Handout 2.2

Pentagon model

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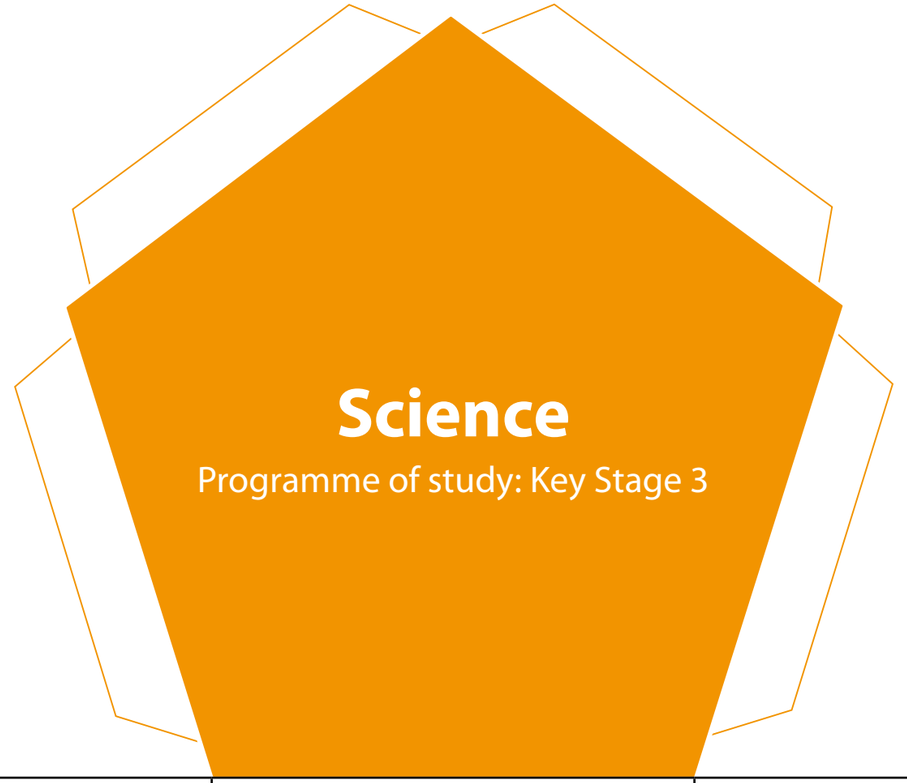

00125-2008DOM-EN

The importance of science

The study of science fires pupils' curiosity about phenomena in the world around them and offers opportunities to find explanations. It engages learners at many levels, linking direct practical experience with scientific ideas. Experimentation and modelling are used to develop and evaluate explanations, encouraging critical and creative thought.

Pupils learn how knowledge and understanding in science are rooted in evidence. They discover how scientific ideas contribute to technological change – affecting industry, business and medicine and improving quality of life. They trace the development of science worldwide and recognise its cultural significance. They learn to question and discuss issues that may affect their own lives, the directions of societies and the future of the world.

1 Key concepts

1.1 Scientific thinking

a Using scientific ideas and models to explain phenomena and developing them creatively to generate and test theories.

b Critically analysing and evaluating evidence from observations and experiments.

1.2 Applications and implications of science

a Exploring how the creative application of scientific ideas can bring about technological developments and consequent changes in the way people think and behave.

b Examining the ethical and moral implications of using and applying science.

1.3 Cultural understanding

a Recognising that modern science has its roots in many different societies and cultures, and draws on a variety of valid approaches to scientific practice.

1.4 Collaboration

a Sharing developments and common understanding across disciplines and boundaries.

2 Key processes

2.1 Practical and enquiry skills

Pupils should be able to:

a use a range of scientific methods and techniques to develop and test ideas and explanations

b assess risk and work safely in the laboratory, field and workplace

c plan and carry out practical and investigative activities, both individually and in groups.

2.2 Critical understanding of evidence

Pupils should be able to:

a 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

b evaluate scientific evidence and working methods.

2.3 Communication

Pupils should be able to:

a use appropriate methods, including ICT, to communicate scientific information and contribute to presentations and discussions about scientific issues.

3 Range and content

3.1 Energy, electricity and forces

a energy can be transferred usefully, stored, or dissipated, but cannot be created or destroyed

b forces are interactions between objects and can affect their shape and motion

c electric current in circuits can produce a variety of effects.

3.2 Chemical and material behaviour

a the particle model provides explanations for the different physical properties and behaviour of matter.

b elements consist of atoms that combine together in chemical reactions to form compounds.

c elements and compounds show characteristic chemical properties and patterns in their behaviour.

3.3 Organisms, behaviour and health

a life processes are supported by the organisation of cells into tissues, organs and body systems.

b the human reproductive cycle includes adolescence, fertilisation and foetal development.

c conception, growth, development, behaviour and health can be affected by diet, drugs and disease.

d all living things show variation, can be classified and are interdependent, interacting with each other and their environment.

e behaviour is influenced by internal and external factors and can be investigated and measured.

3.4 The environment, Earth and universe

a geological activity is caused by chemical and physical processes.

b astronomy and space science provide insight into the nature and observed motions of the sun, moon, stars, planets and other celestial bodies.

c human activity and natural processes can lead to changes in the environment.

4 Curriculum opportunities

During the key stage pupils should be offered the following opportunities that are integral to their learning and enhance their engagement with the concepts, processes and content of the subject.

The curriculum should provide opportunities for pupils to:

a research, experiment, discuss and develop arguments

b pursue an independent enquiry into an aspect of science of personal interest

c use real-life examples as a basis for finding out about science

d study science in local, national and global contexts, and appreciate the connections between these

e experience science outside the school environment, including in the work place, where possible

f use creativity and innovation in science, and appreciate their importance in enterprise

g recognise the importance of sustainability in scientific and technological developments

h explore contemporary and historical scientific developments and how they have been communicated.

Science
Programme of study: Key Stage 3
Science
Programme of study: Key Stage 3
Science
Programme of study: Key Stage 3
Science
Programme of study: Key Stage 3

How science works yearly learning objectives

1 *How science works*

1.1 Explanations, argument and decisions

1.1a1 Scientific thinking: developing explanations using ideas and models

Year 7	Year 8	Year 9	Year 10	Year 11	Extension
• use an existing model or analogy to explain a phenomenon	• describe more than one model to explain the same phenomenon and discuss the strengths and weaknesses of each model	• describe the strengths and weaknesses of a range of available models and select the most appropriate	• justify the selection of a particular model as the most appropriate	• evaluate the effectiveness of using models and analogies in their explanations	• recognise that it is possible to have and to use different, and sometimes conflicting, models in their explanation
• recognise and explain the value of using models and analogies to clarify explanations	• describe how the use of a particular model or analogy supports an explanation	• explain why the manipulation of a model or analogy might be needed to clarify an explanation	• devise own simple models or analogies to explain observations, data or scientific ideas	• evaluate the strengths and weaknesses of their own models and analogies	• explain how devising and using alternative models could help to make a 'creative leap' in an explanation

1.1a2 Scientific thinking: challenge and collaboration in the development of explanations

Year 7	Year 8	Year 9	Year 10	Year 11	Extension
• recognise that scientists of all disciplines and nationalities often work together to develop explanations	• recognise that science is a communal, and therefore fallible, human activity and that different explanations can arise from individual bias	• describe how bias, a lack of evidence or misconceptions can give rise to inappropriate theories and the role of scientists in questioning these	• describe the process of validating the work of other scientists and explain how this influences the acceptance or rejection of a theory	• explain why it is important for the scientific community to have a process for validating the work of other scientists and how this has influenced the acceptance of current theories	• explain and justify why a 'scientific claim' should be accepted or rejected by the application of the key components of validation to the evidence
• recognise that science cannot yet explain everything	• recognise questions that the scientific process cannot yet answer	• identify some questions that the scientific process cannot yet completely answer but can contribute to	• identify some questions that the scientific process cannot yet completely answer but can contribute to, and explain the reasons for this	• explain why scientific proof is only ever provisional	• explore the implications of the provisional nature of scientific proof

1.1a3 Scientific thinking: developing argument

Year 7	Year 8	Year 9	Year 10	Year 11	Extension
• 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	• 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	• use criteria to select relevant scientific data and other sources of evidence to support or negate an argument	• explain how the use of criteria improves the effectiveness of selecting scientific data and other sources of evidence to support or negate an argument	• devise criteria to select relevant scientific data and other sources of evidence to support or negate an argument in familiar contexts	• devise criteria to select relevant scientific data and other sources of evidence to support or negate an argument in less familiar contexts
• recognise that scientific evidence can be used to support or disprove theories	• describe how scientific evidence from different sources carries different weight in supporting or disproving theories	• explain how scientific evidence from a range of sources can be used to support or disprove theories	• describe examples of where scientific theories, applications and models have been changed by new evidence or societal norms	• explain how scientific theories, applications and models have been changed or modified by scientists as a result of new evidence	• explain how scientific theories, applications and models have been changed by the strength of new evidence, changes in societal norms or values

00125-2008DOM-EN

1.1b Applications, implications and cultural understanding

Year 7	Year 8	Year 9	Year 10	Year 11	Extension
• describe some benefits and drawbacks of scientific developments with which they are familiar	• explain some issues, benefits and drawbacks of scientific developments with which they are familiar	• evaluate the issues, benefits and drawbacks of scientific developments with which they are familiar	• evaluate the relevant issues, benefits and drawbacks of scientific developments with which they are familiar and draw conclusions about which would be more appropriate	• describe and evaluate examples of perceived and actual risk arising from the application of scientific or technological developments	• evaluate and analyse the potential impact of the application of new scientific and technological developments
• recognise that decisions about the use and application of science and technology are influenced by society and individuals	• 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	• recognise that different decisions on the use and application of scientific and technological developments may be made in different economic, cultural and social contexts	• explain that scientific evidence could be shaped by a number of factors and used to influence decisions taken on the application of scientific and technological developments	• describe the power and limitations of science in addressing a range of moral or ethical issues, and how this could influence the impact of decisions taken on the application of scientific and technological developments	• explain how scientific evidence can be shaped by bias, scientific status, political or economic factors, and how this could influence the impact of decisions taken on the application of scientific and technological developments

1.1c Communication for audience and with purpose

Year 7	Year 8	Year 9	Year 10	Year 11	Extension
• use key scientific vocabulary and terminology in discussions and written work	• use a range of scientific vocabulary and terminology consistently in discussions and written work	• communicate effectively and use appropriate scientific terminology and conventions in discussion and written work	• communicate effectively using a wide range of scientific terminology and conventions in discussion and written work	• communicate qualitative and quantitative evidence effectively using scientific terminology and conventions, drawing on abstract ideas and models as appropriate to the audience and purpose	• use a wide range of technical vocabulary and techniques with fluency, demonstrating communication and numerical skills as appropriate for a range of audiences and purposes
• identify and use the conventions of various genres for different audiences and purposes in scientific writing	• adapt the stylistic conventions of a range of genres for different audiences and purposes in scientific writing	• adapt the stylistic conventions of a wider range of genres for different audiences and purposes in scientific writing	• use simple criteria to judge the appropriateness of a piece of scientific writing for a particular audience	• devise criteria to judge the appropriateness of a piece of scientific writing for a particular audience	• critically evaluate criteria used to judge the appropriateness of a piece of scientific writing for a particular audience

1.2 Practical and enquiry skills

1.2a Using investigative approaches: planning an approach

Year 7	Year 8	Year 9	Year 10	Year 11	Extension
• 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	• explain how the planned approach to answer a scientific question was informed by scientific knowledge, understanding or other sources of evidence	• explain how the planned approach was informed by a range of scientific knowledge, understanding and evidence and, where appropriate, how this influenced the method of data collection	• explain how to plan appropriate approaches to investigatory work by synthesising information from a range of sources in complex contexts and where variables are less easily controlled	• explain why different approaches are required to investigate different kinds of scientific questions and how scientific knowledge, understanding and sources of evidence are used in the different approaches

00125-2008DOM-EN

How science works yearly learning objectives

1.2b Using investigative approaches: selecting and managing variables

Year 7	Year 8	Year 9	Year 10	Year 11	Extension
• 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	• use and apply independent and dependent variables in an investigation by choosing an appropriate range, number and value for each one	• identify key factors in complex contexts where variables are less easily controlled	• use and apply key variables in complex contexts, including ones in which variables are less easily controlled	• identify and manage a range of variables in complex contexts including ones in which variables are less easily controlled

1.2c Using investigative approaches: assessing risk and working safely

Year 7	Year 8	Year 9	Year 10	Year 11	Extension
• 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	• explain how approaches to practical work were adapted to control risk	• use and apply risk assessment in carrying out practical procedures	• explain why the chosen approach to practical work needed to be adapted to control risk	• explain how hazards are identified and risks managed to collect data in a safe and skilful manner

1.2d Using investigative approaches: obtaining and presenting primary evidence

Year 7	Year 8	Year 9	Year 10	Year 11	Extension
• describe and record observations and evidence systematically	• explain how the observation and recording methods are appropriate to the task	• use and apply qualitative and quantitative methods to obtain and record sufficient data systematically	• explain how inherent variation, e.g. from human error, sensitivity and accuracy of instrument, needs to be considered when collecting data	• use and apply systematic observation and precise measuring with a range of apparatus, while taking account of inherent variation, to obtain and record reliable data	• use and apply systematic observation and precise measuring with a range of apparatus, while taking account of inherent variation, to obtain and record reliable data in a more demanding context
• 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	• 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	• explain how the presentation of experimental results through the routine use of tables, charts and line graphs makes it easier to see patterns and trends	• apply and use appropriate ways of recording relevant observations and comparisons, clearly identifying points of particular significance	• explain how the chosen presentation of data has been used to support a valid conclusion	• explain how the chosen presentation of data takes account of uncertainty or alternative conclusions

00125-2008DOM-EN

How science works yearly learning objectives

1.2e Working critically with primary evidence

Year 7	Year 8	Year 9	Year 10	Year 11	Extension
• describe patterns and trends in results and link this evidence to any prediction made	• describe how the patterns and trends in the results link to the conclusions drawn and whether the evidence is sufficient	• explain how patterns and trends in results can be manipulated to be consistent with the evidence gathered and the predictions made	• explain how the numerical data have been manipulated to make valid comparisons and conclusions linked to the original scientific question	• synthesise and manipulate data, analyse findings and draw valid and reliable conclusions consistent with the evidence and linked to the original scientific question • recognise recognise that correlation does not always imply causation	• synthesise and manipulate data, analyse findings, draw valid and reliable conclusions consistent with the evidence, and explain how strongly the evidence relates to the original scientific question explain • explain why correlation does not always imply causation
• describe and suggest how planning and implementation could be improved	• describe and suggest, with reasons, how planning and implementation could be improved	• explain how improvements to the planning and implementation would have led to the collection of more valid and reliable evidence and a more secure conclusion	• evaluate the planning and implementation, and explain how this could account for errors and anomalies and how inadequacies could be remedied	• evaluate the planning and implementation, and explain how this could account for errors and anomalies and the subsequent impact on the conclusion in simple contexts	• evaluate the planning and implementation, and explain how this could account for errors and anomalies and the subsequent impact on the conclusion in more complex contexts

1.2f Working critically with secondary evidence

Year 7	Year 8	Year 9	Year 10	Year 11	Extension
• describe patterns and trends in secondary evidence and link these to the prediction or conclusion drawn	• describe what needs to be considered in the collection and manipulation of simple secondary evidence to evaluate the conclusion or interpretation made	• explain whether the collection and manipulation of secondary evidence is sufficient or insufficient to support the conclusion or interpretation made	• explain, using scientific knowledge and understanding, how some of the limitations in the collection and manipulation of secondary evidence can distort the conclusion drawn	• evaluate the conclusions drawn by others, including scientists, in familiar or less complex contexts and consider how strongly the evidence supports these conclusions or claims	• evaluate the conclusions drawn by others, including scientists, in less familiar or more complex contexts, and consider how strongly the evidence supports these conclusions or claims
• recognise that different conclusions may be drawn from secondary data	• recognise that the selection, ordering or rejection of secondary data could lead to different conclusions	• explain how secondary numerical data have been manipulated to support a particular conclusion or viewpoint	• recognise that scientific controversies can arise from different interpretations of the same evidence	• describe a range of issues that can affect the credibility of data	• explain how scientific controversies can arise from different ways of interpreting evidence

00125-2008DOM-EN

Handout 2.6

Department planner

Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec -08
Focus	Focus	Focus	Focus	Focus	Focus	Focus	Focus	Focus	Focus	Focus
What will we do?	**What?**	**What?**	**What?**	**What?**	**What?**	**What?**	**What?**	**What?**	**What?**	**What?**
Who will do it?	**Who?**	**Who?**	**Who?**	**Who?**	**Who?**	**Who?**	**Who?**	**Who?**	**Who?**	**Who?**
When by?	**When by?**	**When by?**	**When by?**	**When by?**	**When by?**	**When by?**	**When by?**	**When by?**	**When by?**	**When by?**
How will we know?	**How will we know?**	**How will we know?**	**How will we know?**	**How will we know?**	**How will we know?**	**How will we know?**	**How will we know?**	**How will we know?**	**How will we know?**	**How will we know?**

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Focus	Focus	Focus	Focus	Focus	Focus	Focus	Focus	Focus	Focus	Focus
What will we do?	**What?**	**What?**	**What?**	**What?**	**What?**	**What?**	**What?**	**What?**	**What?**	**What?**
Who will do it?	**Who?**	**Who?**	**Who?**	**Who?**	**Who?**	**Who?**	**Who?**	**Who?**	**Who?**	**Who?**
When by?	**When by?**	**When by?**	**When by?**	**When by?**	**When by?**	**When by?**	**When by?**	**When by?**	**When by?**	**When by?**
How will we know?	**How will we know?**	**How will we know?**	**How will we know?**	**How will we know?**	**How will we know?**	**How will we know?**	**How will we know?**	**How will we know?**	**How will we know?**	**How will we know?**

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