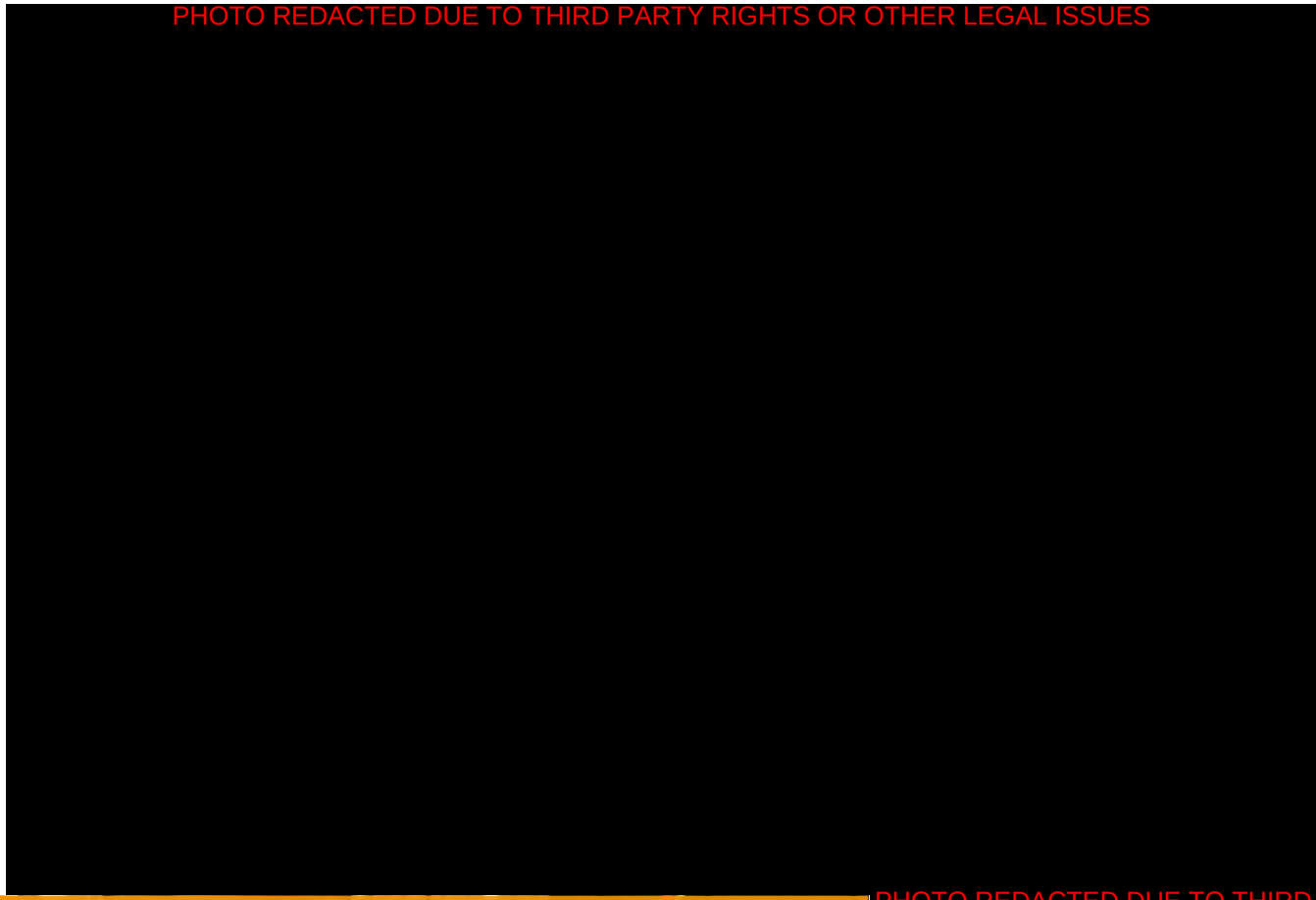
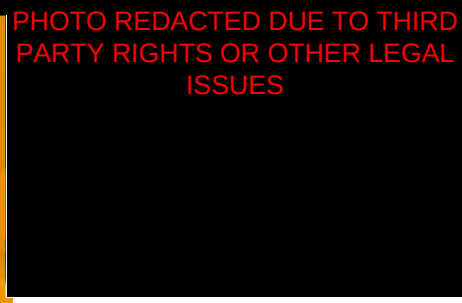
Renewing the Framework for secondary science

Spring 2008 subject leader development meeting: Sessions 2, 3 and 4

Department for Education

The National Strategies
Secondary





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department for
children, schools and families

National Curriculum

Renewing the Framework for secondary science

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DSI COLOURWORKS 02-2008

Renewing the Framework for secondary science

Spring 2008 subject leader development meeting: Sessions 2, 3 and 4

Contents

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Session 2 presentation handouts

What's changed in my subject?

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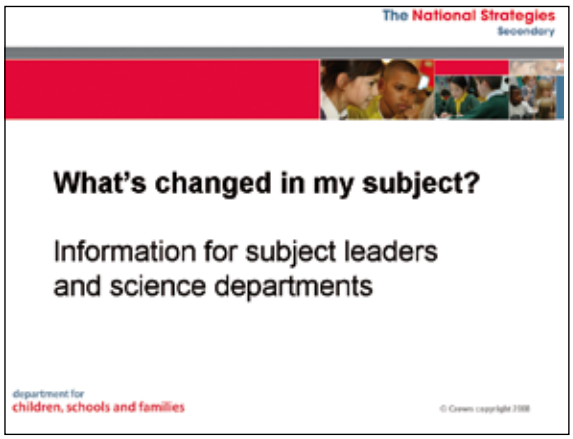

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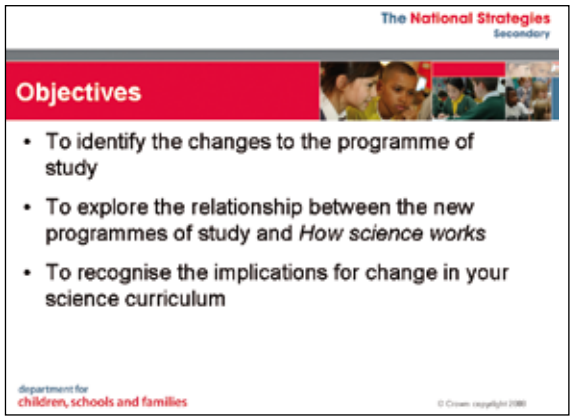

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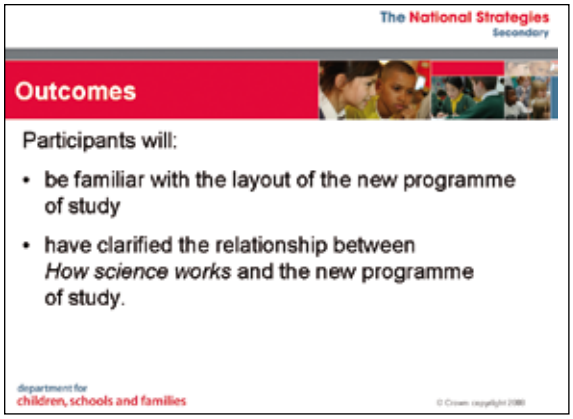

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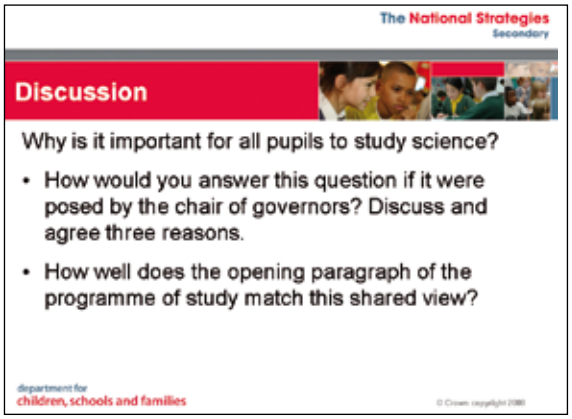

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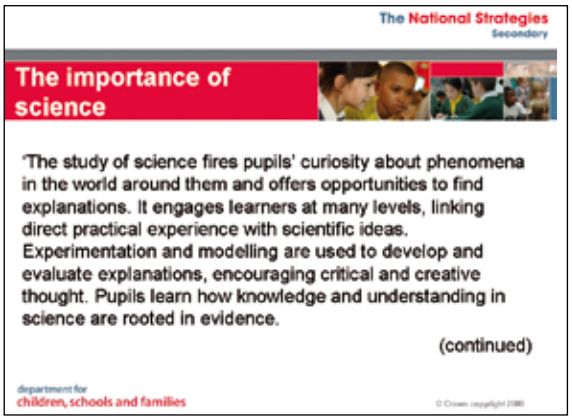

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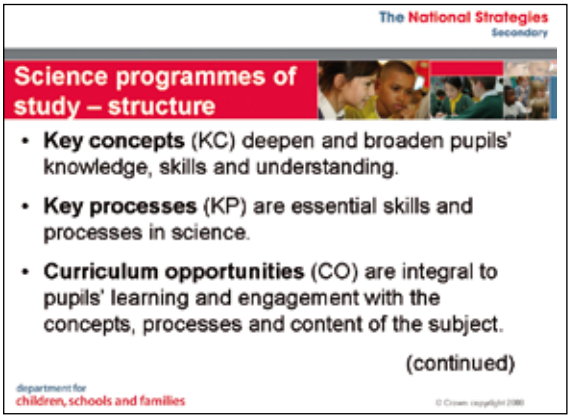

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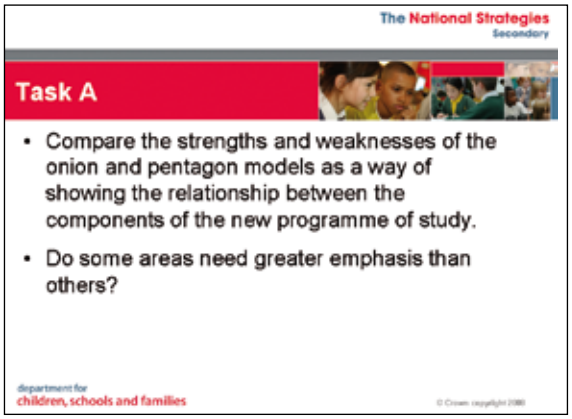

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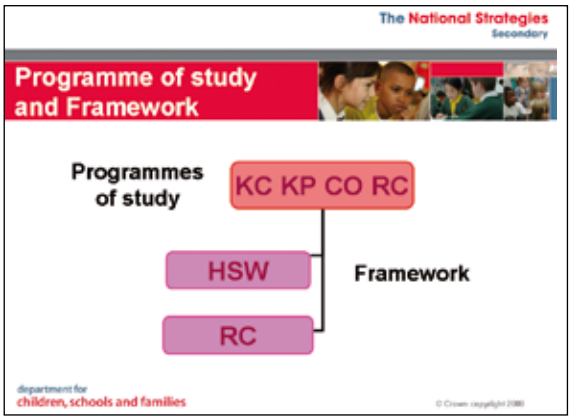

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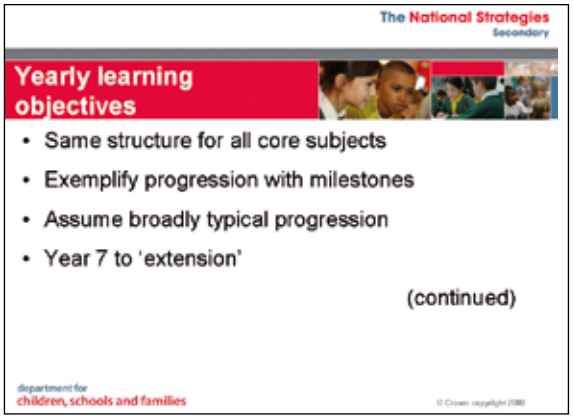

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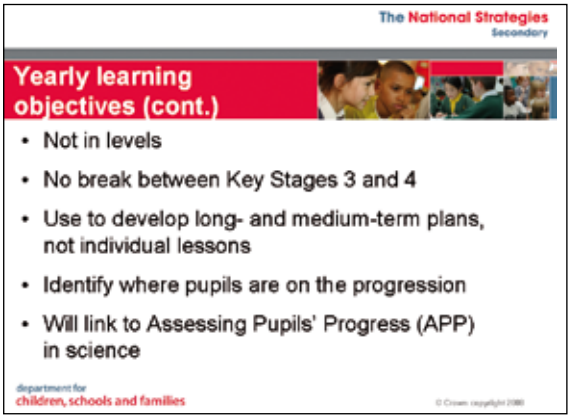

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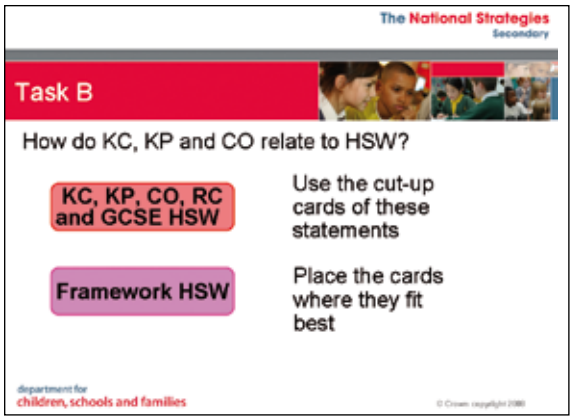

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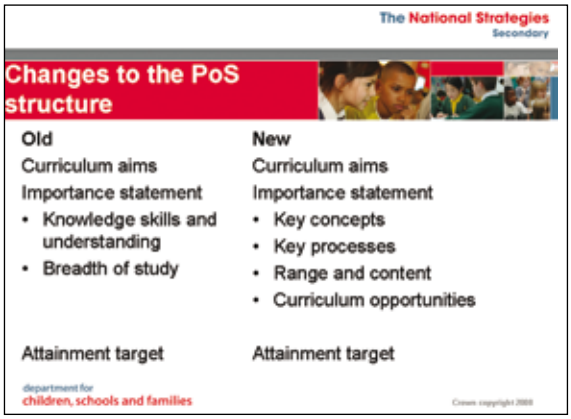

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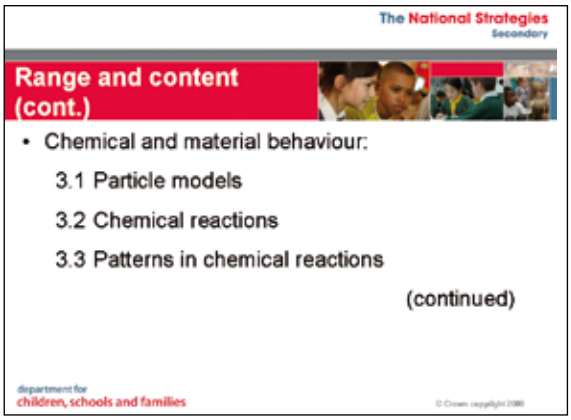

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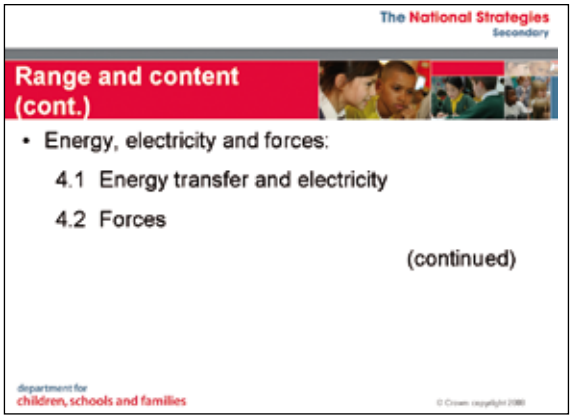

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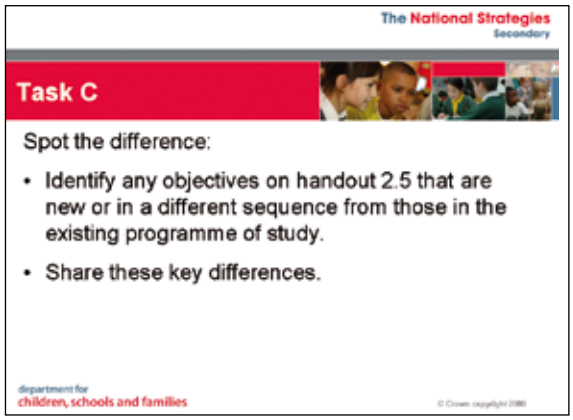

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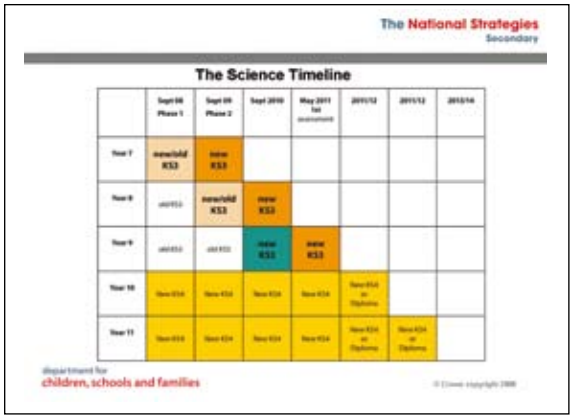

Using the Framework to promote powerful learning

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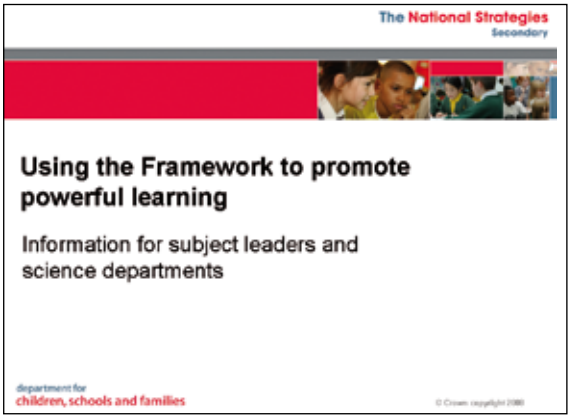

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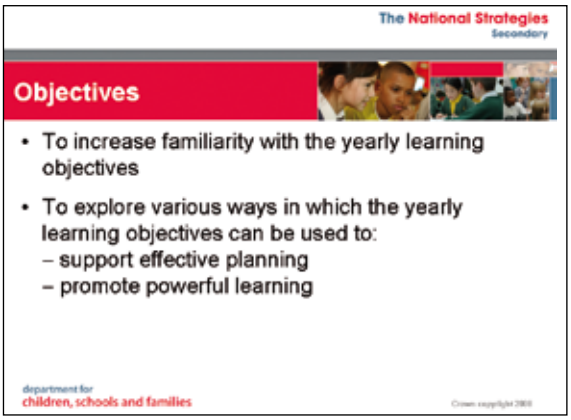

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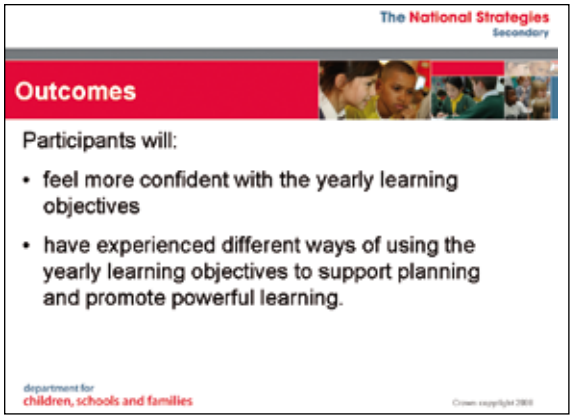

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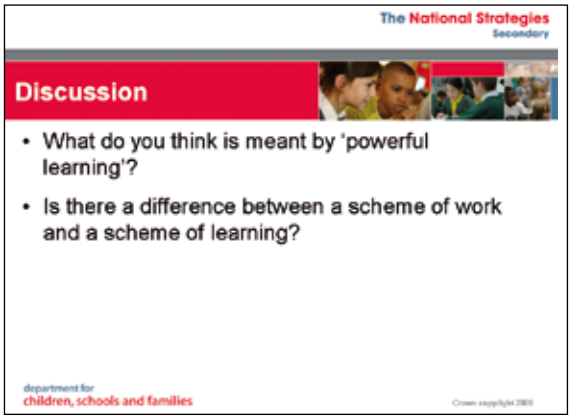

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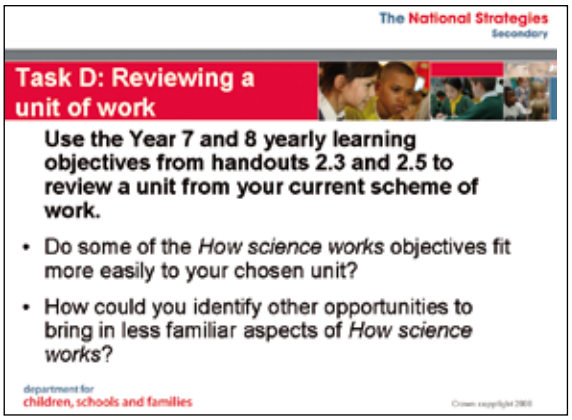

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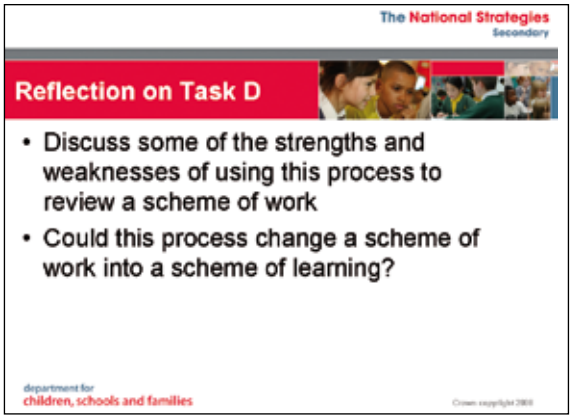

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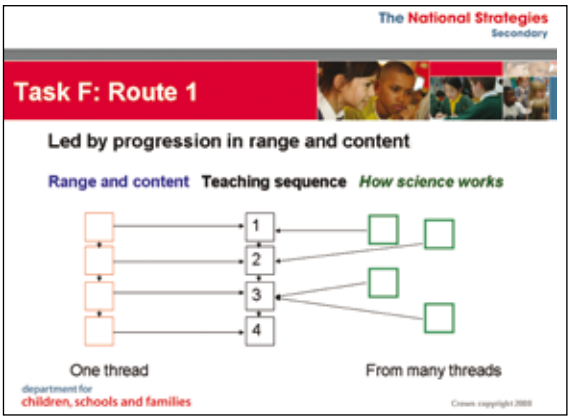

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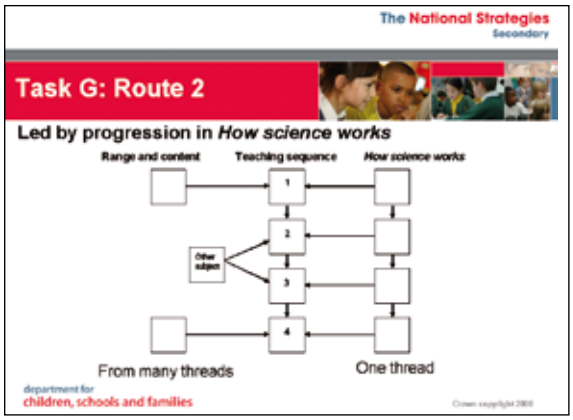

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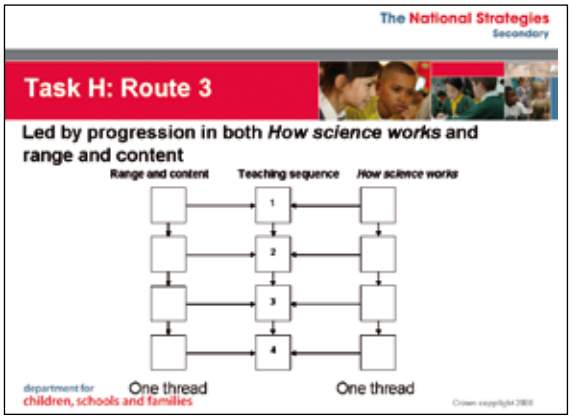

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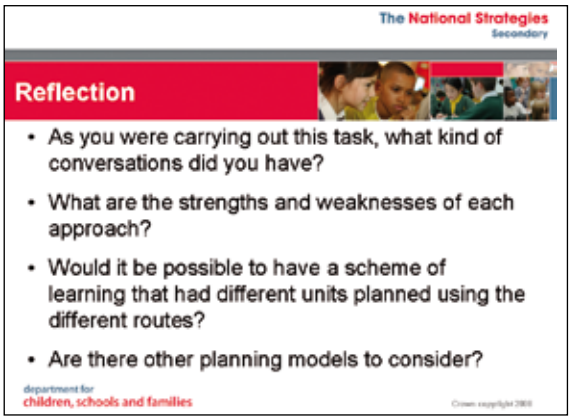

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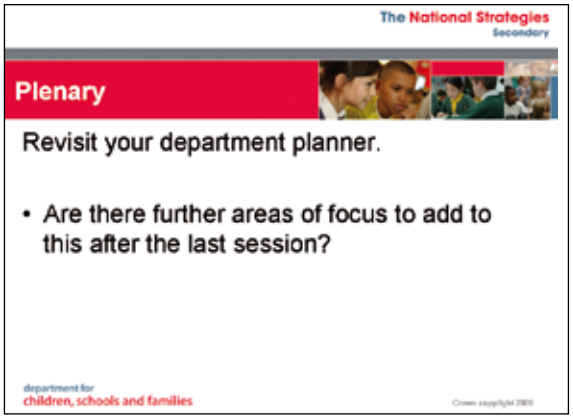
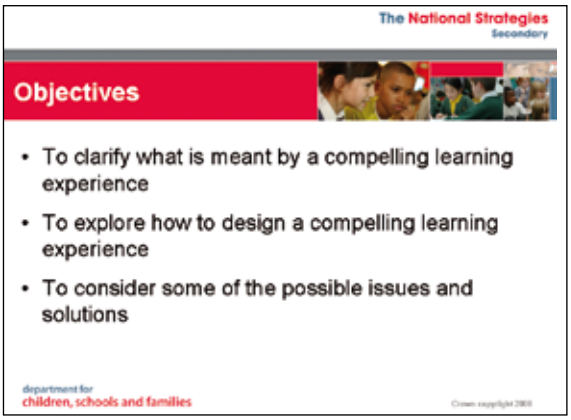


Designing compelling learning experiences

Slide 4.1

Slide 4.2



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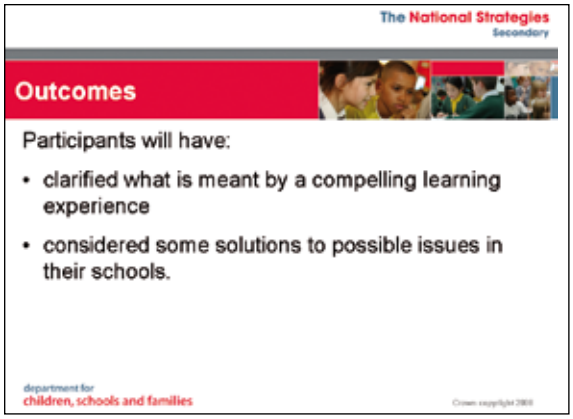

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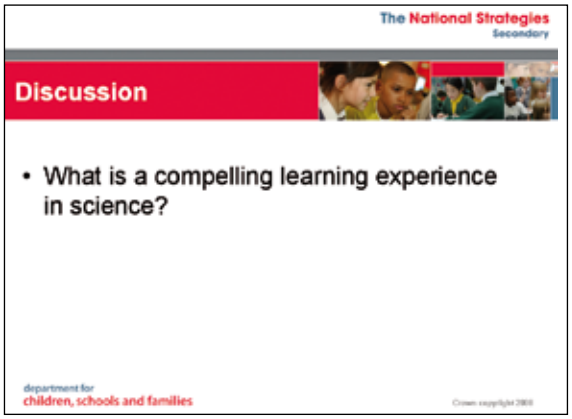

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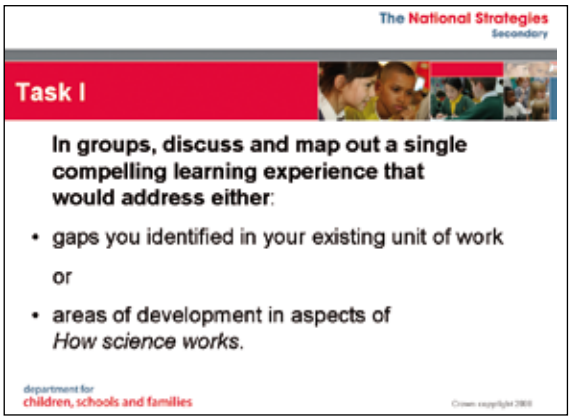

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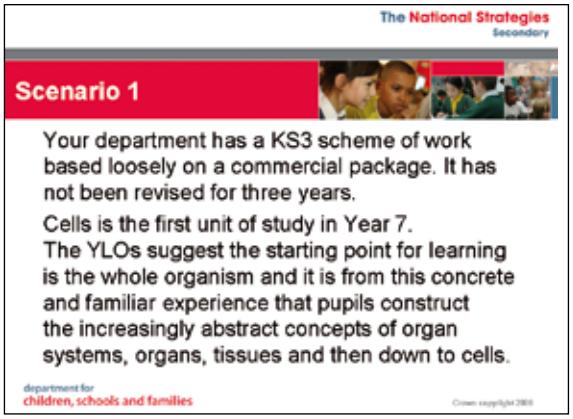

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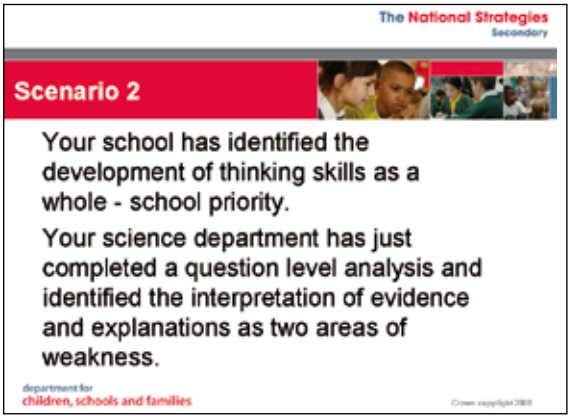

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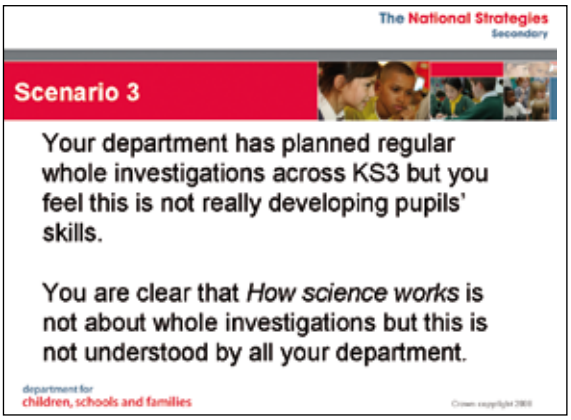

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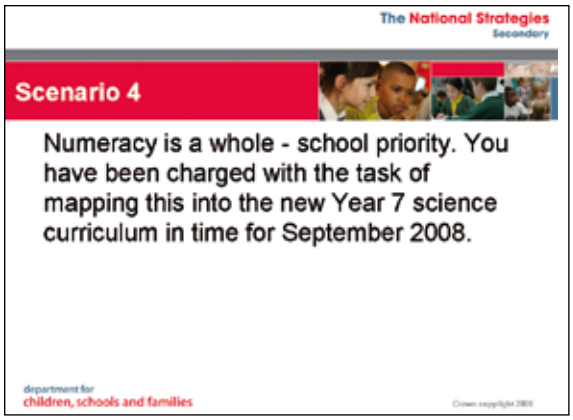

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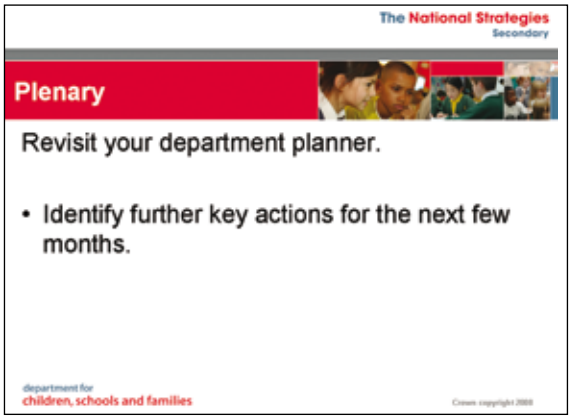
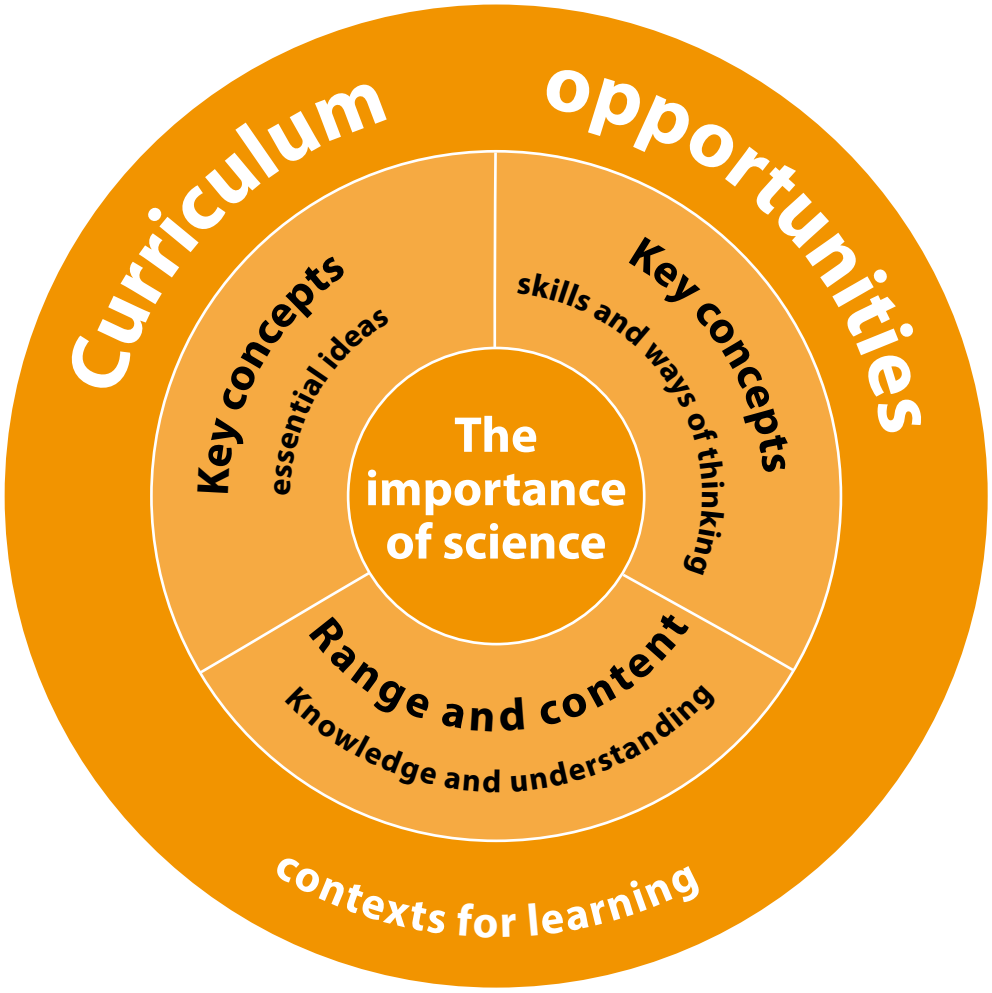


Handout 2.1

Onion model



Handout 2.4 (1 of 6)

KC, KP, CO and HSW card sort

Copy each of the four sections onto different coloured card and cut them up.

Key concepts

Using scientific ideas and models to explain phenomena and developing them creatively to generate and test theories KC
Critically analysing and evaluating evidence from observations and experiments KC
Exploring how the creative application of scientific ideas can bring about technological developments and consequent changes in the way people think and behave KC
Examining the ethical and moral implications of using and applying science KC
Recognising that modern science has its roots in many different societies and cultures, and draws on a variety of valid approaches to scientific practice KC
Sharing developments and common understanding across disciplines and boundaries KC

Handout 2.4 (2 of 6)

KC, KP, CO and HSW card sort

Key processes

Pupils should be able to use a range of scientific methods and techniques to develop and test ideas and explanations KP
Pupils should be able to assess risk and work safely in the laboratory, field and workplace KP
Pupils should be able to plan and carry out practical and investigative activities, both individually and in groups KP
Pupils should be able to obtain, record and analyse data from a wide range of primary and secondary sources, including ICT sources, and use their findings to provide evidence for scientific explanations KP
Pupils should be able to evaluate scientific evidence and working methods KP
Pupils should be able to use appropriate methods, including ICT, to communicate scientific information and contribute to presentations and discussions about scientific issues KP

Handout 2.4 (3 of 6)

KC, KP, CO and HSW card sort

Curriculum opportunities

Research, experiment, discuss and develop arguments CO
Pursue an independent enquiry into an aspect of science of personal interest CO
Use real real-life examples as a basis for finding out about science CO
Study science in local, national and global contexts and appreciate the connections between these CO
Experience science outside the school environment, including in the workplace, where possible CO
Use creativity and innovation in science, and appreciate their importance in enterprise CO
Recognise the importance of sustainability in scientific and technological developments CO
Explore contemporary and historical scientific developments and how they have been communicated CO

Handout 2.4 (4 of 6)

KC, KP, CO and HSW card sort

How science works

Pupils should be taught: 1a. how scientific data can be collected and analysed HSW
Pupils should be taught: 1c. how explanations of many phenomena can be developed using scientific theories, models and ideas HSW
Pupils should be taught: 1b. how interpretation of data and using creative thought provide evidence to test ideas and develop theories HSW
Pupils should be taught: 1d. that there are some questions that science cannot currently answer, and some that science cannot address HSW
Pupils should be taught: 2a. to plan to test a scientific idea, answer a scientific question, or solve a scientific problem HSW
Pupils should be taught: 2c. to work accurately and safely, individually and with others, when collecting first-hand data HSW

(continued)

Handout 2.4 (5 of 6)

KC, KP, CO and HSW card sort

How science works (cont.)

Pupils should be taught: 2b. to collect data from primary or secondary sources, including using ICT sources and tools HSW
Pupils should be taught: 2d. to evaluate methods of collection of data and consider their validity and reliability as evidence HSW
Pupils should be taught: 3a. to recall, analyse, interpret, apply and question scientific information or ideas HSW
Pupils should be taught: 3c. to present information, develop an argument and draw a conclusion, using scientific, technical and mathematical language, conventions and symbols, and ICT tools HSW
Pupils should be taught: 3b. to use both qualitative and quantitative approaches HSW
Pupils should be taught: 4a. about the use of contemporary scientific and technological developments and their benefits, drawbacks and risks HSW

(continued)

Handout 2.4 (6 of 6)

KC, KP, CO and HSW card sort

How science works (cont.)

Pupils should be taught: 4c. how uncertainties in scientific knowledge and scientific ideas change over time and about the role of the scientific community in validating these changes HSW
Pupils should be taught: 4b. to consider how and why decisions about science and technology are made, including those that raise ethical issues, and about the social, economic and environmental effects of such decisions HSW

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Range and context yearly learning objectives

2 Organisms, behaviour and health

2.1 Life processes

Year 7	Year 8	Year 9	Year 10	Year 11	Extension
• describe the role of organ systems in plants and animals that can contribute to the seven life processes	• explain how the organs and tissues in plants and animals function to support the seven life processes in a healthy organism	• explain how the specialisation of cells in plants and animals support the seven life processes in a healthy organism • explain how chemical, physical and biological factors can disrupt the seven life processes	• explain how individual intracellular and extracellular processes and structures in plants and animals support the seven life processes • explain why certain chemical, physical and biological factors can disrupt the seven life processes	• explain how the different intracellular and extracellular processes work together to support life in familiar contexts • evaluate the impact of chemical, physical and biological factors and explain their effects on the life processes	• use and apply their understanding of how life processes in organisms work together in unfamiliar contexts • critically evaluate the relative impact of chemical, physical and biological factors and their effect on life processes in unfamiliar contexts

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Range and context yearly learning objectives

Handout 2.5 (2 of 11)

2.2 Variation and interdependence

Year 7	Year 8	Year 9	Year 10	Year 11	Extension
• describe how organisms can vary and how this may lead to their survival in changing environments • describe how the major taxonomic groups are classified • use a combination of food chains within a habitat to produce food webs	• explain how variation has benefits and limitations for the survival of organisms in specific habitats • describe some examples of variation arising from inherited and environmental factors • explain energy transfer in food chains and webs and relate this to the abundance of organisms	• explain how variation in organisms can be artificially induced and the effect of these organisms on the environment • explain how internal and external factors can affect energy transfer in food chains and webs	• explain how the combined effects of changes to genes and environmental change can lead to variation in a species • explain the fluctuations in distribution and population size using: – energy flow – pyramids of number and biomass – predator/prey relationships	• apply and use their knowledge of variation and interdependence to explain: – natural selection – the applications and implications of artificial selection – evolutionary and ecological relationships	• apply and use their extensive knowledge of variation and interdependence to explain and critically evaluate the impact of human activity on evolutionary and ecological relationships

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Range and context yearly learning objectives

Handout 2.5 (3 of 11)

2.3 Behaviour

Year 7	Year 8	Year 9	Year 11	Year 11	Extension
• describe simple learned and innate behaviours in response to internal and external stimuli and how these aid survival	• explain how changes in learned behaviour due to internal and external stimuli are of benefit to the organism	• make links between observed social behaviours and the benefit to the survival of the species	• explain how chemical and electrical signals enable body systems to respond to internal and external changes and the effect of this on behaviour	• explain the effects of natural and artificial substances on chemical and electrical signals within the body, and possible effects on behaviour	• evaluate evidence from different sources about the impact of natural and artificial substances on behaviour

Range and context yearly learning objectives

Handout 2.5 (4 of 11)

3 Chemical and material behaviour

3.1 Particle models

Year 7	Year 8	Year 9	Year 10	Year 11	Extension
• describe matter using a simple model and use it to explain changes of state • recognise the link between heating and cooling and changes of state • use the simple particle model to explain the physical characteristics of solids, liquids and gases	• apply and use the particle model to describe a range of physical observations • apply and use the particle model to describe a range of separation techniques	• evaluate and refine the particle model to explain a range of physical observations • evaluate and refine the particle model to explain a range of separation techniques	• apply particle models in unfamiliar contexts, and begin to evaluate the strengths and weaknesses of the model • refine the particle model to explore the structure of atoms, including protons, neutrons and electrons	• use the particle model and ideas from science and across disciplines to explain phenomena and evaluate the use of the model	• use the particle model and ideas from science and across disciplines to explain complex phenomena and make critical evaluations to justify the use of a 'good enough' model

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Range and context yearly learning objectives

Handout 2.5 (5 of 11)

3.2 Chemical reactions

Year 7	Year 8	Year 9	Year 10	Year 11	Extension
• sort some reactions into reversible and irreversible • recognise that new materials are made during chemical reactions	• recognise that materials can be made up of one or more kinds of particles • describe the type and arrangement of atoms in elements, compounds and mixtures • describe and develop a particle model to explain the differences between the terms a*toms, elements, compounds* and *mixtures*	• use a particle model to construct predictions for simple chemical reactions and to produce word equations	• use a particle model to construct predictions for chemical reactions and to produce symbol equations • explain the evidence that a chemical reaction has taken place in terms of energy transfer and rearrangements of bonds between atoms	• use a particle model to predict the outcome of chemical reactions and to produce balanced symbol equations • explain the evidence that a chemical reaction has taken place in terms of rearrangements of bonds between atoms, using the model of the differences of electron structure between elements	• use a particle model to predict the outcome of complex chemical reactions and to produce balanced symbol equations and ionic half-equations when appropriate • explain the evidence that a chemical reaction has taken place (in a system at equilibrium) in terms of energy transfer and rearrangements of bonds between atoms

Range and context yearly learning objectives

Handout 2.5 (6 of 11)

3.3 Patterns in chemical reactions

Year 7	Year 8	Year 9	Year 10	Year 11	Extension
• describe, record and group observations from chemical reactions	• describe patterns in a range of chemical reactions	• link experimental and numerical data to illustrate a range of patterns in chemical reactions	• explain properties and patterns in reactivity in terms of a particle model for atomic structure	• apply knowledge of patterns of reactivity in the periodic table to predict the outcomes of reactions from a range of familiar contexts	• apply knowledge of patterns of reactivity in the periodic table to evaluate critically a range of domestic and industrial processes including systems at equilibrium

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Range and context yearly learning objectives

4 Energy, electricity and forces

4.1 Energy transfer and electricity

Year 7	Year 8	Year 9	Year 10	Year 11	Extension
• describe how energy can be stored, e.g. food, fuels and electrical cells • describe how energy is transferred in simple contexts such as heating and cooling, food chains and simple circuits • recognise that quantitative measures of energy transfer are needed to inform decisions, e.g. about lifestyles • describe how energy stored in a range of energy resources, e.g. food, biomass, oil, gas, wind and waves, can be usefully transferred	• use a simple model of energy transfer to describe common observations • explain why quantitative measures of energy transfer should also be considered when making informed decisions, e.g. building wind farms • explain how electricity is generated using a variety of energy resources	• develop more complex models of energy transfer mechanisms (incorporating ideas about particles or waves) • use energy-accounting systems, including Sankey diagrams, to track energy transfers • apply the idea of energy conservation and dissipation to simple biological, chemical and physical systems • use quantitative measures of energy transfer to support informed decision-making	• apply the concept of conservation of energy to energy efficiency calculations in living and non-living systems • develop the idea of energy dissipation in a variety of contexts • evaluate the economic costs and environmental effects of energy use through the measurement of energy transfers and efficiency calculations • describe the effects of energy transfer to living systems by electromagnetic and nuclear radiation	• use quantitative measures and the concept of energy conservation to evaluate a range of strategies to conserve limited energy resources • use and apply complex models of energy transfer to a wide range of phenomena • explain a wide range of complex phenomena using the principle of conservation of energy and appropriate wave or particle models	• apply broader or deeper knowledge and understanding of energy in explanations of observations and phenomena • use valid and rational argument to offer solutions to problems arising from the applications and implications of energy

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Range and context yearly learning objectives

Handout 2.5 (8 of 11)

4.2 Forces

Year 7	Year 8	Year 9	Year 10	Year 11	Extension
• recognise the forces acting on an object in different situations • distinguish between situations involving balanced and unbalanced forces • recognise that forces can combine or wholly or partly cancel each other out and their size and direction can be represented using arrows • recognise that there are contact forces and forces that act at a distance	• apply ideas about balanced and unbalanced forces to explain the way objects move • investigate situations where forces are applied over large and small areas or have a turning effect • recognise that forces at a distance get weaker as the distance increases	• recognise how simple quantitative relationships can be applied to the way objects move (including balanced and unbalanced forces) • recognise how simple quantitative relationships can be applied to situations where forces are applied over large and small areas or have a turning effect	• use simple quantitative relationships to make predictions in more complex situations • use simple relationships involving more complex quantities, to make quantitative predictions in familiar situations	• use relationships involving more complex quantities to make quantitative predictions in more complex and unfamiliar situations	• apply knowledge and understanding of forces in explanations of observations and phenomena to complex and unfamiliar contexts • use valid and rational argument to offer solutions to problems arising from the applications and implications of forces

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Range and context yearly learning objectives

Handout 2.5 (9 of 11)

5 The environment, Earth and the universe

5.1 Changing environment and sustainability

Year 7	Year 8	Year 9	Year 10	Year 11	Extension
• describe how natural and human processes have changed the atmosphere over time	• explain some of the changes that have led to the composition of the current atmosphere • recognise simple ideas of sustainable development	• use one or more models, such as the carbon cycle or food webs, to explain some of the consequences of changes in the environment	• use primary and secondary forms of evidence to describe and explain the impact of human actions at a local, regional and global level	• evaluate the accuracy and validity of primary and secondary evidence in relation to human impact on the biosphere • describe and analyse how complex data could be represented or misrepresented to justify decisions taken to manage sustainability	• link and synthesise data and evidence from a range of sources to explain human impact on the biosphere • describe how evidence and arguments from different political and economic perspectives have been used to justify decisions taken to manage sustainability

Range and context yearly learning objectives

Handout 2.5 (10 of 11)

5.2 Changing Earth

Year 7	Year 8	Year 9	Year 10	Year 11	Extension
• recognise the processes involved in the formation of rocks	• describe the processes involved in the formation of sedimentary, metamorphic and igneous rocks and use the characteristics of the rocks to explain how they formed	• use the rock cycle as a model to explain the cyclical nature of rock-forming processes and the timescales over which they operate	• use the theory of plate tectonics to explain some of the major slow (long-term) changes and the distribution and nature of active zones on the surface of the Earth	• link plate tectonic theory to its supporting geological evidence	• apply and use the theory of plate tectonics to explain related geological phenomena

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Range and context yearly learning objectives

5.3 Earth, space and beyond

Year 7	Year 8	Year 9	Year 10	Year 11	Extension
• describe the apparent movement of the Sun across the sky and the pattern in the changing appearance of the Moon	• describe the position of the Earth in relation to the position of other bodies in the Solar System and use this to explain some phenomena • recognise that astronomy and space science provide evidence about the Solar System	• apply models and use scientific data to explain the relative movement of the celestial bodies in the Solar System • describe how astronomy and space science provide evidence of the Solar System and galaxy	• explain some methods used to explore the Solar System and galaxy (both from the Earth and from space) • explain how the electromagnetic spectrum can inform the study the stars in our galaxy (and universe)	• evaluate the available evidence and explain why it favours an expanding universe as the current consensus model	• explain, using available evidence and models of the universe, why the ultimate fate of the universe is difficult to predict

Handout 3.1

Year 7 and Year 8 *How science works* yearly learning objectives

1 *How science works*	Year 7	Year 8
1.1a1 Scientific thinking: developing explanations using ideas and models	● use an existing model or analogy to explain a phenomenon ● recognise and explain the value of using models and analogies to clarify explanations	● describe more than one model to explain the same phenomenon and discuss the strengths and weaknesses of each model ● describe how the use of a particular model or analogy supports an explanation
1.1a2 Scientific thinking: challenge and collaboration in the development of explanations	● recognise that scientists of all disciplines and nationalities often work together to develop explanations ● recognise that science cannot yet explain everything	● recognise that science is a communal, and therefore fallible, human activity and that different explanations can arise from individual bias ● recognise questions that the scientific process cannot yet answer
1.1a3 Scientific thinking: developing argument	● identify a range of scientific data and other evidence to back an argument and the counterclaim in less complex and/or familiar contexts, e.g. establishing a wind farm ● recognise that scientific evidence can be used to support or disprove theories	● identify a range of scientific data and other evidence to back an argument and the counterclaim in more complex and/or less familiar contexts, e.g. use of antibiotics ● describe how scientific evidence from different sources carries different weight in supporting or disproving theories

1.1b Applications, implications and cultural understanding	• describe some benefits and drawbacks of scientific developments with which they are familiar • recognise that decisions about the use and application of science and technology are influenced by society and individuals	• explain some issues, benefits and drawbacks of scientific developments with which they are familiar • recognise that decisions about the use and application of science and technology are influenced by society and individuals, and how these could impact on people and the environment
1.1c Communication for audience and with purpose	• use key scientific vocabulary and terminology in discussions and written work • identify and use the conventions of various genres for different audiences and purposes in scientific writing	• use a range of scientific vocabulary and terminology consistently in discussions and written work • adapt the stylistic conventions of a range of genres for different audiences and purposes in scientific writing
1.2a Using investigative approaches: planning an approach	• describe an appropriate approach to answer a scientific question using a limited range of information and making relevant observations or measurements	• describe an appropriate approach to answer a scientific question using sources of evidence and, where appropriate, making relevant observations or measurements using appropriate apparatus
1.2b Using investigative approaches: selecting and managing variables	• recognise the range of variables involved in an investigation and decide which to control	• describe and identify key variables in an investigation and assign appropriate values to these

1.2c Using investigative approaches: assessing risk and working safely	• explain how action has been taken to control obvious risk and how methods are adequate for the task	• explain how to take action to control the risks to themselves and others, and demonstrate competence in their practical techniques
1.2d Using investigative approaches: obtaining and presenting primary evidence	• describe and record observations and evidence systematically • recognise that the presentation of experimental results through the routine use of tables, bar charts and simple graphs makes it easier to see patterns and trends	• explain how the observation and recording methods are appropriate to the task • describe ways in which the presentation of experimental results through the routine use of tables, charts and line graphs makes it easier to see patterns and trends
1.2e Working critically with primary evidence	• describe patterns and trends in results and link this evidence to any prediction made • describe and suggest how planning and implementation could be improved	• describe how the patterns and trends in the results link to the conclusions drawn and whether the evidence is sufficient • describe and suggest, with reasons, how planning and implementation could be improved
1.2f Working critically with secondary evidence	• describe patterns and trends in secondary evidence and link these to the prediction or conclusion drawn • recognise that different conclusions may be drawn from secondary data	• describe what needs to be considered in the collection and manipulation of simple secondary evidence to evaluate the conclusion or interpretation made • recognise that the selection, ordering or rejection of secondary data could lead to different conclusions

Handout 3.2

Year 7 and Year 8 range and content yearly learning objectives

2 Organisms, behaviour and health	Year 7	Year 8
2.1 Life processes	• describe the role of organ systems in plants and animals that can contribute to the seven life processes	• explain how the organs and tissues in plants and animals function to support the seven life processes in a healthy organism
2.2 Variation and interdependence	• describe how organisms can vary and how this may lead to their survival in changing environments • describe how the major taxonomic groups are classified • use a combination of food chains within a habitat to produce food webs	• explain how variation has benefits and limitations for the survival of organisms in specific habitats • describe some examples of variation arising from inherited and environmental factors • explain energy transfer in food chains and webs and relate this to the abundance of organisms
2.3 Behaviour	• describe simple learned and innate behaviours in response to internal and external stimuli and how these aid survival	• explain how changes in learned behaviour due to internal and external stimuli are of benefit to the organism
3 Chemical and material behaviour	**Year 7**	**Year 8**
3.1 Particle models	• describe matter using a simple model and use it to explain changes of state • recognise the link between heating and cooling and changes of state • use the simple particle model to explain the physical characteristics of solids, liquids and gases	• apply and use the particle model to describe a range of physical observations • apply and use the particle model to describe a range of separation techniques

3.2 Chemical reactions	• sort some reactions into reversible and irreversible • recognise that new materials are made during chemical reactions	• recognise that materials can be made up of one or more kinds of particles • describe the type and arrangement of atoms in elements, compounds and mixtures • describe and develop a particle model to explain the differences between the terms *atoms, elements, compounds* and *mixtures*
3.3 Patterns in chemical reactions	• describe, record and group observations from chemical reactions	• describe patterns in a range of chemical reactions
4 Energy, electricity and forces	**Year 7**	**Year 8**
4.1 Energy transfer and electricity	• describe how energy can be stored, e.g. food, fuels and electrical cells • describe how energy is transferred in simple contexts such as heating and cooling, food chains and simple circuits • recognise that quantitative measures of energy transfer are needed to inform decisions, e.g. about lifestyles • describe how energy stored in a range of energy resources, e.g. food, biomass, oil, gas, wind and waves, can be usefully transferred	• use a simple model of energy transfer to describe common observations • explain why quantitative measures of energy transfer should also be considered when making informed decisions, e.g. building wind farms • explain how electricity is generated using a variety of energy resources

4.2 Forces	• recognise the forces acting on an object in different situations • distinguish between situations involving balanced and unbalanced forces • recognise that forces can combine or wholly or partly cancel each other out and their size and direction can be represented using arrows • recognise that there are contact forces and forces that act at a distance	• apply ideas about balanced and unbalanced forces to explain the way objects move • investigate situations where forces are applied over large and small areas or have a turning effect • recognise that forces at a distance get weaker as the distance increases
5 The environment, Earth and the universe	**Year 7**	**Year 8**
5.1 Changing environment and sustainability	• describe how natural and human processes have changed the atmosphere over time	• explain some of the changes that have led to the composition of the current atmosphere • recognise simple ideas of sustainable development
5.2 Changing Earth	• recognise the processes involved in the formation of rocks	• describe the processes involved in the formation of sedimentary, metamorphic and igneous rocks and use the characteristics of the rocks to explain how they formed
5.3 Earth, space and beyond	• describe the apparent movement of the Sun across the sky and the pattern in the changing appearance of the Moon	• describe the position of the Earth in relation to the position of other bodies in the solar system and use this to explain some phenomena • recognise that astronomy and space science provide evidence about the solar system

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