. For molecular substances, the number in a formula also gives the number of each type of atom in a molecule.

Chemical change

During a chemical reaction, atoms are rearranged and therefore a new substance (or substances) is formed with different properties to the reactants.

Understanding chemical reactions

Chemical reactions are represented by chemical equations. A word equation summarises the reactants and products of a reaction.

A symbolic chemical equation provides not only qualitative information about the substances in the reaction, but also quantitative information relating to the both the substances and the ratio in which they react. State symbols are used to indicate whether substances are in the solid, liquid or gas state or if they are dissolved in water (aqueous).

For any chemical reaction, the total mass of the reactant substances is equal to the mass of the products. Mass is conserved.

Mass is conserved because during a chemical reaction the atoms are rearranged. No new atoms are created and none are destroyed. A symbolic chemical equation must therefore be balanced so that the number of atoms of each type are the same on both sides of the equation.

If a reaction takes place in an open system and a product is in the gas state, then this product is able to escape. The measured mass will therefore decrease.

Evaporation

The atoms (or molecules) that make up a substance are constantly moving but they do not all have the same kinetic energy. There is a distribution of energies. Some atoms (or molecules) will have enough energy to overcome the forces of attraction holding the atoms (or molecules) together and escape to mix with the air. This allows evaporation to take place below the boiling point of a substance.

Periodic Table

An individual atom is itself made up of even smaller particles. The atomic model describes an atom as consisting of a central nucleus (made up of protons and neutrons) surrounded by electrons.

Science story at age 14-16

Atoms are held together by electrostatic forces. These chemical bonds may be explained by three different models: covalent, ionic and metallic.

Chemical bonds can form between atoms or ions. An ion is an atom with positive or negative charge.

The properties of a substance, for example melting point, boiling point and electrical conductivity, depend upon its structure and the type of bonding.

New materials can be designed (for example polymers and nanomaterials) that have specific desired properties.