QUALIFICATION AWAITING ACCREDITATION

OCR
Oxford Cambridge and RSA

GCSE (9–1)
Transition Guide

GATEWAY SCIENCE CHEMISTRY A

J248
For first teaching in 2016

KS3–KS4 focus
Chemical reactions

Version 1

Can also be used for teaching:
GCSE (9–1) GATEWAY SCIENCE COMBINED SCIENCE A

www.ocr.org.uk/chemistry

Introduction

GCSE (9–1) *CHEMISTRY A*

QUALIFICATION AWAITING ACCREDITATION

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.

'These draft qualifications have not yet been accredited by Ofqual. They are published (along with specimen assessment materials, summary brochures and sample resources) to enable teachers to have early sight of our proposed approach.

Further changes may be required and no assurance can be given at this time that the proposed qualifications will be made available in their current form, or that they will be accredited in time for first teaching in 2016 and first award in 2018 (2017 for AS Level qualifications).'

Key Stage 3 Content

Taken from

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/335174/SECONDARY_national_curriculum_-_Science_220714.pdf

- differences between atoms, elements and compounds
- chemical symbols and formulae for elements and compounds
- conservation of mass changes of state and chemical reactions
- chemical reactions as the rearrangement of atoms
- representing chemical reactions using formulae and using equations
- combustion, thermal decomposition, oxidation and displacement reactions
- defining acids and alkalis in terms of neutralisation reactions
- energy changes on changes of state (qualitative)
- exothermic and endothermic chemical reactions (qualitative)
- the Periodic Table: periods and groups; metals and non-metals
- the properties of metals and non-metals
- the chemical properties of metal and non-metal oxides with respect to acidity

Key Stage 4 Content

Sub-Topic C3.1 Introducing chemical reactions

C3.1 a use chemical symbols to write the formulae of elements and simple covalent and ionic compounds

C3.1b use the names and symbols of common elements and compounds and the principle of conservation of mass to write formulae and balanced chemical equations and **half equations**

C3.1c use the names and symbols of common elements from a supplied periodic table to write formulae and balanced chemical equations where appropriate to include the first 20 elements, Group 1, 7. and 0 and other common elements included within the specification

C3.1d use the formula of common ions to deduce the formula of a compound

C3.1e construct balanced ionic equations

C3.1f describe the physical states of products and reactants using state symbols (s, l, g and aq)

C3.1g recall and use the definitions of the Avogadro constant (in standard form) and of the mole to include the calculation of the mass of one atom/molecule

C3.1h explain how the mass of a given substance is related to the amount of that substance in moles and vice versa

C3.1i recall and use the law of conservation of mass

C3.1j explain any observed changes in mass in non-enclosed systems during a chemical reaction and explain them using the particle model

C3.1k deduce the stoichiometry of an equation from the masses of reactants and products and explain the effect of a limiting quantity of a reactant

C3.1l use a balanced equation to calculate masses of reactants or products

Sub-Topic C3.2 Energetics

C3.2a distinguish between endothermic and exothermic reactions on the basis of the temperature change of the surroundings

C3.2b draw and label a reaction profile for an exothermic and an endothermic reaction to include activation energy, energy change, reactants and products

C3.2c explain activation energy as the energy needed for a reaction to occur

C3.2d calculate energy changes in a chemical reaction by considering bond making and bond breaking energies

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Key Stage 4 Content *(continued)*

Sub-Topic C3.3 Types of chemical reactions

C3.3a explain reduction and oxidation in terms of loss or gain of oxygen, identifying which species are oxidised and which are reduced to include the concept of oxidising agent and reducing agent

C3.3b explain reduction and oxidation in terms of gain or loss of electrons, identifying which species are oxidised and which are reduced

C3.3c recall that acids form hydrogen ions when they dissolve in water and solutions of alkalis contain hydroxide ions

C3.3d describe neutralisation as acid reacting with alkali or a base to form a salt plus water

C3.3e recognise that aqueous neutralisation reactions can be generalised to hydrogen ions reacting with hydroxide ions to form water

C3.3f recall that carbonates and some metals react with acids and write balanced equations predicting products from given reactants

C3.3g use and explain the terms dilute and concentrated (amount of substance) and weak and strong (degree of ionisation) in relation to acids to include ratio of amount of acid to volume of solution

C3.3h recall that relative acidity and alkalinity are measured by pH

C3.3i describe neutrality and relative acidity and alkalinity in terms of the effect of the concentration of hydrogen ions on the numerical value of pH (whole numbers only) to include pH of titration curves

C3.3j recall that as hydrogen ion concentration increases by a factor of ten the pH value of a solution decreases by a factor of one

C3.3k describe techniques and apparatus used to measure pH

Sub-Topic C3.4 Electrolysis

C3.4a recall that metals (or hydrogen) are formed at the cathode and non-metals are formed at the anode in electrolysis using inert electrodes to include the terms cations and anions

C3.4b predict the products of electrolysis of binary ionic compounds in the molten state to include compounds such as sodium chloride

C3.4c describe competing reactions in the electrolysis of aqueous solutions of ionic compounds in terms of the different species present to include the electrolysis of aqueous Sodium chloride and copper sulfate using inert electrodes

C3.4d describe electrolysis in terms of the ions present and reactions at the electrodes

C3.4e describe the technique of electrolysis using inert and noninert electrodes

Comment

The topic of Chemical reactions takes on a lot of new content as you move from Key Stage 3 up to Key Stage 4.

One big change is the level of maths involved in the chemistry. At Key Stage 3, the only calculations involved may be changes in mass throughout a reaction (see 'change during a reaction' worksheet). At Key Stage 4, learners are expected to use Avagadro's constant, calculate moles (see 'using Avagadro's number' weblink) and use bond energy to determine energy change (see 'Calculating bond energies' weblink, the worksheet and the extension sheet).

These skills do not extend past multiplying or dividing but are often points that clearly discriminates between the high and low ability learners.

While quite a few of the skills needed in the Key Stage 4 study of chemical reactions are not troubling individually, many are cumulative, meaning that you must fully understand one to be able to understand the next.

A good example of this is the skill of 'determining the formula of a compound from common ions'. To do this, learners need to know: the common ions, which requires time; they have to understand the meaning of the charges on ions; finally they have to pair them correctly in terms of stoichiometry and write them in a formula. Writing the formula can also require the understanding of 'use of brackets in equations' (see 'Ionic compounds' worksheet).

Because of this, when a learner gets stuck on this type of question there are many different possible misconceptions which the teacher has to check and resolve.

It is important that learners have a firm understanding of Chemical equations at Key Stage 3 so that they can identify the number of each element in a compound and the number of atoms in total.

The activity 'Atoms and elements in a compound' helps to build these skills.

The topic of energetics does not grow substantially between Key Stage 3 and Key Stage 4. Learners should already think of exothermic reactions as 'hot reactions', giving out heat, and vice versa for endothermic reactions.

One common misconception comes when signs and energy values are added to reactions. For example, if a reaction has an energy change of -92kJ, it is very common for learners to think that this is endothermic as they associate the '-' sign with temperature.

Another common misconception is that learners think that endothermic reactions involve only breaking bonds and exothermic reactions involve only making new bonds. The reality is that both happen to different extents in both reaction types.

An area that learners often struggle with is reduction. Many learners are familiar with oxidation reactions from Key Stage 3; it is easy to see the link between 'oxidation' and the adding of 'oxygen' to a substance (see 'Oxidation Reduction' worksheet). Reduction however does not have as convenient a name. Also, at a higher level, learners will need to understand that reduction is GAIN of electrons which seems counter intuitive. In this situation, it is useful to think of it as a reduction in the overall charge (by adding electrons, the charge becomes more negative and is therefore reduced in value).

The topic of Acidity has some big changes in Key Stage 4 too. From Key Stage 3, learners often link acids with the colour red, neutral with green and alkalis with blue/purple but they often forget that this is not the colour of the solution, but of the indicator. At Key Stage 4, pH also causes difficulty as they think of it as a measure of acidity and so pH14 should be highly acidic.

At a higher level, learners must start to think of pH in terms of hydrogen ion concentration; this requires understanding of ions. Although learners do not need to understand pH as '-log of H^+ concentration' they are expected to know that as pH decreases by a value of one, the concentration of H^+ increases by ten. Some higher level groups will find it easier if this is explained in terms of logorithms (see 'Acids and alkalis' pack).

The topic of Electrolysis is completely new at Key Stage 4 and relies heavily on new understanding. The ideas of oxidation and reduction at the electrodes, formation of ions and ionic half equations involving electrons are all difficult ideas and all tie in to this topic. Fortunately electrolysis is an area where there are several practicals which can help to cement ideas in place (see 'tin man' practical).

The selection of tasks and activities accompanying this guide should help learners to build understanding from the basics at Key Stage 3 to the more complex at Key Stage 4 and give you confidence in your approach to teaching the topic 'Chemical reactions'.

Activities

Change during a reaction
Resources: www.ocr.org.uk/Images/304427-chemical-reactions-learner-resource.doc

A short activity intended to help learners think about the changes that can happen during a reaction and lay the foundations for the topic of conservation of mass.

Atoms and elements in compounds
Resources: www.ocr.org.uk/Images/304427-chemical-reactions-learner-resource.doc

This activity should help learners to count the different number of elements in a compound and differentiate this from the total number of each atom.

Acid and Alkalis pack
RSC
Resources: http://www.rsc.org/learn-chemistry/resource/res00000840/acids-and-alkalis?cmpid=CMP00000947

This guide provides a collection of practical and teaching activities based around acids/alkalis and bridges from Key Stage 3 through to Key Stage 5.

Periodic table activity
RSC
Resources: http://www.rsc.org/learn-chemistry/resource/res00001113/interactive-periodic-table-game?cmpid=CMP00002097

This game helps learners to identify the different areas of the periodic table and begin to recognise the types of elements in each section as well as their properties and symbols. This works well displayed on a white board and played as a class.

Checkpoint task

This task is designed to provide challenge for learners at different levels; the questions are designed to be quick to answer so that the task can be completed quickly in a lesson but still give valuable information about a variety of skills.

Question 1
This question shows whether learners can identify the elements in a compound but also whether they understand the naming prefix mono/di.

Question 2
Part (a) tests if learners can identify elements easily AND determine what chemicals would be formed. It is also testing if they can work out ionic compounds using their position on the Periodic Table. A difficult task.

Part (b) simply tests their understanding of the word 'state'.

Question 3
Recalling numbers in standard form can be difficult. The 'distractors' are designed to make learners think.

Question 4
Mole calculations are easy when you know how so this question will show who knows about this and who does not.

Question 5
This question is testing learners' understanding of the conservation of mass.

Question 6
The reactants are placed centrally on the energy axis to avoid giving any clues. Many learners will draw the wrong axis, others will forget the activation energy bump.

Question 7
Parts (a) and (b): this is a simple recall question and balancing task. Errors here link back to ionic balancing and learners may need a revise the topic of 'balancing charges'.

Question 8
Part (a): this question can be quite demanding and will highlight your strongest learners. For this to be done correctly, learners will need to remember common chemical formulae, recall a common reaction and know how to balance a chemical equation.

Part (b) is testing learners' understanding of pH and the fact that, in this experiment, the pH will increase towards 7 (i.e. neutral) as the acid is used up.

Question 9
Most learners should understand that the simple binary ionic compound will create lead and bromine, but they may not know how to work out which is a positive ion or which is a negative ion or may not know which electrode is which. These are all important skills to learn.

Checkpoint task:
www.ocr.org.uk/Images/304426-chemical-reactions-checkpoint-task.doc

Activities

Using Avagadro's number

chemteam

Resources: http://www.chemteam.info/Mole/Avogadro-Number-CalcsII.html

A web page that explains how to use Avagadro's number to determine the number of atoms in a given mass and how to link mass to number of moles. It has worked examples, practice questions and answers.

Calculating bond energies

Bitesize

Resources: http://www.bbc.co.uk/schools/gcsebitesize/science/triple_aqa/calculating_energy_changes/energy_from_reactions/revision/7/

The bitesize website gives an overview of how to perform the energy calculations and some worked examples.

Calculating bond enthalpies worksheet

Rohan

Resources: http://www-rohan.sdsu.edu/~chem105/EnthPractice.pdf

The website provides four questions and answers based on bond enthalpy. To help low ability learners, draw the Lewis structures for the chemicals involved on a white board.

Ionic compounds

Resources: Learner resource – activity 3

This activity provides the formula of several common ions and gives the names of ionic compounds for which the learners should determine the formula.

Oxidation reduction

Resources: Learner resource – activity 4

This activity uses a few examples to get learners to think about whether each element has gained or lost oxygen. This is a simplified way of thinking about reduction without covering the idea of gaining electrons.

Electrolysis of molten zinc chloride

Resources: http://www.rsc.org/learn-chemistry/resource/res00000826/electrolysis-of-molten-zinc-chloride?cmpid=CMP00005020

This is a practical demonstration of an electrolysis. It has a good visual impact as you can link in the topics of 'molten ionic compounds' and show that they conduct and that a metal is produced.

Activities

Calculating bond enthalpies worksheet

CSUN.edu

Resources: http://www.csun.edu/~jte35633/worksheets/Chemistry/16-2BondEnergy.pdf

A worksheet with a selection of bond enthalpy questions including high ability 'Lewis structure' bases questions.

Answers:

1. -184 kJ/mol	2. -549 kJ/mol	3. 0 kJ/mol
4. -489 kJ/mol	5. -808 kJ/mol	6. -36 kJ/mol (CO taken as triple bond)
7. -203 kJ/mol	8. -116 kJ/mol	9. -97 kJ/mol
10. -214 kJ/mol	11. -3527 kJ/mol	12. -312 kJ/mol
13. -138 kJ/mol		

'Tin Man' electrolysis
Flinnsci

Resources: https://www.flinnsci.com/media/621556/91646.pdf

This is a very interesting electrolysis which shows the formation of metal crystals. It is technical but could be set up as a practical for high abilty groups. The products are not straightforward and there is an explanation of this on the sheet.

Acid and Alkalis pack

Resources: http://www.rsc.org/learn-chemistry/resource/res00000840/acids-and-alkalis?cmpid=CMP00000947

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