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GCSE (9–1)
Transition Guide

GATEWAY SCIENCE CHEMISTRY A AND TWENTY FIRST CENTURY SCIENCE CHEMISTRY B

J248
For first teaching in 2016

KS3–KS4 focus
Particles, Atoms and Elements

Version 1

www.ocr.org.uk/chemistry

Contents

GCSE (9–1)

GATEWAY SCIENCE CHEMISTRY A AND 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 4 Transition Guides are written by experts with experience of teaching at both key stages.

Key Stage 3 Content

Key Stage 3 National Curriculum Content

- The particulate nature of matter;
- the properties of the different states of matter in terms of the particle model;
- changes of state in terms of the particle model;
- atoms, elements and compounds;
- a simple (Dalton) atomic model;
- differences between atoms, elements and compounds;
- conservation of mass changes of state and chemical reactions;
- the concept of a pure substance;
- mixtures, including dissolving;
- diffusion in terms of the particle model;
- simple techniques for separating mixtures;
- the identification of pure substances.

Key Stage 4 Content

GCSE Subject Criteria Content

- Recall the typical size (order of magnitude) of atoms and small molecules;
- describe how and why the atomic model has changed;
- 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;
- calculate numbers of protons, neutrons and electrons in atoms and ions;
- recall relative charges and approximate relative masses of protons, neutrons and electrons;
- calculate relative formula masses of species;
- deduce the empirical formula of a compound;
- explain what is meant by the purity of a substance;.
- explain that many useful materials are formulations of mixtures;
- describe, explain and exemplify the processes of filtration, crystallisation, simple distillation, and fractional distillation;
- describe the techniques of paper and thin layer chromatography;
- recall that chromatography involves a stationary and a mobile phase;
- interpret chromatograms, including measuring Rf values;
- suggest suitable purification techniques given information about the substances involved.

Comment

In the transition from Key Stage 3 (KS3) to Key Stage 4 (KS4) there are two main areas which are developed upon the most:

The atomic model at KS3 is a simple Dalton model of connecting spheres. The atoms are often shown to be visibly different using colours or shading helping to distinguish elements from compounds and mixtures. At KS4 the atoms must be understood in more detail, including the subatomic particles, their masses and charges. More importantly elements are differentiated by these subatomic particles rather than the more visual methods of KS3.

This section also branches into quantitative chemistry like formula mass and later into empirical formula and other calculations. These often challenge student's mathematical abilities and their skill at remembering a sequence of calculations.

Separation and purification of materials is visited to different extents at KS3, most students understand filtration and evaporation but fewer are able to explain distillation or chromatography. Evaporation and crystallisation of salts has a large focus at KS4 and students are expected to be able to suggest equipment and methods to purify named salts. These methods require understanding of acids, bases and neutralisation. However, the evaporation and crystallisation methods are the same as learned at KS3 and a solid foundation at this point can make these topics easier to grasp.

Chromatography is often used as an interesting practical during KS3, the explanation of this topic is rarely approached as ideas of relative solubility and absorbance are difficult to understand. At KS4, explanation gives way to interpretation and students are expected to be able to explain chromatograms qualitatively by sight or quantitatively using Rf values.

Challenges and misconceptions

The periodic table presents lots of ways for students to get mixed up. When using the periodic table to determine the number of sub atomic particles, students often understand that the atomic number gives the number of protons and electrons. However, at least one student will always confuse the mass number with the number of neutrons. Even after extensive teaching and reminding, students still get this wrong. It can help to teach the number of neutrons first and then build onto the number of protons.

Another common problem is students understanding the charge of electrons and how their gain or loss affects the charge of ions. Many mistakenly think that losing electrons causes a negative charge. This can be helped by showing the balance of + and – in an atom visually, the image of a seesaw and its movements when adding or removing – to each side can be useful for this.

During calculations, like formula mass, students often forget to follow the BODMAS rules of maths eg for Ammonia NH_3 they might type into their calculator 14 + 1 x 3 = 45 rather than 14 + (1 x 3) = 17. It often helps to remind them of these maths rules before you begin.

During the working out of empirical formula, the most common mistakes are that students occasionally use atomic number rather than atomic mass. Another common mistake is when making a ratio of the mole quantities they don't divide by the smallest number but one that looks small, ie less decimal places.

With chromatography, students tend to quickly grasp that similar chemicals travel similar distances, they often mistakenly think that this distance relates to the size or mass of the molecule at hand rather than their solubility.

Activities

Chemical reactions word amt (Learner Sheet Task 1)
Resources**:** http://www.ocr.org.uk/Images/220999-particles-atoms-and-elements-learner-activity.doc

This is a differentiated revision task which summarises the atoms and elements topic in one sheet.

Students are given the sheet which has many boxes, each containing tasks at different levels. Students work their way through as many of the tasks as they can. You can tell students to only work on tasks of their own level and above, or to pick one from each level to ensure a range of abilities. These can be peer assessed and used as a formative or summative test.

Elements and compounds (Learner Sheet Task 2)

This is a simple starter task which can assess understanding of the topic. Students simply answer true or false for each questions and complete a picture match activity at the end. This is most suitable for a low ability group and relies on low level skills rather than higher level thinking.

BBC Bitesize
Resources**:** http://www.bbc.co.uk/education/subjects/znxtyrd

This science section of the bitesize website has sections on States of matter, Atoms, elements and the periodic table, Chemical reactions and tests, Acids, alkalis and salts and other topics.

Each section contains an 'activity' section which gives an animated introduction and explanation of the topic, and a 'test' section which is a self-marking multiple choice quiz on the topic.

This is excellent for use in an ICT suite as students can learn from the clips and test themselves. Alternatively this could be set as homework and students could print the result of their multiple choice quiz to hand in.

Another option is to display the quiz and talk through it with the class or print the quiz and have the students complete it on paper.

Doc Brown
Resources: http://www.docbrown.info/ks3chemistry/ks3chemistry.htm

This website has some animated multiple choice quiz questions which self-mark. These can be used in a similar way to the Bitesize activities, however the questions do not come with any guidance and so are aimed at higher level students. In an ICT suite, students could use the internet to research their answers as the quiz keeps track of how many attempts they have at each question, so they cannot simply 'guess their way through'.

You Tube
Resources: https://www.youtube.com/watch?v=Tm-M4OFSaCU

This video gives a nice summary on compounds and mixtures. This has some questions to go with the content and another clip linked which answers the questions.

Resources: https://www.youtube.com/watch?v=IFv-k7XuMFM

Another video animation which uses Lego to show how elements, compounds and mixtures differ.

Chemical mix up
Resources: http://mint.ua.edu/games/chemical-mixup/

MINT centre

This is a game in which students determine whether a substance is an element, compound or mixture. Before beginning each level they are shown which substance are which and are then expected to remember. The game has three levels and students compete against the clock.

This activity could be used individually if students have access to a computer or displayed on an interactive white board and used as a whole class activity.

Checkpoint task

Millionaire quiz

This consists of 15 questions which could be printed and given to students. Each is multiple choice and tests common misconceptions which may have been acquired during KS3.

All students should stand up for the start of the activity. Have a student read out the first question and the four possible answers. All students mark their answer onto the sheet. You then read out the correct answer, all those who got the question wrong sit down but continue to take part in the quiz. The idea is that fewer and fewer will remain standing as the questions go on. You can call the last person standing the winner and assign a prize. You can also collect total scores to identify the weakest and strongest students.

This gives you a very visual way to see where your strongest students are as the questions generally increase in difficulty.

Use the 'Quiz follow on' to help students put the contents of the Millionaire quiz into context. This can be printed for each student.

Resources: http://www.ocr.org.uk/Images/220996-particles-atoms-and-elements-checkpoint-activity.doc

TES resource

This resource tests students' ability to use the periodic table to find elements and their symbols. It also assesses the ability to count the number of elements in a compound.

You will need a free login to TES to access this.

https://www.tes.co.uk/teaching-resource/elements-and-compounds-6045725

Activities

The density of Carbon Dioxide

Resources: http://www.nuffieldfoundation.org/practical-chemistry/density-carbon-dioxide

Nuffield Foundation

A practical showing the high density of CO_2 and how it can put out a candle.

A solid-solid reaction

Resources: http://www.nuffieldfoundation.org/practical-chemistry/solid-solid-reaction

Nuffield Foundation

A practical showing the difference in rate between a solid-solid reaction and one in liquid.

Paper chromatography

Resources: https://www.youtube.com/watch?v=gpFb635N2wo

You Tube

This is a quick animation which gives an overview of how chromatography works and explains how to work out Rf values.

This is another clip on the same topic.

https://www.youtube.com/watch?v=ZCzgQXGz9Tg

Chromatography on a molecular level

Resources: http://chem-ilp.net/labTechniques/TLCAnimation.htm

Chem-ilp

This animation shows the action of chromatography on a molecular level to help students understand the process more thoroughly.

Empirical formula and molecular formula introduction

Resources: https://www.youtube.com/watch?v=wnRaBWvhYKY

You Tube

A video guide explaining empirical and how it differs from molecular formula. A very clear and visual guide which students will understand.

The YouTube channel from this user also has step by step guides on many other chemistry topics which you may find useful.

https://www.youtube.com/user/tdewitt451

10 things you should be able to do (Learner Sheet Task 3)

Resources: http://www.ocr.org.uk/Images/220999-particles-atoms-and-elements-learner-activity.doc

This is a sheet aimed at the early end of GCSE chemistry, it gives increasingly difficult tasks which students should be able to do, from labelling an atom to balancing equations.

Activities

Naming compounds (Learner Sheet Task 4)

This activity approaches naming compounds, those with 2 components ending in -ide and those containing three (including oxygen) which end in -ate.

There are three columns of difficulty, you can set these as a progression for all students or assign each student one of the columns and a time limit.

Writing word equations (Learner Sheet Task 5)

This activity tests students' ability to comprehend written text and convert it into a word equation. A lower ability task.

Element match dominoes (Learner Sheet Task 6)

Students match questions with answers after cutting the sheet up. Make sure the students cut them out in pairs not individual squares. This tests knowledge of the atom, the periodic table and groups.

Relative Formula mass calculations (Learner Sheet Task 7)

An activity which gives students compounds for which they need to calculate the M_r (formula mass) these get progressively harder and should challenge students at all levels.

Chromatography true or false (Learner Sheet Task 8)

An activity designed to assess understanding of chromatography analysis. Some of the questions have more than one answer and make students think about how inks can be separated and how Rf values are used.

Resources: http://www.ocr.org.uk/Images/220999-particles-atoms-and-elements-learner-activity.doc

Activities

PEN and ions (Learner Sheet Task 9)

This activity tests the ability of students to work out the number of electrons and protons in an atom, what charge ion the atom would form and then begin to form compounds from the ions.

Empirical formula, Reacting mass, Calculations practice (Learner Sheet Task 10, 11 and 12)

These activities give students the opportunity to practice the calculations required in the specification.

The calculations practice activity covers all types of calculations and allow students to mark as they go with a built in mark scheme.

Resources: http://www.ocr.org.uk/Images/220999-particles-atoms-and-elements-learner-activity.doc

What are the dissolved solids in sea water?

Nuffield Foundation

An experiment where several solids are separated from sea water. This requires more complex equipment and a fair amount of time. Better suited to high abilities.

Resources: http://www.nuffieldfoundation.org/practical-chemistry/what-are-dissolved-solids-sea-water

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/

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