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GCSE (9–1)
Transition Guide

TWENTY FIRST CENTURY SCIENCE CHEMISTRY B

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For first teaching in 2016

KS3–KS4 focus
Chemical patterns

Version 1

www.ocr.org.uk/chemistry

Contents

GCSE (9–1)

TWENTY FIRST CENTURY SCIENCE CHEMISTRY B

Key Stage 3 to 4 Transition guides focus on how a particular topic is covered at the different key stages and provide information on:

- Differences in the demand and approach at the different levels;
- Useful ways to think about the content at Key Stage 3 which will help prepare students for progression to Key Stage 4;
- Common student misconceptions in this topic.

Transition guides also contain links to a range of teaching activities that can be used to deliver the content at Key Stage 3 and 4 and are designed to be of use to teachers of both key stages. Central to the transition guide is a Checkpoint task which is specifically designed to help teachers determine whether students have developed deep conceptual understanding of the topic at Key Stage 3 and assess their 'readiness for progression' to Key Stage 4 content on this topic. This checkpoint task can be used as a summative assessment at the end of Key Stage 3 teaching of the topic or by Key Stage 4 teachers to establish their students' conceptual starting point.

Key Stage 3 to 3 Transition Guides are written by experts with experience of teaching at both key stages.

Key Stage 3 Content

Atoms, elements and compounds

- a simple (Dalton) atomic model
- differences between atoms, elements and compounds
- chemical symbols and formulae for elements and compounds
- conservation of mass in changes of state and chemical reactions

The Periodic Table

- the varying physical and chemical properties of different elements
- the principles underpinning the Mendeleev periodic table
- the periodic table: periods and groups; metals and non-metals
- how patterns in reactions can be predicted with reference to the periodic table
- the properties of metals and non-metals
- the chemical properties of metal and non-metal oxides with respect to acidity

Chemical reactions

- chemical reactions as the rearrangement of atoms
- representing chemical reactions using formulae and using equations
- combustion, thermal decomposition, oxidation and displacement reactions

Key Stage 4 Content

C2.1 How have our ideas about atoms developed over time?

1. describe how and why the atomic model has changed over time to include the main ideas of Dalton, Thomson, Rutherford and Bohr

2. describe the atom as a positively charged nucleus surrounded by negatively charged electrons, with the nuclear radius much smaller than that of the atom and with most of the mass in the nucleus

3. recall relative charges and approximate relative masses of protons, neutrons and electrons 4. estimate the size and scale of atoms relative to other particles M1d

5. recall the typical size (order of magnitude) of atoms and small molecules

6. relate size and scale of atoms to objects in the physical world M1d

7. calculate numbers of protons, neutrons and electrons in atoms, given atomic number and mass number of isotopes or by extracting data from the Periodic Table M1a

C2.2 What does the Periodic Table tell us about the elements?

1. explain how the position of an element in the Periodic Table is related to the arrangement of electrons in its atoms and hence to its atomic number

2. describe how Mendeleev organised the elements based on their properties and relative atomic masses

3. describe how discovery of new elements and the ordering elements by atomic number supports Mendeleev's decisions to leave gaps and reorder some elements

4. describe metals and non-metals and explain the differences between them on the basis of their characteristic physical and chemical properties, including melting point, boiling point, state and appearance, density, formulae of compounds, relative reactivity and electrical conductivity

5. recall the simple properties of Group 1 elements including their reaction with moist air, water, and chlorine

6. recall the simple properties of Group 7 elements including their states and colours at room temperature and pressure, their colours as gases, their reactions with Group 1 elements and their displacement reactions with other metal halides

7. predict possible reactions and probable reactivity of elements from their positions in the Periodic Table

Key Stage 4 Content

8. describe experiments to identify the reactivity pattern of Group 7 elements including displacement reactions PAG1

9. describe experiments to identify the reactivity pattern of Group 1 elements

C2.3 How do metals and non-metals combine to form compounds?

1. recall the simple properties of Group 0 including their low melting and boiling points, their state at room temperature and pressure and their lack of chemical reactivity

2. explain how observed simple properties of Groups 1, 7 and 0 depend on the outer shell of electrons of the atoms and predict properties from given trends down the groups

3. explain how the reactions of elements are related to the arrangement of electrons in their atoms and hence to their atomic number

4. explain how the atomic structure of metals and non-metals relates to their position in the Periodic Table

5. describe the nature and arrangement of chemical bonds in ionic compounds

6. explain ionic bonding in terms of electrostatic forces and transfer of electrons

7. calculate numbers of protons, neutrons and electrons in atoms and ions, given atomic number and mass number or by using the Periodic Table M1a

8. construct dot and cross diagrams for simple ionic substances

9. explain how the bulk properties of ionic materials are related to the type of bonds they contain

10. use ideas about energy transfers and the relative strength of attraction between ions to explain the melting points of ionic compounds compared to substances with other types of bonding

11. describe the limitations of particular representations and models of ions and ionically bonded compounds, including dot and cross diagrams, and 3-D representations

12. translate information between diagrammatic and numerical forms and represent three dimensional shapes in two dimensions and vice versa when looking at chemical structures for ionic compounds M4a, M5b

Key Stage 4 Content

C2.4 How are equations used to represent chemical reactions?

1. use chemical symbols to write the formulae of elements and simple covalent and ionic compounds

2. use the formulae of common ions to deduce the formula of Group 1 and Group 7 compounds

3. use the names and symbols of the first 20 elements, Groups 1, 7 and 0 and other common elements from a supplied Periodic Table to write formulae and balanced chemical equations where appropriate

4. describe the physical states of products and reactants using state symbols (s, l, g and aq)

C2.5 What are the properties of the transition metals? (separate science only)

1. recall the general properties of transition metals (melting point, density, reactivity, formation of coloured ions with different charges and uses as catalysts) and exemplify these by reference to copper, iron, chromium, silver and gold

Comment

At key stage 3 atoms are thought of as discrete particles, so electrons, protons and neutrons are not discussed. This means that explaining differences in reactivity is not possible until key stage 4, when the importance of the electron is studied. This also means that different types of bonding are not explored until key stage 4, it is sufficient to be aware that atoms are bonded when part of a molecule or a compound. At key stage 3 reinforcement of the particle model is important. Ideas such as conservation of mass, that matter is not continuous and that there is a logical reason to explain changes in weight, appearance etc are important. Transition metals are the common metals that most will be familiar with from key stage 3 but at key stage 4 their chemical properties are introduced.

If misconceptions about the particle theory have developed, it can make it difficult for learners to understand chemical bonding. The scale of the size of atoms is hard to understand and some learners use their observations to adapt their own view of the particle theory, with ideas such as *particles explode, burn, contract, expand and/or change shape* being fairly common. Some learners may think that gases have no mass, so will find it hard to understand mass changes when oxygen reacts with a fuel or element. This limited thinking also prevents understanding of the nature of a chemical reaction, so it is important to refer to specific particles to show what is happening at a particle level. It is also important to give a visual representation of what is happening by using molecular models and using symbol equations to further illustrate the role of the particles. This will develop understanding of what a chemical reaction is, as the list of possible signs of a chemical reaction (such as colour change, temperature change) can be confusing. Some of the vocabulary (eg substance, compound) used in chemistry can be initially confusing, so producing an illustrated glossary could be a useful activity. Some learners think that most metals are magnetic. This is often because most metal objects that they are familiar with contain iron and so are magnetic. By testing samples of different metals, hopefully this misconception will be overcome.

As only two atoms tend to be drawn when showing ion formation, learners can think that only two ions are formed and that the ionic bond is between them, when in fact ionic bonds form in three dimensions and thousands of ions form even the smallest crystal. They may not appreciate that the formula of ionic compounds shows a ratio of the ions in the lattice and therefore tend to think of them as molecular compounds.

At key stage 3 it is beneficial to use both word and symbol equations. Despite perception of symbol equations as "hard", showing where atoms go during a reaction by giving symbol equations helps to make sense of chemistry and remove the mystery of different reactions. If they are used with word equations and molecular models then confidence with their use and a greater understanding of chemical reactions should develop.

The key stage 3 activities provide a variety of activities to investigate the periodic table and the scientific thinking behind it. The *Black Box* activities are a useful way of introducing how to interpret patterns. *Build your own periodic table cube is a useful homework activity*, which could use the Web Elements *interactive periodic table* to find out the relevant information. The cubes can then be used in subsequent lessons to illustrate trends in groups or periods and this could be reviewed with the *Teachers TV* clip. The two checkpoint tasks could be carried out at the end of the topic in key stage 3 or at the start of the topic in key stage 4 to find out which areas need further study. *The Atom Detectives* would be a useful activity to start the topic at key stage 4, while the *Understanding how atoms are made up* activity is a useful review of atomic structure. The *Starter for Ten* pack provides some useful starters, once some ionic bonding has been studied.

Activities

Build your own periodic table cube
Resources: http://smart-learning.co.uk/teachers-club/science/homework-activity-build-your-own-periodic-table/

A homework activity to research 6 key facts about an element. The cubes could then be used to illustrate trends in properties in subsequent lessons.

Interactive periodic table
Resources: https://www.webelements.com/

An interactive periodic table, useful for research.

The Nature of Science: Black Box
Resources: http://www.rsc.org/learn-chemistry/resource/res00001275/black-box

This resource tries to give learners an awareness of science as a changing body of knowledge. It contains activities for learners which help them understand the difference between observation and inference, and how to interpret patterns.

Teachers TV: KS3/4 science – Periodic Table
Resources: http://www.rsc.org/learn-chemistry/resource/res00002232/teachers-tv-ks3-4-science-periodic-table

This Teachers TV video looks at different elements in the Periodic Table and some properties they exhibit. The video also explains and demonstrates trends across the Periodic Table.

Checkpoint task

Task 1 Using Models

The first checkpoint task has two sections: A What is a chemical reaction? and B Key Words. The first checks that learners do not have misconceptions about particles (for example, particles themselves expand, burn or disappear) and that they are aware that bonds break and new bonds form during a chemical reaction. In Part A the learners use molecular models to suggest what happens to the atoms or molecules involved in burning carbon, hydrogen and then methane. Using models should help learners to realise that the particles cannot change size or disappear and that what there is to start with must just be rearranged. This should help overcome any misconceptions with the particle model. The second part checks that learners have clear understanding of the important words used in chemistry: element, compound, mixture and molecule. Both parts are best carried out using molecular models.

Task 2 Patterns in the periodic table

In the second checkpoint task, learners will analyse data in a table to decide which elements could be metals or non-metals and to look for patterns in behaviour. By using letters which are not the elements' symbols, learners cannot use learned answers to answer most of the questions, but have to show understanding of the differences between metals and non-metals and simple differences in their reactivity, such as metals on the left hand side becoming more reactive going down the group.

Link to Checkpoint task

Activities

The Atom Detectives
http://www.rsc.org/learn-chemistry/resource/res00001332/the-atom-detectives

This resource presents chemists as real people and not stereotypical 'mad scientists'. It looks at how the model of the atom has developed over the last 200 years and explores how scientists work together to develop new ideas. Group or individual work.

Ionic Bonding Teaching Resources
http://thescienceteacher.co.uk/ionic-bonding/

Lesson ideas to challenge learners aged 11 to 16 to think hard about ions and ionic bonding. Includes tests for transition metal ions.

Elements infographics
http://www.rsc.org/learn-chemistry/resource/res00001679/elements-infographics#!cmpid=CMP00005042

Fifteen attractive infographics which give information such as the atomic numbers, melting and boiling points, trends in reactivity and electronegativity, discovery dates, as well as various uses for the elements in the periodic table.

Starter for Ten: 3 bonding
http://www.rsc.org/learn-chemistry/resource/res00000954/starters-for-ten#!cmpid=CMP00001408

A selection of quizzes and activities that could be used at the start of chemistry lessons.

Understanding how atoms are made up
http://www.rsc.org/learn-chemistry/resource/res00000086/afl-understanding-how-atoms-are-made-up

This activity enables learners to check their understanding of atomic structure. They work together in a group to demonstrate their mastery of ideas to other learners and to the teacher. The teacher provides external validation of the group.

Activities

General H002: Atomic structure
http://www.rsc.org/learn-chemistry/resource/rwq00000026/generalh002-atomic-structure

A 10 question quiz suitable for individual activity. Knowledge of isotopes is required.

Revising the periodic table
http://www.rsc.org/learn-chemistry/resource/res00001090/revising-the-periodic-table

A thought provoking activity based on concept mapping, for dealing with some of the misconceptions that learners may have about the periodic table.

Resources, links and support

Science Spotlight – Our termly update Science Spotlight provides useful information and helps to support our Science teaching community. Science Spotlight is designed to keep you up-to-date with Science here at OCR, as well as to share information, news and resources. Each issue is packed full with a series of exciting articles across the whole range of our Science qualifications: www.ocr.org.uk/qualifications/by-subject/science/science-spotlight/

Find resources and qualification information through our science page: www.ocr.org.uk/qualifications/bysubject/science/

Contact the team: science@ocr.org.uk

Continue the discussion on the science community forum: http://social.ocr.org.uk/

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To find out more about GCSE and A Level reform please visit: http://www.ocr.org.uk/qualifications/gcse-and-a-level-reform

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