

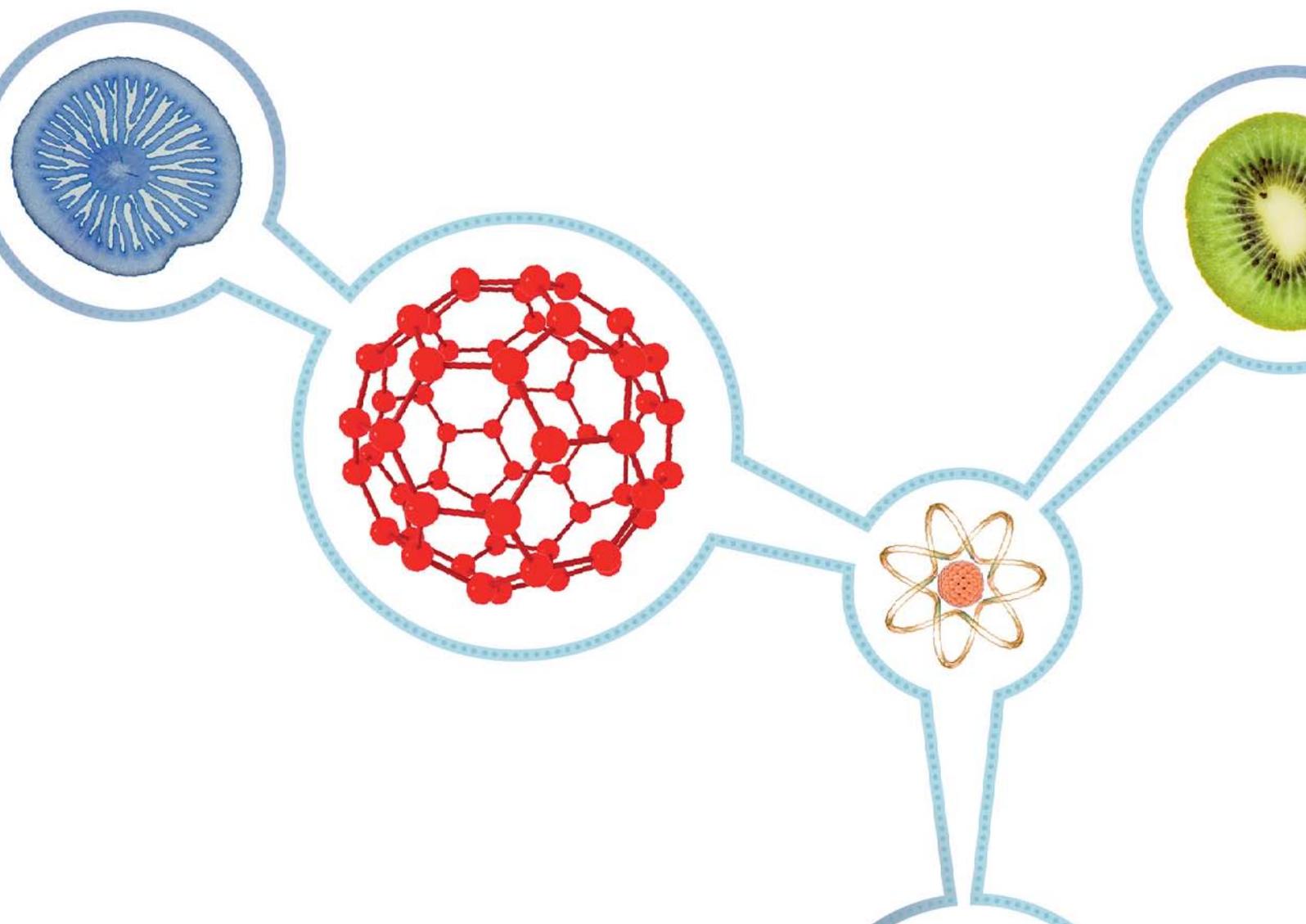
GATEWAY SCIENCE SUITE

# TEACHERS' HANDBOOK

J261 – J265

VERSION 1 JUNE 2011

This handbook is designed to accompany the OCR GCSE Gateway science specifications for centres starting to teach the new Gateway Suite in the 2011/12 academic year.



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# INTRODUCTION

## OCR is offering new GCSE Science suites for first teaching in September 2011.

We've taken this opportunity to improve the quality of our GCSEs for teachers and students alike.

We want to make the introduction of these new GCSEs as easy for you to manage as possible.

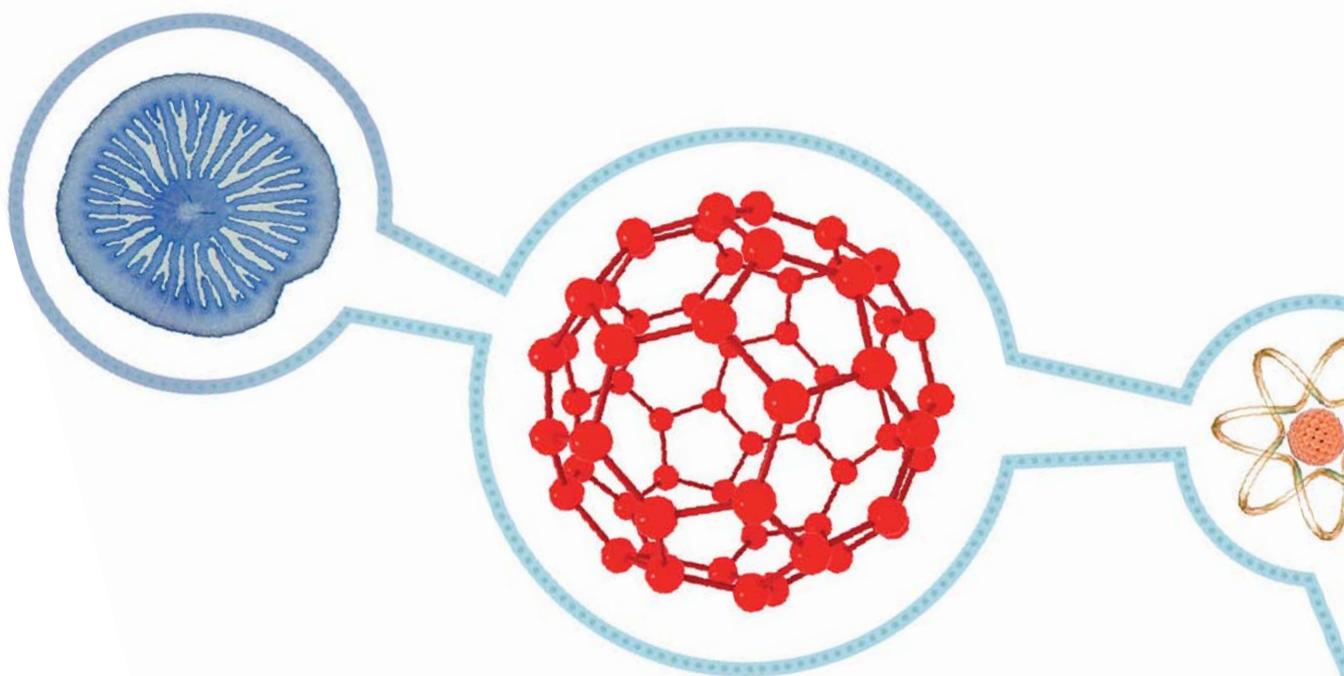
The main changes are:

- Controlled assessment will be introduced
- The opportunity has been taken to bring course content up to date
- Examinations will provide opportunity for extended writing
- All GCSEs will meet the requirements of the Disability Discrimination Act.

A consistent approach is followed across all our GCSE Gateway Science Suite of GCSEs. These specifications offer the flexibility that unitised qualifications bring, allowing teaching and assessment to be undertaken in either a linear or unitised fashion.

OCR is developing a range of support materials, following extensive research and consultation with teachers. We are designing them to save you time when preparing for the new specifications and to support you while teaching them.

It is important to make the point that this Teacher's Handbook plays a secondary role to the Specifications themselves. The GCSE Gateway Science Suite specifications are the documents on which assessment is based: they specify what content and skills need to be covered. At all times therefore, the Teacher's Handbook should be read in conjunction with the specifications. If clarification on a particular point is sought, then that clarification will be found in the specification itself.



# GATEWAY SCIENCE SUITE: OVERVIEW OF CHANGES

The new specifications have been developed with the principle of minimum change.

Where major changes have been made, this is as a result of the Ofqual fundamental review of the GCSE criteria and the bringing of the sciences' criteria into line with other GCSEs.

The introduction of terminal requirements, limits to the number of re-sit opportunities and controlled assessment are three major areas of change which will have fundamental effects on teaching.

Ofqual has produced new Subject Criteria for Science, Additional Science, Biology, Chemistry, and Physics, which prescribe the content, skills, assessment objectives, weightings etc.

For GCSE Science, the content is that of the Programme of Study for KS4 and 100% of the content is prescribed. For Additional Science, the amount of content prescribed by the criteria is about 75%. The

prescribed content of, for example, GCSE Physics comprises the physics content of Science and Additional Science.

The introduction of the new Subject Criteria has required certain topics to be moved from one module of the Science specification to another in the Additional Science specification and vice versa.

We have also taken the opportunity to address issues raised by teachers about particular areas of the specifications, increasing the clarity of the requirements. Changing the specifications has also provided us with the opportunity to address areas that have been raised by others:

- need for more extended answers in the question papers
- need to encourage practical work in schools
- need to extend use and coverage of mathematical skills
- need to strengthen continuity from KS3 to KS4 and KS4 to KS5.

	What stays the same?	What changes?
<b>Structure:</b>	For all GCSEs in the Gateway Science Suite: <ul style="list-style-type: none"> <li>• The course can be taught in a modular or linear fashion</li> <li>• The course comprises two externally assessed units and one internally assessed unit</li> <li>• Externally assessed units are tiered – Foundation and Higher Tier</li> </ul>	<ul style="list-style-type: none"> <li>• Unit weightings have been altered – Unit 1 now 35%, Unit 2 now 40%</li> <li>• The higher weighting on Unit 2 papers is due to an additional 'Data and Evidence' section linked to the Unit 2 modules</li> <li>• Controlled assessment replaces skills assessment, now 25% weighting</li> </ul>
<b>Content:</b>	<ul style="list-style-type: none"> <li>• The original modules are retained and updated</li> </ul> <p><b>Biology B, Chemistry B &amp; Physics B</b></p> <ul style="list-style-type: none"> <li>• Content is divided into 6 modules, B1 – B6, C1 – C6, P1 – P6</li> </ul> <p><b>Science B</b></p> <ul style="list-style-type: none"> <li>• Content is divided into 6 modules, B1, B2, C1, C2, P1, P2</li> </ul> <p><b>Additional Science B</b></p> <ul style="list-style-type: none"> <li>• Content is divided into 6 modules, B3, B4, C3, C4, P3, P4</li> </ul>	<ul style="list-style-type: none"> <li>• Some content has been moved between modules to meet the revised Subject Criteria from Ofqual</li> <li>• Module C3 has become C4 and vice versa</li> <li>• Content and terminology have been updated and some content statements have been replaced in all specifications</li> </ul>
<b>Assessment:</b>	<ul style="list-style-type: none"> <li>• Modules are externally assessed within two units, in sections</li> <li>• Papers include structured questions and objective questions</li> <li>• January and June assessments are available</li> <li>• Controlled assessment available in June series only</li> <li>• Certification available in January and June series</li> </ul>	<ul style="list-style-type: none"> <li>• New terminal and re-sit rules apply to science GCSEs</li> <li>• The internally assessed unit is based on a single investigative task divided into three parts (the Science style of controlled assessment can no longer be used for Separate Sciences)</li> <li>• There will be a choice of controlled assessment tasks, set by OCR, and valid for entry in one year only</li> <li>• Unit 1 paper is 1 hour 15 minutes long, with a total of 75 marks; Unit 2 paper is 1 hour 30 minutes long, with a total of 85 marks</li> <li>• How Science Works will be assessed in all units</li> <li>• Quality of Written Communication (QWC) will be assessed in all units</li> </ul>

# SUBJECT SPECIFIC GUIDANCE

## THE SPECIFICATION

### OVERVIEW

The Gateway approach remains the same. The specification provides an outline scheme of work, which can be used to develop detailed lesson plans.

Each GCSE course is made up of 6 modules. Modules are organised to contribute to Science, Additional Science, Biology, Chemistry and Physics, as described in the section on assessment. This permits centres teaching Science/Additional Science and Separate Sciences to teach in mixed classes.

A module is divided into eight items. Items have been planned to be delivered in approximately 2.5 hours teaching time.

The Chemistry modules include an additional item, Fundamental Chemical Concepts, which is ideas and concepts that permeate through all the chemistry modules.

All specifications include an additional item, Fundamental Scientific Processes (How Science Works), which underpins the knowledge of scientific explanations in the specification.

Each item is organised in the specification as a double page spread for ease of use. Teachers can, at a glance, identify the learning outcomes at each level and the suggested activities, which could be used in teaching. The double page spread is in four columns:

- Column 1 provides a range of suggested teaching activities for the item. These activities include practical investigative work and research opportunities, which will enable teachers to integrate skills, knowledge and understanding of How Science Works into the scheme of work. The suggested activities will not be examined.
- Column 2 lists the learning outcomes that will be assessed only on the Foundation Tier papers.
- Column 3 lists the learning outcomes that will be assessed on both the Foundation and Higher Tier papers.

- Column 4 lists the learning outcomes that will only be assessed on the Higher Tier papers.

In each of the assessable learning outcome columns, clarification points provide guidance on:

#### Depth

e.g. P1d - Explain why most lasers produce an intense coherent beam of light:

- waves have the same frequency
- waves are in phase with each other
- waves have low divergence.

#### Context

e.g. B1c - Describe how vectors spread disease:

- limited to mosquito.

#### Exemplification

e.g. C1g - Recall the necessary physical properties of perfumes:

- evaporates easily
- non-toxic
- does not react with water
- does not irritate the skin
- insoluble in water.

## TERMINOLOGY USED IN LEARNING OUTCOMES

**Recall** now replaces **State**. For example:

Recall that exposure to ultraviolet radiation can cause:

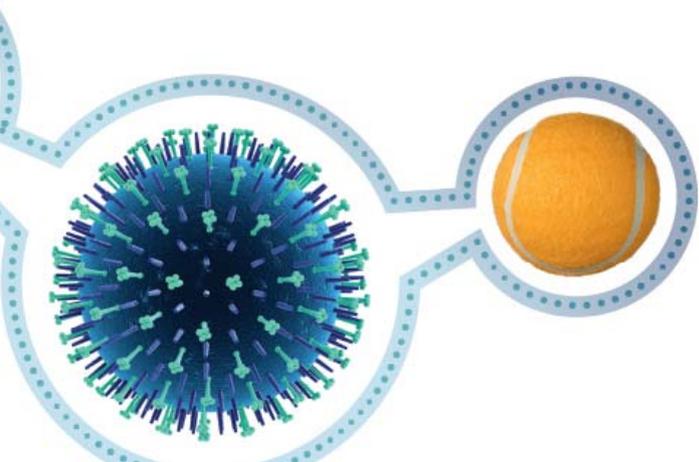
- suntan
- sunburn
- skin cancer
- cataracts
- premature skin ageing.

**Recall** now replaces **Know**. For example:

Recall that LPG contains propane and butane gases.

**Explain** is now used instead of **Understand**, **Recall** and **Describe** in some places. The types of explanation required may be 'explain how' or 'explain why'. For example:

Explain why protein deficiency (kwashiorkor) is common in developing countries, limited to:



- overpopulation
- limited investment in agricultural techniques.

Explain how some animals are adapted to avoid being caught as prey, to include:

- eyes on side of head for wide field of view
- living in groups (herds or shoals) to reduce the chance of being caught
- cryptic and warning colouration
- mimicry
- breeding strategy (synchronous breeding).

Other commonly used terms, with examples, are given below:

**Evaluate** information on materials used to manufacture cars (no recall expected).

**Describe** reduction as the removal of oxygen from a substance.

**Predict** the name of the acid and alkali needed to make a named fertiliser, for example: ammonium nitrate.

**Understand** why falling objects do not experience drag when there is no atmosphere.

**Use and apply** the equation, including a change of subject:  $\text{force} = \text{change in momentum}/\text{time}$ .

**Analyse** surface area to volume ratios in the context of different environmental stresses.

**Recognise** that over long periods of time, groups of organisms can change and that this is called evolution.

**Interpret** data on indicator species.

**Construct** balanced symbol equations for the neutralisation of acids by bases and carbonates, limited to:

- sulfuric acid, nitric acid and hydrochloric acid
- ammonia, potassium hydroxide, sodium hydroxide and copper oxide
- sodium carbonate and calcium carbonate.

## FUNDAMENTAL SCIENTIFIC PROCESSES

This new item covering How Science Works is an addition to all the Gateway specifications. The item is displayed in the same format as other items. The left hand column indicates links to other items within the specification.

Candidates require an understanding of the main processes in science that underpin the learning outcomes. They will need to be prepared to answer questions related to How Science Works. When planning schemes of work and lesson plans, teachers will need to incorporate these ideas.

### FOR EXAMPLE:

Standard Demand: Explain how publishing results through scientific conferences and publications enables results to be replicated and further evidence to be collected.

B3a – Describe how Watson and Crick used data from other scientists to build a model of DNA, to include:

- X-ray data showing that there were two chains wound in a helix
- data indicating that the bases occurred in pairs.

High Demand: Explain the value of using teams of scientists to investigate scientific problems.

B3a – Explain why new discoveries, such as Watson and Crick's, are not accepted or rewarded immediately, to include:

- the importance of other scientists repeating or testing the work.

### FOR EXAMPLE:

Low Demand: Describe a simple scientific idea using a simple model.

C3b – Describe the effect of changing the concentration on the rate of a chemical reaction.

Standard Demand: Explain a scientific process, using ideas or models.

C3b – Explain, in terms of the reacting particle model, why changes in temperature change the rate of reaction.

Exemplar part question from Foundation Tier paper:

Colin and Ann want the reaction to go faster. They do not want to change the volume of acid or mass of zinc.

Explain, using the reacting particle model, two ways Colin and Ann can increase the rate of the reaction.

### FOR EXAMPLE:

Low Demand: Describe risks from new scientific or technological advances.

P1e – Describe some concerns about children using mobile phones.

Standard Demand: Suggest ways of limiting risks and recognise the benefits of activities that have a known risk.

P1e – Describe why there may or may not be dangers:

- to residents near to the site of a mobile phone transmitter mast
- to users of mobile phones

P1e – Describe how potential dangers may be increased by frequent use.

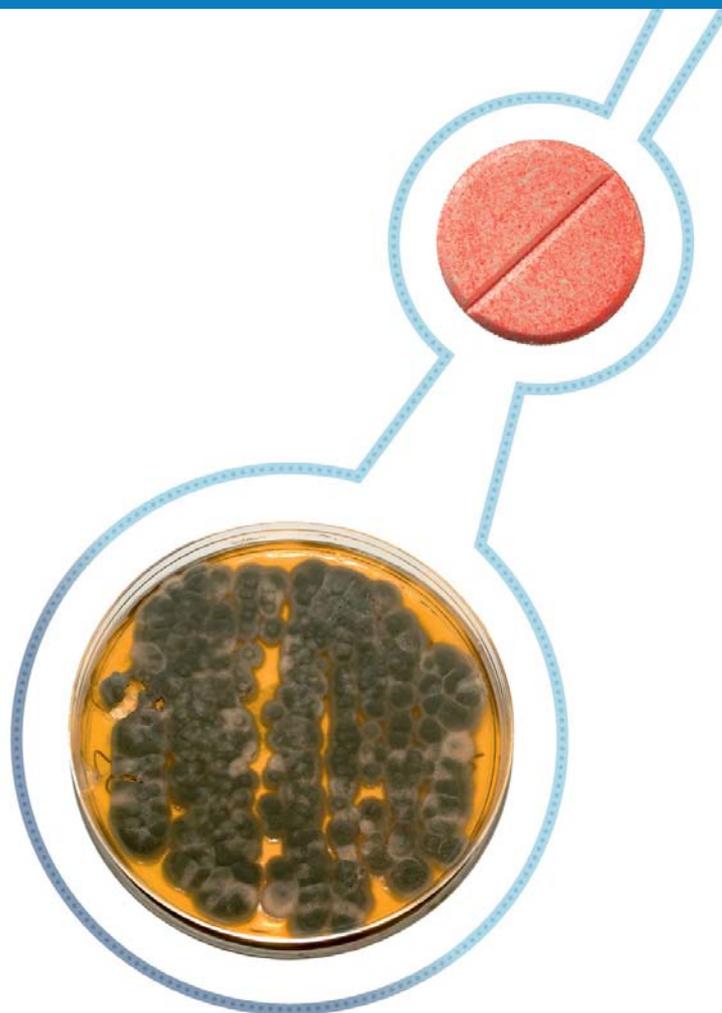
P1e – Explain how publishing scientific studies into the effects of mobile phone microwave radiation enables results to be checked.

High Demand: Analyse personal and social choices in terms of a balance of risk and benefit.

P1e – Understand that in the presence of conflicting evidence individuals and society must make choices about mobile phone usage and location of masts in terms of balancing risk and benefit.  
Exemplar part question from Higher Tier paper:

Clare's father is deciding whether or not to buy her a mobile phone. He is concerned that there may be health risks associated with using a mobile phone.

Give examples of the potential health risks and describe how Clare's father should evaluate the risks when making his decision.



## MODULE TITLES

### Biology

B1 Understanding Organisms

B2 Understanding our Environment

B3 Living and Growing

B4 It's a Green World

B5 The Living Body

B6 Beyond the Microscope

### Chemistry

C1 Carbon Chemistry

C2 Chemical Resources

C3 Chemical Economics

C4 The Periodic Table

C5 How Much (Quantitative Analysis)

C6 Chemistry Out There

### Physics

P1 Energy for the Home

P2 Living for the Future (energy resources)

P3 Forces for Transport

P4 Radiation for Life

P5 Space for Reflection

P6 Electricity for Gadgets

## OVERVIEW OF CHANGES TO BIOLOGY SPECIFICATION CONTENT

Changes to the Subject Criteria by Ofqual have resulted in some items being moved from the biology modules for Science to the biology modules for Additional Science and vice versa.

New	New Title	Current
B1g	Controlling plant growth	B3f
B2a	Classification	B2b
B2b	Energy flow	B4e
B2c	Recycling	B4h
B3a	Molecules of Life	B3a part, B1g section 1
B3b	Proteins and Mutations	B3a part, B1h part
B3c	Respiration	B1a part
B3e	The circulatory system	B3c section 1-3
B3f	Growth and development	B3e section 1, 2, B6a part section 1
B4a	Ecology in the local environment	B2a
B4b	Photosynthesis	B2c
B4c	Leaves and Photosynthesis	B4a
B4d	Diffusion and Osmosis	B4b part, B3b plant part
B4e	Transport in plants	B4b part, B4c
B4f	Plants need minerals	B4d
B4g	Decay	B4g
B4h	Farming	B4f
B5e	Digestion	B1b section 3
B5f	Waste disposal	B5e
B5g	Life goes on	B5f, B1f section 3
B5h	Growth and Repair	B3e section 3, B5g, B5h section 2
B6a	Understanding microbes	B6a part, B6c part
B6c	Useful Microorganisms	B6a section 1, B6c

**DETAILED CHANGES FOR EACH BIOLOGY MODULE ARE LOCATED IN APPENDIX A.**

## OVERVIEW OF CHANGES TO CHEMISTRY SPECIFICATION CONTENT

Changes to the Subject Criteria by Ofqual have resulted in some items being moved from the chemistry modules for Science to the chemistry modules for Additional Science and vice versa.

New	New Title	Current
C1a	Making crude oil useful	C1d
C1b	Using carbon fuels	C1g
C1c	Clean Air	C2f
C1f	Cooking and food additives	C1a sections 2, 3 C1b sections 2, 4
C1g	Smells	C1c
C1h	Paints and pigments	C2a
C2a	The structure of the earth	C2c
C2c	Metals and alloys	C2d
C2d	Making cars	C2e
C2e	Manufacturing chemicals – making ammonia	C4d
C2f	Acids and bases	C4a
C2g	Fertilisers and crop yields	C4c
C2h	Chemicals from the sea – sodium chloride	C6d
C3a	Rates of reaction (1)	C2g part
C3b	Rates of reaction (2)	C2g part
C3c	Rates of reaction (3)	C2h
C3d	Reacting masses	C4b sections 1,2
C3e	Percentage yield and atom economy	C4b section 3
C3f	Energy	C1h
C3g	Batch or continuous?	C4f
C3h	Allotropes of carbon and nanochemistry	C4g
C4a	Atomic structure	C3a
C4b	Ionic bonding	C3b
C4c	The Periodic Table and covalent bonding	C3c
C4d	The group 1 elements	C3d
C4e	The group 7 elements	C3e
C4f	Transition elements	C3g
C4g	Metal structures and properties	C3h
C5b	Percentage composition and empirical formula	C5a part
C6a	Electrolysis	C5b
C6b	Energy transfer – fuel cells	C6a
C6c	Redox reactions	C6b
C6d	Alcohols	C6c
C6h	Detergents	C4e

**DETAILED CHANGES FOR EACH CHEMISTRY MODULE ARE LOCATED IN APPENDIX B.**

## OVERVIEW OF CHANGES TO PHYSICS SPECIFICATION CONTENT

Changes to the Subject Criteria by Ofqual has resulted in some items being moved from the physics modules for Science to the physics modules for Additional Science and vice versa.

New	New Title	Current
P1b	Keeping houses warm	P1c, P1b
P1c	A spectrum of waves	P1g section 1
P1d	Lights and lasers	P1g sections 2, 3; P1e section 4
P1e	Cooking and communicating using waves	P1d
P1f	Data transmission	P1e sections 1,2, 3, paragraph 2 of 4
P1g	Wireless signals	P1f
P1h	Stable earth	P1h sections 1, 2
P2b	Generating electricity	P2b sections 1, 2; P2c section1
P2c	Global warming	P1h section 3
P2d	Fuels for power	P2c section 2; P2b section 3
P2e	Nuclear radiations	P2d; P2c section 3
P4e	What is radioactivity?	P4f
P4f	Uses of radioactivity	P4g
P4g	Treatment	P4e
P4h	Fission and Fusion	P4h
P5d	Action and Reaction	P4d
P6c	It's logical	P6g sections 1, 2
P6d	Even more logical	P6h; P6g section 3
P6e	Motoring	P6c
P6f	Generating	P6d
P6g	Transforming	P6e
P6h	Charging	P6f

**DETAILED CHANGES FOR EACH PHYSICS MODULE ARE LOCATED IN APPENDIX C.**

# ASSESSMENT

**There are three units of assessment for each GCSE qualification: two written papers and controlled assessment. The style of the papers has changed slightly to meet the new criteria, terminal rules and the other points made earlier in the Introduction.**

## External Assessment

The table below summarises the makeup of the examination papers for each GCSE science subject.

GCSE	Unit 1 Weighting 35%, 1 hour 15 minutes			Unit 2 Weighting 40%, 1 hour 30 minutes			
	Section A 25 marks	Section B 25 marks	Section C 25 marks	Section A 25 marks	Section B 25 marks	Section C 25 marks	Section D 10 marks
Science	Biology 1	Chemistry 1	Physics 1	Biology 2	Chemistry 2	Physics 2	Data and evidence
Additional Science	Biology 3	Chemistry 3	Physics 3	Biology 4	Chemistry 4	Physics 4	Data and evidence
Biology	Biology 1	Biology 2	Biology 3	Biology 4	Biology 5	Biology 6	Data and evidence
Chemistry	Chemistry 1	Chemistry 2	Chemistry 3	Chemistry 4	Chemistry 5	Chemistry 6	Data and evidence
Physics	Physics 1	Physics 2	Physics 3	Physics 4	Physics 5	Physics 6	Data and evidence

## 1. TERMINAL RULES

When certificating for the qualification, candidates must take at least 40% of the overall assessment in that final examination series. This terminal rule also applies to candidates re-sitting units in a subsequent year and applying for certification again. This is why the Unit 2 paper has a weighting of 40%. When taken on its own in the final examination series, it meets the terminal requirements.

The terminal 40% can be satisfied by combining any units as long as the total is 40% or above at the final sitting, i.e. at the point of certification. Therefore, candidates could be entered for Unit 2 (40%) on its own, or Unit 1 (35%) plus the controlled assessment (25%). However, controlled assessment can only be entered in the June series.

How could this work in practice? For example:

Year 10 candidates sit Unit 1 (35%) in January. In June they sit Unit 2 (40%) and enter the controlled assessment (25%). Entries for certification are made. The terminal rule is met. A GCSE grade is awarded.

However, for one candidate, performance on Unit 2 is below expectation. The candidate re-sits Unit 2 in January in Year 11 and certifies the GCSE again. As Unit 2 is 40% of the total mark, it can be taken on its own and still meet the terminal rule. A GCSE grade is awarded.

## 2. RE-SIT RULES

Each unit can only be taken once with one re-sit opportunity. Taking a unit at Foundation Tier and then at Higher Tier counts as the two opportunities. Usually, the better of the two results will be counted. However, if a re-sit forms part of the terminal 40% for a qualification, then that paper's result will be counted, even if the result is lower than on the previous attempt.

Continuing the example given in the previous section, the candidate initially gets an overall GCSE Science grade C. On sitting Unit 2 in the next January in Year 11, the candidate achieves a lower score on the Unit 2 paper. This results in a new GCSE with an overall grade D. The original higher grade C cannot be taken away from the candidate.



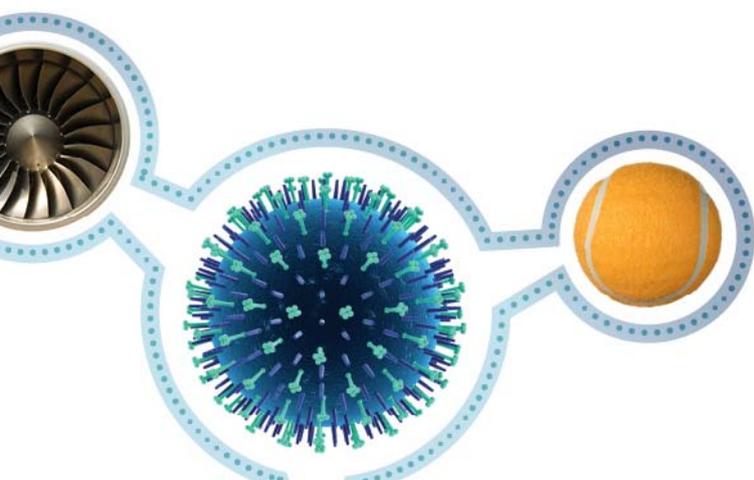
### 3. POSSIBLE PATTERNS OF DELIVERY AND ASSESSMENT

#### SCIENCE AND ADDITIONAL SCIENCE

Year	January series	June series
Year 10	Science Unit 1	Science Unit 2 Controlled assessment Certification
Year 11	Additional Science Unit 1	Additional Science Unit 2 Controlled assessment Certification

However, a resit may be required.

Year	January series	June series	Notes
Year 10	Science Unit 1	Science Unit 2 Controlled assessment Resit Science Unit 1 Certification for Science	The highest mark for Science Unit 1 will count at Science certification because the terminal requirement is met by Unit 2.
Year 11	Additional Science Unit 1 Resit Science Unit 2 Certification for Science	Additional Science Unit 2 Controlled assessment Resit Additional Science Unit 1 Certification for Additional Science	The re-sit mark of Science Unit 2 will have to count in January due to the terminal rule. Marks from Unit 1 (highest mark) and controlled assessment are available for use from a previous series. The highest mark for Additional Science Unit 1 will count at Additional Science certification.
Year 12	Resit Additional Science Unit 2 Certification for Additional Science		The re-sit mark of Additional Science Unit 2 will have to count in January due to the terminal rule. Marks from Unit 1 and controlled assessment are available from the previous series.



Some centres may wish to start teaching the three Separate Sciences in Year 9. Spacing out the examinations and controlled assessments would be sensible, and an example is given below.

The controlled assessment can be carried out at any time during the school year but the tasks submitted must be for the correct June year date.

Year	January series	June series	June to July
Year 9		Biology Unit 1 Chemistry Unit 1	Candidates carry out the Chemistry controlled assessment
Year 10	Physics Unit 1  Candidates carry out the Physics controlled assessment during the spring term	Submit Chemistry controlled assessment Submit Physics controlled assessment	Candidates carry out the Biology controlled assessment
Year 11	Chemistry Unit 2 Chemistry Certification	Biology Unit 2 Submit Biology controlled assessment Biology Certification Physics Unit 2 Physics Certification	

#### 4. STYLE OF THE QUESTION PAPERS

There is no choice of questions.

The type of questions used in the papers is similar to the old specification. However, there are now six mark extended answer questions.

Questions are written to meet the requirements of the assessment objectives.

Objective	Assessment Objective	Question type
A01	<b>Recall, select and communicate their knowledge and understanding of science</b>	Recalling information Selecting an appropriate formula
A02	<b>Apply skills, knowledge and understanding of science in practical and other contexts</b>	Applying knowledge in a new context Identifying trends/patterns Using a formula to calculate Analysing results
A03	<b>Analyse and evaluate evidence, make reasoned judgements and draw conclusions based on evidence</b>	Drawing and justifying conclusions Evaluating a method

## 5. OBJECTIVE TYPE QUESTIONS

Objective type questions include:

- choosing a word to complete sentences
- selecting items by ticking in a list
- matching items in two lists by drawing lines from one list to the other
- answering a question by selecting from a list, pictures, diagrams etc.

Example:

Look at the list of actions.

The eye is the receptor for all these actions.

Which of the actions are reflexes?

Put a tick (✓) in the box next to each reflex action.

Put a cross (X) in the box next to each of the actions which are not reflex actions.

Automatically blinking when an object is thrown towards your face.	
Changing the shape of your pupil without thinking in bright light.	
Turning on the light when it gets dark.	

Example:

Phil decides to use natural gas (methane) to heat his house.

Look at the word equation.

It shows what happens during the **complete combustion** of methane.

methane + oxygen → ..... + water

Finish the word equation.

## 6. SHORT ANSWER QUESTIONS

Short answer questions will require candidates to write a few words or a sentence. These questions have mark allocations of 1–3 marks.

Examples:

The diagram shows an animal cell.

Write down the function of mitochondria in the cell. [1]

The scientists Thompson, Rutherford and Bohr told other scientists about their ideas about atoms.

Suggest how and explain why they told other scientists. [2]

Phil adds a bulb to his circuit. [circuit diagram provided]. He wants to change the brightness of the bulb but he needs to make sure the bulb is not damaged. He could do this by changing or adding components.

Describe the components he could change or add. Explain how this makes a difference. [3]

## 7. EXTENDED ANSWER QUESTIONS

Longer answer questions require candidates to write about a topic. The questions may require, for example: giving an explanation or a description, drawing conclusions from an experiment and justifying a prediction. There will be one extended answer question in each section of the paper. There are usually no bullet points giving guidance to candidates about addressing certain points in their answer. However, the actual wording of the question will sometimes be longer to give guidance.

Within a paper, the three extended answer questions will be set at different levels of difficulty. Therefore in a Foundation Tier paper, it is likely that one of the extended answer questions will be set at a level of demand such that candidates operating at a grade G level will not be at a disadvantage.

These questions also assess the Quality of Written Communication (QWC) and have a mark allocation of 6 marks. The pencil symbol  will remind candidates about QWC. The mark scheme for the extended answer questions will be of a type known as "Level of Response".

### THE LEVEL OF RESPONSE MARK SCHEME IS DIVIDED INTO 4 LEVELS:

A candidate's answer will be marked firstly by consideration of the science within the answer. Does the science match to Level 1 or Level 2 or Level 3? Once the appropriate level has been selected, a decision has to be made on the Quality of Written Communication in order to choose which mark within the level should be given. For example:

A candidate answers a question with a in-depth knowledge of the topic, writes about what is required in the question and is therefore a match to level 3. Specialist terms have been used well and there are only one or two spelling mistakes. Therefore a mark of 6 can be awarded. However, if specialist terms had not been used appropriately and the answer contained a lot of spelling mistakes then a mark of 5 would be awarded.

The table shows the Quality of Written Communication at each level.

Level	0	1	2	3
0 marks	Insufficient or irrelevant science. Answer not worthy of credit.			
1 – 2 marks	Answer may be simplistic. There may be limited use of specialist terms. Many errors of grammar, punctuation and spelling.			
3 – 4 marks	For the most part the information is relevant and presented in a structured and coherent format. Specialist terms are used for the most part appropriately. There are occasional errors in grammar, punctuation and spelling.			
5 – 6 marks	All information in the answer is relevant, clear, organised and presented in a structured and coherent format. Specialist terms are used appropriately. Few, if any, errors in grammar, punctuation and spelling.			

In addition to the marking levels in the table above, each extended answer mark scheme contains notes indicating the relevant points which should be included in the candidate's answer. These relevant points should not be treated as a list of points to be ticked off when marking.

### Examples of extended answer questions:

Example from a Higher tier paper:

This article appeared in a recent newspaper.  
[article about patch to test blood glucose levels]

Mary has type 1 diabetes.

She eats a very large meal.

Explain why using the monitor will help her.

 The quality of written communication will be assessed in your answer to this question. [6]

Example from a Foundation tier paper:

Electrostatics is used in the car manufacturing industry to spray paint cars.

[diagram of car body with paint gun in front]

The paint travels to the car.

Explain how electrostatic charge is useful in spray painting and suggest how the manufacturers can reduce potential dangers to the workers doing the spray painting

 The quality of written communication will be assessed in your answer to this question. [6]

Example from a Foundation tier paper:

Titanium, Ti, atomic number 22, is used to make the wings of some aeroplanes.

Predict four physical properties of titanium.

Explain why you make your predictions and relate the properties to the use of titanium in making aeroplane wings.

 The quality of written communication will be assessed in your answer to this question. [6]

### Example of extended answer question and mark scheme from a Foundation Tier paper:

- (a) Basil thinks that his geranium shoots grow towards light.

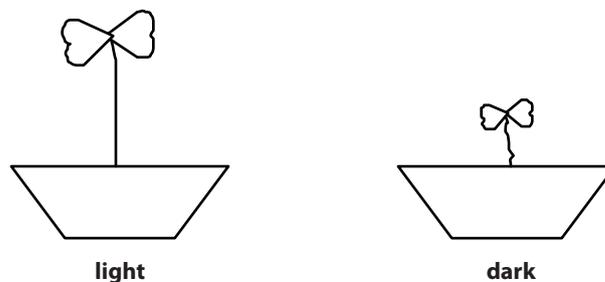
He does an experiment to test this.

#### Method

I left one plant locked in a dark cupboard for one week.

I left another plant on my desk in a classroom for two weeks and watered it every day.

Look at the diagrams of the plants at the end of the experiment.



Based on his evidence Basil concludes that geranium shoots do grow towards the light, because the plant in the light grew better.

Is Basil right to draw this conclusion?

Evaluate his method and his conclusion.

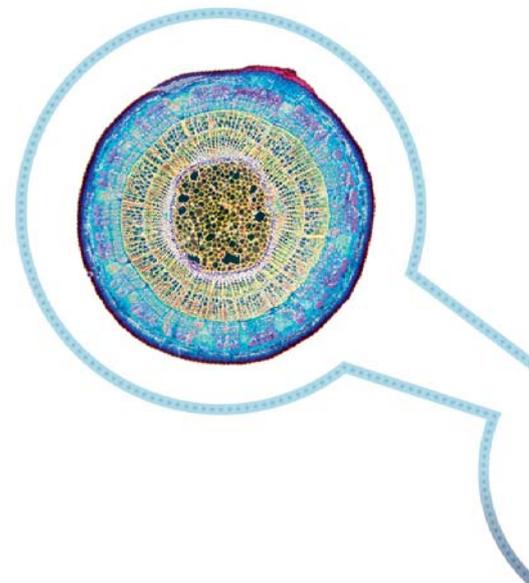
 The quality of written communication will be assessed in your answer to this question.

Expected answer	Additional guidance
<p><b>Level 3</b> Answer thoroughly evaluates both conclusion and method, in terms of not testing directional growth, and applies knowledge of how to conduct this experiment to discuss in detail the flaws in the experimental method outlined including lack of unidirectional light and controlling variables. All information in answer is relevant, clear, organised and presented in a structured and coherent format. Specialist terms are used appropriately. Few, if any, errors in grammar, punctuation and spelling. (5–6 marks)</p> <p><b>Level 2</b> A limited evaluation of conclusion and method, and applies knowledge of how to conduct this experiment to discuss specific flaws in the method including timing and watering. For the most part the information is relevant and presented in a structured and coherent format. Specialist terms are used for the most part appropriately. There are occasional errors in grammar, punctuation and spelling. (3–4 marks)</p> <p><b>Level 1</b> An incomplete answer, simple evaluation in terms of conclusion not right, applies knowledge to experimental method to identify method was not a 'fair test'. Answer may be simplistic. There may be limited use of specialist terms. Errors of grammar, punctuation and spelling prevent communication of the science. (1–2 marks)</p> <p><b>Level 0</b> Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	<p><b>Relevant points include:</b></p> <ul style="list-style-type: none"> <li>Basil is not right to draw this conclusion based on his evidence</li> </ul> <p>evaluation of conclusion</p> <ul style="list-style-type: none"> <li>idea that conclusion not valid / not based on evidence</li> <li>because experiment did not test directional growth</li> <li>experiment was testing whether plant grows in light or dark</li> </ul> <p>evaluation of method</p> <ul style="list-style-type: none"> <li>not enough detail to allow method to be followed</li> <li>reference to condition of unidirectional light required / idea that should have blocked out light from all but one direction</li> <li>reference to not watering both batches equally</li> <li>reference to not leaving them to grow for the same length of time</li> <li>idea of not a 'fair test'</li> <li>reference to not doing repeats / controlling variables</li> <li>reference to variables that were not controlled eg size of plant at the start</li> </ul> <p><b>allow</b> examples of how the experiment should have been done</p>

Candidates will need to be prepared for these questions. They should have practice in identifying the key requirements of the question. In the question about diabetes given above, candidates are not required to just write all they know about diabetes. Rather, they are required to use their knowledge of diabetes to explain why the monitor will help Mary.

Suggesting to candidates that they underline or highlight key phrases or words in the question may be helpful.

These extended answer questions require more than just a list of words. Candidates are expected to link ideas together often with an explanation. This can be in the form of a series of bullet points if this is appropriate but must include links and/or explanations to answer the question.



## 8. UNIT 2 SECTION D

Section D is a new style section in Unit 2 of all the GCSE sciences papers. It addresses Assessment Objective 3: **Analyse and evaluate evidence, make reasoned judgements and draw conclusions based on evidence.** Section D is marked out of 10 marks.

Section D will usually consist of one question subdivided into part-questions. They will test the candidates' ability to use data and evidence, analyse information and draw conclusions.

Questions on the Science and Additional Science papers may be based on biology and/or chemistry and/or physics. However, no recall of content is required for these questions. The processes of How Science Works are likely to be assessed in this section.

Candidates will be required to read information and use it in answering the questions. They may be asked to use data to plot graphs or bar charts, perform calculations such as means and percentages, comment on the reliability of experimental methods and results and suggest conclusions.

Candidates need to have practice in skills such as interpreting data, making judgements, drawing conclusions from unfamiliar data and commenting on experimental results. Centres may like to make use of data from the Science in the News tasks used in the previous specification in developing these skills.

## 9. COMMAND WORDS USED IN EXAMINATION PAPERS

It is important that candidates are able to recognise the command words used in questions in external assessment papers, and understand what kind of response is required by each command word.

This list sets out some of the commonly used command words and provides guidance on the meanings of these words. The list is not intended to be exhaustive or exclusive, but is intended as a guide to the most commonly used command words.

The exact requirements of a command word must always be interpreted within the context of the question in which it appears.

<b>Calculate</b>	Work out a numerical answer. The question will indicate whether or not working must be shown. Appropriate units may be given on the answer line, but if the units are not given they should be included in the answer. <i>Compare with <b>Estimate and Predict.</b></i>
<b>Compare</b>	Identify similarities and differences.

<b>Complete</b>	Add words, numbers, labels or plots to complete a sentence, table, diagram or graph.
<b>Describe</b>	Set out the facts or characteristics. The answer should address <i>what</i> happens, and <i>when</i> and/or <i>where</i> it happens. The <i>breadth</i> of answer required (i.e. how much of the topic to cover) will be indicated in the question stem. The <i>depth</i> of answer required (i.e. the amount of detail needed) can be judged from the number of answer lines and the number of marks allocated to the question. <i>Compare with <b>Explain.</b></i>
<b>Discuss</b>	Give a detailed account that addresses a range of ideas and arguments. It may be necessary to consider opposing sides of a debate, and/or to include ideas, opinions and facts.
<b>Draw</b>	Produce a diagram with sufficient detail and labels to illustrate the answer. <i>Compare with <b>Sketch.</b></i>
<b>Estimate</b>	Suggest an approximate value, without necessarily performing an accurate calculation or measurement. Appropriate units may be given on the answer line, but if the units are not given they should be included in the answer. <i>Compare with <b>Calculate and Predict.</b></i>
<b>Explain</b>	Set out reasons and/or mechanisms to address <i>why</i> and/or <i>how</i> something happens. The <i>breadth</i> of answer required (i.e. how much of the topic to cover) will be indicated in the question stem. The <i>depth</i> of answer required (i.e. the amount of detail needed) can be judged from the number of answer lines and the number of marks allocated to the question. <i>Compare with <b>Describe.</b></i>
<b>Evaluate</b>	Comment on given facts, data or information, and give a judgement, conclusion or opinion if appropriate.
<b>Justify</b>	Provide evidence or explanation that supports an answer, to explain why the answer was given.
<b>Label</b>	Add names or other identifying words to a diagram (using a straight line from the word to the appropriate feature on the diagram).
<b>Measure</b>	Determine a numeric value (a quantity for a variable) using a suitable measuring instrument.
<b>Name</b>	Provide appropriate word(s) or term(s).
<b>Outline</b>	Set out only the key or essential facts, steps or characteristics.
<b>Plot</b>	Translate data into a suitable graph or chart, with labelled axes.
<b>Predict</b>	Write down a possible outcome or value, based on given or calculated information or data. <i>Compare with <b>Calculate and Estimate.</b></i>
<b>Show</b>	Write down details, steps or calculations to prove a fact or answer.

<b>Sketch</b>	Produce a simple, freehand drawing to illustrate the general point being conveyed. Detail is not required. In the context of a graph, the general shape of the curve would be sufficient without plotting precise points. <i>Compare with Draw.</i>
<b>Suggest</b>	Apply scientific knowledge and understanding from the specification to a novel situation or context.
<b>Write down</b>	Provide a concise answer with no supporting argument.

## 10. AVAILABILITY OF ASSESSMENT

The external examination papers will normally be available in both the January and June series. Controlled assessment can only be entered in the June series.

Certification takes place at both the January and June series.

## 11. IMPLEMENTATION OF THE NEW ASSESSMENT

The table below summarises when the first assessment opportunities are for each unit.

	Unit 1	Unit 2	Controlled Assessment	Certification
<b>Science</b>	January 2012	June 2012	June 2012	June 2012
<b>Additional Science</b>	June 2012	June 2013	June 2013	June 2013
<b>Biology</b>	January 2012	June 2013	June 2013	June 2013
<b>Chemistry</b>	January 2012	June 2013	June 2013	June 2013
<b>Physics</b>	January 2012	June 2013	June 2013	June 2013



# CONTROLLED ASSESSMENT

**Controlled assessment replaces the Skills Assessment unit of the previous Gateway courses. It has been termed controlled assessment because of the level of control laid down in the Controlled Assessment Regulations for each subject.**

Task setting is under high control. This means that tasks are set by OCR and are available only on Interchange. Each task is dated and can only be submitted in that year. They cannot be submitted earlier or later than the date on the front of the task. Tasks will usually be put up on Interchange on 1st June two years prior to the submission date to give centres the opportunity to use the task either in Year 10 or Year 11. There will be a limited selection of tasks available.

On the previous specification there were two possible routes for the Skills Assessment for candidates taking Biology, Chemistry and/or Physics. The changes to the Subject Criteria now dictate that these candidates can only undertake one type of controlled assessment.

Controlled assessment tasks, based on Modules 1 or 2, set for Science can only be used for Science. Centres can select whether candidates complete a Biology, Chemistry or Physics task for Science.

Controlled assessment tasks, based on Modules 3 or 4, set for Additional Science can be used for Additional Science and also the appropriate Separate Science. For Additional Science, centres can select whether candidates complete a Biology, Chemistry or Physics task.

Tasks based on Modules 1 or 2 and 5 or 6, using the same criteria as Additional Science, will be developed for the Separate Sciences. Centres can then choose whether to use controlled assessment tasks from Modules 1–6 for Biology, Chemistry and Physics.

The controlled assessment unit requires the completion of one assessment task. Each task is divided into three parts which are linked into an overall theme. The three parts should be taken in the order of Part 1, Part 2 and Part 3. All parts of the same task must be submitted. Stimulus material will be provided which will introduce candidates to the task and direct the work they produce. Candidates may carry out research for the task with limited supervision, i.e. requirements are clearly specified but some work may be completed without direct supervision by the teacher. This means that research activities can be carried out as homework. Data collection from experimental work will require teacher supervision as normal for safety procedures. However, candidates can work in small groups when carrying out experimental work.

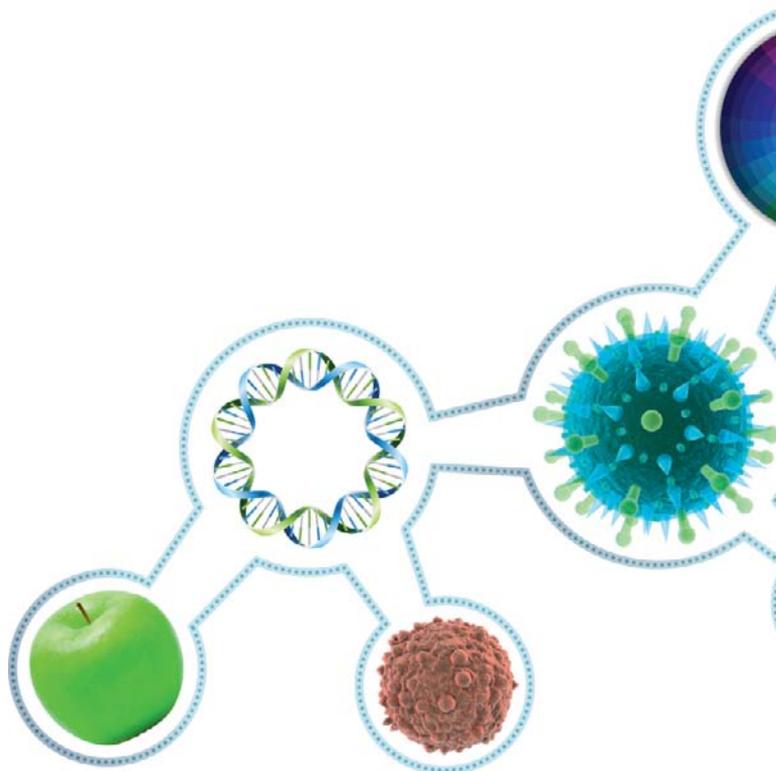
A high level of control will apply for processing, analysis, interpretation and evaluation of findings when materials, obtained through research and data collection, including the use of secondary data, are used and applied. This will be carried out under formal, direct teacher supervision at all times. Candidates must work independently at this time.

Task marking is medium control. Teachers will mark candidates' work using marking criteria and guidance produced by OCR. Specific criteria will be produced for each task. A centre's marking will then be postally moderated by an external moderator appointed by OCR.

Controlled assessment tasks will also assess the Quality of Written Communication (QWC).

Candidates need to be prepared for the controlled assessment task by including the skills required in the teaching programme. An analysis of these skills and how they can be developed is included in the *Guide to controlled assessment*.

Further details and guidance on candidate preparation, delivery and marking of the controlled assessment will be provided in the *Guide to controlled assessment*.



# RESOURCES

**The existing resources can still be used for the new specifications. Collins is our publishing partner and has produced updated books to cover the new specifications.**

The following resources may be useful for new topics in the specification.

N.B. Web addresses may have changed.

## A RESOURCE LIST FOR TEACHERS

### BIOLOGY

B1a – Heart disease, blood pressure, coronary arteries etc.

Wellcome Trust – Big Picture – Obesity

[http://www.nhs.uk/conditions/blood-pressure-\(high\)/Pages/Introduction.aspx](http://www.nhs.uk/conditions/blood-pressure-(high)/Pages/Introduction.aspx);

[http://www.cks.nhs.uk/patient\\_information\\_leaflet/blood\\_pressure\\_high](http://www.cks.nhs.uk/patient_information_leaflet/blood_pressure_high);

[http://hcd2.bupa.co.uk/fact\\_sheets/html/cholesterol.html](http://hcd2.bupa.co.uk/fact_sheets/html/cholesterol.html)

[http://www.ehealthmd.com/library/lowercholesterol/lc\\_plans.html](http://www.ehealthmd.com/library/lowercholesterol/lc_plans.html)

[www.abpischools.org.uk](http://www.abpischools.org.uk)

B1b – First and second class proteins, EAR for protein

<http://www.netfit.co.uk/nutrition/nutrition/proteins.htm>

<http://openlearn.open.ac.uk/mod/resource/view.php?id=257409>

[www.nhlbisupport.com/bmi](http://www.nhlbisupport.com/bmi)

[www.nhs.uk/Tools/Pages/Healthyweightcalculator.aspx](http://www.nhs.uk/Tools/Pages/Healthyweightcalculator.aspx)

B1c – Immunisation

[www.askbaby.com/vaccination-dates.htm](http://www.askbaby.com/vaccination-dates.htm)

B1d – Binocular vision

<http://www.wisegeek.com/what-is-binocular-vision.htm>

<http://www.avoidglasses.com/how-we-judge-distance-key-to-choosing-the-best-eye-exercises>

B1e – Action of depressants and stimulants

Wellcome Trust – Big Picture – Addiction

<http://www.biologymad.com/NervousSystem/synapses.htm>

[www.abpischools.org.uk](http://www.abpischools.org.uk)

– Alcohol content

[http://www.drinkdriving.org/drink\\_driving\\_information\\_bloodalcoholcontentcalculator.php](http://www.drinkdriving.org/drink_driving_information_bloodalcoholcontentcalculator.php)

B1f – Type 1 and type 2 Diabetes

[http://www.diabetes.org.uk/Guide-to-diabetes/Introduction-to-diabetes/What\\_is\\_diabetes](http://www.diabetes.org.uk/Guide-to-diabetes/Introduction-to-diabetes/What_is_diabetes)

[www.abpischools.org.uk](http://www.abpischools.org.uk)

B1h – Cystic fibrosis – story of Paul

[www.abpischools.org.uk](http://www.abpischools.org.uk)

B2a – Evolutionary tree

<http://www.nature.com/scitable/topicpage/reading-a-phylogenetic-tree-the-meaning-of-41956>

B2c – Carbon sinks

<http://www.environment-agency.gov.uk/news/106432.aspx>

<http://www.ieta.org/ieta/www/pages/index.php?IdSitePage=124>

B2e – Organisms as specialists and generalists

[http://en.wikipedia.org/wiki/Generalist\\_and\\_specialist\\_species](http://en.wikipedia.org/wiki/Generalist_and_specialist_species)

B2f – Lamarck

<http://www.sparknotes.com/biology/evolution/lamarck/section2.rhtml>

Speciation

<http://www.globalchange.umich.edu/globalchange1/current/lectures/speciation/speciation.html>

B2f – Hostile reaction of natural selection

<http://www.darwins-theory-of-evolution.com>

Many sources are available

B2g – Carbon footprint

<http://www.carbonfootprint.com>

<http://www.carbontrust.co.uk/cut-carbon-reduce-costs/calculate/carbon-footprinting/pages/carbon-footprinting.aspx>

B2g – Using living and non-living methods of measuring pollution

Standard textbooks

<http://www.explainthatstuff.com/waterpollution.html>

B3f – Issues of stem cells

<http://stemcells.nih.gov/info/basics>

<http://www.allaboutpopularissues.org/pros-and-cons-of-stem-cell-research.htm>

B3g – Ethical issues of genetic modification

<http://www.buzzle.com/articles/pros-and-cons-of-genetic-engineering.html>

[http://www.bionetonline.org/english/content/ff\\_eth.htm](http://www.bionetonline.org/english/content/ff_eth.htm)

B4b – van Helmont

<http://www.saskschools.ca/~pvsd/vsfprojects/foodforlife/foodforlife/www.simplydivinecatering.com/history>

B5b – Circulation

<http://biology.about.com/library/organs/blcircsystem2.htm>

<http://ablemedia.com/ctcweb/showcase/megill2.html>

B5c – Hole in the heart

[http://www.daviddarling.info/encyclopedia/H/hole\\_in\\_the\\_heart.html](http://www.daviddarling.info/encyclopedia/H/hole_in_the_heart.html)

B5d – Asthma

<http://www.nhs.uk/conditions/asthma/Pages/Introduction.aspx>

B5h – Organ donation

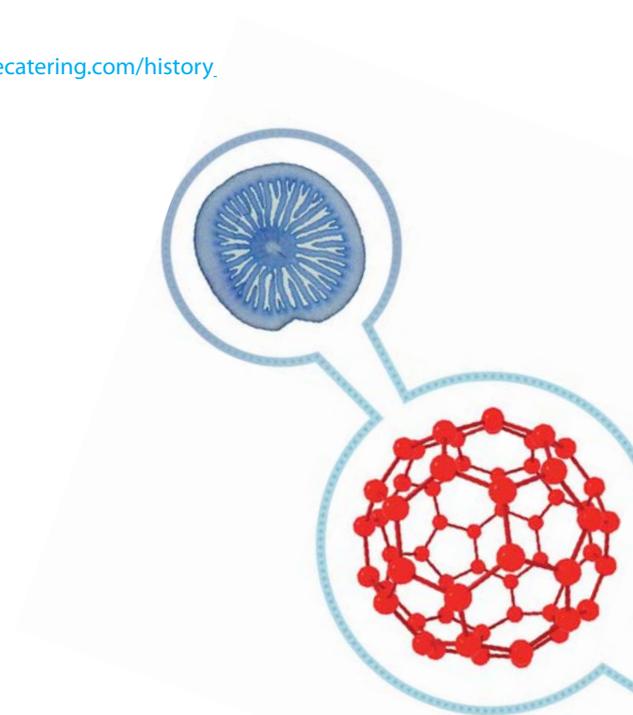
<http://www.nhs.uk/Livewell/Donation/Pages/Ethicsandworries.aspx>

B6b – Resistance to antibiotics

<http://health.howstuffworks.com/human-body/cells-tissues/question561.htm>

B6e – Soil food web

[http://soils.usda.gov/sqi/concepts/soil\\_biology/soil\\_food\\_web.html](http://soils.usda.gov/sqi/concepts/soil_biology/soil_food_web.html)



**CHEMISTRY**

C1a – Petrochemicals or fuels

<http://business.mapsofindia.com/india-petroleum-industry/multifaceted-uses-of-petrochemicals.html>

HowStuffWorks and BBC websites have useful pages

C1c – Internal combustion engine and high temperature

[http://www.speedace.info/internal\\_combustion\\_engine.htm](http://www.speedace.info/internal_combustion_engine.htm); [http://en.wikipedia.org/wiki/Internal\\_combustion\\_engine](http://en.wikipedia.org/wiki/Internal_combustion_engine)

C1d – PVA polymer slime

[www.practicalchemistry.org](http://www.practicalchemistry.org)

C1g – Testing cosmetics

[www.aboutanimaltesting.co.uk/animal-testing-cosmetics.html](http://www.aboutanimaltesting.co.uk/animal-testing-cosmetics.html)

C1h – Emulsion paints

<http://uk.answers.yahoo.com/question/index?qid=20080928145628AAgrJlW>

C2a – Wegener and continental drift

Collins Ideas and Evidence CD

<http://www.ucmp.berkeley.edu/geology/techist.html>; [http://en.wikipedia.org/wiki/Continental\\_drift](http://en.wikipedia.org/wiki/Continental_drift)

<http://www.scientus.org/Wegener-Continental-Drift.html>

C2a – Plate tectonics

<http://www.bbc.co.uk/schools/gcsebitesize/geography/platetectonics/>

C2c – Electrolysis in purification of copper

Heinemann Gateway Science

C2c – Nitinol for spectacles

<http://www.gcsescience.com/ex37.htm>

Heinemann Gateway Science

Cambridge Gateway Science

C2f – Word equations to show neutralisation of acids by bases and carbonates

Text books covering Gateway Module 5

C2g – Fertilisers

<http://www.gcsescience.com/hf.htm>

C2h – Sodium chloride

See resources for C6 legacy specification

C3h – Nanotubes

<http://www.understandingnano.com/nanotubes-carbon.html>

Fullerenes

<http://www.hhmglobal.com/knowledge-bank/articles/fullerene-nanomedicines-for-medical-and-healthcare-applications>

C4a – Atomic structure theories

[http://www.bbc.co.uk/schools/gcsebitesize/science/add\\_aqa/radiation/atomsisotopesrev4.shtml](http://www.bbc.co.uk/schools/gcsebitesize/science/add_aqa/radiation/atomsisotopesrev4.shtml)

C4c – Periodic Table

<http://www.bbc.co.uk/schools/gcsebitesize/science/edexcel/patterns/periodictablerev1.shtml>

<http://www.usetute.com.au/pthistor.html>



C6b – Fuel cells

<http://auto.howstuffworks.com/fuel-efficiency/alternative-fuels/fuel-cell.htm>

## PHYSICS

P1a – Thermograms

<http://en.wikipedia.org/wiki/Thermography>

P1b – Sankey diagrams

[http://en.wikipedia.org/wiki/Sankey\\_diagram](http://en.wikipedia.org/wiki/Sankey_diagram) ; <http://www.gcse-science.com/pen20-energy-efficiency.htm>

[http://www.wghs.org.uk/~sciences/general\\_pages/sankey/sankey.htm](http://www.wghs.org.uk/~sciences/general_pages/sankey/sankey.htm)

- Energy saving

<http://www.energysavingadvice.co.uk/>

P1c – William Herschel's experiment

[http://www.practicalphysics.org/go/Resources\\_16.html](http://www.practicalphysics.org/go/Resources_16.html)

- Waves

[http://www.practicalphysics.org/go/Topic\\_1.html;jsessionid=aISytQK53ad-?topic\\_id=1](http://www.practicalphysics.org/go/Topic_1.html;jsessionid=aISytQK53ad-?topic_id=1)

P1e – Dangers of frequent use

<http://www.telegraph.co.uk/health/healthnews/7725169/Landmark-study-set-to-show-potential-dangers-of-heavy-mobile-phone-use.html>;

<http://www.emwatch.com/Cellphones.htm>

P1f – Remote controls and infrared

<http://www.ustr.net/infrared/infrared1.shtml>

- Switch to digital TV

[http://www.digitaluk.co.uk/what\\_and\\_why](http://www.digitaluk.co.uk/what_and_why)

P1g – DAB broadcasts

[http://en.wikipedia.org/wiki/Digital\\_Audio\\_Broadcasting](http://en.wikipedia.org/wiki/Digital_Audio_Broadcasting)

P2c -- Global warming

[http://news.bbc.co.uk/cbbcnews/hi/find\\_out/guides/world/global\\_warming/newsid\\_1575000/1575441.stm](http://news.bbc.co.uk/cbbcnews/hi/find_out/guides/world/global_warming/newsid_1575000/1575441.stm)

P2d – Model power station

<http://www.energyquest.ca.gov/projects/geothermal-pp.html>

P2f – Robot spacecraft

See book on Google: Robot spacecraft by Joseph A. Angelo Jr.

P2g – Earth-Moon system

[http://www.cliffsnotes.com/study\\_guide/Origin-of-the-EarthMoon-System.topicArticleId-23583,articleId-23500.html](http://www.cliffsnotes.com/study_guide/Origin-of-the-EarthMoon-System.topicArticleId-23583,articleId-23500.html)

P2h – Ptolemaic models

[http://www.polaris.iastate.edu/EveningStar/Unit2/unit2\\_sub1.htm](http://www.polaris.iastate.edu/EveningStar/Unit2/unit2_sub1.htm)

- Copernican model

[http://www.polaris.iastate.edu/EveningStar/Unit2/unit2\\_sub2.htm](http://www.polaris.iastate.edu/EveningStar/Unit2/unit2_sub2.htm)

- Galilean model

[http://www.polaris.iastate.edu/EveningStar/Unit2/unit2\\_sub5.htm](http://www.polaris.iastate.edu/EveningStar/Unit2/unit2_sub5.htm)

P3e – Fuel consumption

[www.dft.gov.uk/vca/fcb/faqs-fuel-consumptio.asp](http://www.dft.gov.uk/vca/fcb/faqs-fuel-consumptio.asp)

[www.fuel-economy.co.uk/calc.shtml](http://www.fuel-economy.co.uk/calc.shtml)

P3f – Momentum

<http://en.wikipedia.org/wiki/Momentum>

P4g – Medical radioisotopes

<http://www.world-nuclear.org/info/inf55.html>

– Safety precautions for radiographers

<http://www.mod.uk/NR/rdonlyres/2DFF0341-C7A2-4F22-B69E-6BD066548715/0/Leaflet28IndustrialRadiographyMar09.pdf>

P4h – Cold fusion

<http://encyclopedia2.thefreedictionary.com/Arguments+in+the+cold+fusion+controversy>

<http://news.bbc.co.uk/1/hi/sci/tech/7959183.stm>

<http://www.newenergytimes.com/v2/books/RebirthofColdFusion/FPColdFusionMethod.shtml>

P5f – Nature of waves

<http://www.spaceandmotion.com/Physics-Christiaan-Huygens-Wave-Theory.htm>

<http://www.citycollegiate.com/wavetheory1.htm>

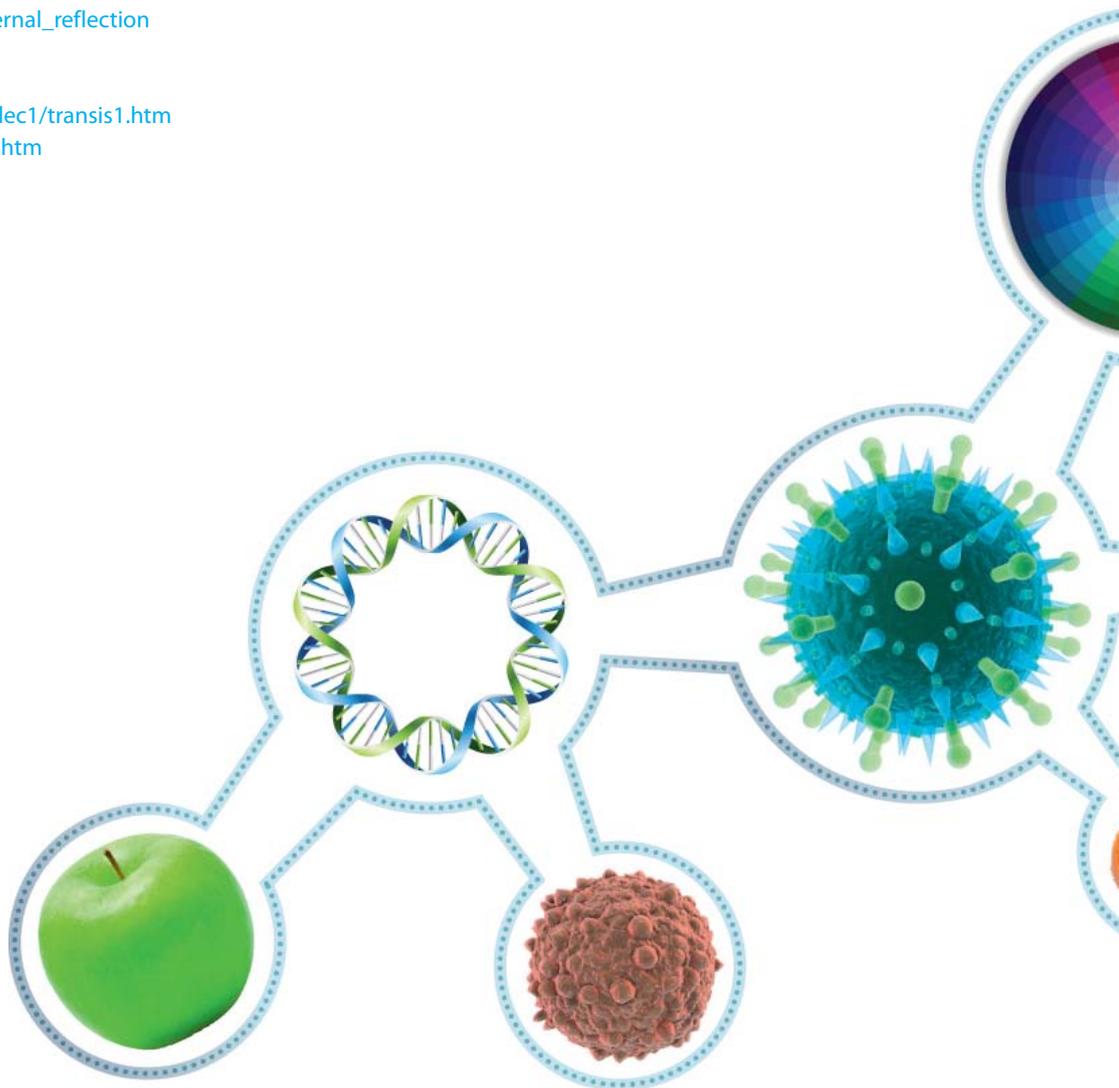
P5g – TIR

[http://en.wikipedia.org/wiki/Total\\_internal\\_reflection](http://en.wikipedia.org/wiki/Total_internal_reflection)

P6c – NPN transistor

<http://www.technologystudent.com/elec1/transis1.htm>

<http://www.kpsec.freeuk.com/trancirc.htm>



# OCR ENDORSED RESOURCES

**OCR works with publishers to offer centres a wealth of quality with Official Publisher Partner and Approved Publication resources, endorsed by OCR for use with OCR specifications.**

By making a choice of endorsed published resources available, you can be confident that materials branded with OCR's "Official Publishing Partner" or "Approved publication" logos have undergone a thorough quality assurance process to achieve endorsement. All responsibility for the content of the published materials rests with the publisher.

These endorsements do not mean that the materials are the only suitable resources available or necessary to achieve an OCR qualification.

## PUBLISHER PARTNER

We have been working closely with Collins, our publisher partner for OCR GCSE Gateway Science 2011, to help ensure their new resources are available when you need them and match the new specifications.



Collins is working with a team of experienced authors to provide resources which will help you deliver the new OCR GCSE Gateway Science specifications. The Science, Additional Science and Separate Science components build on each other, so your department can buy as needed and use them with all students taking different 2011 GCSE science routes.

Reduce planning time – the student books, teacher packs, homework activities, interactive books and assessment package are fully integrated and matched to the Collins GCSE Gateway scheme of work so you can get started straight away.

## COLLINS NEW GCSE SCIENCE OCR GATEWAY RESOURCES:

Science	Available
Student Book	January 2011
Teacher Pack	January 2011
Homework Book	January 2011
Assessment	January 2011
Interactive Book	March 2011
<b>Additional Science</b>	
Student Book	March 2011
Teacher Pack	April 2011
Homework Book	March 2011
Interactive Book	April 2011
Assessment	March 2011
Foundation Revision Workbook (Core and Additional)	March 2011
Higher Revision Workbook (Core and Additional)	March 2011
<b>Biology, Chemistry and Physics</b>	
<b>Student Book</b>	<b>April 2011</b>
Teacher Pack	May 2011
Homework Book	May 2011
Assessment	May 2011
Interactive Book	May 2011
Foundation Revision Workbook	April 2011
Higher Revision Workbook	April 2011
<b>Evaluation Pack</b>	<b>January 2011</b>

For further details and to order an Evaluation Pack visit [www.collinseducation.com/gcscscience2011](http://www.collinseducation.com/gcscscience2011)



## ENDORSED PUBLICATIONS



OCR still endorses other publisher materials (Approved Publications), which undergo a thorough quality assurance process to achieve endorsement. By offering a choice of endorsed materials, centres can be assured of quality support for all OCR qualifications.

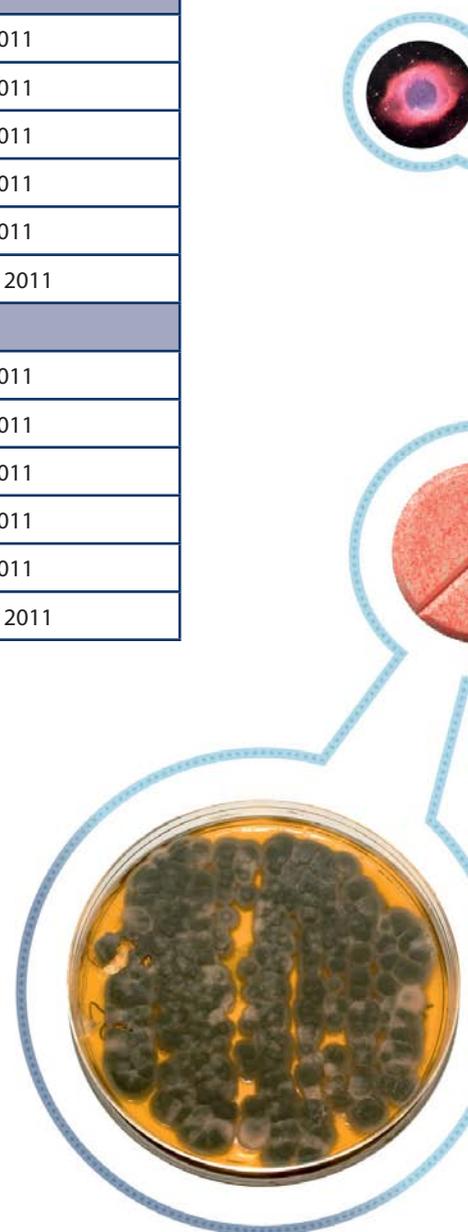
Other endorsed resources available for this specification include *OCR Gateway GCSE Science* from Oxford University Press. These resources have been developed for the needs of real students and teachers, and provide a simple and clear approach to the new specifications.

This comprehensive suite of OCR GCSE Gateway Science resources will be available as follows.

<b>OCR Gateway GCSE Science</b>		
Evaluation Pack	978 019 912808 2	January 2011
<b>GCSE Science</b>		
Student Book	978 019 913552 3	Spring 2011
Resources and Planning Pack	978 019 913555 4	Spring 2011
Resources and Planning OxBOS CD-ROM	978 019 913556 1	Spring 2011
Exam Preparation and Assessment OxBOS CD-ROM	978 019 913557 8	Spring 2011
Revision Guide	978 019 913553 0	Spring 2011
Online Homework	978 019 912844 0	Summer 2011
<b>GCSE Additional Science</b>		
Student Book	978 019 913558 5	Spring 2011
Resources and Planning Pack	978 019 913560 8	Spring 2011
Resources and Planning OxBOS CD-ROM	978 019 913561 5	Spring 2011
Exam Preparation and Assessment OxBOS CD-ROM	978 019 913562 2	Spring 2011
Revision Guide	978 019 913559 2	Spring 2011
Online Homework	978 019 912845 7	Summer 2011
<b>GCSE Separate Science</b>		
Student Book	978 019 913563 9	Spring 2011
Resources and Planning Pack	978 019 913565 3	Spring 2011
Resources and Planning OxBOS CD-ROM	978 019 913566 0	Spring 2011
Exam Preparation and Assessment OxBOS CD-ROM	978 019 913567 7	Spring 2011
Revision Guide	978 019 913564 6	Spring 2011
Online Homework	978 019 912846 4	Summer 2011

<b>GCSE Biology</b>		
Student Book	978 019 913568 4	Spring 2011
Resources and Planning Pack	978 019 913570 7	Spring 2011
Resources and Planning OxBox CD-ROM	978 019 913571 4	Spring 2011
Exam Preparation and Assessment OxBox CD-ROM	978 019 913572 1	Spring 2011
Revision Guide	978 019 913569 1	Spring 2011
Online Homework	978 019 912847 1	Summer 2011
<b>GCSE Chemistry</b>		
Student Book	978 019 913573 8	Spring 2011
Resources and Planning Pack	978 019 913575 2	Spring 2011
Resources and Planning OxBox CD-ROM	978 019 913576 9	Spring 2011
Exam Preparation and Assessment OxBox CD-ROM	978 019 913577 6	Spring 2011
Revision Guide	978 019 913574 5	Spring 2011
Online Homework	978 019 912848 8	Summer 2011
<b>GCSE Physics</b>		
Student Book	978 019 913578 3	Spring 2011
Resources and Planning Pack	978 019 913580 6	Spring 2011
Resources and Planning OxBox CD-ROM	978 019 913581 3	Spring 2011
Exam Preparation and Assessment OxBox CD-ROM	978 019 913582 0	Spring 2011
Revision Guide	978 019 913579 0	Spring 2011
Online Homework	978 019 912849 5	Summer 2011

To order an Evaluation Pack, or for further details, please visit the Oxford University Press website at [www.oxfordsecondary.co.uk/ocrgatewayscience](http://www.oxfordsecondary.co.uk/ocrgatewayscience)



# OCR TRAINING AND ADDITIONAL SUPPORT

**In order to help you implement the new GCSE Gateway Science Specification effectively, OCR offers a comprehensive package of support. This includes:**

## SUPPORT NETWORK – “CLUSTERS”

Centres are encouraged to join a cluster group. Cluster groups are organised on geographical areas and all centres are eligible to join. Each cluster appoints its own coordinator who organises meetings at times to suit the member centres. OCR supports the clusters by providing:

- free training for the coordinator twice a year
- resources to disseminate to the cluster members
- regular updates to the coordinator for dissemination
- a route for clarification of points raised by member centres
- a national coordinator who maintains regular contact with the coordinators.

Centres benefit from being in a cluster through the additional resources and updates, as well as having a local contact.

## OCR TRAINING

A full range of training events provide valuable support, for the delivery and assessment of OCR qualifications.

### **Get Ready...**

An overview of new OCR specifications

### **Get Started...**

For teachers preparing to deliver or already delivering OCR specifications

### **Get Ahead...**

For teachers wanting to improve delivery and assessment of a current OCR specification

### **Lead the way...**

To encourage creativity and innovation

View up-to-date event details and make online bookings at [www.oceventbooker.org.uk](http://www.oceventbooker.org.uk) or view our new training e-books at [www.ocr.org.uk/training](http://www.ocr.org.uk/training).

If you are unable to find what you are looking for, contact us by e-mail [training@ocr.org.uk](mailto:training@ocr.org.uk) or telephone 02476 496398.

## COMMUNITY

The OCR community is a place where you can collaborate with your colleagues around subjects and discuss education and assessments

Visit <http://social.ocr.org.uk/>, choose your community and join the discussion!

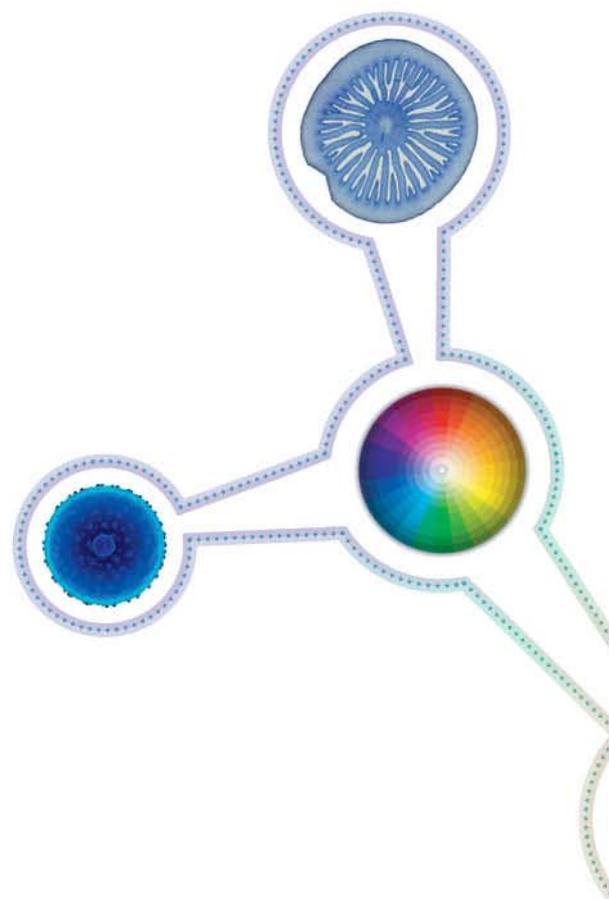
## INTERCHANGE

OCR Interchange has been developed to help you to carry out day to day administration functions online, quickly and easily. The site allows you to register and enter candidates online. In addition, you can gain immediate free access to candidate information at your convenience.

Sign up at <https://interchange.ocr.org.uk>

## E-ALERTS

Sign up for e-alerts at [www.ocr.org.uk/2011signup](http://www.ocr.org.uk/2011signup) and be the first to know when new support is available.



# APPENDIX A

## Detailed changes to Biology modules

Details of content additions, deletions and changes.

Sections numbered under content refer to new specification sections.

### Module B1

Module B1 now Understanding Organisms

Current item B1g is now in module B3.

New item	Practical/research activities	Content additions and deletions (sections refer to new items)	Current item
B1a Fitness and Health	Add: Produce a poster or leaflet encouraging a healthy life style.	<p>Sec 1 LD Change: 'state' to 'explain why'. Add: 2 clarification points.</p> <p>Sec 1 SD Change: 'state' to 'recall' and 'systolic information' to 'systolic data'. Add: Describe the factors that increase blood pressure (4 bullet points). Describe the factors that decrease blood pressure (2 bullet points).</p> <p>Sec 1 HD Amend to: Explain the possible consequences of having high blood pressure. Explain the possible consequences of having low blood pressure.</p> <p>Existing sec 3 becomes new sec 2.</p> <p>Sec 2 SD Add: Analyse the results of different ways of measuring fitness (6 examples given).</p> <p>Sec 2 HD Add: Evaluate different ways of measuring fitness.</p> <p>Sec 3 New.</p> <p>Sec 3 LD Add: Recognise that the risk of developing heart disease can be increased by a number of factors (4 clarification points). Describe how cholesterol can restrict or block blood flow in arteries by forming plaques. Analyse data that show the changing incidence of heart disease in the UK.</p> <p>Sec 3 SD Add: Explain how smoking and diet increase blood pressure (2 clarification points). Explain how diet can increase the risk of heart disease to include (2 clarification points). Interpret data that showing possible links between the amount of saturated fat eaten, the build up of cholesterol plaques and the incidence of heart disease.</p> <p>Sec 3 HD Add: Explain why carbon monoxide reduces the carrying capacity of red blood cells, using the idea that it combines with the haemoglobin preventing the oxygen transport. Explain how narrowed coronary arteries, together with a thrombosis, increase the risk of a heart attack.</p>	B1a Fit for life Sec 1, 3
B1b Human Health and Diet	B1b Human Health and Diet	<p>Sec 1 LD Delete: Existing. Add: Explain why a balanced diet should include (6 bullet points).</p> <p>Sec 1 SD Add: Further clarification to 1st statement.</p> <p>Sec 1 HD Delete: Existing. Add: Describe the storage of biological molecules (3 bullet points).</p>	B1b What's for lunch? Sec 1 and 2

		<p>Sec 2 LD Combine: 1st and 2nd statements. Add: Recall that proteins are only used as an energy source when fats or carbohydrates are unavailable.</p> <p>Sec 2 SD Change: 'recall that' to 'explain why' in 1st statement; 'RDA' to 'EAR' in 3rd statement. Delete: 2nd statement. Add: Explain how low self-esteem, poor image and desire for perfection can lead to poor diet and risks involved.</p> <p>Sec 2 HD Delete: Existing. Add: Describe the difference between first and second class proteins (2 clarification points). Understand that the EAR is an estimated daily figure for an average person of a certain body mass. Explain why the EAR for protein may vary depending on age, pregnancy, and lactation.</p>	
B1c Staying healthy		<p>Sec 1 LD Change: 'state' to 'recall' in 1st statement; 'dysentery' to 'malaria' in 2nd statement. Delete: 'such as fungi, bacteria...'</p> <p>Sec 1 SD Change: 'state' to 'recall'.</p> <p>Sec 1 HD Amend to: Explain how knowledge of the life cycle of a disease and the way in which vectors spread disease can help control infections (1 clarification point).</p> <p>Sec 2 LD Add: Understand that some disorders have other causes, to include genetic causes.</p> <p>Sec 2 SD Delete: 1st statement.</p> <p>Sec 3 LD Change: 'state' to 'recall' in 1st statement.</p> <p>Sec 3 SD Change: 'state' to 'explain' in 1st statement. Delete: 3rd and 5th statements. Add: Clarification to 4th statement. Recall the difference between antibiotics and antiviral drugs.</p> <p>Sec 4 LD Change: 'state that' to 'explain why'.</p> <p>Sec 4 SD Change: 'explain why' to 'describe how'.</p> <p>Sec 4 HD Amend to: Explain why blind and double blind trials are used in testing new drugs against placebos or the best existing treatment.</p>	B1c Keeping healthy
B1d The nervous system		<p>Sec 1 LD Delete: 1st statement. Add: Describe how animals detect changes in their environment (stimuli) using receptors which generate nerve impulses.</p> <p>Sec 1 SD Add: and brought to focus on the retina (to 2nd statement).</p> <p>Sec 1 HD Delete: Existing. Add: Explain how the eye focuses light (accommodation) from near and distant objects.</p> <p>Sec 2 LD Delete: Existing. Add: Explain advantages and disadvantages of monocular and binocular (2 clarification points).</p> <p>Sec 2 SD Delete: Existing. Add: Explain how binocular vision helps to judge distances by comparing the images from each eye – the more similar the images, the further away the object.</p> <p>Sec 3 LD Change: 'state' to 'describe'.</p>	B1d Keeping in touch

		<p>Sec 3 SD Change: 'state' to explain how' in 1st statement; 'state that' to 'explain a cause of' in 2nd statement.</p> <p>Sec 3 HD Delete: 1st statement. Amend to: Explain how long and short-sight can be corrected by corneal surgery or by different lenses in glasses or contact lenses.</p>	
B1e Drugs and you	Add: Research and presentation of info on drugs.	<p>Sec 1 LD Change: 'state' to 'recognise'.</p> <p>Sec 1 SD Delete: Existing. Add: Existing sec 2.</p> <p>Sec 1 HD Delete: Existing.</p> <p>Sec 2 SD Delete: Existing. Add: Existing sec 1.</p> <p>Sec 2 HD Delete: Existing. Add: Existing sec 1, with clarification points.</p> <p>Sec 3 LD Change: 'state' to 'recall' in 1st statement.</p> <p>Delete: 2nd and 3rd statements. Add: 1st statement from existing sec 3 SD.</p> <p>Sec 3 SD Delete: 1st and 3rd statements. Add: Explain why damage to ciliated epithelia cells can lead to smokers cough.</p> <p>Sec 3 HD Delete: Existing. Add: Evaluate data on the effects of smoking in populations (to include cancer, heart disease, emphysema and birth weights of babies born to mothers who smoke).</p> <p>Sec 4 LD Amend to: Recognise the short term and long term effects of alcohol on the body (2 clarification points).</p> <p>Sec 4 SD Delete: 1st statement. Add: Interpret information on reaction times, accident statistics and alcohol levels.</p> <p>Sec 4 HD Delete: Existing. Add: Describe how the liver can become damaged as it removes alcohol (cirrhosis) to include (2 clarification points).</p>	B1e Drugs and you
B1f Staying in balance	Add: Measuring body temperatures. Poster warning of hypothermia. Research diabetes.	<p>Sec 1 LD Change: 'state' to 'recognise'.</p> <p>Sec 1 SD Change: 'explain' to 'understand' in 1st statement; 'understand' to 'explain why' in 2nd statement.</p> <p>Sec 1 HD Change: 'understand' to 'explain'.</p> <p>Sec 2 LD Change: 'state' to 'recall' in 1st statement.</p> <p>Delete: 5th statement.</p> <p>Sec 2 SD Change: 'describe' to 'explain' in 1st statement. Add: Understand that the body temperature of 37°C is the optimum temperature for the action of many enzymes.</p> <p>Sec 2 HD Change: 'describe' to 'explain how' in 1st statement; 'explain that' to 'explain how' in 3rd statement. Add: via the nervous and hormonal systems (to 3rd statement). Delete: 2nd statement.</p> <p>Sec 3 LD Delete: Existing. Add: Name and locate pancreas. Recall that pancreas produces the hormone insulin. Recall that Type 1 diabetes is caused by the failure of the pancreas to produce insulin. Describe how insulin travels around the body.</p>	B1f Staying in balance Sec 1, 2, 3

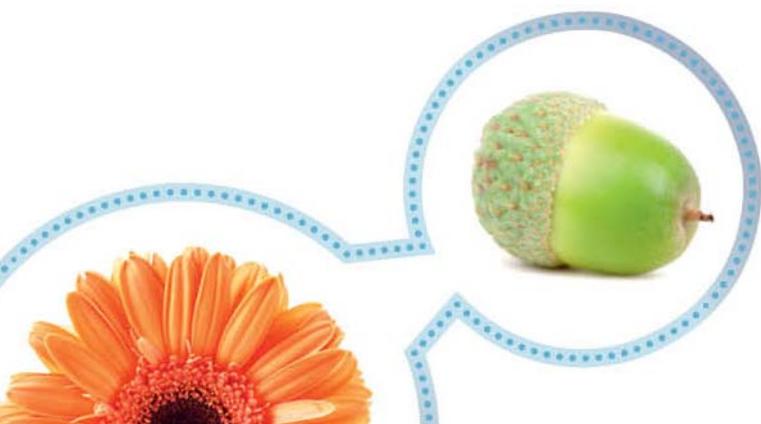
		<p>Sec 3 SD Delete: Existing. Add: Recall that insulin controls blood sugar levels. Explain how Type 2 diabetes can often be controlled by diet but that Type 1 diabetes also needs to be treated by insulin dosage. Explain why responses controlled by hormones are usually slower than responses controlled by the nervous system.</p> <p>Sec 3 HD Delete: 1st and 2nd statements; 'by converting excess blood glucose...' in 3rd statement. Add: Clarification to 4th statement.</p>	
B1g Controlling Plant growth	From existing B3f Add: Use of ICT and time lapse videos.	<p>Existing sec 2 becomes new sec 1.</p> <p>Sec 1 LD Add: Existing sec 1 (reworded). Recognise that plants as well as animals respond to changes in their environment. Understand how growth towards light increases the plant's chance of survival. Amend to: Understand why roots grow downwards.</p> <p>Sec 1 SD Change: 'state' to 'describe' in 1st and 2nd statements; 'state' to 'recall' in 2nd statement.</p> <p>Sec 2 LD Change: 'state' to 'recognise'.</p>	B3f Controlling plant growth Sec 1, 2, 3
B1h Variation and inheritance		<p>Sec 1 LD Combine: 1st, 2nd and 3rd statements, amending wording. Add: Recall that chromosomes are held in the nucleus and that they carry information in the form of genes, which control inherited characteristics. Recognise that most body cells contain chromosomes in matched pairs. Recall that gametes have half the number of chromosomes of body cells.</p> <p>Sec 1 SD Change: 'state' to 'recall' in 2nd statement. Add: 3rd statement from existing sec 1 HD. Recall that most body cells have the same number of chromosomes but this number varies between species (humans have 23 pairs).</p> <p>Sec 1 HD Change: 'recognise that there is a' to 'understand the' in 1st statement. Delete: 3rd statement. Add: genotype; phenotype (to 5th statement).</p> <p>Sec 2 LD Change: 'state' to 'recognise'.</p> <p>Sec 2 SD Change: 'recall' to 'understand'. Add: Understand the issues raised by knowledge of inherited disorders in a family.</p> <p>Sec 2 HD Change: 'explain' to 'recall'. Delete: 3rd statement.</p>	B1h Who am I? Sec 1, 2

**Module B2**

Old items B2a and B2c are now in module B4.

New item	Practical/research activities	Content additions and deletions (sections refer to new items)	Current item
B2a Classification	Delete: Reference to 2 habitats. Add: Collect plants/ animals and develop key. Use key to identify.	<p>Sec 1 New.</p> <p>Sec 1 LD Add: Understand that organisms can be classified into groups according to shared characteristics. Describe the characteristics used to place organisms into the five Kingdoms.</p> <p>Sec 1 SD Add: Understand that the variety of life is a continuous spectrum which makes it difficult to place organisms into distinct groups. Describe the classification of organisms into kingdom, phylum, class, order, family, genus and species. Explain the importance of classification of species in terms of identifying evolutionary and ecological relationships.</p> <p>Sec 1 HD Add: Describe classification systems to include natural (based on evolutionary relationships) and artificial (for purposes of identification). Explain how the use of DNA sequencing information has led to changes in understanding of classification. Understand why systems of classification change over time.</p> <p>Sec 2 New.</p> <p>Sec 2 LD Add: Use characteristics to place organisms into the different classes of arthropods, limited to (4 bullet points).</p> <p>Sec 2 SD Add: Understand that the evolutionary relationships between organisms can be displayed using evolutionary trees.</p> <p>Sec 2 HD Add: Understand how the evolutionary relationships of organisms in a group can be modelled by analysing multiple characteristics and how this has been facilitated by ICT.</p> <p>Sec 3 LD Change: 'recall' to 'recognise'. Add: may show great variation (as bullet point).</p> <p>Sec 3 SD Amend to: Explain the importance of the binomial system as the international basis of naming species.</p> <p>Sec 3 HD Amend to: Explain some of the problems of classifying organisms into species (3 bullet points).</p> <p>Sec 4 LD Delete: Existing. Add: Understand why similar species tend to live in similar types of habitat.</p> <p>Sec 4 SD Delete: 1st statement. Combine: 2nd and 3rd statements.</p> <p>Sec 4 HD Change: 'explain that' to 'explain how'.</p>	B2b Grouping organisms

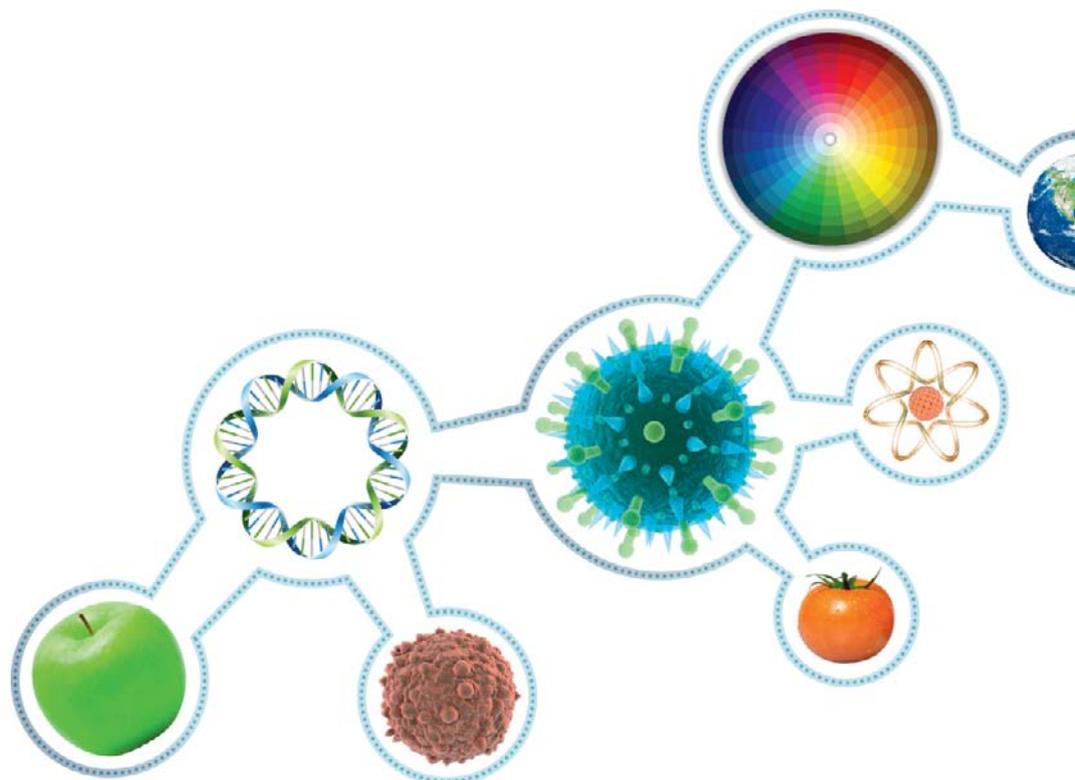
<p>B2b Energy flow</p>	<p>From existing B4e Add: Research food chains in different habitats. Consider and compare sources of food.</p>	<p>Sec 1 LD Delete: Existing. Add: Explain the term trophic level. Understand that there are organisms other than green plants that are producers. Explain why some organisms are both primary and secondary consumers. Explain how changes in the population of one organism may affect the other organisms in a food web. Sec 1 SD Delete: 1st and 3rd statements. Amend: Reword 2nd statement. Add: Understand how pyramids of biomass show the dry mass of living material at each stage of a food chain. Explain why pyramids of numbers and pyramids of biomass for the same food chains can be different shapes. Sec 1 HD Add: Explain the difficulties in constructing pyramids (2 clarification points). Sec 1 LD Delete: Existing. Add: Explain how energy from the Sun flows through food webs. Interpret data on energy flow in food webs. Sec 2 SD Delete: 1st and 2nd statements. Add: excretion (as 3rd bullet point). Describe how excretory products, faeces and uneaten parts can be used as the starting point for other food chains.</p>	<p>B4e Energy flow Sec 1, 2</p>
<p>B2c Recycling</p>	<p>From old B4h Add: Composting activities. Comparing recycling schemes. Leaf decomposition. Nitrogen cycle snakes/ladders game. Investigate nitrogen fixing bacteria.</p>	<p>Sec 1 LD Change: 'state' to 'recognise' in 1st statement; 'state' to 'recall' in 2nd statement. Add: Recognise that many soil bacteria and fungi are decomposers, which decay dead organisms. Describe the importance of this decay process in making elements available again to living organisms. Recall that carbon is taken up by plants as carbon dioxide. Amend to: Recall that two of the most important elements that are required are: carbon; nitrogen. Sec 1 SD Add: Explain why recycling of nutrients takes longer in waterlogged or acidic soils than it does in well drained neutral soils. Sec 1 HD Delete: 1st statement. Amend to: Explain how carbon is recycled in nature. Add: oceans act as carbon sinks (as 4th bullet point). Sec 2 LD Add: 2nd and 3rd statements from sec 2 SD. Recall that nitrogen is taken up by plants as nitrates. Sec 2 SD Delete: 2nd and 3rd statements.</p>	<p>B4h Recycling</p>



B2d Inter- dependence	Add: Research invasive species – suggestions listed.	<p>Sec 1 LD Delete: 1st and 2nd statements. Add: Explain how competition may influence the distribution and population size of animals or plants, related to the availability of food, water, shelter, light and minerals.</p> <p>Sec 1 SD Delete: 1st statement. Add: 1st statement from existing sec 1 HD, deleting examples.</p> <p>Sec 1 HD Delete: Existing. Add: Use the terms interspecific and intraspecific to describe given examples of competition and explain why intraspecific competition is often more significant. Explain what is meant by the term ecological niche. Understand that similar organisms will occupy similar ecological niches.</p> <p>Sec 2 LD Delete: Existing. Add: Existing sec 2 SD.</p> <p>Sec 2 SD Delete: Existing. Add: Existing sec 2 HD.</p> <p>Sec 2 HD Delete: Existing. Add: Explain why the cycles of population for predator and prey are out of phase with each other.</p> <p>Sec 3 LD Delete: Existing. Add: Recall that some organisms benefit from the presence of organisms of a different species. Describe one example of such a relationship limited to cleaner species, to include oxpecker and buffalo.</p> <p>Sec 3 SD Amend to: Describe other types of interdependence between organisms (2 clarification points).</p> <p>Sec 3 HD Delete: Bullet points.</p>	B2d Compete or die
B2e Adaptations	Delete: Draw diagrams. Change: 'design' predator to 'identify'. Add: ICT for poster showing adaptation to habitat.	<p>Sec 1 LD Delete: 1st and 2nd statements. Change: 'describe' to 'explain'. Amend: Clarification points.</p> <p>Sec 1 SD Delete: Existing. Add: Explain how adaptations to cold environments help organisms survive, to include (2 clarification points). Explain how adaptations to hot environments help organisms survive to include (2 clarification points). Explain how adaptations to dry environments help organisms survive to include (1 clarification point).</p> <p>Sec 1 HD Delete: Existing. Add: Analyse surface area to volume ratios in the context of different environmental stresses. Explain how counter-current heat exchange systems (eg in penguins) minimise heat loss. Understand that some organisms are biochemically adapted to extreme conditions, including different optimum temperature for enzymes in extremophiles and organisms with antifreeze proteins.</p> <p>Sec 2 LD Change: 'recognise' to 'recall'.</p> <p>Sec 2 HD Delete: Existing. Add: Describe how some organisms are: specialists (clarification); generalists (clarification).</p>	B2e Adapt to fit

<p>B2f Natural selection</p>	<p>Delete: Section 1. Reorder so Lamarck is in section 2.</p>	<p>Sec 1 New. Sec 1 LD Add: Existing sec 2. Change: 'apply knowledge that' to 'explain why' in 2nd statement. Add: Recognise that over long periods of time, groups of organisms can change and that this is called evolution. Understand how when environments change some species survival or evolve but many become extinct. Sec 1 SD Add: 3rd statement from existing sec 2, changing 'explain' to 'recall'. Understand Darwin's theory of evolution by natural selection to include (4 clarification points). Sec 1 HD Add: 4th statement from existing sec 2. Understand why speciation requires geographical or reproductive isolation of populations. Sec 2 LD Delete: Existing. Add: Recall that: many theories have been put forward to explain how evolution may occur; most scientists accept the theory of natural selection first put forward by Charles Darwin. Sec 2 SD Add: 2nd statement from existing sec 2 HD. Recognise that natural selection as a theory is now widely accepted (2 bullet points). Sec 2 HD Delete: 1st, 2nd and 4th statements. Amend: Split 3rd statement into two. Add: Recognise that the theory of natural selection has developed as new discoveries have been made, to include the understanding of inheritance.</p>	<p>B2f Survival of the fittest Sec 2</p>
<p>B2g Population and pollution</p>	<p>Add: Germination of seeds/seedlings and acid rain. Research links between carbon dioxide levels and global temperatures. Explore chemical impact on plant growth.</p>	<p>Sec 1 LD Change: 'state' to 'recognise'. Amend to: Explain how as the human population increases, resource use increases and therefore more pollution is created; pollutants limited to (4 clarification points). Sec 1 SD Delete: 1st statement. Amend to: Explain the causes and consequences of: global warming; ozone depletion; acid rain. Add: 2nd statement from existing sec 1 HD. Understand that population growth is the result of the birth rate exceeding the death rate. Sec 1 HD Change: 'explain that' to 'explain how'. Delete: 2nd statement. Add: Explain the term carbon footprint in terms of the amount of greenhouse gases given off in a certain period of time. Sec 2 LD Change: 'recall' to 'understand'. Sec 2 SD Change: 'explain that' to 'explain how'. Delete: 2nd statement. Add: Describe how pollution can be measured (2 clarification points). Sec 2 HD Add: Describe the advantages and disadvantages of using living and non-living methods of measuring levels of pollution.</p>	<p>B2g Population out of control?</p>

B2h Sustainability	Delete: Web addresses. References to w Whales. Add: Research organisms used to be in UK. Use of ICT for info leaflet. Research seed banks.	<p>Sec 1 LD Delete: Existing. Add: Existing sec 1 SD. Change: 'describe reasons' to 'explain' in 1st statement.</p> <p>Sec 1 SD Delete: Existing. Add: Existing sec 1 HD, changing 'discuss' to 'explain'. Explain why species are at risk of extinction if the number of individuals or habitats falls below a critical level.</p> <p>Sec 1 HD Add: Explain why species are at risk of extinction if there is not enough genetic variation in the population. Evaluate a given example of a conservation programme in terms of (4 clarification points).</p> <p>Sec 2 LD Change: 'consider' to 'discuss'.</p> <p>Sec 2 SD Change: 'state' to 'recognise'; 'consider' to 'describe'.</p> <p>Sec 2 HD Change: 'state' to 'recognise'. Amend to: Describe issues concerning whaling, to include: getting international agreement, policing and enforcing such agreements and hunting for research.</p> <p>Sec 3 LD Change: 'explain' to 'recognise' in 1st statement; 'explain' to 'recall' in 2nd statement.</p> <p>Sec 3 SD Add: Clarification to 1st statement.</p> <p>Sec 3 HD Change: 'discuss' to 'explain'; 'recognise' to 'understand'.</p>	B2h Sustainability
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## Module 3

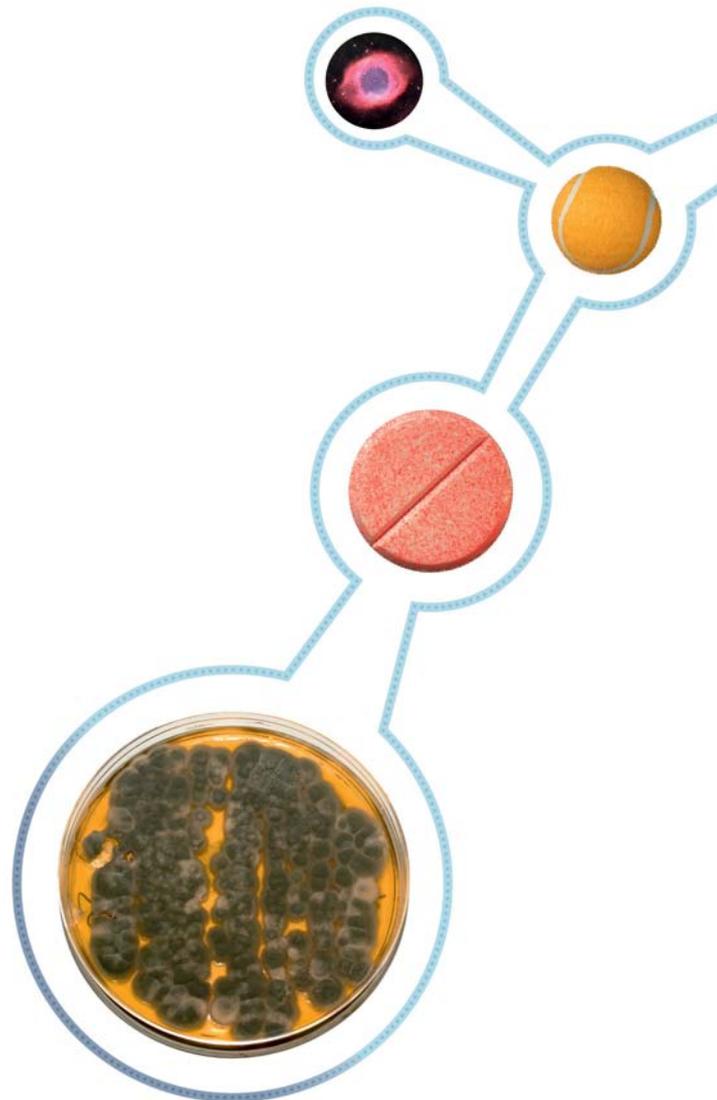
New item	Practical/research activities	Content additions and deletions (sections refer to new items)	Current item
B3a Molecules of life	Delete: Examine DNA fingerprint results. Enzyme activities. Add: Examine a model of DNA. Carry out role playing exercise to demonstrate base pairing. Research Human Genome project. Research roles of Watson, Crick and others.	<p>Sec 1 LD Delete: Existing. Add: Existing sec 1 SD. Change: 'state' to 'recall'.</p> <p>Sec 1 SD Delete: Existing. Add: Explain why liver and muscle cells have large numbers of mitochondria.</p> <p>Sec 1 HD Add: Recall that: some structures in cells, such as ribosomes, are too small to be seen with the light microscope; ribosomes are in the cytoplasm and are the site of protein synthesis.</p> <p>Sec 2 LD Change: 'state' to 'recall'. Add: Recall that the information in genes is in the form of coded instructions called the genetic code. Understand that the genetic code controls cell activity and consequently some characteristics of the organism. Recall that DNA controls the production of different proteins.</p> <p>Sec 2 SD Delete: Existing. Add: Describe the structure of DNA as two strands coiled to form a double helix, each strand containing chemicals called bases, of which there are four different types with cross links between the strands formed by pairs of bases. Describe chromosomes as long, coiled molecules of DNA, divided up into regions called genes. Recall that each gene: contains a different sequence of bases; codes for a particular protein. Recall that proteins are made in the cytoplasm and understand why a copy of the gene is needed as the gene itself cannot leave the nucleus.</p> <p>Sec 2 HD Delete: 4th statement. Add: Explain how the code needed to produce a protein is carried from the DNA to the ribosomes by a molecule called mRNA. Explain how DNA controls cell function by controlling the production of proteins, some of which are enzymes.</p> <p>Sec 3 New.</p> <p>Sec 3 LD Add: Recall that the structure of DNA was first worked out by two scientists called Watson and Crick.</p> <p>Sec 3 SD Add: Describe how Watson and Crick used data from other scientists to build a model of DNA, to include (2 clarification points).</p> <p>Sec 3 HD Add: Explain why new discoveries, such as Watson and Crick's, are not accepted or rewarded immediately, to include (1 clarification point).</p>	B3a Molecules of life Sec 1, 2

<p>B3b Proteins and mutations</p>		<p>Sec 1 New. Sec 1 LD Add: Recall some examples of proteins to include: collagen; insulin; haemoglobin. Sec 1 SD Add: Recognise that proteins are made of long chains of amino acids. Describe some functions of proteins, to include (4 clarification points). Sec 1 HD Add: Explain how each protein has its own number and sequence of amino acids, which results in differently shaped molecules, which have different functions. Existing B3a sec 4 becomes new sec 2. Sec 2 LD Delete: Existing. Add: Describe enzymes as: proteins; molecules that speed up a chemical reaction; working best at a particular temperature. Understand that enzymes have active sites that substrate molecules fit into when a reaction takes place. Sec 2 SD Delete: 1st statement. Combine: 2nd, 4th and 5th statements. Add: 2nd statement from existing sec 4 HD. Sec 2 HD Delete: 1st and 2nd statements. Amend: Bullet points. Add: Calculate and interpret Q10 value for a reaction over a 10°C interval, given graphical or numerical data, using the formula (given). Existing B1h sec 3 becomes new sec 3. Sec 3 LD Change: 'state' to 'describe'. Add: Recognise that different cells and different organisms will produce different proteins. Sec 3 SD Amend to: Understand that mutations occur spontaneously but can be made to occur more often by radiation or chemicals. Understand that mutations are often harmful but may be beneficial or have no effect. Add: Recall that gene mutations may lead to the production of different proteins. Sec 3 HD Delete: Existing. Add: Understand that only some of the full set of genes are used in any one cell; some genes are switched off. Understand that the genes switched on determine the functions of a cell. Explain how changes to genes alter, or prevent the production of the protein which is normally made.</p>	<p>B3a Molecules of life Sec 4  B1h Who am I? Sec 3</p>
<p>B3d Cell division</p>		<p>Sec 1 LD Delete: Existing. Add: Describe the difference between simple organisms which are unicellular and more complex organisms which are multicellular. Sec 1 SD Delete: 2nd and 3rd statements. Sec 1 HD Delete: Existing. Add: Explain why becoming multicellular requires the development of specialised organ systems, limited to (3 clarification points). Sec 2 New. Sec 2 LD Add: Recall that most body cells contain chromosomes in matching pairs. Explain why chromosomes have to be copied to produce new cells for growth. Recall that this type of cell division is also needed for (3 clarification points).</p>	<p>B3d Divide and rule Sec 1, 2</p>

		<p>Sec 2 SD Add: 2nd and 3rd statements from existing sec 1, changing 'state' to 'recall'. Add: Explain why these new cells are genetically identical. Explain why DNA replication must take place before cells divide.</p> <p>Sec 2 HD Add: Describe how, prior to mitosis, DNA replication occurs, to include (2 clarification points). Describe how in mitosis the chromosomes (3 clarification points).</p> <p>Existing sec 2 becomes new sec 3.</p> <p>Sec 3 LD Delete: 2nd and 3rd statement. Amend to: Recall that in sexual reproduction gametes join in fertilisation. Add: Recall that gametes have half the number of chromosomes of body cells. Understand that in sexual reproduction to produce a unique individual half the genes come from each parent. Explain why sperm cells are produced in large numbers: to increase the chance of fertilisation.</p> <p>Sec 3 SD Delete: 1st, 3rd and 4th statements. Change: 'sate' to 'recall' in 2nd statement. Add: Explain why fertilisation results in genetic variation, limited to (2 clarification points).</p> <p>Sec 3 HD Amend: Reword.</p>	
B3e The circulatory system	Delete: Sec 1, 4, 5 and 2nd, 3rd and 4th statements in sec 3.	<p>Sec 1 LD Amend to: Describe the functions of components of the blood: red blood cells; white blood cells; platelets.</p> <p>Sec 1 SD Delete: 2nd and 3rd statements. Add: Describe the function of plasma.</p> <p>Sec 1 HD Change: 'explain' to 'describe' in 2nd statement.</p> <p>Sec 2 LD Change: 'state' to 'recall'.</p> <p>Sec 3 LD Amend: Reword 1st statement. Change: 'state' to 'recall'. Add: Explain, in terms of pressure difference, why blood flows from one area to another.</p> <p>Sec 3 SD Change: 'state' to 'identify'.</p>	B3c Keep it moving Sec 1, 2, 3
B3f Growth and development	Add: Grow seedlings from seeds and measure growth rates using different measurements.	<p>Sec 1 LD Combine: 1st, 2nd and 3rd statements. Add: Understand that bacterial cells are smaller and simpler than plant and animal cells.</p> <p>Sec 1 SD Delete: Existing. Add: Identify simple differences between bacterial, animal and plant cells. Recall that bacterial cells lack: true nucleus; mitochondria; chloroplasts.</p> <p>Sec 1 HD Delete: Existing. Add: Describe the difference between the arrangement of DNA in a bacterial cell and a plant/animal cell, to include (2 bullet points).</p> <p>Sec 2 New.</p> <p>Sec 2 LD Add: Recall that growth can be measured as an increase in height, wet mass or dry mass. Interpret data on a typical growth curve for an individual.</p>	B3e Growing up Sec 1, 2

		<p>Sec 2 SD Add: Recall that dry mass is the best measure of growth. Interpret data on increase in mass (including wet and dry mass). Describe the main phases of a typical growth curve. Recall that in human growth there are two phases of rapid growth, one just after birth and the other in adolescence.</p> <p>Sec 2 HD Add: Explain the advantages and disadvantages of measuring growth by (3 bullet points). Explain why the growth of different parts of an organism may differ from the growth rate of the whole organism.</p> <p>B3e existing sec 2 becomes new sec 3.</p> <p>Sec 3 LD Amend: Statements reworded.</p> <p>Sec 3 SD Change: 'state' to 'recall'. Add: Recall that stem cells can be obtained from embryonic tissue and could potentially be used to treat medical conditions. Discuss issues arising from stem cell research in animals.</p> <p>Sec 3 HD Delete: Existing. Add: Explain the difference between adult and embryonic stem cells.</p> <p>Sec 4 New.</p> <p>Sec 4 LD Add: Understand that animals grow in the early stages in their lives whereas plants grow continually. Understand that all parts of an animal are involved in growth whereas plants grow at specific parts of the plant.</p> <p>Sec 4 SD Add: Explain why plant growth differs from animal growth, to include (4 clarification points).</p>	
B3g New genes for old		<p>Existing sec 2 becomes new sec 1.</p> <p>Sec 1 LD Delete: Existing. Add: Existing sec 2 SD.</p> <p>Sec 1 SD Delete: Existing. Add: Recognise that a selective breeding programme can lead to inbreeding, which can cause health problems within the species.</p> <p>Sec 1 HD Change: 'explain that' to 'explain how'.</p> <p>Existing sec 3 becomes new sec 2.</p> <p>Sec 2 LD Amend: Reword statements.</p> <p>Sec 2 SD Add: Discuss the ethical issues involved in genetic modification.</p> <p>Sec 2 HD Change: 'describe' to 'understand'. Add: Clarification to bullet points.</p> <p>Sec 3 New.</p> <p>Sec 3 LD Add: Recognise that in the future it may be possible to use genetic engineering to change a person's genes and cure certain disorders.</p> <p>Sec 3 SD Add: Recall that changing a person's genes in an attempt to cure disorders is called gene therapy.</p> <p>Sec 3 HD Add: Recall that gene therapy could involve body cells or gametes. Explain why gene therapy involving gametes is controversial.</p>	B3g New Genes for Old Sec 2, 3

B3h Cloning	Add: Research the current scientific and legal position on xenotransplants.	<p>Sec 1 LD Amend to: Recall that (2 clarification points). Change: 'state' to 'recall' in 1st statement; 'state' to 'recognise' in 2nd statement.</p> <p>Sec 1 SD Delete: Existing. Add: Understand that Dolly the sheep was produced by the process of nuclear transfer and that nuclear transfer involves placing the nucleus of a body cell into an egg cell. Describe some possible uses of cloning (3 clarification points). Understand the ethical dilemmas concerning human cloning.</p> <p>Sec 1 HD Change: 'discuss' to 'describe' in 2nd statement; 'discuss' to 'explain' in 3rd statement. Delete: 4th statement.</p> <p>Sec 2 LD Delete: 1st statement. Add: Recognise that plants grown from cuttings or tissue culture are clones.</p>	B3h More of the same
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## Module 4

New item	Practical/research activities	Content additions and deletions (sections refer to new items)	Current item
B4a Ecology in the local environment	Add: Map the distribution of plant species at different distances from a pond/tree.	<p>Sec 1 LD Add: 1st statement from sec 2. Use keys to identify plants and animals.</p> <p>Sec 1 SD Add: 2 clarification points and calculation for population size.</p> <p>Sec 1 HD Delete: Existing. Add: Explain the effect of sample size on the accuracy of an estimated population size. Explain the need to make certain assumptions when using capture-recapture data (3 clarification points).</p> <p>Sec 2 New.</p> <p>Sec 2 LD Add: Explain how the distribution of organisms within a habitat is affected by the presence of other living organisms as well as physical factors.</p> <p>Sec 2 SD Add: Explain the differences between: ecosystem and habitat; community and population. Describe how to map the distribution of organisms in a habitat using a transect line. Interpret data from kite diagrams showing the distribution of organisms.</p> <p>Sec 2 HD Add: Explain what it means for an ecosystem to be described as self supporting in all factors other than an energy source. Describe zonation as a gradual change in the distribution of species across a habitat. Explain how a gradual change of an abiotic factor can result in the zonation of organisms in a habitat.</p> <p>Sec 3 LD Amend: Reword statement. Add: Define biodiversity as the variety of different species living in a habitat.</p> <p>Sec 3 SD Add: Compare the biodiversity of natural ecosystems and artificial ecosystems to include: native woodlands and lakes with forestry plantations and fish farms.</p> <p>Sec 3 HD Delete: Existing. Add: Explain reasons for the differences between the biodiversity of native woodlands and lakes compared with forestry plantations and fish farms.</p>	B2a Ecology in the school grounds
B4b Photo-synthesis	Amend: Greenhouses to glass houses.	<p>Sec 1 LD Delete: Existing. Add: Existing sec 1 SD. Change: 'state' to 'recall and use'. Add Understand that oxygen is a waste product in this reaction.</p> <p>Sec 1 SD Delete: Existing. Add: Existing sec 1 HD. Change: 'state' to 'recall and use'. Describe the development of the understanding of the process of photosynthesis, to include (3 clarification points).</p> <p>Sec 1 HD Delete: Existing. Add: Explain how experiments using isotopes have increased our understanding of photosynthesis, to include: that oxygen produced by photosynthesis comes from the water and not the carbon dioxide.</p> <p>Describe photosynthesis as a two stage process (2 clarification points).</p>	B2c The food factory

		<p>Sec 2 LD Amend to: Recall that the glucose made in photosynthesis is transported as soluble sugars but is stored as insoluble starch. Change: 'explain' to 'recall' in 2nd statement.</p> <p>Sec 2 SD Delete: 1st statement. Amend: Reword 2nd statement.</p> <p>Sec 2 HD Add: 2 clarification points.</p> <p>Sec 4 LD Amend to: Understand that plants carry out respiration as well as photosynthesis.</p>	
B4c Leaves and photo-synthesis	Add: Use ICT to examine leaves. ( <a href="http://www.plantscienceimages.org.uk">www.plantscienceimages.org.uk</a> )	<p>Sec 1 LD Delete: 1st, 2nd and 3rd statements. Change: 'describe' to 'recall' in 4th and 5th statements.; 'leaf pores' to 'stomata' in 5th statement. Add: Understand why chloroplasts are not found in all plant cells. Recall that chlorophyll pigments in chloroplasts absorb light energy for photosynthesis. Understand that broader leaves enable more sunlight to be absorbed.</p> <p>Sec 1 SD Delete: 5th bullet point in 1st statement; 3rd and 4th statements. Add: vascular bundle (as bullet point).</p> <p>Sec 1 HD Add: Interpret data on the absorption of light by photosynthetic pigments (chlorophyll a and b, carotene and xanthophyll) to explain how plants maximise the use of energy from the Sun.</p>	B4a Who planted that there?
B4d Diffusion and osmosis	From B3b sec 1, B4b sec 1, 2, 4.	<p>Existing B3b sec 1 becomes new sec 1.</p> <p>Sec 1 LD Change: 'state' to 'recall'. Add: 'by diffusion' to 1st statement. Describe diffusion as the movement of a substance from a region of high to low concentration.</p> <p>Sec 1 SD Delete: 1st statement. Add: Explain the net movement of particles by diffusion from an area of high concentration to an area of low concentration, as a consequence of the random movement of individual particles.</p> <p>Sec 1 HD Delete: 1st statement. Change: 'explain that' to 'explain how'.</p> <p>Existing B4b sec 1 becomes new sec 2.</p> <p>Sec 2 LD Change: 'state' to 'recognise'. Add: by osmosis (to statement).</p> <p>Sec 2 HD Change: 'state' to 'recall'.</p> <p>Sec 3 LD Change: 'state' to 'understand' in 2nd statement.</p> <p>Sec 3 SD Delete: Existing. Add: Explain how plants are supported by the turgor pressure within cells: water pressure acting against inelastic cell wall. Explain wilting in terms of a lack of turgor pressure.</p> <p>Sec 3 HD Delete: Existing. Add: Explain the terms: flaccid, plasmolysed, turgid.</p> <p>Existing B3b sec 5 becomes new sec 4.</p> <p>Sec 4 LD Delete: Existing. Add: Existing sec 5 SD.</p> <p>Sec 4 SD Delete: Existing. Add: Existing sec 5 HD.</p> <p>Existing B4b sec 5 becomes new sec 5.</p>	<p>B3b Diffusion Sec 1, 5</p> <p>B4b Water, water everywhere Sec 1, 5</p>

		<p>Sec 5 LD Add: Recall that water moves in and out of animal cells through the cell membrane.</p> <p>Sec 5 HD Amend to: Explain why there are differences in the effects of water uptake and loss on plant and animal cells.</p>	
B4e Transport in plants	Add: Examine stained tissues of some species of plants.	<p>Sec 1 LD Delete: Existing.</p> <p>Sec 2 LD Amend to: Describe how water travels through a plant (3 clarification points).</p> <p>Sec 2 SD Change: 'state' to 'recall'.</p> <p>Sec 2 HD Add: Explain how transpiration and water loss from leaves are a consequence of the way in which leaves are adapted for efficient photosynthesis.</p> <p>Sec 3 SD Amend to: Describe the effect on transpiration rate. Add: Interpret data from experiments on transpiration rate.</p> <p>Existing B4b sec 4 becomes new sec 4.</p> <p>Sec 4 LD Change: 'explain' to 'understand'.</p> <p>Sec 4 SD Change: 'describe' to 'explain'. Add: 1st and 2nd statements from existing sec 3, changing 'explain that' to 'explain how' and 'state' to 'recall'.</p>	<p>B4c Transport in plants Sec 1, 2, 3</p> <p>B4b Water, water everywhere Sec 3, 4</p>
B4f Plants need minerals	Add: Practical available from SAPS (HSW practical activities).	<p>Sec 1 LD Change: 'state' to 'recall'.</p> <p>Sec 1 SD Change: 'state that' to 'explain why'.</p> <p>Sec 1 HD Amend to: Describe how elements obtained from soil minerals are used in the production of compounds in plants, limited to (4 clarification points).</p> <p>Sec 2 LD Delete: Existing. Add: Describe experiments to show the effects on plants of mineral deficiencies (2 clarification points).</p> <p>Sec 2 SD Amend to: Relate mineral deficiencies to the resulting poor plant growth (4 clarification points).</p> <p>Sec 3 LD Amend to: Describe how minerals are absorbed to include: dissolved in solution; by the root hairs; from the soil.</p> <p>Sec 3 HD Change: 'recall that' to 'explain how'. Combine: 2nd and 3rd statements.</p>	B4d Plants need minerals too
B4g Decay		<p>Sec 1 LD Change: 'state' to 'recall'. Delete: 2nd statement. Add: Explain why decay is important for plant growth.</p> <p>Sec 1 HD Amend: Reword statement.</p> <p>Sec 2 SD Change: 'state' to 'recall'.</p> <p>Sec 2 HD Amend to: Explain how saprophytic fungi digest dead materials in terms of extracellular digestion.</p> <p>Sec 4 LD Change: 'state' to 'recognise'.</p> <p>Sec 4 SD Delete: Clarification points.</p>	B4g Decay

B4h Farming		<p>Sec 1 LD Amend to: Analyse data to show that farmers can produce more food if they use pesticides and understand that these practices can cause harm to the environment and to health. Recall that pesticides kill pests which are any organisms that damage crops. Recall that examples of pesticides include (3 clarification points).</p> <p>Sec 1 SD Delete: 1st and 2nd statements. Amend to: Explain the disadvantages of using pesticides (3 clarification points).</p> <p>Sec 1 HD Delete: Existing.</p> <p>Sec 2 LD Add: 1st statement from existing sec 1 SD. Change: 'explain' to 'recall'.</p> <p>Sec 2 SD Add: 2nd statement from existing sec 1. Change: 'explain' to 'understand'.</p> <p>Sec 2 HD Add: 1st statement from existing sec 1.</p> <p>Sec 3 LD Delete: 2nd bullet point.</p> <p>Sec 3 SD Add: Existing sec 3 HD. Change 'discuss' to 'explain'.</p> <p>Sec 3 HD Delete.</p> <p>Sec 4 SD Add: Clarification points to 1st statement. Further clarification to bullet points. In the context of biological control (to start of 2nd statement).</p>	B4f Farming
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## Module 5

New item	Practical/research activities	Content additions and deletions (sections refer to new items)	Current item
B5a Skeletons	Add: Examine human and animal skeletons and identify some bones.	<p>Sec1 LD Amend to: Describe the different forms of internal skeleton.</p> <p>Sec 1 SD Change: 'describe' to 'explain why' in 1st statement; 'state' to 'understand' in 3rd statement; 'state that' to 'explain why' in 4th statement.</p> <p>Sec 1 HD Change: 'understand' to 'describe how'. Add: ossification into 2nd statement.</p> <p>Sec 2 LD: Change: 'state' to 'recall'.</p> <p>Sec 2 SD Change: 'state' to 'recall' in 1st statement; 'understand' to 'explain why' in 2nd statement.</p> <p>Sec 2 HD Amend to: Explain why it can be dangerous to move a person with a suspected fracture.</p> <p>Sec 3 LD Change: 'state' to 'describe'.</p> <p>Sec 3 SD Amend: Reword 1st statement. Delete: 2nd statement.</p> <p>Sec 3 HD Change: 'understand' to 'explain'. Delete: 2nd statement.</p>	B5a In good shape

<p>B5b Circulatory systems and the cardiac cycle</p>	<p>Add: Construct a time line of discoveries about blood circulation using various sources. Research heart disease in the world and display the information using charts and graphs.</p>	<p>Sec 1 LD Change: 'state' to 'recall'. Add: Understand the difference between open and closed circulatory systems.          Sec 1 SD Delete: 3rd statement. Add: Explain why animals need a blood circulatory system. Compare the circulatory systems of fish and mammals.          Sec 1 HD Change: 'understand' to 'explain why' in 2nd and 3rd statements. Add: Clarification to 1st statement. Understand that the blood is under higher pressure in a double circulatory system compared with a single circulatory system and how this allows materials to be transported more quickly around the body.          Sec 2 LD Add: Understand how heart muscle causes blood to move.          Sec 2 SD Delete: 1st statement.          Sec 2 HD Add: Explain the sequence of contraction of the atria and ventricles and the sequence of opening of the semilunar and atrio-ventricular valves.          Sec 3 LD Amend to: Describe the heart as made of powerful muscles which are supplied with food substances, including glucose, and oxygen by the coronary artery. Combine: 2nd and 3rd statements. Add: Understand why the heart needs a constant supply of glucose and oxygen.          Sec 3 SD Change: 'state' to 'understand how' in 2nd statement; 'state' to 'recognise' 3rd and 4th statements. Add: Recall that heart rate can be increased by the hormone adrenaline.          Sec 3 HD Add: Clarification points to 1st statement. Delete: 3rd statement.</p>	<p>B5b The vital pump</p>
<p>B5c Running repairs</p>	<p>Delete: Investigation into how many people carry donor cards. Add: Research causes of heart disease.</p>	<p>Sec 1 LD Change: 'state' to 'recognise'.          Sec 1 SD Delete: 1st and 5th statements. Amend: Reword and add clarification points to 2nd, 3rd and 4th statements. Add: Explain the consequences of a 'hole in the heart' (3 clarification points).          Sec 1 HD Delete: Existing. Add: Explain how a 'hole in the heart' results in less oxygen in the blood. Understand why unborn babies can all have a 'hole in the heart' and do not need a double circulatory system and why the hole closes soon after birth. Explain the advantages and disadvantages of a heart pacemaker or artificial heart valves over a heart transplant. Existing sec 3 becomes new sec 2.          Sec 2 LD Amend to: Describe reasons for blood donation. Change: 'state' to 'recall' in 2nd and 4th statements; 'state' to 'describe' in 3rd statement.          Sec 2 SD Delete: 1st and 4th statements. Change: 'state' to 'recall' in 3rd and 4th statements. Add: Describe the process of blood clotting, limited to: platelets in contact with damaged blood vessels, causing a series of chemical reactions leading to the formation of a mesh of fibrin fibres (clot).</p>	<p>B5c Running repairs Sec 1, 3</p>

		Sec 2 HD Change: 'describe' to 'explain' in 1st statement. Delete: 2nd and 3rd statements. Add: Recall that unsuccessful blood transfusions cause agglutination (blood clumping). Describe which blood groups (A, B, AB and O) have which agglutinins, limited to (2 clarification points). Explain which blood groups can be used to donate blood to which other blood groups.	
B5d Respiratory systems	Delete: Experiment on respiration of peas. Add: Research one or more industrial respiratory diseases and present the information in a poster or leaflet.	<p>Sec 1 LD Change: 'state' to 'understand why' in 1st statement; to 'understand' in 2nd statement. Amend to: Recognise that larger, more complex animals have special organs for exchange of gases, such as gills and lungs. Add: Understand how surface area affects the exchange of gases.</p> <p>Sec 1 SD Change: 'explain how' to 'recognise that'. Add: 2 clarification points.</p> <p>Sec 1 HD Add: Existing sec 1 SD, with 2 clarification points. Change: 'explain how' to 'explain why'.</p> <p>Sec 2 LD Change: 'identify the main parts' to 'describe the functions of the main parts' in 1st statement; 'understand' to 'explain' in 2nd statement. Add: Describe the direction of exchange of carbon dioxide and oxygen at the lungs and in tissues.</p> <p>Sec 2 SD Change: 'understand the terms' to 'explain the terms'. Delete: 2nd statement. Add: Understand the process of ventilation in terms of changing volume and pressure to include breathing in humans. Explain how gaseous exchange occurs within alveoli by diffusion between air and blood.</p> <p>Sec 2 HD Delete: 1st statement. Add: Explain how gaseous exchange surfaces are adapted for efficient gaseous exchange (clarification given).</p> <p>Sec 3 SD Change: 'understand' to 'recognise'. Add: Clarification points to 2nd statement and clarification to 3rd statement.</p> <p>Sec 3 HD Amend to: Explain why the respiratory system is prone to diseases. Change: 'explain' to 'describe'. Add: Clarification points to 2nd statement. Delete: 3rd statement.</p>	B5d Breath of life
B5e Digestion	Add: Investigate the movement of food molecules across partially permeable membranes.	<p>Existing sec 3 becomes new sec 1.</p> <p>Sec 1 LD Amend: Reword 2nd statement. Add: Describe the position and function of the parts of the human digestive system (6 bullet points). Understand that in chemical digestion the digestive enzymes breakdown large food molecules into smaller ones so they can be absorbed into the blood.</p> <p>Sec 1 SD Amend: Reword 2nd statement with 3 clarification points. Delete: 3rd and 4th statements. Add: Explain the importance of physical digestion (2 clarification points). Recall that stomach acid aids protease function.</p>	B1b What's for lunch? Sec 3

		<p>Sec 1 HD Amend to: Explain how bile, from the gall bladder, improves fat digestion. Add: Explain why the pH in the stomach is maintained at acidic levels, whereas the pH in the mouth and small intestine is alkaline. Understand that breakdown of starch is a two step process involving breakdown of starch into maltose and maltose into glucose.</p> <p>Sec 2 New.</p> <p>Sec 2 LD Add: Recognise that food enters the blood in the small intestine and leaves in body tissues.</p> <p>Sec 2 SD Add: Understand why large molecules need to be broken down into small molecules. Describe how small digested food molecules are absorbed into the blood plasma or lymph in the small intestine by diffusion.</p> <p>Sec 2 HD Add: Explain how the small intestine is adapted for the efficient absorption of food.</p>	
B5f Waste disposal	Delete: Research methods of artificial respiration. Add: Investigate the effect of exercise on rate of breathing.	<p>Sec 1 LD Amend to: Explain the difference between egestion and excretion. Change: 'state' to 'recall' in 3rd statement. Delete: 4th statement. Add: Understand that the amount and concentration of urine produced is affected by water intake, temperature and exercise.</p> <p>Sec 1 SD Change: 'state' to 'understand' in 3rd statement. Amend: Reword 4th statement to include amount and concentration. Delete: 5th statement. Add: Clarification to 1st statement. Understand the importance of maintaining a constant concentration of water molecules in blood plasma.</p> <p>Sec 1 HD Combine: 3rd and 4th statements, adding clarification points. Delete: 5th statement.</p> <p>Sec 2 LD Delete: Existing. Add: 4th statement from existing sec 1. Change: 'state' to 'recall'.</p> <p>Sec 2 SD Delete: Existing. Add: 5th statement from existing sec 1, amending wording.</p> <p>Sec 2 HD Add: 5th statement from existing sec 1, amending wording.</p>	B5e Waste disposal Sec 1
B5g Life goes on		<p>Sec 1 New.</p> <p>Sec 1 LD Add: Describe the function of the scrotum (clarification point). Describe the main stages of the menstrual cycle (3 clarification points).</p> <p>Sec 1 SD Add: Describe the role of hormones in the menstrual cycle (4 clarification points). Recall that FSH and LH are released by the pituitary gland in the brain.</p> <p>Sec 1 HD Add: Explain how negative feedback mechanisms affect hormone production in the menstrual cycle.</p> <p>Sec 2 LD Change: 'state' to 'understand'. Add: Understand the causes of infertility, limited to (3 clarification points). Recognise that in some, but not all, cases pregnancy can be achieved with the help of fertility treatment.</p>	B5f Life goes on

		<p>Sec 2 SD Change: 'describe' to 'explain'. Add: Explain the arguments for and against such infertility treatments.</p> <p>Sec 2 HD Delete: Existing. Add: Evaluate infertility treatments in terms of moral issues, risks and benefits.</p> <p>Sec 3 LD Add: Understand reasons for checking foetal development.</p> <p>Sec 3 SD Amend to: Describe how foetal development can be checked to identify conditions such as Down's syndrome using amniocentesis and chromosomal analysis. Add: Existing sec 3 HD, amending wording.</p> <p>Sec 3 HD Delete: Existing.</p> <p>Sec 4 New.</p> <p>Sec 4 LD Add: 1st statement from existing B1f sec 3, amending wording.</p> <p>Sec 4 SD Add: 2nd statement from existing B1f sec 3, amending wording.</p> <p>Sec 4 HD Add: 2nd statement from existing B1f sec 3, amending wording.</p>	<p>B1f Staying in balance Sec 3 (part)</p>
B5h Growth and repair	Add: Research donor cards and other donor organisations such as Anthony Nolan Trust. Research the history of one organ transplant.	<p>Existing B5h sec 2 becomes new sec 1.</p> <p>Sec 1 LD Change: 'state' to 'recall' in 1st statement; to 'understand' in 2nd statement. Combine: 3rd and 4th statements.</p> <p>Sec 1 SD Amend to: Recall that extremes of height are usually caused by genes or hormone imbalance. Delete 3rd and 4th statements. Add: Recognise that different parts of a foetus and a baby grow at different rates. Understand why a baby's length, mass and head size are regularly monitored during their first months: to provide early warning of growth problems. Understand the use of average growth charts. Amend: Reword 5th statement.</p> <p>Sec 1 HD Delete: 2nd and 3rd statements. Change: 'state' to 'recall' in 1st statement; 'discuss possible problems' to 'describe possible consequences' in 4th statement.</p> <p>Existing B5g sec 1 becomes new sec 2.</p> <p>Sec 2 LD Delete: Existing. Add: Recall that, due to disease or trauma, it is sometimes necessary to replace body parts with biological or mechanical parts. Recall that some mechanical replacements such as the heart and lung machine, kidney dialysis and mechanical ventilators are used outside the body.</p> <p>Sec 2 SD Change: 'state' to 'explain' in 1st statement; 'describe' to 'explain' in 2nd statement. Delete: 3rd statement. Add: 1st statement from existing sec 1 HD.</p> <p>Sec 2 HD Delete: 1st statement.</p> <p>Existing B5g sec 2 becomes new sec 3.</p> <p>Sec 3 LD Change: 'know' to 'understand'.</p> <p>Sec 3 SD Change: 'state' to 'describe'.</p> <p>Sec 3 HD Amend to: Describe the advantages and disadvantages of a register of donors.</p>	<p>B5h Size matters Sec 2</p> <p>B5g New for old Sec 1, 2</p>

## Module 6

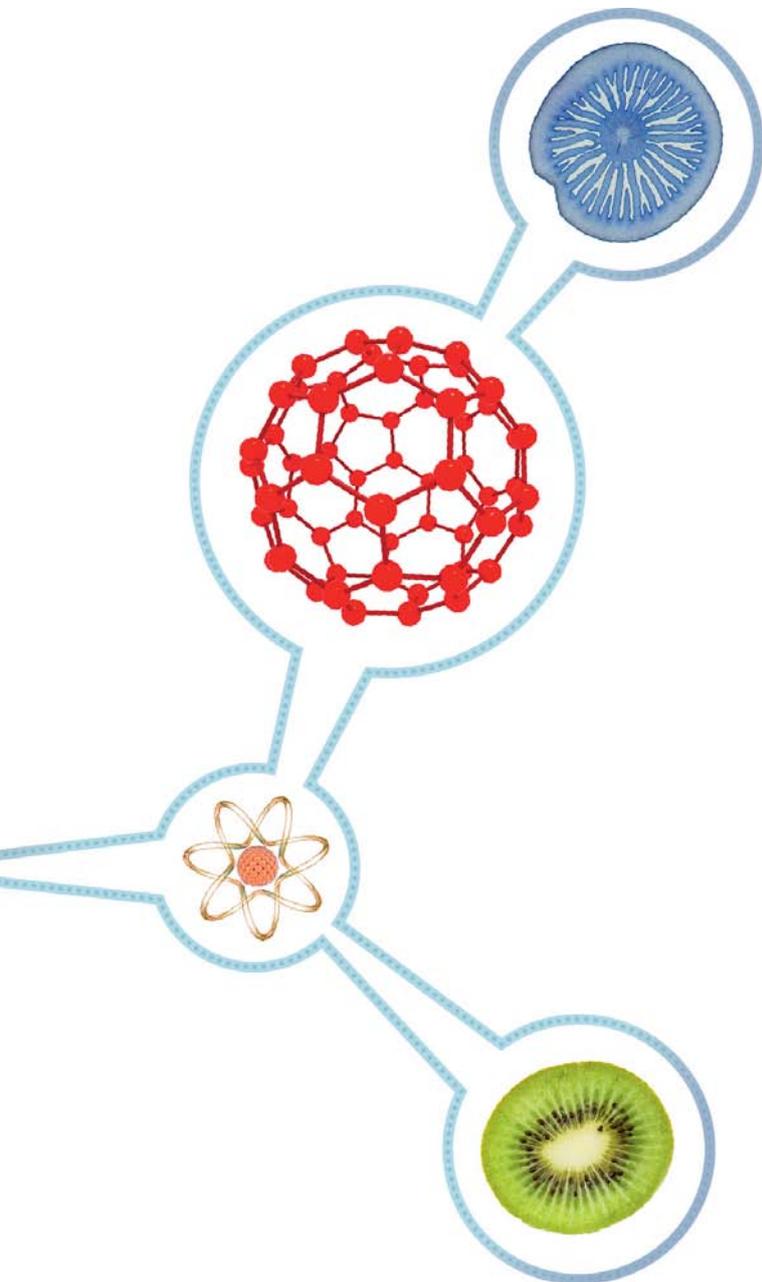
New item	Practical/research activities	Content additions and deletions (sections refer to new items)	Current item
B6a Understanding microbes	Delete: Making yoghurt. Add: Prepare a culture of bacteria using aseptic technique. Make a slide of yeast and stain with methylene blue.	<p>Sec 1 LD Delete: 1st statement. Change: 'know' to 'recall' in 2nd statement; 'be able to label' to 'indentify and label' in 3rd statement; 'state' to 'recognise' in 4th statement. Add: Existing sec 2, changing 'state that' to 'describe how'. Understand that bacteria can reproduce very rapidly in suitable conditions. Recognise that bacteria can be grown in large fermenters.</p> <p>Sec 1 SD Amend to: Describe how the parts of bacterial cells relate to their function, to include (3 clarification points). Delete: 2nd and 3rd statements. Add: Existing sec 2, amending wording and deleting 'and that they can be...' Describe aseptic techniques for culturing bacteria on an agar plate.</p> <p>Sec 1 HD Amend: Reword statement. Add: Existing sec 2. Explain reasons for the safe handling of bacteria.</p> <p>Sec 2 New.</p> <p>Sec 2 LD Add: Recall that yeast is a fungus. Identify and label parts of a yeast cell, to include (4 clarification points). Describe how yeast reproduces asexually by budding.</p> <p>Sec 2 SD Add: Describe how yeast growth rate can be increased, its optimum growth rate being controlled by (4 clarification points).</p> <p>Sec 2 HD Add: Describe how yeast growth rate doubles for every 10°C rise in temperature until the optimum is reached.</p> <p>Sec 3 New.</p> <p>Sec 3 LD Add: Understand that viruses are (2 clarification points).</p> <p>Sec 3 SD Add: Describe the structure of viruses as (2 clarification points). Understand that viruses (3 clarification points).</p> <p>Sec 3 HD Add: Explain how a virus reproduces, to include (4 clarification points).</p>	B6a Understanding bacteria Sec 1, 2
B6b Harmful micro-organisms	Delete: Grow bacteria on agar dishes using appropriate aseptic techniques.	<p>Sec 1 LD Change: 'disease causing organisms' to 'pathogens' in 1st statement. Delete: TB, septic wounds, smallpox, malaria, dysentery caused by protozoa in 2nd statement. Add: Understand that some microorganisms are pathogens.</p> <p>Sec 1 SD Delete: 1st statements. Amend to: Understand how the transmission of diseases can be prevented, limited to (4 clarification points).</p> <p>Sec 1 HD Delete: 1st statement.</p> <p>Sec 2 LD Delete: Existing. Add: Existing sec 2 SD, deleting dysentery and amending wording.</p> <p>Sec 2 SD Delete: Existing. Add: Existing sec 2 HD, changing 'describe' to 'explain why'.</p> <p>Sec 2 HD Delete: Existing.</p>	B6b Harmful micro-organisms

		<p>Sec 3 LD Change: 'recall' to 'recognise'. Add: Understand that bacteria can develop resistance to antibiotics.</p> <p>Sec 3 SD Add: Recall that viruses are unaffected by antibiotics. Explain how some strains of bacteria are developing resistance to antibiotics by natural selection.</p> <p>Sec 3 HD Add: Explain the importance of various procedures in the prevention of antibiotic resistance to include (2 clarification points).</p>	
B6c Useful micro-organisms	Add: Measure and record the pH of milk as it is converted to yoghurt using pH paper/pH meter/ data logger. Consider adverts for 'pro-biotic' yoghurts.	<p>B6a existing sec 3 becomes new sec 1.</p> <p>Sec 1 LD Change: 'state' to 'recall'.</p> <p>Sec 1 HD Delete: Existing. Add: Describe the action of Lactobacillus bacteria in yogurt making, to include (2 clarification points).</p> <p>B6c existing sec 1 becomes new sec 2.</p> <p>Sec 2 LD Amend to: Describe fermentation as the production of alcohol, including wine and beer by the breakdown of sugars by yeast in the absence of oxygen. Add: Recall that a gas, carbon dioxide, is also produced during fermentation.</p> <p>Sec 2 SD Change: 'state' to 'recall and use'. Add: existing sec 4.</p> <p>Sec 2 HD Change: 'state' to 'recall and use'. Add: 2nd and 3rd statements from existing sec 2, amending wording; existing sec 4, changing 'state' to 'describe'.</p> <p>B6c existing sec 5 becomes new sec 3.</p> <p>Sec 3 SD Delete: 1st statement.</p> <p>Sec 3 HD Change: 'recognise that' to 'understand how' in 1st statement; 'state' to 'understand' in 2nd statement.</p>	<p>B6a Understanding bacteria Sec 3</p> <p>B6c Microorganisms – factories for the future</p>
B6d Biofuels		<p>Sec 1 New.</p> <p>Sec 1 LD Add: Explain how plants produce biomass. Recognise examples of fuels from biomass, to include: alcohol; biogas; wood.</p> <p>Sec 1 SD Add: Describe different methods of transferring energy from biomass, to include (2 clarification points). Given data, evaluate different methods of transferring energy from biomass. Describe the advantages of using biofuels, to include (3 clarification points).</p> <p>Sec 1 HD Add: Explain why the burning of biofuels does not cause a net increase in greenhouse gas levels if (2 clarification points). Explain how, in some areas, the use of large areas of land to produce biofuels is resulting in (2 clarification points).</p> <p>Sec 2 LD Amend: Reword 1st and 2nd statements. Add: 1st and 3rd statements from existing sec 1, amending wording.</p> <p>Sec 2 SD Add: 1st statement from existing sec 1.</p> <p>Sec 2 HD Add: 1st statement from existing sec 1, changing 'recognise' to 'recall'. Change: 'recognise' to 'understand'.</p>	<p>B6d Biofuels Sec 1, 2</p>

		<p>Sec 3 LD Amend: Reword statement.</p> <p>Sec 3 SD Delete: Existing. Add: Recall that a mixture of petrol and alcohol: is called gasohol; is used for cars in countries such as Brazil.</p> <p>Sec 3 HD Delete: Existing. Add: Understand why gasohol is more economically viable in countries that have ample sugar cane and small oil reserves.</p>	
B6e Life in soil	Add: Carry out an experiment to show life in soil sample. Compare the composition of different soils.	<p>Sec 1 LD Delete: 2nd and 3rd statements.</p> <p>Sec 1 SD Delete: Existing. Add: Describe the difference between a sandy soil and a clay soil in terms of particle size. Recall that loam is a soil that contains a mixture of clay and sand. Recall that if the dead material in soil is largely decomposed, it is called humus. Describe simple experiments to compare the humus, air and water content of different soils.</p> <p>Sec 1 HD Delete: Existing. Add: Explain how particle size affects the air content and permeability of soils. Explain the results of soil experiments in terms of mineral particle size and organic matter content.</p> <p>Sec 2 New.</p> <p>Sec 2 LD Add: 1st statement from existing sec 1 SD. Describe the role of bacteria and fungi as decomposers.</p> <p>Sec 2 SD Add: Interpret data on soil food webs.</p> <p>Sec 3 New.</p> <p>Sec 3 LD Add: Explain why soil is important for the majority of plants.</p> <p>Sec 3 SD Add: 1st statement from existing sec 1, amending wording. Explain the importance of humus in the soil, limited to (2 clarification points).</p> <p>Sec 3 HD: Add 3rd and 4th statements from existing sec 1. Change: 'describe' to 'explain'.</p> <p>Existing sec 2 becomes new sec 4.</p> <p>Sec 4 LD Add: Recognise that earthworms can improve soil structure and fertility.</p> <p>Sec 4 SD Change: 'describe the importance of' to 'explain why'.</p>	B6e Life in soil Sec 1, 2
B6f Microscopic life in water	Delete: Design an animal.	<p>Sec 1 LD. Delete: 2nd and 3rd statements. Change: 'state' to 'recognise'.</p> <p>Sec 1 SD Change: 'describe' to 'explain' in 1st statement; 'state' to 'explain' in 2nd statement. Delete: 3rd statement.</p> <p>Sec 1 HD Delete: 3rd statement.</p> <p>Sec 2 LD Change: 'state' to 'recognise' in 1st statement. Combine: 2nd, 3rd and 4th statements, splitting into two.</p> <p>Sec 2 SD Delete: Existing. Add: Describe how factors affecting photosynthesis vary at different depths and in different seasons in water, to include: light; temperature; minerals. Interpret data on seasonal fluctuations in phytoplankton and zooplankton.</p>	B6f Microscopic life in water

		<p>Sec 2 HD Delete: 1st statement. Add: Understand that 'grazing food webs' are most common in the oceans but some food chains rely on: 'marine snow'; bacteria, deep in the ocean, acting as producers.</p> <p>Sec 3 LD Delete: Bullet points. Add: 2nd statement from existing sec 1, changing 'state' to 'recall'. Recognise various pollutants of water, to include: oil, sewage, PCBs, fertilisers, pesticides and detergents.</p> <p>Sec 3 SD Change: 'describe' to 'explain' in 1st statement.</p> <p>Sec 3 HD Change: 'understand' to 'explain'.</p>	
B6g Enzymes in action	Amend: Wording to last practical.	<p>Sec 1 LD Amend to: Describe everyday uses of enzymes, limited to (4 clarification points). Amend: Reword 2nd statement.</p> <p>Sec 1 SD Change: 'state' to 'describe'.</p> <p>Sec 1 HD Delete: Existing. Add: Explain why the products of digestion will easily wash out of clothes, in terms of their solubility. Explain why biological washing powders may not work in acidic or alkaline tap water.</p> <p>Sec 2 HD Amend to: Explain how foods are sweetened using invertase (3 clarification points).</p> <p>Sec 3 LD Amend to: Recall how some enzymes can be immobilised (2 clarification points). Change: 'state' to 'recall' in 2nd statement.</p> <p>Sec 3 SD Change: 'describe' to 'explain the'. Add: Describe how enzymes can be immobilised in gel beads by (2 clarification points).</p> <p>Sec 3 HD Delete: 2nd statement. Add: Explain the condition of lactose intolerance (3 clarification points).</p>	B6g Enzymes in action
B6h Gene technology	Delete: Research plant crops and GM crops. Add: Extract DNA from wheat germ. Use gene splicing kits.	<p>Sec 1 LD Delete: 1st and 2nd statements. Amend: Reword 3rd and 4th statements. Add: Describe the process of genetic engineering (3 clarification points).</p> <p>Sec 1 SD Combine: 1st and 2nd statements. Add: 1st statement from existing sec 2.</p> <p>Sec 1 HD Add: 1st statement from existing sec 2, amending wording. Explain why genes from one organism can work in another, making genetic engineering possible.</p> <p>Sec 2 LD Delete: Existing. Add: Recall that bacteria can be genetically engineered to produce useful human proteins, to include: insulin; human growth hormone. Describe how these bacteria can be grown in large fermenters to produce large quantities of proteins.</p> <p>Sec 2 SD Delete: 1st statement.</p> <p>Sec 2 HD Delete: 1st statement. Change: 'state' to 'recall'. Add: Recall that bacteria have loops of DNA called plasmids in their cytoplasm. Explain how, because these plasmids can be taken up by bacteria, they can be used as 'vectors' in genetic engineering.</p> <p>Sec 3 New.</p>	B6h Genetic engineering Sec 1, 2

		<p>Sec 3 LD Add: Recall that a person's DNA can be used to produce a DNA 'fingerprint'. Understand that this can be used to identify a person because a person's DNA is unique.</p> <p>Sec 3 SD Add: Interpret data on DNA 'fingerprinting' for identification. Describe the arguments for and against the storage of DNA 'fingerprints'.</p> <p>Sec 3 HD Add: Describe the stages in the production of a DNA 'fingerprint', to include (4 clarification points).</p>	
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## APPENDIX B

### Detailed changes to Chemistry modules

Details of content additions, deletions and changes.

Sections numbered under content refer to new specification sections.

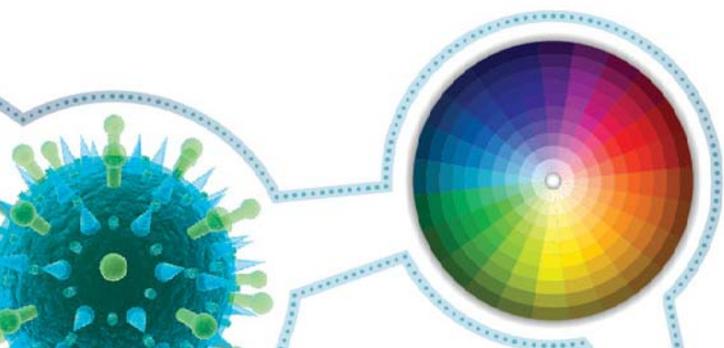
#### Module C1

Old item C1h is now in module C3.

New item	Practical/research activities	Content additions and deletions (sections refer to new items)	Current item
C1 Fundamental chemical concepts		There are numerous changes between the old and the new specifications. Please see the new specification for details.	C1 Fundamental chemical concepts
C1a Making crude oil useful		Sec 1 LD Add: Two clarification points. Sec 1 HD Add: Discuss the problems associated with the finite nature of crude oil (3 bullet points). Sec 2 HD Delete: Existing. Add: Explain in terms of molecular size, intermolecular forces and boiling point why crude oil can be separated by fractional distillation. Understand that during boiling the intermolecular forces between molecules break but covalent bonds within the molecule do not. Sec 3 SD Add: Damage to birds' feathers causing death. Use of detergents to clean up oils slicks and consequent damage to wildlife. Sec 3 HD Add: Clarification points. Sec 4 SD Change: 'because they' to 'that' in 2nd bullet.	C1d Making crude oil useful
C1b Using carbon fuels		Sec 1 LD Add: 2nd statement and bullet points from SD. Sec 1 SD Delete: 1st statement. Add: Suggest the key factors that need to be considered when choosing a fuel for a particular purpose. Sec 1 HD Delete: Bullet points. Add: Explain why the amount of fossil fuels being burnt is increasing (2 bullets). Sec 2 LD Change: 'state' to 'understand why' in 2nd statement; 'state' to 'recall' in 1st and 3rd statements. Add: Construct word equations to show the complete combustion of a hydrocarbon fuel given the reactants/products. Sec 2 SD Delete: 1st statement. Add: Construct word equations to show the complete combustion of a hydrocarbon fuel (not all reactants/products given). Sec 3 LD Change: 'state' to 'understand why' in 1st statement; 'describe' to 'explain why' in relation to blue Bunsen flame in 2nd statement; 'know' to 'recall' in 3rd statement.	C1g Using carbon fuels

C1c Clean air	Add: Research main processes in carbon cycle. Produce timeline for evolution of atmosphere.	<p>Sec 1 LD Change: 'recognise' to 'understand' in 2nd statement; 'recognise' to 'understand how photosynthesis...' in 3rd statement. Swap: 2nd and 3rd statements.</p> <p>Sec 1HD Amend: Reworded.</p> <p>Sec 2 LD Add: Clarification.</p> <p>Sec 2 HD Add: Explain why the high temperature inside an internal combustion engine allows nitrogen from the air to react with oxygen to make oxides of nitrogen.</p> <p>Sec 3 LD Change: 'state' to 'recall'.</p> <p>Sec 3 SD Change: 'state' to 'understand'.</p> <p>Sec 3 HD Change: 'describe' to 'explain how use of a catalytic converter removes carbon monoxide from exhaust fumes using the balanced symbol equation'</p>	C2f Clean air
C1d Making polymers	Add: Demo making poly(phenylethene) (RSC website). PVA polymer slime (RSC website).	<p>Existing sec 3 becomes new sec 1.</p> <p>Sec 1 LD Change: 'state' to 'recall'.</p> <p>Sec 1 SD Change: 'describe' to 'recall that' in 1st statement. Amend: Reword 2nd statement.</p> <p>Existing sec 4 becomes new sec 2.</p> <p>Sec 2 LD Delete: Bullet points.</p> <p>Sec 2 SD Change: 'describe alkanes as' to 'recall that alkanes are'.</p> <p>Existing sec 5 becomes new sec 3.</p> <p>Sec 3 LD Delete: Bullet points.</p> <p>Sec 3 SD Change: 'describe alkanes as' to 'recall that alkanes are'. Add: Understand that double bonds involve two shared pairs of electrons. Describe how the reaction with bromine can be used to test for an alkene (2 clarification points).</p> <p>Sec 3 HD Delete: 2nd statement. Add: Explain the reaction between bromine and alkenes (2 clarification points).</p> <p>Existing sec 1 becomes new sec 4.</p> <p>Sec 4 LD: Change: 'state' to 'deduce'.</p> <p>Sec 4 HD Change: 'construct' to 'describe'.</p> <p>Existing sec 2 becomes new sec 5.</p> <p>Sec 5 LD: Delete: 2nd statement. Combine: 1st, 3rd and 4th statements.</p> <p>Sec 5 SD: Amend: Reword to include 'addition polymerisation' and 'alkene monomer molecules'.</p> <p>Sec 5 HD: Amend to: Explain addition polymerisation in terms of addition of unsaturated molecules.</p>	C1e Making polymers
C1e Designer polymers	Delete: Dorothy Warren books. Add: Research local councils waste disposal.	<p>Sec 2 LD Delete: Existing. Add: Recall that nylon is used in clothing.</p> <p>Sec 2 HD Change: 'describe' to 'explain why'.</p> <p>Sec 3 LD Amend to: Understand that many polymers are non-biodegradable and so... Delete: 3rd statement.</p> <p>Sec 3 SD Add: 2 clarification points to 1st statement. Change: 2nd statement to 'Explain environmental and economic issues related to the use and disposal of polymers'. Delete: Bullet points.</p>	C1f Designer polymers

<p>C1f Cooking and food additives</p>	<p>Delete: Sec 1. Add: New sec 2 (RSC material). Food additives research. Food labelling research. Discussion on using food additives. Investigating emulsifiers. Testing for action as emulsifiers.</p>	<p>C1a existing sec 2 becomes new sec 1. Sec 1 LD Delete: 2nd, 3rd and 4th statements. Add: Explain why cooking food is a chemical change (2 clarification points) Sec 1 SD Delete: 1st, 2nd and 4th statements. Add: this is called denaturing (to statement). Sec 1 HD Delete: 1st statement. Add: Explain why the texture of egg or meat changes when it is cooked: shape of protein molecules permanently changes. Amend: Reword 2nd statement. C1b existing sec 4 becomes new sec 2. Sec 2 LD Delete: Existing. Add: 1st statement from existing C1b sec 2, amending wording. Sec 2 SD Delete: 2nd statement. Sec 2 HD Change: 'explain how' to 'explain why'. C1a existing sec 3 becomes new sec 3. Sec 3 LD Delete: 1st and 2nd statements. Amend to: Explain how baking powder helps make cakes rise. Recall that the chemical test for carbon dioxide is that it turns lime water cloudy. Sec 3 SD Delete: 1st, 2nd and 4th statements. Amend to: Recall the word equation for the decomposition of sodium hydrogencarbonate (not all products given). Add: Existing sec 3 HD, changing 'write' to 'construct' and adding, 'some or all formulae given'. Sec 3 HD Change: 'write' to 'construct'. Add: formulae not given (to end of statement).</p>	<p>C1a Cooking Sec 2, 3</p> <p>C1b Food additives Sec 2, 4</p>
<p>C1g Smells</p>		<p>Sec 1 LD Combine: 1st, 2nd and 3rd statements. Sec 1 SD Delete: 3rd statement. Sec 2 LD Delete: 1st and 2nd statements. Change: To 'Recall the necessary physical properties of perfumes'. Sec 2 HD Amend: Clarification points. Sec 3 LD Combine: 2nd, 3rd and 4th statements to Understand the terms solvent, solute, solution, soluble and insoluble. Sec 4 LD Amend to: Recall that testing of cosmetics on animals is banned in the EU. Delete: 2nd statement. Add: 1st statement from SD. Sec 4 SD Delete: Existing. Add: Explain why testing of cosmetics on animals has been banned in the EU. Sec 4 HD Add: Explain why people have different opinions about whether the testing of cosmetic products on animals is ever justified.</p>	<p>C1c Smells</p>



C1h Paints and pigments	Delete: Reference to Active Science. Historical survey of dyeing fabrics. Add: Make simple paint. Demo objects containing thermochromic pigments.	Sec 1 LD Delete: 1st and 2nd statements. Change: 'describe' to 'recall'. Add: Relate the ingredients of paint to their function (solvent, binding medium, pigment). Sec 2 LD Delete: Existing. Add: Explain why paint is used (in a given context). Sec 2 SD Amend: To Describe how most paints dry (2 clarification points). Sec 2 HD Amend: To Explain how oil paints dry (2 clarification points). Sec 3 Delete: Existing (on dyeing). Sec 3 LD Add: Recall uses of thermochromic pigments. Sec 3 SD Delete: Existing. Add: Explain why thermochromic pigments are suited to a given use. Sec 3 HD Delete: Existing. Add: Explain how acrylic paints can be added to thermochromic pigments to make even more colour changes. Sec 4 SD Change: To 'Explain why...' Sec 4 HD Change: To 'Recall that ...'	C2a Paints and pigments Sec 1, 2, 4
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**Module C2**

Old item C2a and C2f are now in module C1.

Old item C2g and C2h are now in module C3.

New item	Practical/research activities	Content additions and deletions (sections refer to new items)	Current item
C2 Fundamental chemical concepts		There are numerous changes between the old and the new specifications. Please see the new specification for details.	C2 Fundamental chemical concepts
C2a The structure of the Earth	Delete: Salol experiment. Website references. Add: 'Wegener and continental drift' from the Collins Ideas and Evidence CD.	Sec 1 LD Combine: 1st and 2nd statements. Change: 'state that' to 'understand how' in 3rd statement. Add: Recall that the movement of tectonic plates is very slow (about 2.5cm per year). Understand the timescales involved in the movement of continents. Recognise that: many theories have been put forward to explain the nature of the Earth's surface; Earth scientists accept theory of plate tectonics. Sec 1 SD Delete: 1st statement. Combine 2nd and 3rd statements. Add: Two clarification points to 4th statement. Explain why the theory of plate tectonics is now widely accepted (2 clarification points). Sec 1 HD Amend: 1st statement with 2 clarification points. Add: plates cooler at ocean margins so sink and pull plates down (to 2nd statement). 4 clarification points to 3rd statement. Sec 2 LD Delete: 1st statement. Add: Explain how the size of crystals in an igneous rock is related to the rate of cooling of molten rock. Sec 2 SD Delete: Existing. Add: Understand that the type of volcanic eruption depends on the composition of the magma.	C2c Does the Earth move? Sec 1, 3, 4

		<p>Sec 2 HD Amend to: Describe different types of igneous rocks that are formed from lava (2 clarification points).</p> <p>Sec 3 LD Amend to: Explain why some people choose to live near volcanoes.</p> <p>Sec 3 SD Amend to: Explain why geologists study volcanoes (2 clarification points).</p> <p>Sec 3 HD Change: 'describe that' to 'explain why'.</p>	
C2b Construction materials	Add: Making a sample of concrete.	<p>Sec 1 LD Delete: Existing. Add: 1st statement from existing sec 2.</p> <p>Sec 1 SD Amend: Reword statement.</p> <p>Sec 2 LD Delete: 2nd bullet point. Change: 'describe' to 'explain why'.</p> <p>Sec 2 SD Delete: Existing. Add: Compare the hardness of limestone, marble and granite.</p> <p>Sec 3 SD Add: Construct word equation for decomposition of limestone (products not given). Construct the balanced symbol equation for decomposition of limestone (some formulae given).</p> <p>Sec 3 HD Amend to: Construct the balanced symbol equation for decomposition of limestone (formulae not given).</p> <p>Sec 5 LD Amend to: Describe how concrete can be reinforced using a steel support.</p>	C2b Construction materials
C2c Metals and alloys	Add: Modelling alloys with plasticine (RSC website). Making solder and comparing properties with lead and tin (RSC website).	<p>Sec 1 LD Change: 'State that' to 'Understand how' in 1st statement; 'state' to 'recall' in 2nd statement. Add: Describe reduction as the removal of oxygen from a substance. Amend: 3rd statement to 'Explain why recycling copper...' (2 bullet points).</p> <p>Sec 1 SD Amend to: Explain some of the advantages and disadvantages of recycling copper.</p> <p>Sec 1 HD Add: 2 bullets to 1st statement. Explain why the electrolytic purification of copper involves both oxidation and reduction: <math>\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}</math> as an example of reduction because electrons are gained; <math>\text{Cu} - 2\text{e}^- \rightarrow \text{Cu}^{2+}</math> as an example of oxidation because electrons are lost.</p> <p>Sec 2 LD Amend: 1st statement to 'Recall alloys are mixtures containing one or more metal elements.' Change: 'state' to 'recall' in 3rd statement. Add: Clarification to bullet points in 3rd statement.</p> <p>Sec 3 LD Add: 2nd statement from existing SD.</p> <p>Sec 3 SD Delete: Existing. Add: 1st statement from existing HD.</p> <p>Sec 3 HD Delete: 1st statement. Add: Evaluate the suitability of metals for a given use given appropriate data. Amend: 2nd statement to include bullet about nitinol for spectacles.</p>	C2d Metals and alloys

C2d Making cars		<p>Sec 1 LD Change: 'state' to 'recall' in 1st and statements. Add: Describe oxidation as the addition of oxygen or the reaction of a substance with oxygen.</p> <p>Sec 1 SD Change: 'state/accelerate' to 'understand/affect' in 1st statement. Add: Understand that rusting is an oxidation reaction (iron reacts with oxygen forming an oxide). Construct word equation for rusting.</p> <p>Amend: 4th statement to 'Explain why aluminium does not corrode in moist conditions.'</p> <p>Sec 1 HD Delete: Existing.</p> <p>Sec 2 LD Amend to: 'Compare the properties of iron and aluminium'. Delete: 2nd statement.</p> <p>Sec 2 SD Change: 'Describe' to 'Understand' in 1st statement.</p> <p>Sec 3 LD Change: 'List' to 'Recall'.</p> <p>Sec 4 SD Change: 'Explain that' to 'Explain why' in 2nd statement.</p>	C2e Cars for scrap
C2e Chemicals from the air: making ammonia	Add: Haber process e.g. Multimedia Science School 11-16 or Boardworks. Watch video of Haber process with pre-prepared questions.	<p>Sec 1 LD Combine: All statements.</p> <p>Sec 1 SD Add: Construct the balanced symbol equation for the manufacture of ammonia in the Haber process (given some or all of the formulae).</p> <p>Sec 1 HD Amend to: Construct the balanced symbol equation for the manufacture of ammonia in the Haber process (formulae not given).</p> <p>Sec 3 LD Change: 'State' to 'Understand'.</p> <p>Sec 4 LD Change: 'Describe' to 'Recall'.</p>	C4d Making ammonia – Haber process and costs
C2f Acids and bases	Delete: Research uses of sulfuric acid. Add: Test everyday household substances.	<p>Sec 1 LD Delete: Existing. Add: Describe how universal indicator can be used to estimate the pH of a solution. Recall the colour changes with litmus.</p> <p>Sec 1 SD Amend to: Understand that indicators use colour change to show changes in pH (2 clarification points).</p> <p>Sec 2 LD Delete: Existing. Add: Recall that an alkali is a soluble base.</p> <p>Sec 2 SD Delete: 1st and 3rd statements. Change: 'State' to 'Recall' in 2nd statement. Add: Recall that in solution all acids contain H<sup>+</sup> ions. Understand that the pH of an acid is determined by the concentration of H<sup>+</sup> ions.</p> <p>Sec 2 HD Delete: Existing. Add: Explain why an acid is neutralised by an alkali in terms of the ions present: acids contain H<sup>+</sup>; alkalis contain OH<sup>-</sup>; neutralisation involves the reaction (equation given).</p> <p>Sec 3 LD Change: 'state' to 'understand'.</p> <p>Sec 3 SD Amend: 1st statement to 'Explain why metal oxides and metal hydroxides neutralise acids'. Add: Construct word equations to show neutralisation of acids by bases and carbonates (names of the products not given). To 4th statement, add 'phosphoric acid' as last clarification point.</p> <p>Sec 3 HD Delete: 1st statement.</p> <p>Sec 4 LD Delete.</p>	C4a Acids and bases

C2g Fertilisers and crop yield	Add: Research processes involved in eutrophication. Eutrophication animation or case study.	<p>Sec 1 LD Amend: 1st statement to 'Recall that fertilisers increase crop yield'. Change: 'state' to 'recall' in 2nd statement. Add: 1st, 2nd and 4th statements from existing sec 2. Understand that the use of fertilisers can be beneficial (increasing food supply) and also cause problems eg death of aquatic organisms (eutrophication).</p> <p>Sec 1 SD Change: 'Explain that' to 'Explain why'. Delete: 2nd statement. Add: Identify arguments for and against the use of fertilisers (2 clarification points).</p> <p>Sec 1 HD Change: 'Describe' to 'Explain' in 2nd statement.</p> <p>Existing sec 3 becomes new sec 2.</p> <p>Sec 2 LD Change: 'label' to 'identify' in 1st statement; 'state' to 'recall' in 2nd statement.</p> <p>Sec 2 SD Change: 'state' to 'predict'. Delete: 2nd, 3rd and 4th bullets.</p>	C4c Fertilisers and crop yield
C2h Chemicals from the sea: the chemistry of sodium chloride		<p>Sec 1 LD Delete: Existing. Add: Recall that sodium chloride (salt) can be obtained from the sea or from salt deposits.</p> <p>Sec 1 SD Change: 'Explain that' to 'Explain how' in 2nd statement.</p> <p>Sec 2 LD Change: 'State' to 'Recall' in 1st statement; 'Describe' to 'Recall' in 2nd statement. .</p> <p>Sec 2 SD Change: 'Describe' to 'Recall'. Delete: 4th bullet. Add: Explain why it is important to use inert electrodes in the electrolysis of sodium chloride solution.</p> <p>Sec 2 HD Delete: 2nd statement. Add: Explain why the electrolysis of sodium chloride involves both reduction and oxidation.</p> <p>Existing sec 4 becomes new sec 3.</p> <p>Sec 3 LD Add: Recall that sodium chloride is used: as a preservative; as a flavouring. Amend: 1st statement to 'Understand that sodium chloride is an important raw material in the chemical industry, including use as a source of chlorine and sodium hydroxide. Change: 'State' to 'Recall' in 2nd – 5th statements.</p> <p>Sec 3 SD Amend to: Describe how sodium hydroxide and chlorine are used to make household bleach.</p> <p>Sec 3 HD Add: Explain the economic importance of the chlor-alkali industry.</p>	C6d Chemistry of sodium chloride Sec 1, 2, 4



## Module C3

New item	Practical/research activities	Content additions and deletions (sections refer to new items)	Current item
C3 Fundamental chemical concepts		There are numerous changes between the old and the new specifications. Please see the new specification for details.	C3 Fundamental chemical concepts
C3a Rate of reaction (1)	Add: Investigate rate of reaction between magnesium ribbon and hydrochloric acid. Sodium thiosulfate and hydrochloric acid measuring reaction time. Other practicals include use of gas syringe and using mass loss.	<p>Sec 1 SD Add: Understand that the rate of a reaction measures how much product is formed in a fixed period of time. Understand common units for the rate of reaction (2 clarification points). Existing sec 5 becomes new sec 2.</p> <p>Sec 2 LD Delete: 2nd and 3rd statements. Add: Label the laboratory apparatus needed to measure rate of reaction producing a gas: gas syringe; flask. Plot experimental results involving gas volumes or mass loss on a graph. Plot experimental results involving reaction times on a graph. Amend to: Interpret data in tabular, graphical and written form about the rate of reaction or reaction time for example (3 bullets).</p> <p>Sec 2 SD Delete: 2nd and 3rd statements. Amend to: Interpret data in tabular, graphical and written form about the rate of reaction or reaction time for example (1 bullet).</p> <p>Sec 2 HD Amend to: Interpret data in tabular, graphical and written form about the rate of reaction or reaction time for example (3 bullets).</p> <p>Sec 3 LD Add: Explain why a reaction stops.</p> <p>Sec 3 SD Add: Recognise and use the idea that the amount of product formed is directly proportional to the amount of limiting reactant used. Recall that the limiting reactant is the reactant not in excess that is all used up at the end of the reaction.</p> <p>Sec 3 HD: Explain, in terms of reacting particles, why the amount of product formed is directly proportional to the amount of limiting reactant used.</p>	C2g Faster or slower (1) Sec 1, 5
C3b Rate of reaction (2)	As C2g.	<p>Existing sec 2 becomes new sec 1.</p> <p>Sec 1 SD Amend to: Understand that the rate of reaction depends on the number of collisions between reacting particles.</p> <p>Sec 1 HD Change: 'Explain' to 'Understand'.</p> <p>Sec 2 LD Amend to: Describe the effect of changing temperature on the rate of chemical reaction.</p> <p>Existing sec 3 becomes new sec 2.</p> <p>Sec 2 SD Amend to: Explain, in terms of the reacting particle model, why changes in temperature change the rate of reaction.</p> <p>Sec 2 HD Amend to: Explain, using the reacting particle model, why changes in temperature change the rate of reaction in terms of successful collisions between particles.</p>	C2g Faster or slower (1) Sec 2, 3, 4, 5

		<p>Existing sec 4 becomes new sec 3, 4.</p> <p>Sec 3 LD Amend to: same phrasing as sec 2, but with 'concentration'.</p> <p>Sec 3 SD Amend to: same phrasing as sec 2, but with 'concentration'.</p> <p>Sec 3 HD Amend to: same phrasing as sec 2, but with 'concentration'.</p> <p>Sec 4 LD Amend to: same phrasing as sec 2, but with 'pressure'.</p> <p>Sec 4 SD Amend to: same phrasing as sec 2, but with 'pressure'.</p> <p>Sec 4 HD Amend to: same phrasing as sec 2, but with 'pressure'.</p> <p>Existing sec 5 becomes new sec 5.</p> <p>Sec 5 LD Delete: 2nd and 3rd statements.</p> <p>Sec 5 SD Delete: 2nd and 3rd statements.</p>	
C3c Rate of reaction (3)	As C2h.	<p>Sec 1 LD change: 'state' to 'recall'.</p> <p>Sec 1 SD change: 'state that' to 'understand why' in 2nd statement.</p> <p>Sec 2 SD Amend to: Explain, in terms of reacting particles and surface area, the differences in rate of reaction between a lump and powdered reactant.</p> <p>Sec 2 HD Amend to: Explain, in terms of collisions between reacting particles, the difference in rate of reaction between a lump and powdered reactant.</p> <p>Sec 3 LD Delete: Existing. Add: Describe an explosion as a very fast reaction which releases a large volume of gaseous products.</p> <p>Sec 4 LD Change: 'recognising' to 'comparing' in bullets.</p> <p>Sec 4 SD Delete: 3rd bullet in 1st statement.</p> <p>Sec 4 HD Amend: Reword statement.</p>	C2h Faster or slower (2)
C3d Reacting masses	Add: Class experiment to confirm the principle of conservation of mass using precipitation reactions.	<p>Sec 1 LD Delete: 1st statement.</p> <p>Sec 2 LD Amend: 1st and 2nd statements to Understand that the total mass of reactants at the start of a reaction is equal to the total mass of the products made and that this is called the principle of conservation of mass. Add: Use the principle of conservation of mass to calculate mass of reactant or product for example (2 bullet points).</p> <p>Sec 2 SD Delete: Existing. Add: Use provided relative formula masses and a symbol equation (1:1 Molar ratio) to show that mass is conserved during a reaction. Explain why mass is conserved.</p> <p>Sec 2 HD Delete: Existing. Add: Use relative formula masses and a provided symbol equation to show that mass is conserved during a reaction.</p> <p>Sec 3 New.</p> <p>Sec 3 LD Add: Use simple ratios to calculate reacting masses and product masses given the mass of a reactant and a product.</p>	C4b Reacting masses Sec 1, 2

		<p>Sec 3 SD Add: Recognise and use the idea that the mass of product formed is directly proportional to the mass of the limiting reactant used.</p> <p>Sec 3 HD Add: Interpret chemical equations quantitatively. Calculate masses of products or reactants from balanced symbol equations using relative formula masses.</p>	
C3e Percentage yield and atom economy	Add: Class practical preparation of magnesium sulfate from a variety of starting materials – comparison of percentage yield and atom economy.	<p>Existing sec 3 becomes new sec 1.</p> <p>Sec 1 LD Change: 'describe' to 'understand'. Delete: 4th bullet point in 2nd statement. Add: Not all reactants react to make product.</p> <p>Sec 1 SD Change: 'state the formula' to 'recall and use formula'.</p> <p>Sec 1 HD Add: Explain why an industrial process wants as high a percentage yield as possible to include: reducing the reactants wasted; reducing costs.</p> <p>Sec 2 New.</p> <p>Sec 2 LD Add: Understand atom economy as a way of measuring the amount of atoms that are wasted when manufacturing a chemical (2 clarification points).</p> <p>Sec 2 SD Add: Recall and use formula for calculating atom economy (formula given). Calculate atom economy when given balanced symbol equation (1:1 molar ratio) and appropriate relative formula masses.</p> <p>Sec 2 HD Add: Calculate atom economy given balanced symbol equation and appropriate relative formula masses. Explain why an industrial process wants as high an atom economy as possible (2 clarification points).</p> <p>Sec 3 New.</p> <p>Sec 3 LD Add: Interpretation of simple percentage yield and atom economy data.</p> <p>Sec 3 SD Add: Interpretation of complex percentage yield and atom economy data.</p>	C4b Reacting masses Sec 3
C3f Energy	As C1h.	<p>Sec 1 LD: Delete: Existing. Add: Existing SD, changing 'describe' to recall'.</p> <p>Sec 1 SD Delete: Existing. Add: Recall bond making as an exothermic process and bond breaking as an endothermic process.</p> <p>Sec 1 HD Delete: 1st and 2nd statements.</p> <p>Sec 2 LD Delete: Existing. Add: Existing SD.</p> <p>Sec 2 SD Delete: Existing. Add: 1st and 2nd statements from existing HD, with change to formula – no recall needed.</p> <p>Sec 2 HD Amend to: Use the formula (energy transferred).</p>	C1h Energy

C3g Batch or continuous?	As C4f.	<p>Sec 1 LD Delete: Existing. Add: Describe the differences between a batch and a continuous process.</p> <p>Sec 1 SD Delete: Existing. Add: Explain why batch processes are often used for the production of pharmaceutical drugs but continuous processes are used to produce chemicals such as ammonia.</p> <p>Sec 2 LD Change: 'state' to 'list'.</p> <p>Sec 2 SD Delete: Existing. Add: Explain why it is often expensive to make and develop new pharmaceutical drugs.</p> <p>Sec 2 HD Delete: Existing. Add: Explain why it is difficult to test and develop new pharmaceutical drugs that are safe to use.</p> <p>Sec 4 New.</p> <p>Sec 4 LD Add: Explain why it is important to manufacture pharmaceutical drugs to be as pure as possible. Describe how melting point, boiling point and thin layer chromatography can be used to establish the purity of a compound.</p> <p>Sec 4 SD Add: Interpret melting point, boiling point and chromatographic data relating to the purity of a substance.</p>	C4f Batch or continuous?
C3h Allotropes of carbon and nano-chemistry	Add: Examine samples of graphite.	<p>Sec 1 New/ Sec 1 LD Add: Explain why diamond, graphite and Buckminster fullerene are forms of carbon. Recognise the structures of diamond, graphite and Buckminster fullerene.</p> <p>Sec 1 SD Add: Explain why diamond, graphite and fullerenes are allotropes of carbon.</p> <p>Sec 2 LD Change: 'describe' to 'list'. Delete: 2nd statement.</p> <p>Sec 2 SD Delete: Existing. Add: Explain, in terms of properties, why diamond is used in cutting tools and jewellery.</p> <p>Sec 2 HD Amend to: Explain, in terms of structure and bonding, why diamond (2 bullet points).</p> <p>Sec 3 LD Change: 'describe' to 'list'.</p> <p>Sec 3 SD Delete: Existing. Add: Explain, in terms of properties, why graphite is used: in pencil leads; in lubricants.</p> <p>Sec 3 HD Amend to: Explain, in terms of structure and bonding, why graphite (3 bullet points, observation without explanation).</p> <p>Sec 4 Delete: Existing.</p> <p>Sec 4 SD Add: Explain why diamond and graphite have a giant molecular structure.</p> <p>Sec 4 HD Add: Predict and explain the properties of substances that have a giant molecular structure.</p> <p>Sec 5 Delete: Existing.</p> <p>Sec 5 LD Add: Recall that nanotubes are used to reinforce graphite in tennis rackets because nanotubes are very strong. Recall that nanotubes are used as semiconductors in electrical circuits.</p>	C4g Nano-chemistry Sec 1, 2, 3

		<p>Sec 5 SD Add: Explain why fullerenes can be used in new drug delivery systems.</p> <p>Sec 5 HD Add: Explain how the structure of nanotubes enables them to be used as catalysts.</p>	
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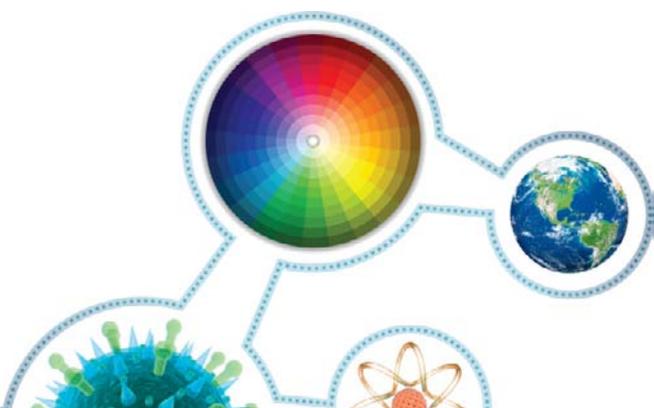
**Module C4**

New item	Practical/research activities	Content additions and deletions (sections refer to new items)	Current item
C4 Fundamental chemical concepts		There are numerous changes between the old and the new specifications. Please see the new specification for details.	C4 Fundamental chemical concepts
C4a Atomic structure	Add: Research or produce a poster of the work of Dalton, JJ Thomson, Rutherford and/or Bohr. Produce a timeline of events for the development of the theory of atomic structure.	<p>Sec 1 LD: Change: 'describe' to 'recall' in 1st statement; 'state' to 'recall' in 2nd statement. Add: Understand that atoms have a very small mass and very small size.</p> <p>Sec 1 SD Change: 'state' to 'recall' in 1st and 2nd statements.</p> <p>Sec 1 HD Amend to: Explain why an atom is neutral in terms of its subatomic particles. Add: Understand that atoms have a radius of about 10<sup>-10</sup>m and a mass of about 10<sup>-23</sup>g.</p> <p>Sec 2 LD Combine: 1st and 2nd statements. Add: 1st and 2nd statements from existing SD, changing 'describe' to 'recall'.</p> <p>Sec 2 SD: Delete: 1st and 2nd statements. Add: Deduce the number of protons, electrons and neutrons in a particle given its atomic number and mass number (2 clarification points).</p> <p>Sec 3 LD Delete: Existing. Add: Explain why a substance is an element or a compound given its formula.</p> <p>Sec 3 SD: Delete: Existing. Add: Describe the arrangement of elements in the periodic table.</p> <p>Sec 4 LD: Add: Deduce the number of occupied shells or the number of electrons from the electronic structure of an element.</p> <p>Sec 4 SD Delete: Existing. Add: Explain how the identity of an element can be deduced from its electronic structure.</p> <p>Sec 5 New.</p> <p>Sec 5 LD Add: Describe the main stages in the development of atomic structure illustrating the provisional nature of evidence (4 clarification points).</p> <p>Sec 5 SD Add: Describe Dalton's atomic theory and how the work of J.J. Thomson, Rutherford and Bohr contributed to the development of the theory of atomic structure (2 clarification points).</p> <p>Sec 5 HD Add: Explain the significance of the work of Dalton, J.J. Thomson, Rutherford and Bohr in the development of the theory of atomic structure (1 clarification point).</p>	C3a What are atoms like?

<p>C4b Ionic bonding</p>		<p>Sec 1 LD Change: 'state' to 'recall'.          Sec 1 SD Delete: 1st and 2nd statements. Amend: Rework 3rd statement, changing 'explain' to 'understand'. Add: Understand that atoms with an outer shell of 8 electrons have a stable electronic structure. Explain how and why metal atoms form positive ions and non-metal atoms form negative ions. Deduce the formula of an ionic compound from the formula of the positive and negative ions.          Sec 1 HD Delete: Existing. Add: Explain, using the dot and cross model, the ionic bonding in simple binary compounds.          Sec 2 LD Delete: Existing. Add: Compare the electrical conductivity of sodium chloride in solid, molten liquid and solution. Compare the melting points of sodium chloride and magnesium oxide.          Sec 2 SD Change: 'state' to 'recall'. Add: Describe the structure of sodium chloride or magnesium oxide as a giant ionic lattice in which positive ions are strongly attracted to negative ions.          Sec 2 HD Delete: Existing. Add: Explain, in terms of structure and bonding, some of the physical properties of sodium chloride (2 clarification points). Explain, in terms of structure and bonding, why the melting point of sodium chloride is lower than that of magnesium oxide. Predict and explain the properties of substances that have a giant ionic structure.</p>	<p>C3b How atoms combine – ionic bonding</p>
<p>C4c The Periodic Table and covalent bonding</p>	<p>Add: Research or produce a poster of the work of Dobereiner, Newlands and/or Mendeleev. Produce a timeline of events for the development of the periodic table and its later confirmation.</p>	<p>Sec 1 LD Delete: 1st, 2nd and 3rd statements. Change: 'state' to 'recall'.          Sec 1 SD Change: 'state' to 'recall'.          Sec 1 HD Delete: Existing. Add: Explain, using the dot and cross model, the covalent bonding in simple binary compounds or molecules containing single and double covalent bonds.          Sec 2 Delete: Existing.          Sec 2 LD Add: Recall that carbon dioxide and water do not conduct electricity.          Sec 2 SD Add: 1st statement from existing HD.          Sec 2 HD Add: Explain, in terms of structure and bonding, some of the physical properties of carbon dioxide and water (2 clarification points). Predict and explain the properties of substances that have a simple molecular structure.          Sec 3 SD Delete: Bullet points. Add: Existing HD.          Sec 4 LD Change: 'recognise' to 'deduce'.          Sec 4 SD Add: Existing HD.          Sec 5 New.          Sec 5 LD Add: Describe the main stages in the development of the classification of elements: Dobereiner; Newlands; Mendeleev. Understand that classification of elements was provisional, based on evidence gathered at the time.</p>	<p>C3c Covalent bonding</p>

		<p>Sec 5 SD Add: Describe the evidence or observations that caused Newlands and Mendeleev to develop new models of periodic classification of elements.</p> <p>Sec 5 HD Add: Explain how further evidence confirmed Mendeleev's ideas about the periodic table (2 clarification points).</p>	
C4d The Group 1 elements		<p>Sec 1 LD Change: 'state' to 'explain why' in 1st statement. Delete: All other statements. Add: Explain why Group 1 elements are stored under oil. 1st statement from existing SD. Construct the word equation for the reaction of a Group 1 element with water.</p> <p>Sec 1 SD Delete: Existing. Add: Predict the properties of Group 1 elements rubidium and/or caesium with water. Construct the balanced symbol equation for the reaction of a Group 1 element with water (given all of some formulae).</p> <p>Sec 1 HD Delete: Existing. Add: Construct the balanced symbol equation for the reaction of a Group 1 element with water (formulae not given). Predict the physical properties of rubidium and/or caesium given information about other Group 1 elements.</p> <p>Sec 2 LD Add: Recognise sodium, lithium and potassium as Group 1 elements.</p> <p>Sec 2 SD Delete: 1st statement. Amend to: Explain why Group 1 elements have similar properties.</p> <p>Sec 2 HD Amend to: Explain why Group 1 elements have similar properties, in terms of forming positive ions with stable electronic structures. Change: 'Write an equation' to 'Construct a balanced symbol equation' in 2nd statement; 'describe' to 'recall' in 4th statement. Delete: 3rd statement. Add: Explain, in terms of electron loss, the trend in reactivity of the Group 1 elements with water.</p> <p>Sec 3 LD Change: 'state' to 'recall'.</p> <p>Sec 3 SD Change: 'carry out' to 'use'. Add: 4th clarification point – colours of the flames.</p>	C3d The Group 1 elements
C4e The Group 7 elements	See RSC website. Good opportunity for predicting/ hypothesising.	<p>Sec 1 LD Change: 'state' to 'recall' in 1st statement; 'halogens' to 'Group 7 elements' in 2nd statement. Add: Describe the uses of some Group 7 elements (3 clarification points).</p> <p>Sec 1 HD Add: Predict the properties of fluorine or astatine given the properties of the other Group 7 elements (4 clarification points).</p> <p>Existing sec 3 becomes new sec 2.</p> <p>Sec 2 LD Amend to: Recognise that Group 7 elements react vigorously with Group 1 elements. Add: Construct the word equation for the reaction between a Group 1 element and a Group 7 element (product given).</p>	C3e The Group 7 elements Sec 1, 3, 4, 5

		<p>Sec 2 SD Delete: 1st statement. Amend to: Identify the metal halide formed when a Group 1 element reacts with a Group 7 element. Construct the word equation for the reaction between a Group 1 element and a Group 7 element (product not given). Add: Construct the balanced symbol equation for the reaction of a Group 1 element and a Group 7 element (some or all formulae given).</p> <p>Sec 2 HD: Amend to: Construct the balanced symbol equation for the reaction of a Group 1 element with a Group 7 element (some or all formulae given).</p> <p>Existing sec 4 becomes new sec 3.</p> <p>Sec 3 LD Delete: Existing. Add: Recall that the reactivity of the Group 7 elements decreases down the group. Construct the word equation for the reaction between a Group 7 element and a metal halide (reactants and products given).</p> <p>Sec 3 SD Delete: 1st statement. Change: 'halogens' to 'Group 7 elements' in 2nd and 3rd statements. Add: Construct balanced symbol equations for the reactions between Group 7 elements and metal halides (some or all formulae given).</p> <p>Sec 3 HD Delete: Existing. Add: Construct balanced symbol equations for the reactions between Group 7 elements and metal halides (formulae not given). Predict the feasibility of displacement reactions eg will bromine react with sodium astatide solution.</p> <p>Existing sec 5 becomes new sec 4.</p> <p>Sec 4 SD Amend to: Explain why Group 7 elements have similar properties.</p> <p>Sec 4 HD Amend to: Explain why Group 7 elements have similar properties in terms of formation negative ions with stable electronic structures. Amend: Minor rewording in other statements.</p>	
C4f Transition elements		<p>Sec 1 LD Change: 'state' to 'deduce' in 1st statement; 'state' to 'recall' in 2nd statement.</p> <p>Sec 1 SD Change: 'state' to 'recall'.</p> <p>Sec 2 LD Change: 'describe' to 'recall' in 2nd statement. Add Construct word equations for thermal decomposition reactions (all reactants and products given).</p>	C3g Transition elements



<p>C4g Metal structure and properties</p>		<p>Sec 1 LD Change: 'state that' to 'explain why'. Delete: 'because it is a good conductor'.          Sec 2 LD Change: 'describe' to 'list'. Delete: 3rd statement. Add: Explain why metals are suited to a given use (data supplied). Suggest properties needed by a metal for a particular given use eg saucepan bases need to be good conductors of heat.          Sec 2 SD Delete: 1st and 3rd statements.          Sec 2 HD Delete: Existing.          Sec 3 New.          Sec 3 LD Add: 3rd statement from existing sec 2.          Sec 3 SD Add: 3rd statement from existing sec 2, changing 'describe' to 'understand'. 1st statement from existing sec 3, amending to Describe how metals conduct electricity.          Sec 3 HD Add: 2nd and 3rd statements from existing sec 2. Amend: 3rd statement to have bullet points.          Sec 4 LD Add: 3rd statement from existing sec 3. Change: 'state' to 'recall'.          Sec 4 SD Add: 3rd statement from existing sec 3. Describe what is meant by the term superconductor.          Sec 4 HD Add: Explain some of the drawbacks of superconductors.</p>	<p>C3h Metal structure and properties Sec 2, 3</p>
<p>C4h Purifying and testing water</p>	<p>Delete: Reference to clean water in the developing world. Add: preparation of an insoluble salt.</p>	<p>Sec 1 LD Delete: 2nd statement. Add: Interpret simple data about water resources in the UK (no recall expected). Explain why water is an important resource for many important industrial chemical processes.          Sec 2 LD Change: 'state' to 'list'.          Sec 2 SD Delete: Existing. Add: Explain why drinking water may contain some of the pollutants listed below: nitrate; lead compounds; pesticide.          Sec 3 LD Change: 'state' to 'list' in 1st statement; 'describe' to 'recall' in 2nd statement.          Sec 3 HD Delete: 1st statement. Amend to: Explain why some soluble substances are not removed from water during purification.          Sec 4 LD Change: 'state' to 'recall'. Add: Construct word equations for the reactions of barium chloride with sulfates and silver nitrate with halides (all reactants and products given).          Sec 4 SD Change: 'write' to 'construct' in 2nd statement; 'recall' to understand in 3rd statement. Add: 'not all reactants and products given' to 2nd statement.          Sec 4 HD Change: 'write' to 'construct' and 'chlorides' to 'halides'.</p>	<p>C4h How pure is our water? Sec 1, 2, 3, 4</p>

## Module C5

New item	Practical/research activities	Content additions and deletions (sections refer to new items)	Current item
C5 Fundamental chemical concepts		There are numerous changes between the old and the new specifications. Please see the new specification for details.	C5 Fundamental chemical concepts
C5a Moles and molar mass	Delete: Water of crystallisation experiment (to C5b). Add: Class practical involving mass changes when carbonates are heated.	Sec 1 LD Amend: Minor changes to wording – recall unit for molar mass. Add: Recall that the unit of molar mass is g/mol. Sec 1 HD Change: 'state' to 'recall'. Sec 2 LD Change: 'recall' to 'understand'.	C5a Moles and empirical formulae Sec 1, 2
C5b Percentage composition and empirical formula	Add: Sec 2 and 3 experiments from C5a. Research the % by mass of essential elements in fertilisers.	Existing sec 3 becomes new sec 1. Sec 1 SD Change: 'recall' to 'understand'. Add: Calculate the percentage by mass of an element in a compound given experimental data about the mass of the element and the mass of the compound. Sec 1 HD Add: 1st statement from existing sec 1, deleting 2nd, 3rd and 4th bullet points. Existing sec 1 becomes new sec 2. Sec 2 LD Delete: 1st and 2nd statements. Sec 2 HD Add: Calculate the percentage by mass of an element in a compound given its formula and atomic masses.	C5a Moles and empirical formulae Sec 1, 3
C5c Quantitative analysis	Change: RDA values to GDA.	Sec 1 HD Amend: Reworded into bullet points. Sec 2 SD Add: 'or how to perform a 1 in 10 dilution' to end of statement. Sec 3 LD Change: 'appreciate' to 'explain'. Add: 3 clarification points. Sec 4 LD Change: 'RDA' to 'GDA'. Add: 1 clarification point. Sec 4 SD Change: 'RDA' to 'GDA'. Add: 1 clarification point. Sec 4 HD Delete: 2nd bullet. Add: Explain why the above conversion may be inaccurate, to include sodium ions coming from other sources.	C5c Quantitative analysis
C5d Titrations	Add: Microscale titrations (details from RSC website). Universal Indicator rainbow (details from RSC website).	Sec 1 LD Delete: 1st statement. Change: 'describe' to 'explain how' in 2nd statement. Add: Interpret a simple pH curve (1 clarification point). Sec 1 SD Delete: 1st and 2nd statements. Sec 2 LD Add: Explain why it is important to use a pipette filter when using a pipette in an acid-base titration. Understand that the titre depends on the concentration of the acid or alkali. Sec 2 HD Amend: Clarification points. Sec 3 SD Amend: Wording and add 'phenolphthalein'.	C5d Titrations

C5e Gas volumes		<p>Sec 2 LD Change: 'describe' to 'recall'.</p> <p>Sec 2 LD delete existing. Add: Explain why a reaction stops.</p> <p>Sec 3 SD Delete: Existing. Add: Understand how the amount of product formed varies with the amount of limiting reactant used. Recall that the limiting reactant is the reactant not in excess that is all used up at the end of the reaction. Explain why a reaction stops in terms of the limiting reactant present given appropriate qualitative information about the reaction.</p> <p>Sec 3 HD Delete: Existing. Add: Explain in terms of reacting particles why the amount of product formed is directly proportional to the amount of limiting reactant used. Calculate the volume of a known number of moles of gas given the molar gas volume of 24 dm<sup>3</sup> at room temperature and pressure (rtp). Calculate the amount in moles of a volume of gas at rtp given the molar gas volume at rtp.</p> <p>Sec 4 LD Amend: Wording. Add: Compare rates of reaction using gradients of graphs.</p> <p>Sec 4 SD Amend: Wording.</p> <p>Sec 4 HD Delete: Bullet points.</p>	C5e Gas volumes
C5f Equilibria		<p>Sec 1 Change: 'state' to 'understand' in 1st statement; 'state' to 'recall' in 3rd statement. Delete: 2nd statement.</p> <p>Sec 1 SD Change: 'describe' to 'recall'. Amend: Wording. Delete 2nd and 3rd statements. Add: Understand how the position of equilibrium is related to the ratio of the concentration of the products to the concentration of the reactants.</p> <p>Sec 2 LD Amend: Wording.</p> <p>Sec 2 SD Change: 'describe' to 'recall'.</p> <p>Sec 2 HD Change: 'explain' to 'understand'. Add: Increasing the temperature moves the position of equilibrium in the direction of the endothermic reaction or vice versa (as clarification point). Explain the effect of changing product concentration, reactant concentration, temperature or pressure on the position of equilibrium given appropriate details about a reaction.</p> <p>Sec 3 LD Delete: 1st and 3rd statements. Add: Describe the manufacture of sulfuric acid (4 clarification points).</p> <p>Sec 2 SD Change: 'state' to 'describe'. Delete: 2nd statement. Add: Understand that the reaction between sulfur dioxide and oxygen is reversible (with equations).</p> <p>Sec 2 HD Delete: 1st statement. Amend: Wording of 2nd statement with greater clarification.</p>	C5f Equilibria

C5g Strong and weak acids	Delete: Data-search for uses of weak acids. Add: Addition of calcium carbonate and magnesium to 2nd practical.	<p>Sec 1 LD Change: 'state' to 'recall' in 1st and 2nd statements; 'state' to 'understand' in 3rd statement.</p> <p>Sec 1 SD Change: 'state' to 'understand' in 1st statement. Combine: 2nd, 3rd and 4th statements. Sec 1 HD Delete: Formulae. Change: 'write' to 'construct' in 3rd statement.</p> <p>Sec 2 LD Combine: 1st and 2nd statements. Change: 'recognise' to 'recall'. Add 'because ethanoic acid is a weak acid' to end of 3rd statement.</p> <p>Sec 2 SD Amend: Reworded and clarification points given.</p> <p>Sec 3 LD Change: 'recognise' to 'understand'.</p> <p>Sec 3 SD Change: 'volume of hydrogen' to 'volume of gaseous products'.</p> <p>Sec 4 LD Change: 'recognise' to 'understand' in 1st statement; 'describe' to 'recall' in 2nd statement.</p> <p>Sec 4 SD Amend: Reworded.</p> <p>Sec 4 HD Amend: Reworded.</p> <p>Sec 5 Delete.</p>	C5g Strong and weak acids
C5h Ionic equations and precipitation	Add: Magnesium carbonate to 2nd practical.	<p>Sec 1 LD Amend to: Describe a precipitation reaction. Change: 'describe' to 'understand' in 2nd statement.</p> <p>Sec 1 SD Amend: Rewording of 2nd statement.</p> <p>Sec 1 HD Delete: Existing. Add: Explain, in terms of collisions between ions, why most precipitation reactions are extremely fast.</p> <p>Sec 2 SD Delete: Existing. Add: Interpret experimental data about the testing of solutions using aqueous barium chloride and aqueous lead nitrate.</p> <p>Sec 2 HD Delete: Existing.</p> <p>Sec 3 SD Add: Existing sec 2 (products not given).</p> <p>Sec 3 HD Add: Existing sec 2. Delete: 1st statement.</p>	C5h Ionic equations



**Module C6**

Current C6h deleted from new.

New item	Practical/research activities	Content additions and deletions (sections refer to new items)	Current item
C6 Fundamental chemical concepts		There are numerous changes between the old and the new specifications. Please see the new specification for details.	C6 Fundamental chemical concepts
C6a Electrolysis	Amend: Practicals amended to sodium hydroxide and sulphuric acid. Add: Use of Hoffmann voltameter.	<p>Sec 1 New.</p> <p>Sec 1 LD Add: Describe electrolysis as the decomposition of a liquid by passing an electric current through it. Recall the anode is the positive electrode and the cathode is the negative electrode. Recall that cations are positively charged and anions are negatively charged. Describe the electrolyte as the liquid which conducts electricity and is decomposed during electrolysis. Recognise anions and cations from their formula.</p> <p>Sec 1 SD Add: Describe electrolysis in terms of flow of charge by moving ions and the discharge of ions at the electrodes.</p> <p>Existing sec 1 becomes new sec 2.</p> <p>Sec 2 LD Change: 'label' to 'identify'. Delete 2nd statement. Add: Describe the chemical tests for hydrogen and oxygen (2 clarification points).</p> <p>Sec 2 SD Delete: 2nd statement. Change: Potassium sulphate to sodium hydroxide; potassium nitrate to sulphuric acid.</p> <p>Sec 2 HD Delete: 1st statement. Change: Potassium sulphate to sodium hydroxide, potassium nitrate to sulphuric acid. Add: Explain why the electrolysis of sodium hydroxide makes hydrogen rather than sodium at the cathode.</p> <p>Existing sec 2 becomes new sec 3.</p> <p>Sec 3 LD Amend: Bullet points in 1st statement. Change: 'state' to 'recall'.</p> <p>Sec 3 SD Delete: Existing. Add: Recall the products of the electrolysis of CuSO<sub>4</sub>(aq) with carbon electrodes: copper is formed at the cathode and oxygen at the anode. Understand how the amount of substance produced during electrolysis varies with time and current.</p> <p>Sec 3 HD Change: 'write' to 'construct'. Delete: 2nd statement.</p> <p>Sec 4 Delete: Lists of electrolytes.</p> <p>Sec 4 SD: Amend: Wording, with clarification points.</p>	C5b Electrolysis Sec 1, 2, 3

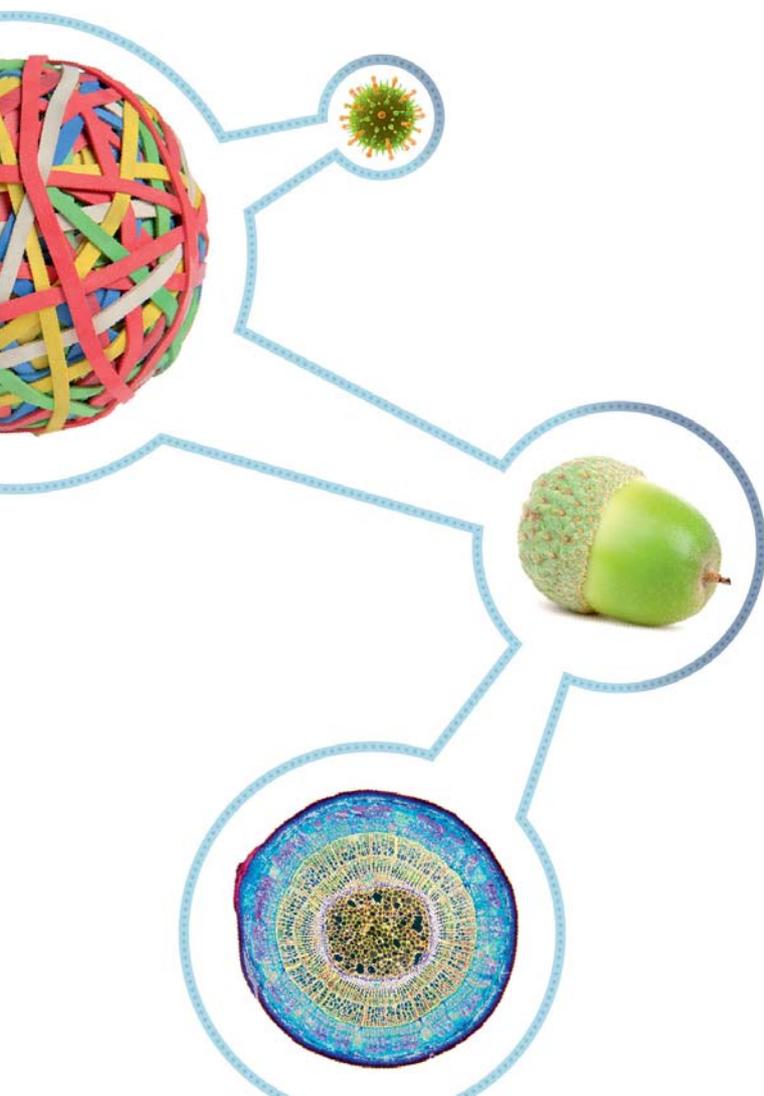
<p>C6b Energy transfers – fuel cells</p>		<p>Sec 1 LD Delete: Existing. Add: Recall that the reaction between hydrogen and oxygen to produce water is exothermic. Understand why fuel cells use exothermic reactions. Construct the word equation for the reaction between hydrogen and oxygen.</p> <p>Sec 1 SD Delete: Existing. Add: Construct the balanced symbol equation for the reaction between hydrogen and oxygen.</p> <p>Sec 1 HD Add: Draw and interpret energy level diagrams for other reactions given appropriate information.</p> <p>Sec 2 LD Delete: Existing. Add: Describe a fuel cell as a cell supplied with fuel and oxygen that uses the energy released from the reaction between the fuel and oxygen to produce electrical energy efficiently. Recall that hydrogen is the fuel in a hydrogen-oxygen fuel cell.</p> <p>Sec 2 SD Delete: Existing. Add: Construct the balanced symbol equation for the overall reaction in a hydrogen-oxygen fuel cell.</p> <p>Sec 2 HD Delete: 1st statement. Amend: Increase clarification in bullet points.</p> <p>Sec 3 LD Change: 'state' to 'recall'.</p> <p>Sec 3 SD Delete: 2nd statement. Amend: Wording and add clarification points.</p> <p>Sec 3 HD Delete: Bullet points.</p> <p>Sec 4 New.</p> <p>Sec 4 LD Add: Explain why a hydrogen-oxygen fuel cell does not form a polluting waste product. Recall that the combustion of fossil fuels such as petrol produces carbon dioxide which has been linked with climate change and global warming.</p> <p>Sec 4 SD Add: Explain why the car industry is developing fuel cells (3 clarification points).</p> <p>Sec 4 HD Add: Explain why the use of hydrogen-oxygen fuel cells will still produce pollution (2 clarification points).</p>	<p>C6a Energy transfers – fuel cells</p>
<p>C6c Redox reactions</p>	<p>Add: Exothermic metal displacement reactions.</p>	<p>Existing sec 4 becomes new sec 1.</p> <p>Sec 1 LD Add: Describe oxidation as the addition of oxygen or the reaction of a substance with oxygen. Describe reduction as the removal of oxygen from a substance.</p> <p>Sec 1 SD Change: 'recognise' to 'understand'.</p> <p>Sec 1 HD Add: 'electrode reactions' (as bullet point) to 3rd statement. Change: 'describe' to 'understand' in 1st statement.</p> <p>Existing sec 1 becomes new sec 2.</p> <p>Sec 2 LD Delete: 2nd statement.</p> <p>Sec 2 SD Change: 'state' to 'understand' in 1st statement; 'state' to 'construct' in 2nd statement.</p> <p>Existing sec 2 becomes new sec 3.</p> <p>Sec 3 LD Change: 'describe' to 'list'. Add: Statement from existing sec 2 SD. Change: 'explain' to 'understand'.</p>	<p>C6b Redox reactions Sec 1, 2, 3, 4</p>

		<p>Sec 3 SD Delete: Existing. Add: Explain how galvanising protects iron from rusting (3 clarification points).</p> <p>Sec 3 HD Delete: Existing. Add: Explain how sacrificial protection protects iron from rusting (3 clarification points). Explain disadvantages of using tin plate as a means of protecting iron from rusting (2 clarification points). Evaluate different ways of rust prevention. Existing sec 3 becomes new sec 4.</p> <p>Sec 4 LD Change: 'state' to 'recall'. Add: Predict, with a reason, whether a displacement reaction will take place.</p> <p>Sec 4 HD Change: 'write' to 'construct'. Add: Explain displacement reactions in terms of oxidation and reduction (2 clarification points).</p>	
C6d Alcohols	Add: The 'Whoosh' bottle demonstration (details from RSC website).	<p>Sec 1 LD Add: Explain why alcohols are not hydrocarbons.</p> <p>Sec 1 SD Change: 'state' to 'recall'.</p> <p>Sec 1 HD Change: 'state' to 'recall'.</p> <p>Sec 2 LD Delete: 1st statement. Change: 'describe' to 'recall'. Delete: 3rd and 4th bullet points. Add: 'yeast' as bullet point.</p> <p>Sec 2 SD Add: Change: 'state' to 'recall'. Construct balanced symbol equation for fermentation (given all the formulae). Amend: Bullet points to 2nd statement.</p> <p>Sec 2 HD Amend to: Construct the balanced symbol equation for fermentation (some or no formulae given).</p> <p>Sec 3 LD Change: 'state' to 'recall'.</p> <p>Sec 3 SD Add: Explain why ethanol made by fermentation is a renewable fuel. Explain why ethanol made by hydration of ethene is a non-renewable fuel.</p> <p>Sec 3 HD Add: Evaluate the merits of the two methods of making ethanol (fermentation and hydration) in terms of (5 clarification points).</p> <p>Sec 4 LD Amend to: Recall that hydration of ethane produces ethanol.</p> <p>SD Add: Construct the balanced symbol equation for the hydration of ethene.</p> <p>Sec 4 HD Delete: Existing.</p>	C6c Alcohols Sec 1, 2, 3, 4



C6e Depletion of the ozone layer		<p>Sec 1 LD Delete: 3rd statement. Change: 'describe' to 'recall'.</p> <p>Sec 1 SD Add: Clarification point.</p> <p>Sec 1 HD Delete: 3rd statement.</p> <p>Sec 2 LD Change: 'state' to 'recall'.</p> <p>Sec 2 SD Delete: 1st and 2nd statements. Change: 'state' to 'recall' in 3rd statement; 'describe' to 'explain' in 4th statement. Add: Describe how CFCs deplete the ozone layer (3 clarification points).</p> <p>Sec 2 HD Delete: 1st and 2nd statements. Add: Explain in terms of electrons how a carbon-chlorine bond can break to form highly reactive chlorine atoms. Explain why only a small number of chlorine atoms will destroy a large number of ozone molecules. Change: 'write symbol equations' to 'interpret the symbol equations'.</p> <p>Sec 4 LD &amp; SD Change: 'describe' to 'recall'.</p>	C6e Depletion of the ozone layer
C6f Hardness of water	Delete: Compare different commercial limescale removers. Add: Which ions cause hardness in water? practical.	<p>Sec 1 LD Change: 'describe' to 'recall'.</p> <p>Sec 1 SD Delete: 1st and 2nd statements. Change: 'state' to 'construct'. Add: Describe the origin of temporary hardness in water (1 clarification point).</p> <p>Sec 1 HD Delete: Existing.</p> <p>Sec 2 LD Change: 'describe' to 'recall'.</p> <p>Sec 2 SD Amend: Split into 2 statements.</p> <p>Sec 3 SD Add: 2nd clarification point. Change: 'describe' to 'explain' in 2nd statement.</p> <p>Sec 3 HD Delete: 2nd statement. Change: 'state the symbol equation' to 'construct...'</p> <p>Sec 4 LD Add: Clarification point.</p> <p>Sec 4 SD Add: Clarification point. Change: 'describe an experiment' to 'plan...'</p> <p>Sec 5 Delete.</p>	C6f Hardness of water Sec 1, 2, 3, 4
C6g Natural fats and oils	Add: Research the composition of various plant oils and animal fats. Comparing the amount of unsaturated fats in food stuffs by titration against bromine (see RSC website)	<p>Sec 1 LD Delete: 2nd statement. Change: 'state' to 'understand' in 1st statement; 'state' to 'recall' in 2nd statement.</p> <p>Sec 1 SD Change: 'state' to 'recall' in 1st statement. Combine: 2nd and 3rd statements. Add: Clarification points to bromine statement.</p> <p>Sec 1 HD Delete: 1st statement. Add: Clarification points to bromine statement.</p> <p>Sec 2 LD Delete: 1st and 2nd statements. Add: Describe an emulsion.</p> <p>Sec 2 SD Amend 2: Describe how immiscible liquids, such as vegetable oil and water, can form an emulsion.</p> <p>Sec 3 LD Change: 'describe' to recall'.</p> <p>Sec 3 SD Change: 'state' to 'recall'.</p>	C6g Natural fats and oils

C6h Detergents	Delete: Preparation of a detergent.	<p>Sec 1 LD Change: 'describe' to 'relate'. Delete: 2nd statement.</p> <p>Sec 1 SD Add: Describe detergents as molecules that have a hydrophilic head and a hydrophobic tail.</p> <p>Sec 1 HD Delete: Existing. Add: Explain how detergents can remove fat or oil stains (2 clarification points).</p> <p>Sec 2 LD Change: 'describe' to 'understand'.</p> <p>Sec 2 HD Add: 3 clarification points.</p> <p>Existing sec 4 becomes new sec 3.</p> <p>Sec 3 LD Change: 'describe' to 'relate'. Delete: 5th bullet point.</p> <p>Existing sec 5 becomes new sec 4.</p> <p>Sec 5 Add: Clarification points to all demands.</p>	C4e Detergents Sec 1, 2, 4, 5
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## APPENDIX C

### Detailed changes to Physics modules

Details of content additions, deletions and changes.

Sections numbered under content refer to new specification sections.

#### Module P1

New Item P1c – content added

New item	Practical/research activities	Content additions and deletions (sections refer to new items)	Current item
P1a Heating houses	Add: Experiments to measure fall and increase in temperature of water. Computer simulation or experiment – plot cooling curve of stearic acid.	<p>Sec 1 LD Delete: Existing. Add: Understand that for warm bodies the rate of cooling depends on the temperature difference compared to the surroundings. Understand that temperature is represented by colour in a thermogram.</p> <p>Sec 1 SD Delete: Existing. Add: Recognise, and understand the consequences of, the direction of energy flow between bodies of different temperatures. Interpret data on rate of cooling. Explain how temperatures can be represented by a range of colours in a thermogram (2 clarification points)</p> <p>Sec 1 HD Delete: 1st and 3rd statements. Add: Understand that temperature is a measurement of the average kinetic energy of particles.</p> <p>Sec 2 LD Change: 'apply knowledge that' to 'describe how'; 'plan an experiment' to 'describe...'. Add: Recall that heat is a measurement of energy and is measured in Joules (J).</p> <p>Sec 2 SD Delete: Existing Add: Understand qualitatively and quantitatively the concept of the specific heat capacity of a material. Use the equation (given).</p> <p>Sec 2 HD Amend: Wording of 1st statement. Add: Describe heat as a measurement of energy on an absolute scale. An initial calculation of temperature may be required.</p> <p>Sec 3 LD Delete: 1st statement.</p> <p>Sec 3 SD Delete: 2nd statement. Add: Understand qualitatively and quantitatively the concept of latent heat of a material. Use the equation (given).</p> <p>Sec 3 HD Amend: Wording of 1st statement. Delete: 2nd statement. Add: Explain why the temperature does not change during a change of state.</p>	P1a Heating houses

<p>P1b Keeping homes warm</p>	<p>Add: Experiments using data logger to test insulation, transfer of energy, reflection of energy, and absorption of energy. Experiments on convection currents. Comparing costs of energy saving measures. Producing a brochure about investing in energy saving measures. Interpret and complete information presented in Sankey diagrams.</p>	<p>Sec 1 New. Sec 1 LD Add: Explain why trapped air in a material is a good insulator. Recall that infrared radiation is (3 clarification points). Understand how absorption and reflection of infrared radiation can be applied in everyday situations. Sec 1 SD Add: Explain how energy transfer in terms of (3 bullet points) and how it can be reduced in homes by energy saving measures (3 clarification points). Understand and use the terms source and sink in the context of energy lost from houses. Sec 1 HD Add: Describe how energy is transferred by conduction (clarification), convection (clarification) and radiation (clarification). Explain how there will be an energy loss in a cavity wall and what further measures could be taken to limit this loss. Sec 2 LD Delete: 2nd, 3rd and 4th bullets. Amend: Wording to 1st and 5th statements. Add: Describe other energy saving measures (2 clarification points). Use the equation for efficiency given the useful energy output and the total energy input; efficiency can be expressed in ratio or percentage terms. of equation to calculate efficiency. Sec 2 SD Add: 'initial cost' and 'annual saving on energy bills' to 1st statement. Amend: Use of equation. Add: Interpret and complete information presented in Sankey diagrams, to show understanding that energy is conserved. Sec 2 HD Amend: Use of equation. Add: which may be used in a Sankey diagram. Efficiency can be expressed in ratio or percentage terms.</p>	<p>P1c How insulation works Sec 1 (part)</p> <p>P1b Keeping homes warm</p>
<p>P1c A spectrum of waves</p>	<p>Amend: Looking at and measuring waves. Add: Raybox mirror and prism experiments for reflection and refraction. Disperse white light with prism. Recreate William Herschel's experiment. Sort and match activities for properties and uses of parts of the electromagnetic spectrum.</p>	<p>Sec 1 LD Delete: 2nd statement. Sec 1 SD Delete: 2nd statement. Sec 1 HD Delete: Existing. Sec 2 LD Add: Recall that electromagnetic waves travel at the same high speed in space or a vacuum. Use the equation: (wave equation). Sec 2 SD Add: Determine the value of the wavelength of a wave from a diagram and be able to use the value in the equation (wave equation). Sec 2 HD Add: Use the equation including a change of subject and use of standard form (or the use of a scientific notation calculator) (wave equation). Sec 3 LD Add: Recall that electromagnetic waves travel in straight lines through a particular medium. Use ray diagrams to describe reflection at single plane (flat) boundaries. Recognise that refraction involves change in direction due to the wave passing from one medium into another.</p>	<p>P1g Light Sec 1</p> <p>(Sec 2, 3 from Legacy P1g moved to New P1d.)</p>

		<p>Sec 3 SD Add: Use basic ray diagrams to demonstrate reflection at multiple plane (flat) boundaries. Understand why refraction occurs at a boundary between mediums. Describe diffraction of waves at an opening.</p> <p>Sec 3 HD Add: Describe a diffraction pattern for waves, including the significance of the size of opening or barrier relative to the wavelength.</p> <p>Sec 4 LD Add: Identify the seven types of electromagnetic waves that comprise the spectrum and place them in order of ascending frequency. Describe an example for communications use for radio, microwave, infrared and visible light.</p> <p>Sec 4 SD Add: 1st statement from SD. Relate the size of a communications receiver to wavelength for radio, microwave, infrared and visible light.</p> <p>Sec 4 HD Add: Describe and explain limiting effects of diffraction on wave based sensors to include: telescopes; optical microscopes.</p>	
P1d Light and lasers	Relate flashing signal light messages to the use of Morse code.	<p>Existing P1g sec 2 becomes new sec 1.</p> <p>Sec 1 SD Add: Clarification points to 1st statement. Describe why Morse code is a digital signal.</p> <p>Existing P1e sec 4 becomes new sec 2.</p> <p>Sec 2 LD Change: 'recognise' to 'understand' in 2nd statement.</p> <p>Sec 2 SD Delete: Existing. Add: Describe what happens to light incident on a boundary, eg glass-air, water-air or perspex-air boundary, below, at and above the critical angle. Understand how transfer of light along an optical fibre depends on the critical angle of the incident light.</p> <p>Sec 2 HD Delete: Existing. Add: Describe applications of TIR in fibre optics.</p> <p>Existing P1g sec 3 becomes new sec 3 .</p> <p>Sec 3 LD Delete: Existing. Add: Understand how the properties of light produced by lasers allows them to be used for (4 bullet points).</p> <p>Sec 3 SD Add: Existing LD statement.</p> <p>Sec 3 HD Amend: Wording. Add: 'low divergence' as bullet to 1st statement. 2 further clarification points to 2nd statement.</p>	P1g Light Sec 2, 3 P1e Infrared signals Sec 4

<p>P1e Cooking and communicating using waves</p>	<p>Delete: Examine iron. Add: Examine radiator and remote control. Experiment to measure temperature increase near object emitting infrared. Experiment to show older mobile phones/microwave oven emit radiation which causes interference with radio signal. Research for and against damage to humans from mobile phones. Survey opinions on mobile phone masts.</p>	<p>Sec 1 LD Delete: 2nd and 3rd statements. Add: Understand how emissions and absorption of infrared radiation is affected by the properties of the surface of an object (3 clarification points). Sec 2 LD Change: 'state' to 'recall'. Delete: 2nd statement. Sec 2 SD Delete: Existing. Add: Describe factors that limit the transmission of information over large distances using microwaves. Sec 2 HD Delete: Existing. Add: Explain how signal loss with microwaves happens because of (4 clarification points). Describe how the problems of signal loss are reduced by (2 clarification points). Sec 3 New. Sec 3 LD Add: Describe some concerns about children using mobile phones. Recall that different studies into the effects of mobile phone use have reached conflicting conclusions. Sec 3 SD Add: Describe why there may or may not be dangers: to residents near to the site of a mobile phone transmitter mast; to users of mobile phones. Describe how potential dangers may be increased by frequent use. Explain how publishing scientific studies into effects of mobile phone microwave radiation enables results to be checked. Sec 3 HD Add: Understand that in the presence of conflicting evidence individuals and society must make choices about mobile phone usage and location of masts in terms of balancing risk and benefit.</p>	<p>P1d Cooking with waves</p>
<p>P1f Data transmission</p>	<p>Add: Research to evaluate switch from analogue to digital and timeline.</p>	<p>Sec 1 SD Add: Describe how infrared signals can carry information to control electrical or electronic devices. Sec 1 HD Add: Explain how the signal from infrared remote control uses a set of digital signals to control different functions of electrical or electronic devices. Sec 2 LD Amend to: Understand how passive infrared sensors and thermal imaging cameras work (1 clarification point). Sec 3 LD Delete: Existing. Add: Existing SD statement. Sec 3 SD Delete: Existing. Add: Understand why it is easier to remove noise from digital signals. Sec 3 HD Delete: Existing. Add: Explain how the properties of digital signals played a part in the switch to digital TV and radio broadcasts, to include use of multiplexing. Sec 4 LD Delete: Existing. Sec 4 SD Delete: 1st and 2nd statements. Sec 4 HD Delete: 1st statement.</p>	<p>P1e Infrared signals Sec 1, 2, 3, 4</p>

P1g Wireless signals	Add: Presentation of uses of wireless technology. Chart radio stations and frequencies. Research expansion of DAB. Timeline first radio transmission to digital switch over.	Sec 1 LD Amend to: Describe the advantages of wireless technology (3 clarification points) but an aerial is needed to pick up the signals. Sec 1 SD Add: 'and reflected and how this can be an advantage or disadvantage for good signal reception' to 1st statement. Change: 'recognise' to 'describe' in 2nd statement. Sec 1 HD Amend: Wording of 1st statement. Add: Recall that the refraction and reflection in the ionosphere is similar to TIR for light. Sec 2 LD Delete: 1st statement. Sec 2 SD Delete: Existing. Add: Understand why nearby radio stations use different transmission frequencies. Describe advantages and disadvantages of DAB broadcasts. Sec 2 HD Add: 'including that between other broadcasts/stations' to 2nd statement.	P1f Wireless signals
P1h Stable Earth	Add: Test seismometer applications in modern smart phones. Presentation on dangers of UV and protection. Leaflet on dangers or sunbeds. Chart SPF's and exposure times. Wall chart CFC pollution and hole in ozone layer and relate to more UV.	Sec 1 LD Add: be recorded on a seismograph; cause a tsunami (as bullets). Sec 1 SD Delete: 1st statement. Change: 'state' to 'recall'. Sec 2 LD Change: 'state' to 'recall'. Add: cataracts; premature skin aging (as bullets). Amend: Wording in 2nd statement, including 'sun block' to 'sunscreen'. Sec 2 SD Add: Describe how people have been informed of the risk of exposure to UV radiation, including from the use of sun beds, in order to improve public health. Sec 2 HD Change: 'describe' to 'explain how'. Delete: 2nd half of 1st statement. Add: Describe how: environmental pollution from CFCs has depleted the ozone layer; this allows more ultraviolet radiation to reach Earth; the potential danger to human health increases because of this. Sec 3 New. Sec 3 LD Add: Recall that the discovery of reduction of ozone layer levels over Antarctica was unexpected. Describe how scientists used existing scientific ideas to explain their measurements. Sec 3 SD Add: Describe how scientists verified their measurements of ozone reduction, and the steps they took to increase confidence in their explanation (3 clarification points). Sec 3 HD Add: Describe how discovery of the hole in the ozone layer over Antarctica changed the behaviour in society at an international level.	P1h Stable Earth Sec 1, 2

**Module P2**

Current Item P2e Our magnetic Field deleted from new.

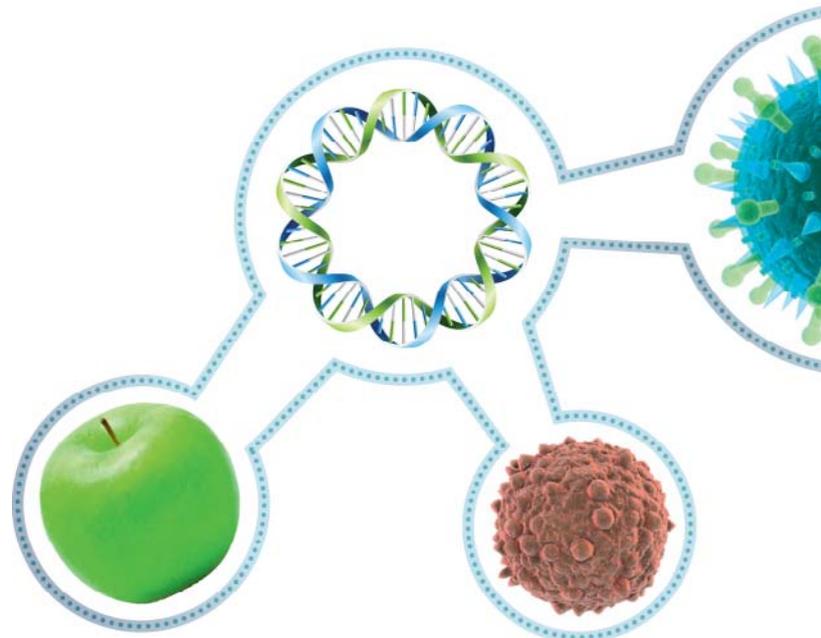
New Item P2c – content added.

New item	Practical/research activities	Content additions and deletions (sections refer to new items)	Current item
P2a Collecting energy from the Sun	Add: Investigate how power of photocell depends on distance from light source. Research/ survey use of wind turbines. Research/ debate to what extent solar energy can help ensure UK's future energy security.	Sec 1 LD Delete: 1st statement. Change: 'describe' to 'recall'. Add: Recall that DC electricity is current in the same direction all the time. Sec 1 SD Delete: 1st statement; 'rugged' bullet point. Sec 1 HD Amend to: Understand how the current and power produced in a photocell depends on. Add: distance from the light source (as bullet). Sec 2 LD Delete: Bullet points and 2nd statement. Add: radiation from the Sun can be absorbed by a surface and transferred into heat energy; produces convection currents (wind) to drive turbines; how glass can be used to provide passive solar heating for buildings; light can be reflected to a focus by a curved mirror (as bullets). Sec 2 SD Delete: Existing. Add: Describe the advantages and disadvantages of wind turbines (5 clarification points). Sec 2 HD Delete: 3rd statement. Amend: Wording to 2nd statement.	P2a Collecting energy from the Sun
P2b Generating electricity		Sec 1 LD Amend to: Describe how to generate electricity using the dynamo effect, by moving the coil or the magnet. Change: 'describe' to 'recall' in 2nd and 3rd statements. Sec 1 SD Delete: Bullet points. Sec 1 HD Delete: Existing. Sec 2 LD Delete: 2nd statement. Sec 2 HD Delete: Existing. Sec 3 New. Sec 3 LD Add: Recognise that there is a significant waste of energy in a conventional power station. Sec 3 LD/SD/HD Add: Use the efficiency equation in the context of a power station (expressed as ratio or percentage).	P2b Generating electricity Sec 1, 2
P2c Global warming	Compare temperature changes inside sealed transparent containers with different gases inside. Discuss advantages/disadvantages of using fossil fuels for making electricity. Discuss possible consequences of global warming. Find out evidence for global warming in last 200 years.	Sec 1 New. Sec 1 LD Add: Understand that some gases in the Earth's atmosphere prevent heat from radiating into space. Recall and recognise that this is known as the greenhouse effect. Recall and identify examples of greenhouse gases (3 bullet points). Sec 1 SD Add: Describe how EM radiation at most wavelengths can pass through the Earth's atmosphere, but certain wavelengths, particularly infrared, are absorbed by some gases in the atmosphere. Recall and identify natural and man-made sources of greenhouse gases (4 examples given).	P1h Stable Earth Sec 3

		<p>Sec 1 HD Add: Explain the greenhouse effect in terms of (3 clarification points). Interpret data about the abundance and relative impact of greenhouse gases (4 examples given).</p> <p>Existing sec 3 becomes new sec 2.</p> <p>Sec 3 New.</p> <p>Sec 3 LD Add: Describe the difficulties of measuring global warming. Explain why scientists working on global warming should allow other scientists to use their data.</p> <p>Sec 3 SD Add: Describe scientific evidence which support or refutes the idea of man-made global warming. Distinguish between opinion and evidence based statements in the context of the global warming debate.</p> <p>Sec 3 HD Add: Explain how it is possible to have good agreements between scientists about the greenhouse effect, but disagreement about whether human activity is affecting global warming.</p>	
P2d Fuels for power	Add: Research use of electricity at home: units/ ratings. Research how demand for electricity is managed now and in future. Research/ explore how demand for electricity is managed in the National Grid now and how this may change in the future.	<p>Sec 1 LD Add: Recall that fuels release energy as heat. Amend: Wording to 2nd.</p> <p>Sec 1 SD Delete: Existing. Add: Describe and evaluate the advantages and disadvantages of different energy sources; factors to include availability, risks, and environmental impact.</p> <p>Sec 1 HD Delete: Existing.</p> <p>Sec 2 LD. Change: 'describe' to 'recall'. Add: Calculate power rating of an appliance using the equation: <math>\text{power} = \text{voltage} \times \text{current}</math>.</p> <p>Sec 2 SD Add: Use the equation: <math>\text{energy supplied} = \text{power} \times \text{time}</math>.</p> <p>Sec 2 HD Amend: Minor changes to wording.</p>	<p>P2c Fuels for power Sec 1, 2</p> <p>P2b Generating electricity Sec 3</p>
P2e Nuclear radiations	Add: Research how to handle radioactive sources safely. Research how nuclear radiation can damage workers etc. Identify risk and hazard assessments.	<p>Sec 1 LD Delete: 'describe and' in 1st statement. Add: Understand that radioactive materials give out nuclear radiation over time.</p> <p>Sec 1 SD Delete: 2nd statement.</p> <p>Sec 2 LD Delete: 2nd statement. Add: Understand that nuclear radiation causes ionisation and that this is potentially harmful.</p> <p>Sec 2 SD Delete: 2nd, 3rd and 4th statements. Add 3 clarification points to 1st statement.</p> <p>Sec 2 HD Delete: Existing. Add: Interpret data and describe experiments that show how alpha, beta and gamma can be identified by their relative penetrating powers. Understand that ionisation can initiate chemical reactions. Explain how ionisation can damage human cells.</p> <p>Sec 3 LD Add: Describe how to handle radioactive materials safely (4 clarification points).</p>	<p>P2d Nuclear radiations Sec 1, 2</p> <p>P2c Fuels for power Sec 3</p>

		<p>Sec 3 SD Delete: 1st statement. Add: Describe some ways of disposing of radioactive waste (3 examples).</p> <p>Sec 3 HD Delete: Bullet points. Add: Explain the problems of dealing with radioactive waste (4 clarification points).</p>	
P2f Exploring our Solar System	<p>Add: Research/ debate advantages/ disadvantages of space exploration. Research problems of manned space flight. Research/ debate advantages/ disadvantages of space exploration. Debate advantages/ disadvantages of using robot spacecraft.</p>	<p>Sec 1 LD Delete: 1st and 3rd statements. Change: 'sate and recognise' to 'recall'. Add: Identify the relative positions of the Earth, Sun and planets (includes the order of the planets). Explain why stars give off their own light and can be seen or detected even though they are far away.</p> <p>Sec 1 SD Delete: Existing. Add: Recall the relative sizes and nature of planets, stars, comets, meteors, galaxies and black holes.</p> <p>Sec 1 HD Delete: Existing. Add: Recall that circular motion requires a centripetal force. Understand that gravitational attraction provides the centripetal force for orbital motion.</p> <p>Sec 2 LD Change: 'describe' to 'recall'. Delete: 2nd statement.</p> <p>Sec 2 SD Delete: Bullet points. Add: Describe a light year as the distance light travels in a year.</p> <p>Sec 2 HD Amend to: Explain why a light-year is a useful unit for measuring very large distances in space.</p> <p>Sec 3 LD Delete: Existing. Add: Compare the resources needed by manned and unmanned spacecraft. Describe why unmanned spacecraft are sent into space.</p> <p>Sec 3 SD Delete: 2nd statement. Add: Compare how information from space is returned to Earth from different distances (2 clarification points).</p> <p>Sec 3 HD Delete: Bullet points.</p>	P2f Exploring our Solar System
P2g Threats to Earth	<p>Add: Discuss the evidence for the presence of the Moon as result of collision between Earth and another planet. Research/ debate theories of dinosaur extinction. Discuss ideas about birth/ death of stars. Research evidence for Black Hole at centre of Milky Way. Research/ debate models to explain start of the universe.</p>	<p>Sec 1 New</p> <p>Sec 1 LD Add: Understand that the Moon may be the remains of a planet which collided with the Earth billions of years ago.</p> <p>Sec 1 SD Add: Describe how a collision between two planets can result in an Earth-Moon system (3 clarification points).</p> <p>Sec 1 HD Add: Discuss the evidence for the Earth-Moon system as the result of a collision between two planets. Existing sec 1 becomes new sec 2.</p> <p>Sec 2 LD Change: 'state' to 'recall'.</p> <p>Sec 2 SD Delete: 1st bullet point in 2nd statement.</p> <p>Sec 2 HD Change: 'large gravity' to 'gravitational attraction'.</p> <p>Existing sec 2 becomes new sec 3.</p> <p>Sec 3 LD Amend to: Describe the make up of a comet (2 clarification points).</p> <p>Sec 3 SD Delete: 2nd bullet.</p>	P2g Threats to Earth Sec 1, 2, 3

		<p>Sec 3 HD Amend to: Explain in terms of changing gravitational attraction why the speed of a comet changes as it approaches a star.</p> <p>Existing sec 3 becomes new sec 4.</p> <p>Sec 4 SD Add: Explain why it is difficult to observe NEOs.</p>	
<p>P2h The Big Bang</p>	<p>Delete: Demonstrate heating by compression with a fire piston. Add: Research/ debate different models which attempt to explain the start of the Universe.</p> <p>Produce a timeline for changing models of the Universe.</p>	<p>Sec 1 SD Change: 'describe' to 'recall' and 'all galaxies' to 'most galaxies'.</p> <p>Sec 2 LD Change: 'describe' to 'recall' in 1st statement; 'describe' to 'understand why' in 2nd statement. Add: are different sizes (as bullet to 1st statement).</p> <p>Sec 2 SD Change: 'medium-weight star' to 'small star' in 1st statement; 'heavy-weight star' to 'large star' in 2nd statement.</p> <p>Sec 2 HD Delete: 3rd bullet to 2nd statement. Amend: Clarification points in 2nd statement.</p> <p>Sec 3 New.</p> <p>Sec 3 LD Add: Recognise that accepted models of the size and shape of the Universe have changed over time. Describe and recognise the Ptolemaic, Copernican, and Galilean models of the Universe, and describe how they differ from each other and the modern day model.</p> <p>Sec 3 SD Add: Describe the evidence or observations that caused Copernicus and Galileo to develop new models, and explain how technological advances contribute to the new models.</p> <p>Sec 3 HD Add: Explain why the theories of the Copernican and Galilean models were considered controversial when they were announced, and were not widely adopted until many years had passed.</p>	<p>P2h The Big Bang</p>



**Module P3**

Current P3f reference to active and passive safety features is deleted from new.

New item	Practical/research activities	Content additions and deletions (sections refer to new items)	Current item
P3a Speed		<p>Sec 1 LD Delete: 1st, 2nd, 3rd and 4th statements. Amend to: Understand why one type of speed camera takes two photographs. Add: use the equation: average speed = distance/time to include change of units from km to m. Understand how average speed cameras work.</p> <p>Sec 1 SD Delete: 2nd statement. Add: Use the equation' including a change of subject: distance = average speed x time = <math>(u+v) / 2 \times \text{time}</math>.</p> <p>Sec 1 HD Delete: 2nd statement. Add: Use the equation, including a change of subject and/or units: distance = average speed x time = <math>(u+v) / 2 \times \text{time}</math>.</p> <p>Sec 2 LD Delete: Existing. Add: Draw and interpret qualitatively graphs of distance against time.</p> <p>Sec 2 SD Delete: 1st statement.</p> <p>Sec 2 HD Amend: 2nd bullet point to 'gradient of distance-time graph for uniform speed'.</p>	P3a Speed
P3b Changing speed		<p>Sec 1 SD Delete: 1st and 3rd statements; 'simple' from 2nd statement. Add: 3 clarification points.</p> <p>Sec 1 HD Delete: 2nd bullet; 'simple'. Amend: Wording to other bullets.</p> <p>Sec 2 LD Change: 'state' to 'recall'. Add: greater change in speed (in a given time) results in higher acceleration (as bullet point). Add: Use the equation: acceleration = change in speed / time taken when given change in speed.</p> <p>Sec 2 SD Add: 2 bullet points to 1st statement. Amend to: Use the equation including prior calculation of the change in speed: acceleration = change in speed / time taken.</p> <p>Sec 2 HD Amend to: Use the equation, including a change of subject: acceleration = change in speed / time taken. Add: in both speed and direction (as bullet point). Amend: Wording to 3rd statement.</p> <p>Sec 3 New.</p> <p>Sec 3 LD Add: Recognise that direction is important when describing the motion of an object. Understand that the velocity of an object is its speed combined with its direction.</p> <p>Sec 3 SD Add: Recognise that for two objects moving in opposite directions at the same speed, their velocities will have identical magnitude but opposite signs. Calculate the relative velocity of objects moving in parallel.</p>	P3b Changing speed

P3c Forces and motion	Add: Make a wall chart, PowerPoint presentation or leaflet to show stopping distances for different speeds.	<p>Sec 1 LD Amend to: Recognise situations where forces cause things to: speed up; slow down; stay at the same speed. Delete: 2nd, 3rd and 4th statements. Add: Use the equation: <math>\text{force} = \text{mass} \times \text{acceleration}</math> when given mass and acceleration</p> <p>Sec 1 SD Amend to: Use the equation, including change of subject: <math>\text{force} = \text{mass} \times \text{acceleration}</math>.</p> <p>Sec 1 HD Delete: Existing. Add: Use the equation, including a change of subject and the need to previously calculate the accelerating force: <math>\text{force} = \text{mass} \times \text{acceleration}</math>.</p> <p>Sec 2 LD Delete: 1st statement. Add: Calculate stopping distance given values for thinking and braking distances. Explain why thinking, braking and stopping distances are significant for road safety.</p> <p>Sec 2 SD Change: 'describe' to 'explain how' in 1st and 2nd statements.</p> <p>Sec 2 HD Add: Draw and interpret the shape of graphs for thinking and braking distances against speed. Explain the effects of increased speed on: thinking distance (clarification) and braking distance (clarification).</p>	P3c Forces and motion
P3d Work and power	Add: Construct a table of examples when work is, and is not, done. Measuring work done by candidate lifting weights, walking up stairs or doing step-ups.	<p>Sec 1 LD Change: 'recognise' to 'recall'.</p> <p>Sec 1 SD Add: Use the equation: <math>\text{weight} = \text{mass} \times \text{gravitational field strength}</math>.</p> <p>Sec 1 HD Add: Use the equation, including a change in subject: <math>\text{weight} = \text{mass} \times \text{gravitational field strength}</math>.</p> <p>Sec 2 LD Delete: 1st and 3rd statements. Amend to: Understand that the amount of work done depends on (2 clarification points). Change: 'state' to 'recall' in 4th statement. Add: Describe how energy is transferred when work is done. Use the equation: <math>\text{work done} = \text{force} \times \text{distance}</math>.</p> <p>Sec 2 SD Amend to: Use the equation, including a change of subject.</p> <p>Sec 2 HD Amend to: Use the equation, then use the value for work done in the power equation below.</p> <p>Sec 3 LD Change: 'state' to 'recall'. Delete: 2nd bullet. Add: have different engine sizes (as bullet point) and these relate to fuel consumption.</p> <p>Sec 3 HD Amend to: Use the equation, including change of subject, when work has been calculated. Add: Use and understand the derivation of the power equation in the form: <math>\text{power} = \text{force} \times \text{speed}</math>.</p>	P3d Work and power

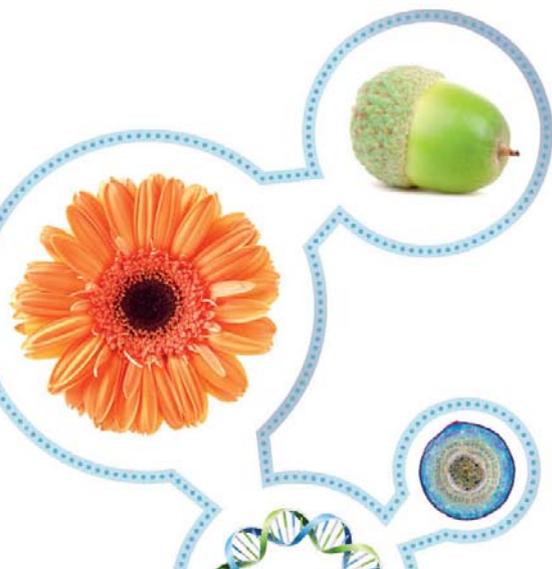
<p>P3e Energy on the move</p>	<p>Add: Carry out research to find out which energy sources can be used to move motor vehicles, and discover what proportion of vehicles use each source. Evaluating data from fuel consumption figures for cars. Construct a wall chart etc. to illustrate the problems of large engine cars and the merits of solar power and bio-fuels.</p>	<p>Sec 1 LD Delete: Existing. Add: Understand that kinetic energy (KE) depends on the mass and speed of an object.          Sec 1 SD Delete: Existing. Add: Use and apply the equation: <math>KE = \frac{1}{2} mv^2</math>.          Sec 1 HD Amend to: Use and apply the equation... including a change of subject.          Sec 2 LD Amend to: Describe how electricity can be used for road transport, and how its use could affect different groups of people and environment (2 clarification points). Add: Recall that bio-fuels and solar energy are possible alternatives to fossil fuels.          Sec 2 SD Delete: Existing. Add: Existing sec 3. Describe arguments for and against the use of battery powered cars. Explain why we may have to rely on bio-fuelled and solar powered vehicles in the future.          Sec 2 HD Delete: Existing. Add: Explain how bio-fuelled and solar powered vehicles (3 clarification points).          Sec 3 LD Delete: Existing. Add: Draw conclusions from basic data about fuel consumption, including emissions (no recall required). Recognise that the shape of moving objects can influence its top speeds and fuel consumption (4 clarification points).          Sec 3 SD Delete: Existing. Add: Interpret data about fuel consumption, including emissions.          Sec 3 HD Add: 1st statement from existing sec 2.          Delete: 'Describe and'. Add: Evaluate and compare data about fuel consumption and emissions.</p>	<p>P3e Energy on the move</p>
<p>P3f Crumple zones</p>	<p>Add: Show videos on road safety and describe how seatbelts reduce the rate at which momentum changes. Use road safety websites/ booklets to find out about safety features of cars and how they are tested, compared, and reported to the public. Draw a timeline showing when different safety features became standard in cars. Test seatbelt materials for stretching.</p>	<p>Sec 1 New.          Sec 1 LD Add: Use the equation: momentum = mass x velocity to calculate momentum.          Sec 1 SD Add: Use the equation including change in subject: momentum = mass x velocity. Describe why the greater the mass of an object and/or the greater the velocity, the more momentum the object has in the direction of motion. Use the equation: force = change in momentum/time to calculate force.          Sec 1 HD Add: Use and apply the equation including a change of subject: force = change in momentum/time. Use Newton's second law of motion to explain the above points: <math>F=ma</math>.          Sec 2 New.          Sec 2 LD Add: Recall that a sudden change in momentum in a collision results in a large force that can cause injury.          Sec 2 SD Add: Explain how spreading the change in momentum over a longer time reduces the likelihood of injury. Explain, using the ideas about momentum, the use of crumple zones, seatbelts, airbags in cars.          Sec 2 HD Add: 1st statement from existing sec 1.          Change: 'explain that' to 'explain why'.          Existing sec 1 becomes new sec 3.</p>	<p>P3f Crumple zones</p>

		<p>Sec 3 LD Delete: 2nd and 3rd statements. Add: Recognise the risks and benefits arising from the use of seatbelts. Recall and distinguish between typical safety features of cars which: are intended to prevent accidents or; are intended to protect occupants in the event of an accident.</p> <p>Sec 3 SD Delete: 2nd and 3rd statements. Add: Describe how test data may be gathered and used to identify and develop safety features for cars.</p> <p>Sec 3 HD Delete: 1st and 2nd statements. Add: Describe how ABS brakes (3 clarification points). Analyse personal and social choices in terms of risk and benefits of wearing seatbelts.</p>	
P3g Falling safely	Add: Use an electronic time device to investigate falling objects. Make a wall chart by drawing a series of pictures of a falling parachutist to show stages of flight for a sky-diver.	<p>Sec 1 LD Delete: Existing. Add: Recognise that frictional forces (drag, friction, air resistance): act against the movement; lead to energy loss and inefficiency; can be reduced (shape, lubricant). Explain how objects falling through the Earth's atmosphere reach a terminal speed.</p> <p>Sec 1 SD Delete: 1st statement. Change: 'describe' to 'explain'.</p> <p>Sec 2 New.</p> <p>Sec 2 LD Add: Understand why falling objects do not experience drag when there is no atmosphere.</p> <p>Sec 2 SD Add: Recognise that acceleration due to gravity is the same for any object at a given point on the Earth's surface.</p> <p>Sec 2 HD Add: Understand that gravitational field strength or acceleration due to gravity (3 clarification points).</p>	P3g Falling safely
P3h The energy of games and theme rides		<p>Sec 1 LD Delete: bullet points.</p> <p>Sec 1 SD Delete: 3rd and 4th statements. Add: Use the equation <math>GPE = mgh</math>.</p> <p>Sec 1 HD Amend to: Understand that for a body falling through the atmosphere at terminal speed (clarification points extended). Add: Use and apply the equation, including a change of subject: <math>GPE = mgh</math>.</p> <p>Sec 2 SD Add: Existing sec 3.</p> <p>Sec 2 HD Add: Use and apply the relationship: <math>mgh = \frac{1}{2}mv^2</math>. Show that for a given object falling to Earth, this relationship can be expressed as: <math>h = v^2 / 2g</math>, and give an example of how this formula could be used.</p> <p>Sec 3 Delete: Existing.</p>	P3h The energy of games and theme rides

**Module P4**

P4h new sections on fusion.

New item	Practical/research activities	Content additions and deletions (sections refer to new items)	Current item
P4a Sparks	Add: Carry out experiments to create static charges and investigate the effects that result.	Sec 1 LD Add: Existing sec 2. Delete: 'describe and'; 1st bullet point. Sec 2 LD Add: Existing sec 1. Delete: 'describe and'. Sec 2 SD Delete: 'State and' in 1st statement. Change: 'State and' to 'understand' in 2nd statement. Sec 2 HD Add: Existing sec 1. Recognise that atoms or molecules that have become charged are ions. Sec 3 LD Delete: 'recognise and' in 1st and 2nd statements. Change: 'vinyl' to 'synthetic carpet'. Sec 3 HD Add: bonding fuel tanker to aircraft (as bullet point in 1st statement). Delete: 2nd statement.	P4a Sparks Sec 1, 2
P4b Uses of electrostatics	Add: Research how electrostatic precipitators work and how effective they are at reducing some pollution. Research how defibrillators are used by medical staff in emergencies.	Sec 1 LD Delete: Existing. Add: Recall that electrostatics can be used for electrostatic precipitators: remove the dust or soot in smoke; used in chimneys. Sec 1 SD Delete: Existing. Add: Existing sec 2. Amend: Wording of bullet points. Sec 1 HD Delete: Existing. Add: 1st statement from existing sec 2. Amend: Wording of bullet points. Sec 2 LD Add: Recall that electrostatics can be used for spraying: spray painting; crop spraying. Sec 2 SD Delete: Existing. Add: Existing sec 3. Amend: Wording of bullet points. Sec 2 HD Delete: Existing. Add: Existing sec 3. Amend: Wording of bullet points. Sec 3 LD Add: Recall that electrostatics can be used for restarting the heart when it has stopped (defibrillator). Recall that defibrillators work by discharging charge. Sec 3 SD Delete: Existing. Add: Existing sec 1. Amend: Wording of bullet points. Sec 3 HD Delete: Existing. Add: Existing sec 1. Amend: Wording of bullet points.	P4b Uses of electrostatics



<p>P4c Safe electricals</p>	<p>Add: Also the effects of length and thickness of resistance wire on current and resistance can be investigated. Research house wiring features such as plugs and ring mains. Compare a range of appliances to identify which are double insulated and what they have in common. Research and compare power and fuse ratings in common household appliances. A circus of appliances with plugs open and comparison of appliance coverings.</p>	<p>Existing sec 2 becomes new sec 1.          Sec 1 LD Add: Explain the behaviour of simple circuits in terms of the flow of electric charge. Describe how variable resistors can be used to change the current in a circuit (2 clarification points) (rheostat configured as a variable resistor only). Recall that resistance is measured in ohms.          Sec 1 SD Add: Clarification points to 1st statement. Change: 'describe' to 'explain' in 1st statement; 'pd' to 'voltage'.          Sec 1 HD Amend to: Use and apply the equation, including change of subject.          Existing sec 3 becomes new sec 2.          Sec 2 LD Change: 'state' to 'recall' and 'describe' to 'state'.          Existing sec 4 becomes new sec 3.          Sec 3 LD Add: Existing sec 5, deleting 'describe and'.          Sec 3 SD Delete: Existing. Add: 1st statement from existing HD. Use the equation: power = voltage x current. Existing sec 5.          Sec 3 HD Delete: 1st statement. Amend to: Explain how the combination of a wire fuse and earthing protects people. Add: Use the equation, including a change in subject: power = voltage x current, to select a suitable fuse for an appliance.          Existing sec 5 becomes new sec 4.</p>	<p>P4c Safe electricals Sec 2, 3, 4, 5</p>
<p>P4d Ultrasound</p>	<p>Add: Use slinky/ rope to demonstrate wave behaviours. Use echoes from hard surfaces to develop idea of reflection of sound, and calculation of distance to the surface.</p>	<p>Sec 1 LD Change: 'state and recognise' to 'recall'. Delete: 1st and 2nd bullet points.          Sec 1 SD Delete: 1st bullet points. Change: 'state and recognise' to 'recall'.          Sec 1 HD Amend to: Describe and compare the motion and arrangement of particles in longitudinal and transverse physical waves (5 bullet points).          Sec 2 LD Amend to: Recognise that ultrasound can be used in medicine. Delete 2nd bullet point. Add: Not expected to describe Doppler effect.          Sec 2 SD Amend to: Recognise that ultrasound can be used in medicine for non-invasive therapeutic purposes such as to break down kidney and other stones.</p>	<p>P4d Ultrasound</p>

<p>P4e What is radio-activity?</p>	<p>Delete: 1st activity. Add: And rocks containing radioactive materials (to 3rd activity). Model radioactive decay with dice or computer simulations. Use the periodic table to construct a graph of proton number against neutron number to show line of stability.</p>	<p>Sec 1 LD Delete: 'Describe and' in 1st statement. Change: 'describe and recognise' to 'understand' in 2nd statement. Add: Recall that nuclear radiation ionises materials. Sec 1 SD Delete: 2nd, 3rd and 4th statements. Add: Explain and use the concept of half-life. Interpret graphical data of radioactive decay to include a qualitative description of half-life. Explain ionisation in terms of (2 clarification points). Sec 1 HD Delete: 1st statement. Add: to include calculation of half-life (to 2nd statement). Explain why alpha particles are such good ionisers. Sec 2 LD Change: 'describe' to 'recall'. Sec 2 SD Add: 2nd, 3rd and 4th statements from existing sec 1. Change: 'state' to 'recall'. Sec 2 HD Delete: 'simple' in 3rd statement.</p>	<p>P4f What is radioactivity?</p>
<p>P4f Uses of radio-isotopes</p>	<p>Add: Research and debate the issues surrounding the storage and disposal of radioactive waste. Investigate the variation of background radiation with location and possible health risks. Research the use of radioisotopes in industry.</p>	<p>Sec 1 LD Add: Understand why background radiation can vary. Recall that background radiation mainly comes from rocks and cosmic rays. Sec 1 SD Add: Recall that some background radiation comes from waste products and man made sources e.g. waste from: industry; hospitals. Sec 1 HD Add: Evaluate the relative significance of sources of background radiation. Sec 2 LD Delete: Existing. Add: Existing SD. Sec 2 SD Delete: Existing. Add: Existing HD. Delete: 2nd bullet point. Sec 2 HD Delete: Existing. Add: Explain why gamma radiation is used as an industrial tracer. Sec 3 LD Change: 'describe' to 'recall'. Sec 3 SD Change: 'describe' to 'explain'. Add: 3 clarification points. Sec 4 LD Add: 1st statement from existing SD. Sec 4 SD Delete: 1st statement. Add: Explain how the radioactive dating of rocks depends on the calculation of the uranium/lead ratio. Sec 4 HD Delete: 1st statement.</p>	<p>P4g Uses of radioisotopes Sec 2, 3, 4</p>
<p>P4g Treatment</p>	<p>Add: Look at x-ray images and research how they are produced. Research the production of medical radioisotopes. Demonstrate and model the tracer idea with a radioactive source (low level sample eg rock, only) hidden in school skeleton and detected outside. Investigate the balance of risks for staff and patients for radiotherapy which kills both healthy and cancerous cells.</p>	<p>Sec 1 LD Delete: Existing. Add: Describe some similarities and differences between X-rays and gamma rays (3 clarification points). Sec 1 SD Delete: Existing. Add: Recall that materials absorb some ionising radiation. Understand how the image produced by the absorption of x-rays depends on the thickness and density of the absorbing materials. Sec 1 HD Change: 'explain that' to 'explain how'. Sec 2 LD Delete: Existing. Add: Recall that medical radioisotopes are produced by placing materials into a nuclear reactor. Sec 2 SD Delete: Existing. Add: Describe how materials become radioactive when they absorb extra neutrons.</p>	<p>P4e Treatment</p>

		<p>Sec 2 HD Delete: Existing.</p> <p>Sec 3 LD Add: Describe uses of nuclear radiation in medicine to include (3 clarification points). Recall that only beta and gamma radiation can pass through skin. Recall that nuclear radiation can damage cells. Describe the role of a radiographer and the safety precautions they must take.</p> <p>Sec 3 SD Delete: Existing. Add: Existing sec 2, changing 'describe that' to 'explain why'. Understand why medical tracers should not remain active in the body for long periods.</p> <p>Sec 3 HD Add: Existing sec 2.</p>	
P4h Fission and fusion	<p>Add: Research nuclear accidents in power plants. Debate the issues surrounding nuclear power as a solution to future UK needs. Investigate potential benefits and difficulties of developing fusion based nuclear reactors. Investigate 'Cold Fusion' controversy (<i>Fleischmann–Pons claims</i>) as example of development of theories and peer review process.</p>	<p>Sec 1 HD Add: more neutrons released (as bullet point).</p> <p>Sec 2 LD Delete: Existing. Add: 1st and 2nd statements from existing SD. 'and that it is kept under control' (to 1st statement). Change: 'state' to 'recall' in 2nd statement.</p> <p>Sec 2 SD Delete: Existing. Add: Understand how the decay of uranium starts a chain reaction. Describe a nuclear bomb as a chain reaction that has gone out of control.</p> <p>Section 3 New.</p> <p>Sec 3 LD Add: Describe the difference between fission and fusion (2 clarification points).</p> <p>Sec 3 SD Add: Describe how nuclear fusion releases energy (3 clarification points). Describe why fusion for power generation is difficult (2 clarification points). Understand why fusion power research is carried out as an international joint venture.</p> <p>Sec 3 HD Add: Explain how different isotopes of hydrogen can undergo fusion to form helium:</p> ${}^1_1\text{H} + {}^2_1\text{H} \rightarrow {}^3_2\text{He}$ <p>Understand the conditions needed for fusion to take place, to include (3 clarification points).</p> <p>Sec 4 New.</p> <p>Sec 4 LD Add: Recall that one group of scientists have claimed to successfully achieve 'cold fusion'. Explain why the claims are disputed: other scientists could not repeat their findings.</p> <p>Sec 4 SD Add: Explain why the 'cold fusion' experiments and data have been shared between scientists.</p> <p>Sec 4 HD Add: Explain why 'cold fusion' is still not accepted as a realistic method of energy production.</p>	P4h Fission

**Module P5**

P5f new section on nature of light

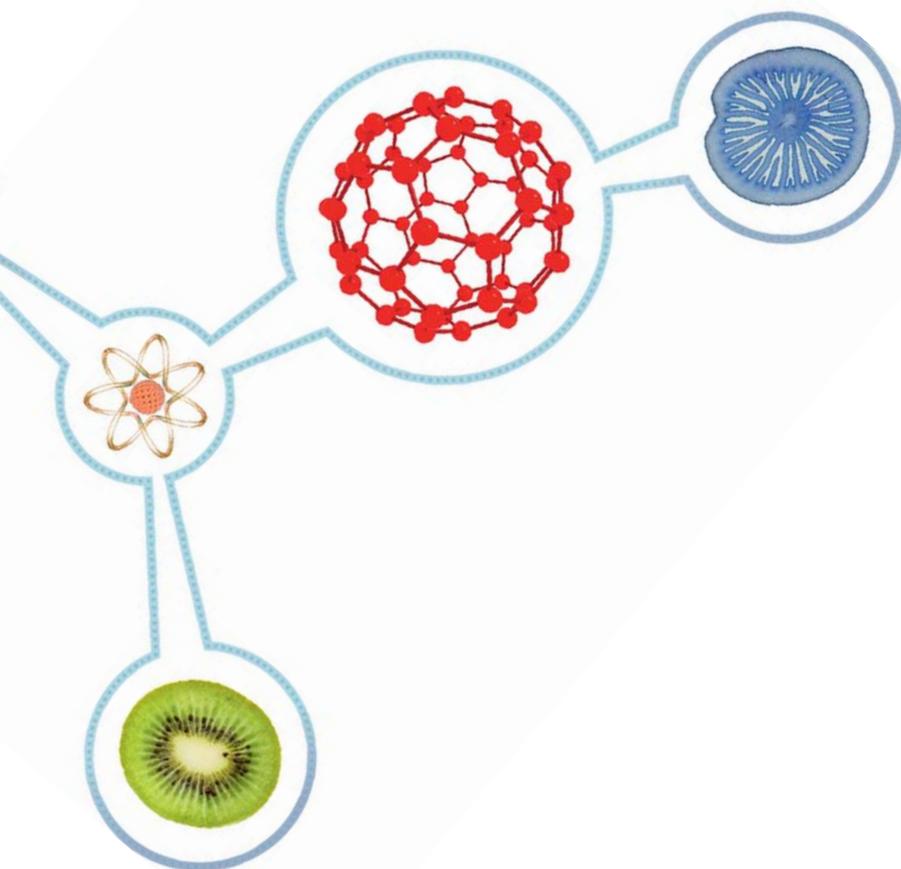
New item	Practical/research activities	Content additions and deletions (sections refer to new items)	Current item
P5a Satellites, gravity and circular motion	Add: Use NASA websites. Demonstration of unbalanced force using a record deck.	Sec 1 LD Delete: 'state and' in 1st statement. 2nd statement. Change: 'state and recognise' to 'describe' in 3rd statement. Add: Recall gravity universal force of attraction. Sec 1 SD Delete: 1st statement. Sec 1 HD Add: 2 clarification points to 2nd statement. Sec 2 LD Change: 'recognise that' to 'describe how' in 1st statement; 'state that' to 'recall how' in 2nd statement. Sec 2 SD Delete: 3rd statement. Combine: 1st and 2nd statements. Change: 'know that circular motion' to 'understand that...' Sec 2 HD Delete: 1st statement. Change: 'explain' to 'understand'. Sec 3 LD Change: 'state and recognise' to 'recall'. Sec 3 SD Combine: 1st and 2nd statements. Amend to: Explain why different satellite applications require different orbits, to include the orbit's: height; period; trajectory (including polar orbit). Sec 3 HD Delete: Existing. Add: Explain why artificial satellites in lower orbits travel faster than those in higher orbits.	P5a Satellites, gravity and circular motion
P5b Vectors and equations of motion		Sec 1 LD Change: 'recognise' to 'recall'. Delete: 2nd statement. Add: Understand how relative speed depends on the direction of movement (in context of two cars travelling on a straight road). Sec 1 SD Change: 'know' to 'describe'. Sec 2 LD Amend: Clarification points in 1st statement reworded. Delete: 2nd statement. Add: Recognise that for any journey: distance travelled can be calculated using the equation: distance = average speed x time; $s = (u+v) / 2 \times t$ . Use the equation $v = u + at$ to calculate final speed. Sec 2 SD Amend to: Use the equation, including a change of subject ( $s = (u+v) / 2 \times t$ ).	P5b Vectors and equations of motion
P5c Projectile motion	Add: Collect information from the internet to produce PowerPoint on how launch angle can affect range of ball.	Sec 1 LD Delete: 2nd statement. Change: 'state and recognise' to 'recall and identify' in 1st statement; 'state' to 'recall' in 3rd statement. Sec 1 SD Add: 2nd statement from existing LD, deleting 'state, recognise and' from statement. Recall that the horizontal and vertical velocities of a projectile are vectors. Sec 1 HD Add: 2nd statement from existing sec 3, changing 'explain' to 'understand'. Sec 2 LD Delete: Existing. Add: Recognise examples of projectile motion in a range of contexts. Sec 2 SD Change: 'explain' to 'recall'. Add: Further clarification.	P5c Projectile motion

		<p>Sec 3 LD Add: Recall that the range of a ball struck in sport depends on the launch angle, with an optimum angle of 45°.</p> <p>Sec 3 SD Change: 'explain' to 'recall' in 1st statement; 'explain' to 'understand' in 2nd statement. Add: Interpret data on the range of projectiles at different launch angles.</p> <p>Sec 3 HD Delete: 2nd statement. Amend to: Explain how for an object projected horizontally (3 clarification points).</p>	
P5d Action and reaction	Add: Discuss examples of collisions in sport. Compare mass of fuel and mass of rockets for commercial rocket systems. Research the use of ion motors for deep space probes.	<p>Sec 1 SD Delete: Existing. Add: Understand that when an object collides with another object or two bodies interact, the two objects exert an equal and opposite force on each other. (Newton's third law of motion).</p> <p>Sec 2 LD Change: 'simple collision' to 'parallel collision'. Add: 2nd statement from existing sec 3, adding 'to include sporting examples and car collisions'.</p> <p>Sec 2 SD Delete: Existing. Add: Describe the opposite reactions in a number of static situations including examples involving gravity. Understand that equal but opposite forces act in a collision and use this to explain the change in motion of the objects, to include recoil.</p> <p>Sec 2 HD Delete: Existing. Add: Existing sec 4, adding 'for collisions when the colliding objects coalesce using the equation <math>m_1 u_1 + m_2 u_2 = (m_1 + m_2) v'</math> to 2nd statement. Change: 'explain' to 'understand' in 1st statement; 'interpret' to 'apply' in 2nd statement.</p> <p>Sec 3 New.</p> <p>Sec 3 LD Add: Explain, using a particle model, how a gas exerts a pressure on the walls of its container.</p> <p>Sec 3 SD Add: Explain, using a particle model, how a change in volume or temperature produces a change in pressure.</p> <p>Sec 3 HD Add: Explain pressure in terms of (2 clarification points).</p> <p>Sec 4 New.</p> <p>Sec 4 LD Add: Recall that in a rocket, the force pushing the particles backwards equals the force pushing the rocket forwards.</p> <p>Sec 4 SD Add: Explain, using kinetic theory, rocket propulsion in terms of fast moving particles colliding with rocket walls creating a force.</p> <p>Sec 4 HD Add: Explain how, for large scale rockets used to lift satellites into Earth's orbit, sufficient force is created to lift the rocket (2 clarification points).</p>	P5d Momentum Sec 1, 2, 4

P5e Satellite communication	Add: Demonstration of single edge diffraction using a laser beam.	<p>Sec 1 LD Delete: 1st statement. Amend: Reword 2nd statement for greater clarification.</p> <p>Sec 1 SD Add: Explain why satellite communication uses digital signals.</p> <p>Sec 1 HD Delete: Existing. Add: Explain why satellite transmitting and receiving dishes need very careful alignment: (3 clarification points).</p> <p>Sec 2 LD Delete: 2nd and 3rd statements. Amend: Reword 1st statement. Add: Recall that some radio waves (eg short wavelength) and microwaves pass through the Earth's atmosphere.</p> <p>Sec 2 SD Combine: 1st and 2nd statements. Delete: 3rd statement.</p> <p>Sec 2 HD Delete: Existing.</p> <p>Sec 3 LD Change: 'describe and recognise' to 'recall' in 1st statement. Delete: 2nd statement. Add: Recognise that radio waves can 'spread' around large objects. Describe a practical example of waves spreading out from a gap.</p> <p>Sec 3 SD Delete: 1st statement. Amend to: Explain why long wave radio waves have a very long range. Add: Recall wave patterns produced by a plane wave passing through different sized gaps.</p> <p>Sec 3 HD Delete: Existing. Add: Describe how the amount of diffraction depends upon the size of the gap and the wavelength of the wave, including the conditions for maximum diffraction.</p>	P5e Satellite communication
P5f Nature of waves	Add: Compare the conflicting theories of Huygens and Newton and how acceptance of the theories changed over time.	<p>Sec 1 LD Delete: 3rd and 4th statements and 'and recognise' from 1st statement. Add: Describe the effect of interference on waves in different contexts, to include: sound; light; water.</p> <p>Sec 1 SD Delete: 1st statement. Add: Apply understanding of interference to describe practical examples of interference effects using sound waves, surface water waves or microwaves. Recall that coherent wave sources are needed to produce a stable interference pattern. Understand that for light the coherent sources are monochromatic light.</p> <p>Sec 1 HD Delete: 'describe and' in 1st statement. Amend: Deleting bullet points and adding 'relates to the type of interference used' in 2nd statement. Describe the properties of coherent wave sources: same frequency; in phase; same amplitude.</p> <p>Sec 2 LD Add: 'to include recall of evidence to support this theory (eg shadows and eclipses)' to 1st statement. Recall that all electromagnetic waves are transverse.</p> <p>Sec 2 SD Amend to: Describe diffraction of light for: a single slit; double slits; and that the interference patterns produced are evidence for the wave nature of light. Change: 'describe' to 'understand' in 2nd statement. Add: Explain what is meant by plane polarised light.</p>	P5f Nature of waves

		<p>Sec 2 HD Delete: 'describe and' in 1st statement. Add: Clarification points to 1st and 2nd statements.</p> <p>Sec 3 New.</p> <p>Sec 3 LD: Recall that explanations of the nature of light have changed over time, with some scientists describing light as waves, and some scientists describing light as particles. Describe reflection of light in terms of a simple particle model.</p> <p>Sec 3 SD Add: Explain why the particle theory of light is not universally accepted.</p> <p>Sec 3 HD Add: Explain how the wave theory of light has supplanted the particle theory, as the evidence base has changed over time.</p>	
P5g Refraction of waves	<p>Delete: Reference to Snell's law. Add: Carry out an experiment to compare the refractive index of glass or Perspex.</p> <p>Carry out an experiment to compare the critical angle of glass or Perspex. Make a wall chart, leaflet, Powerpoint, of many uses of TIR.</p>	<p>Sec 1 LD Delete: 1st statement. Change: 'state and recognise that for' to 'explain why'.</p> <p>Sec 1 SD Combine: 1st and 2nd statements. Amend: Reword, changing 'describe' to 'explain' and adding clarification points. Delete: 3rd statement. Add: Describe refractive index as a measure of the amount of bending after a boundary. Use the equation: (refractive index).</p> <p>Sec 1 HD Delete: Existing. Add: Interpret data on refractive indices and speed of light to predict the direction of refraction (Snell's law not required). Use the refractive index equation, including a change of subject. This will require the use of standard form notation and/or a scientific notation calculator.</p> <p>Sec 2 LD Delete: 2nd statement. Add: Recall the order of the spectral colours and relate this to the order of the wavelength.</p> <p>Sec 2 SD Delete: 3rd statement.</p> <p>Sec 2 HD Delete: 1st statement. Add: Clarification points to 2nd statement.</p> <p>Sec 3 LD Add: Recall the many uses of TIR (3 bullet points).</p> <p>Sec 3 SD Add: Describe the optical path in devices using TIR (3 bullet points).</p> <p>Sec 3 HD Amend to: Explain the conditions under which total internal reflection (TIR) can occur. Delete: 2nd statement. Amend to: Explain how the refractive index of a medium relates to its critical angle.</p>	P5g Refraction of waves

P5h Optics	Reordered. Add: Examine different lenses from old spectacles. Carry out an experiment with a convex lens to measure magnification.	<p>Sec 1 LD Change: 'recognise' to 'recall and identify' in 1st statement; 'state' to 'recall' in 2nd statement. Delete: 'state and' from 5th statement.</p> <p>Sec 1 SD Add: For a convex lens recall and recognise (4 clarification points).</p> <p>Sec 1 HD Add: Explain the refraction by a convex lens of (3 clarification points).</p> <p>Sec 2 LD Amend to: Recognise and recall that convex lenses produce real images on a screen.</p> <p>Sec 2 SD Amend to: Describe how a convex lens produces a real image on film and screen respectively. Add: A suitable diagram may be required or given.</p> <p>Sec 3 LD Change: 'state' to 'recall'. Add: in some spectacles (as bullet point).</p> <p>Sec 3 SD Add: Use the equation: (magnification).</p> <p>Sec 3 HD Delete: 1st and 2nd statements. Add: Describe the properties of a real and virtual images. Amend to: Use the equation, including a change of subject: (magnification).</p>	P5h Optics
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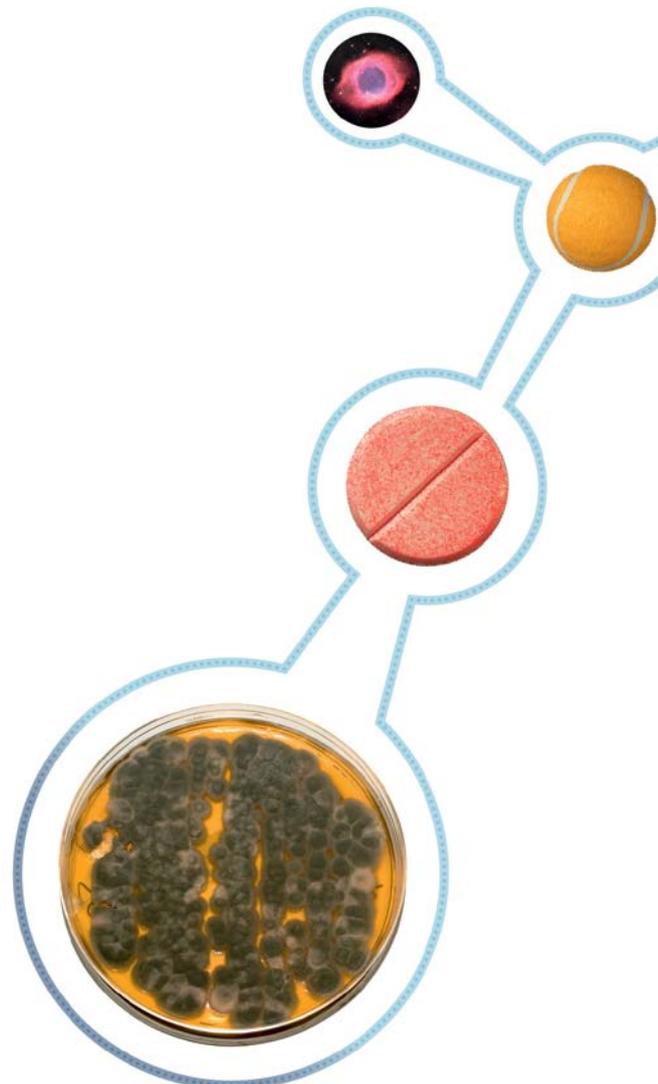
## Module P6

New item	Practical/research activities	Content additions and deletions (sections refer to new items)	Current item
P6a Resisting		<p>Sec 1 LD Change: 'state' to 'recognise and draw' in 1st statement. Add: 'rheostat' to 2nd statement.</p> <p>Sec 1 SD Delete: 'describe and'.</p> <p>Sec 1 HD Amend to: Explain the effect of changing the length of resistance wire in a variable resistor (rheostat) on the resistance.</p> <p>Sec 2 LD Change: 'state' to 'recall' in 1st statement; 'state and recognise' to 'recall and identify' in 2nd statement.</p> <p>Add: Use the equation:  <math display="block">\text{resistance} = \text{voltage} / \text{current}</math></p> <p>Sec 2 SD Add: 'including a change of subject' to 1st statement. Change: 'describe how' to 'use' in 2nd statement.</p> <p>Sec 2 HD Delete: 1st statement.</p> <p>Sec 3 LD Delete: Existing. Add: Understand that current in a wire is a flow of charge carriers called electrons. Use models of atomic structure to explain electrical resistance in a metal conductor in terms of charge carriers (electrons) colliding with atoms (ions) in the conductor. Recall and identify how the resistance changes as a wire becomes hot.</p> <p>Sec 3 SD Add: 'and recognise' to statement. Use kinetic theory to explain that for metallic conductors, the collision of charge carriers with atoms makes the atoms vibrate more. This increased atomic vibration (2 clarification points).</p>	P6a Resisting
P6b Sharing	<p>Add: Use multimeters to show how the resistance of LDRs and thermistors are affected by external conditions. Investigate how the fixed resistor in a potential divider can affect the output voltage in temperature sensors and light sensors. Use multimeters to measure the resistance of resistors individually, in series and in parallel.</p>	<p>Sec 1 LD Delete 1st statement. Change: 'describe and recognise' to 'recall'. Add: Understand that two or more resistors in series increase the resistance of the circuit. Calculate the total resistance for resistors in series.</p> <p>Sec 1 SD Change: 'pd' to 'voltage' in 2nd statement. Add: Understand that the output voltage depends on the relative values of the resistors R1 and R2.</p> <p>Sec 1 HD Amend to: Calculate the value of <math>V_{out}</math> when R1 and R2 are in a simple ratio. Add: Understand that when R2 is very much greater than R1, the value of <math>V_{out}</math> is approximately <math>V_{in}</math>. Understand that when R2 is very much less than R1, the value of <math>V_{out}</math> is approximately zero.</p> <p>Sec 2 LD Change: 'describe and recognise' to 'recall and identify' in 1st and 2nd statements. Add: Recognise and draw the symbol for a light dependent resistor (LDR) and a thermistor.</p> <p>Sec 2 HD Change: 'explain how' to 'explain why'.</p> <p>Sec 3 New.</p> <p>Sec 3 SD Add: Understand that placing resistors in parallel rather than in series will reduce the total resistance of the circuit.</p> <p>Sec 3 HD Calculate total resistance for resistors in parallel.</p>	P6b Sharing

<p>P6c It's logical</p>	<p>Add: Examine a simple NPN transistor circuit used as a switch. View a microprocessor chip with casing removed using a microscope. Examine a combination of transistors used as an AND gate. Build logic gate circuits to solve problems.</p>	<p>Sec 1 New. Sec 1 LD Add: Recall that the transistor is the basic building block of electronic components and that the average computer may have millions/billions of them within its circuits. Recall that the transistor is an electronic switch. Recognise and draw the symbol for an NPN transistor and label its terminals. Sec 1 SD Add: Describe the benefits and drawbacks of increasing miniaturisation of electronic components to manufacturers and to users of the products. Understand how a small base current is needed to switch a greater current flowing through the collector and emitter. Use the equation <math>I_e = I_b + I_c</math>. Sec 1 HD Add: Explain how increasing availability of computer power requires society to make choices about acceptable uses of new technologies. Complete a labelled circuit diagram to show how a NPN transistor can be used as a switch for a light-emitting diode LED (circuit diagram given). Explain why a high resistor is placed in the base circuit. Existing sec 1 becomes new sec 2. Sec 2 LD Change: 'state' to 'recall'. Add: Recall that transistors can be connected together to make logic gates. Sec 2 SD Delete: Existing. Add: Recognise the circuit diagram for an AND gate as two transistors connected together (diagram given). Recall that other logic gates can be made from a combination of two transistors. Sec 2 HD Add: Complete a labelled diagram to show how two transistors are connected to make an AND gate.</p>	<p>P6g It's logical Sec 1, 2</p> <p>Sec 1</p>
<p>P6d Even more logical</p>	<p>Delete: Bistable circuit. Add: Investigate the operation of a relay.</p>	<p>Existing P6h sec 1 becomes new sec 1. Sec 1 LD Change: 'state' and 'recognise' to 'recall and identify'. Sec 1 HD Change: 'explain how to work out the' to 'complete a'. Existing P6g sec 3 becomes new sec 2. Existing P6h sec 3 becomes new sec 3. Sec 3 LD Amend to: Recognise and draw the symbols for an LED and a relay. Change: 'state' to 'recall' in 3rd statement. Sec 3 SD Delete: 1st statement. Add: Explain how an LED and series resistor can be used to indicate the output of a logic gate. Sec 3 HD Delete: 1st statement. Change: 'describe that' to 'explain why'.</p>	<p>P6h Even more logical Sec 1, 3</p> <p>P6g It's logical Sec 3</p>

P6e Motoring	Add: Build a DC motor.	<p>Sec 1 LD Change: 'describe' to 'recall' in 1st statement; 'recognise and describe that' to 'explain why' in 3rd statement.</p> <p>Sec 1 SD Change: 'or' to 'and' in 1st statement; 'describe' to 'understand' in 2nd statement.</p> <p>Sec 1 HD Change: 'describe' to 'explain how'.</p> <p>Sec 2 LD Change: 'state' to 'recall'. Add: fan (to list).</p> <p>Recall that electric motors transfer energy to the load (as useful work) and to the surroundings (as waste heat).</p>	P6c Motoring
P6f Generating	Add: Demonstrate the induction effect using a strong magnet and a wire. Using a coil and a strong magnet, show the effect of increasing the number of turns and changing the relative motion of the magnet and coil. Compare the voltage output of AC and DC generators using CRO and how rotation speed affects the output.	<p>Sec 1 LD Amend to: Label a diagram of an AC generator to show the coil, magnets, slip rings and brushes.</p> <p>Sec 1 SD Change: 'describe' to 'understand' in 1st and 2nd statements.</p> <p>Sec 2 LD Amend to: Describe a generator as a motor working in reverse. Change: 'describe' to 'recall' in 2nd statement. Add: Explain why electricity is useful: (2 clarification points).</p> <p>Sec 2 SD Amend to: Explain why the rotation of a magnet inside a coil wire induces an alternating current. Change: 'describe' to 'recall' in 2nd statement.</p>	P6d Generating
P6g Transforming	Add: Demonstrate step-up and step-down transformers. Research how real transformers in the National Grid work. Demonstrate model power lines to show power losses.	<p>Sec 1 LD Combine: 1st and 2nd statements. Delete: 3rd and 4th statements. Change: 'describe' to 'recall' in 5th statement. Add: Understand and use the terms step-up transformer and step-down transformer.</p> <p>Sec 1 SD Delete: 1st and 4th statements. Add: and how this construction changes the size of the output (to end of 3rd statement).</p> <p>Sec 1 HD Add: Use and manipulate the equation: (transformers).</p> <p>Sec 2 LD Change: 'state' to 'recall'. Add: Recognise and draw the symbol for a transformer.</p> <p>Sec 2 SD Amend to: Explain why an isolating transformer is used in some mains circuits (eg bathroom shaver sockets). Delete 2nd statement.</p> <p>Sec 2 HD Change: 'explain that' to 'explain why'. Delete: 2nd bullet point. Add: Improve safety in some mains circuits (as bullet point).</p> <p>Sec 3 LD Change: 'describe' to 'recall'.</p> <p>Sec 3 SD Amend to: Recall and identify that some power is lost through heat in the transmission of electrical power in cables and transformers.</p> <p>Sec 3 HD Add: Understand how power loss in the transmission of electrical power is related to the current flowing in the transmission lines. Use the equation: power loss = current<sup>2</sup> X resistance.</p>	P6e Transforming

P6h Charging	Add: Show students mains voltage-time history from an uninterruptable power supply.	<p>Sec 1 LD Change: 'state' to 'recall' in 2nd statement; 'state' to 'understand' in 3rd statement.</p> <p>Sec 1 SD Change: 'state and recognise' to 'recall and identify' in 3rd statement.</p> <p>Sec 1 HD Amend: Rewording.</p> <p>Sec 2 SD Change: 'describe how' to 'recall that'.</p> <p>Sec 3 LD Delete: 2nd, 3rd and 4th statements. Add: Describe the function of a capacitor. Recall and identify that a capacitor will produce a more constant (smoothed) output. Explain why many devices need a more constant voltage supply.</p> <p>Sec 3 SD Delete: Existing. Add: Describe the result of a current flowing in a circuit containing an uncharged capacitor (2 clarification points). Understand how the flow of current changes with time when a conductor is connected across a charged capacitor.</p> <p>Sec 3 HD Change: 'explain' to 'describe' in 1st statement.</p>	P6f Charging
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