The National Strategies
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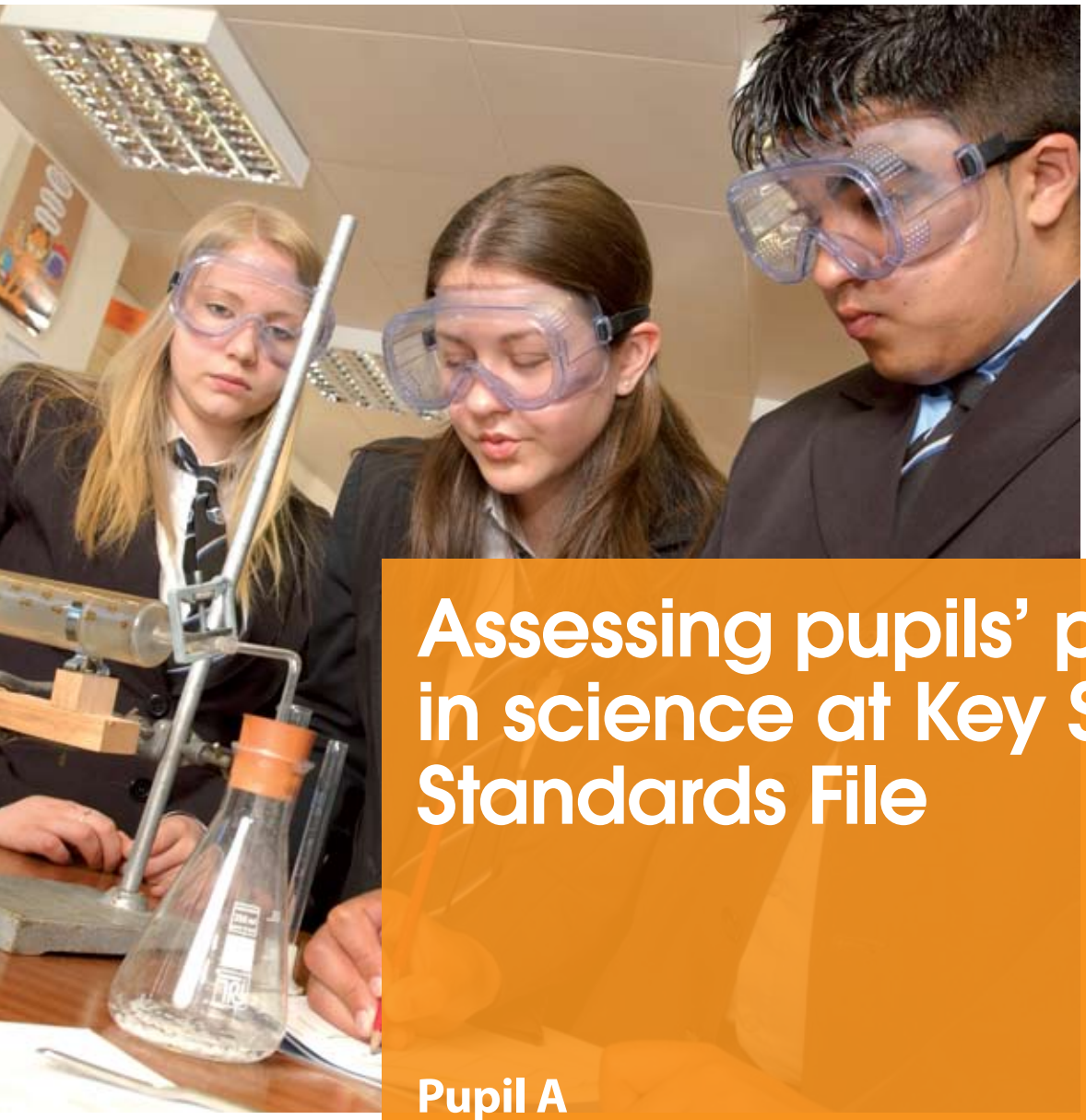

Assessing pupils' progress in science at Key Stage 3: Standards File

Pupil A

department for children, schools and families

QCA Qualifications and Curriculum Authority

Assessing pupils' progress in science at Key Stage 3: Standards File

Pupil A

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Pupil A Year 9 High level 6 Science Standards File

Pupil profile

Pupil A works in a set where pupils' attainment ranges from level 5 to level 7. She has strong communication and interpersonal skills, but her conceptual explanations are not yet at the same level. Her teacher assessed her to be working at high level 6, and identified areas in which she is making some progress towards level 7.

The evidence

1. Rates of reaction data evaluation task
2. Investigating rates of reaction
3. Plants and photosynthesis summary booklet
4. Human impact poster
5. Presentation on sustainable development
6. How scientists affect our lives – homework task

00055-2009BKT-EN

1. Rates of reaction data evaluation task

Assessment focuses

AF3, AF5

Context

Pupils were working on a topic on rates of reaction. As a whole-class activity, the teacher gave them a briefing sheet about an experiment carried out by a fictitious student called Jimmy. Using word processing software, the pupils were required to:

1. explain what valid conclusion could be drawn from Jimmy's results;
2. suggest how Jimmy's procedure could be improved to make it more reliable.

Pupil briefing sheet

Evaluation Task

How does the concentration of acid affect the rate of reaction?

Jimmy investigated this problem using the following equipment and method:

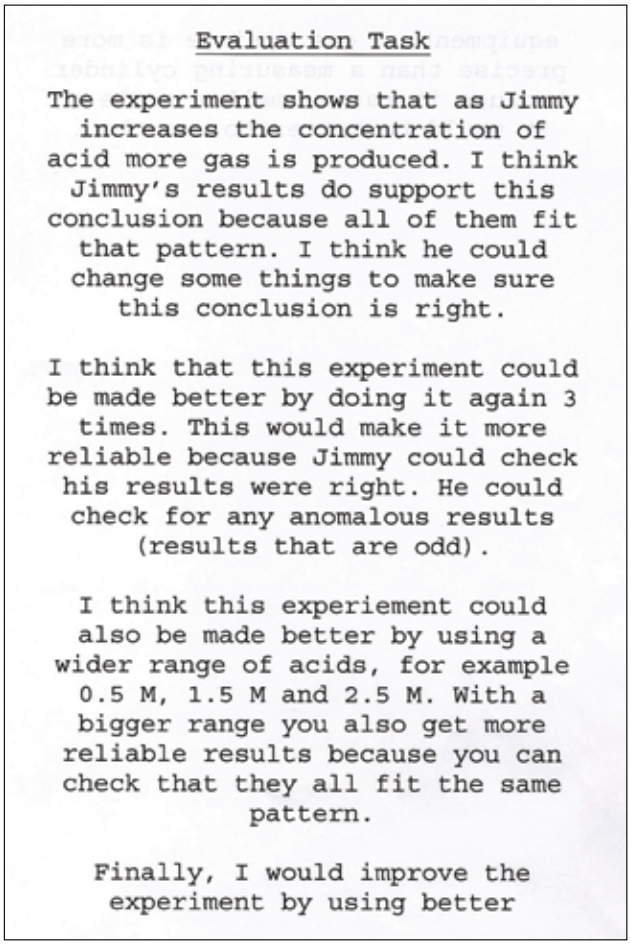
1.0M, 2.0M, 3.0M HCl, medium sized marble chips, conical flask, bung and delivery tube, 100cm^3 measuring cylinder, 25cm^3 measuring cylinder, beehive shelf, water trough, balance, stop clock

- Collect and set up the equipment
- Measure 25cm^3 1.0M HCl
- Weigh 1.0g marble chips
- Fill the water trough and 100cm^3 measuring cylinder with water
- Put the marble chips and acid in the conical flask, quickly put in the bung with the delivery tube and start the stop clock
- Stop the stop clock at 1 minute and measure how much gas has been collected

Here are Jimmy's results

Concentration of HCl (M)	Volume of gas collected (cm^3)
1.0	24
2.0	46
3.0	75

Pupil A's work



Evaluation Task

The experiment shows that as Jimmy increases the concentration of acid more gas is produced. I think Jimmy's results do support this conclusion because all of them fit that pattern. I think he could change some things to make sure this conclusion is right.

I think that this experiment could be made better by doing it again 3 times. This would make it more reliable because Jimmy could check his results were right. He could check for any anomalous results (results that are odd).

I think this experiement could also be made better by using a wider range of acids, for example 0.5 M, 1.5 M and 2.5 M. With a bigger range you also get more reliable results because you can check that they all fit the same pattern.

Finally, I would improve the experiment by using better equipment. A gas syringe is more precise than a measuring cylinder because it has a smaller scale so it would be better to use that.

Teacher's notes

AF3

Pupil A used appropriate scientific terminology and abstract ideas to communicate her thoughts. She used the terms 'anomalous' and 'precise' correctly. Her understanding of the term 'range' is less clear from what she has written. She has given some examples of values of acid concentrations (0.5 M, 1.5 M and 2.5 M) that she claims increase range, which they do to a small extent, because she includes an acid of lower concentration than those used in Jimmy's experiment. Speaking to her afterwards, however, it was clear that she could distinguish between a range of types of acid and the numerical range of concentrations, but she did not succeed in communicating this clearly in her written work. She was uncertain on the correct use of the term 'interval'.

AF5

Pupil A made valid comments on the quality of data and suggested reasons based on scientific knowledge and understanding for limitations of evidence. She recognised the small number of measurements as a limitation to the evidence collected and to the reliability of conclusions.

She drew a conclusion that is consistent with the evidence available. She identified the general pattern in the results, and correctly did not get pre-occupied by the fact that the volumes are not exact multiples. She has shown scientific thinking in her approach to measurement.

Next steps

- Further activity on the terms 'range' and 'interval', and the distinctions between the terms 'precision', 'accuracy' and 'reliability'.
- Discussion, using examples, of when repetition is most important, and whether it is necessary in all measurement activities.
- Discussion, using examples, of appropriate levels of precision in measurement activities.

Assessment commentary

This is a pupil who can think scientifically about measurements, seeing through the uncertainty and variability of measurement to recognise and communicate patterns. She is confident in the use of some but not all relevant scientific terminology.

It is not clear whether her emphasis on triple repetition of measurements indicates that she is 'trying to say the right thing' to receive credit or whether she has a full understanding of the value of repeating measurements. Her suggested triple repetition is less important to reliability than an increase in range of acid concentrations and a decrease in interval. Though use of a gas syringe offers greater precision, an increase in measurement precision by itself here offers little benefit to the reliability of the evidence and the validity of the conclusion, compared with considering a greater range of acid concentrations with a smaller interval.

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2. Rates of reaction investigation

Assessment focuses

AF1, AF3, AF4, AF5

Context

All pupils in the class worked in groups of three to carry out an investigation on the effect of the concentration of hydrochloric acid on rate of reaction with marble chips. Before doing the practical work they were given the task of identifying the variables and also explaining how they were going to control them.

They were given a lesson to complete the practical, choosing equipment themselves from a given selection.

In the next lesson, pupils were given the opportunity to write up their investigation, working independently but with the opportunity for discussion. Pupil A likes working with IT and chose to word-process her work. Pupils were given an outline of how to structure their reports. They were told it must include:

- an introduction (identifying the independent, dependent and control variables);
- their results;
- their findings;
- an evaluation.

Pupils did not have time to do more extended work, such as producing graphs, as they were given a time limit of one hour.

Pupil A's work

Rates of Reaction Investigation

I am going to investigate how the concentration of acid affects the rate of reaction between marble chips and hydrochloric acid.

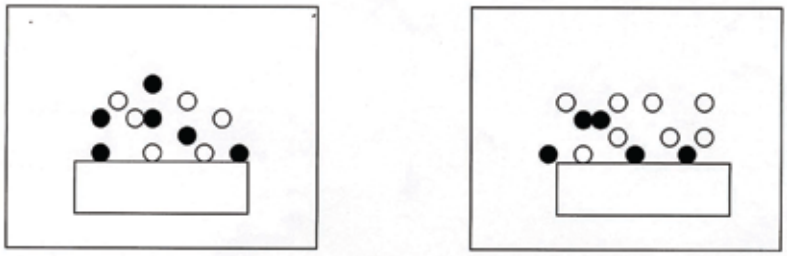
I am going to change the concentration of acid so this is the independent variable and I am going to record the time it takes to collect 50cm3 of carbon dioxide so this is the dependent variable. I am going to keep the volume of acid, the mass of marble chips and the size of marble chips the same, these are the control variables.

Results

Concentration of HCl (M)	Time taken to produce 50cm3 CO2 (s)	Time taken to produce 50cm3 CO2 (s)	Time taken to produce 50cm3 CO2 (s)	Average time (s)
1.0	456.02	439.72	445.11	446.95
2.0	234.59	223.36	212.43	223.46
3.0	101.34	98.04	96.09	98.49

Findings

I have found out the higher the concentration of acid the faster the carbon dioxide is produce so the rate of reaction is faster. This is because there are more acid molecules in the higher concentrated acid so they collide more which causes the reaction to go faster.



○ Water particles
● Acid particles

Evaluation

My experiment was good because all my results fit the same pattern and there were no odd ones. It was hard to collect the gas in a measuring cylinder because we kept getting air bubbles. A gas syringe would be better because it is more precise.

Teacher's notes

AF1

Pupil A uses abstract ideas when explaining the reaction process, taking more than one factor into account. The written explanation of the effect of concentration successfully uses a sophisticated particle explanation. She relates the concentration of the acid to the number of particles and to the frequency of collisions affecting the rate of reaction. Her attempt to provide a visual representation was less successful because she tried to do more than was possible in the limited time. She would have done better by drawing a pencil sketch onto a print-out of her work, rather than trying to use the computer to create graphics.

AF3

Pupil A produced the report independently, based on previous learning and without specific guidance on the structure for this piece of work. She chose appropriate forms to communicate qualitative and quantitative data.

AF4

Pupil A applied her scientific knowledge and understanding to plan her investigation. She selected equipment, controlled variables appropriately and controlled risk independently. She repeated measurements appropriately, although times given to two decimal places are unnecessarily precise.

AF5

The conclusion given is fully consistent with the measurements, and Pupil A provided explanations using scientific knowledge and an understanding of the particle model.

Pupil A made valid comments on the quality of the data, identifying a problem of air bubbles in collecting the gas, but did not suggest a solution explicitly in her report, writing only that a gas syringe would be 'more precise'. In discussion, however, she explained that a gas syringe is easier to read, has 'smaller' scale divisions, and does not get air bubbles.

She calculated averages independently and correctly.

Next steps

- Discussion, using examples, of appropriate levels of precision in measurement activities.
- Activity on visual representation and on the need for a balance between attractive presentation and the speed of work, with particular reference to the importance and acceptability of quick and clear sketches.

Assessment commentary

The group of pupils identified an appropriate approach, based on their scientific knowledge and understanding. They selected and used methods to collect adequate data to reach a conclusion, recognising and controlling the risks.

In her account, Pupil A identified significant variables, recognising those that are independent and dependent. She presented quantitative data appropriately, and manipulated this to calculate suitable averages. Her conclusion is consistent with the collected evidence.

She went on to use scientific knowledge to provide an explanation based on abstract ideas of particle behaviour.

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3. Plants and photosynthesis summary booklet

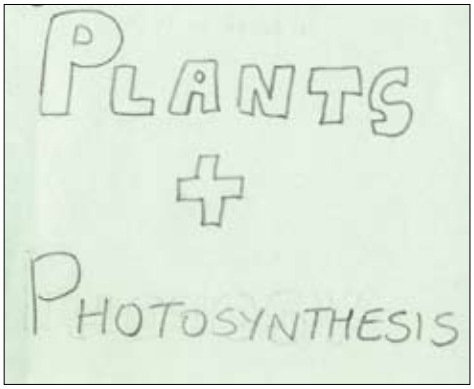
Assessment focuses

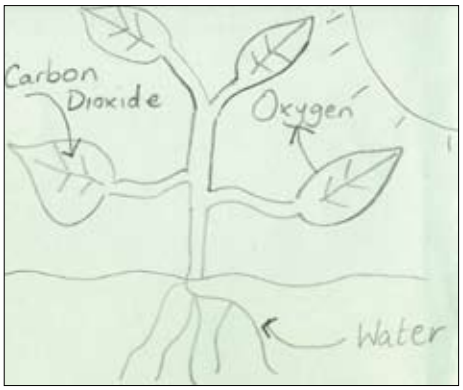
AF1, AF3

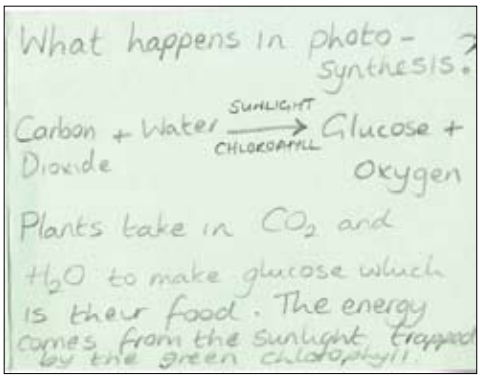
Context

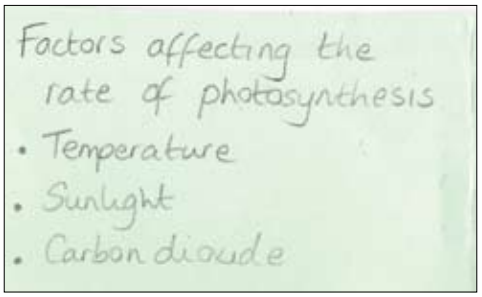
Pupils worked individually to produce a concise summary booklet on plants and photosynthesis. The selection of material for inclusion in their summaries was left to them, using the internet, text books and revision guides. They spent a lesson on this, as a review activity at the end of a topic on photosynthesis.

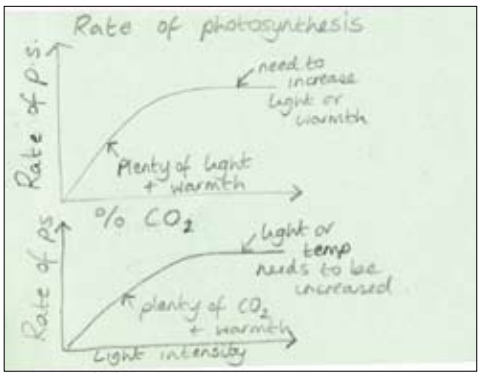
Pupil A's work

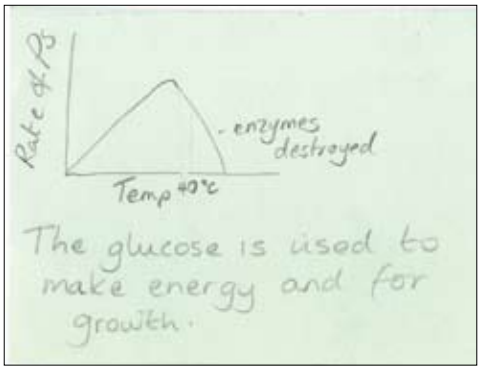


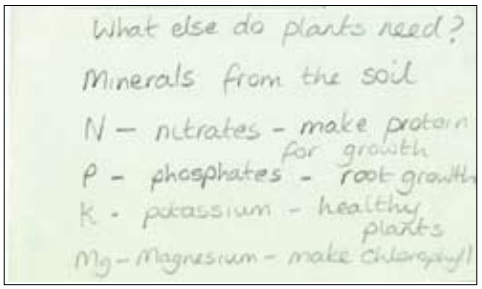












Teacher's notes

AF1

Pupil A used abstract ideas of chemical reactions within plants as a background to her explanation.

Her graphs show abstract information that takes account of several factors in the explanation of the process. There is a minor error in labelling the second graph, where the annotation connected to the line of the graph refers to 'light' where 'carbon dioxide' would be correct. The suggestion that glucose is used to 'make' energy shows that she may not understand energy as well as might be expected, but through discussion she was able to clarify this.

AF3

Pupil A created a communication tool that is appropriate to its purpose. She collected a good selection of images and text to create a concise graphic summary, with the exception that the material on nutrients is redundant, as no explanation was given of its relevance to photosynthesis. She used a variety of scientific conventions, including illustration of movement of reactants and products, word equations, chemical formulae and graphs that are generally well labelled.

A key point about the function of glucose has been left almost to the end, when its importance would make it fit better near the start.

She has not explained the significance of the peak in the graph showing the dependence of the rate of photosynthesis on temperature. She has referred to 'enzymes' but she has not provided an indication that she understands their significance.

Next steps

- Class discussion of the appropriateness of information and the need to show why particular information is key and should be included in a 'concise summary', involving peer review of each other's work.
- Review of energy, and of the idea that the reactions of photosynthesis produce glucose which is an effective store of energy for cell activity.
- Activity on referencing information.

Assessment commentary

The pupil has achieved conciseness and has included several key points, including concepts of rates of photosynthesis that are quite sophisticated, making explicit connections between abstract ideas and referring to quantitative relationships between variables.

The idea of 'making energy' as opposed to energy transfer is conceptually flawed but representative of an appropriate response at Key Stage 3.

She has not justified her decision to include some information (such as that relating to enzymes and minerals).

Confirmation of Pupil A's understanding of photosynthesis can be evidenced through further discussion about the contents of the summary booklet.

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4. Human impact poster

Assessment focuses

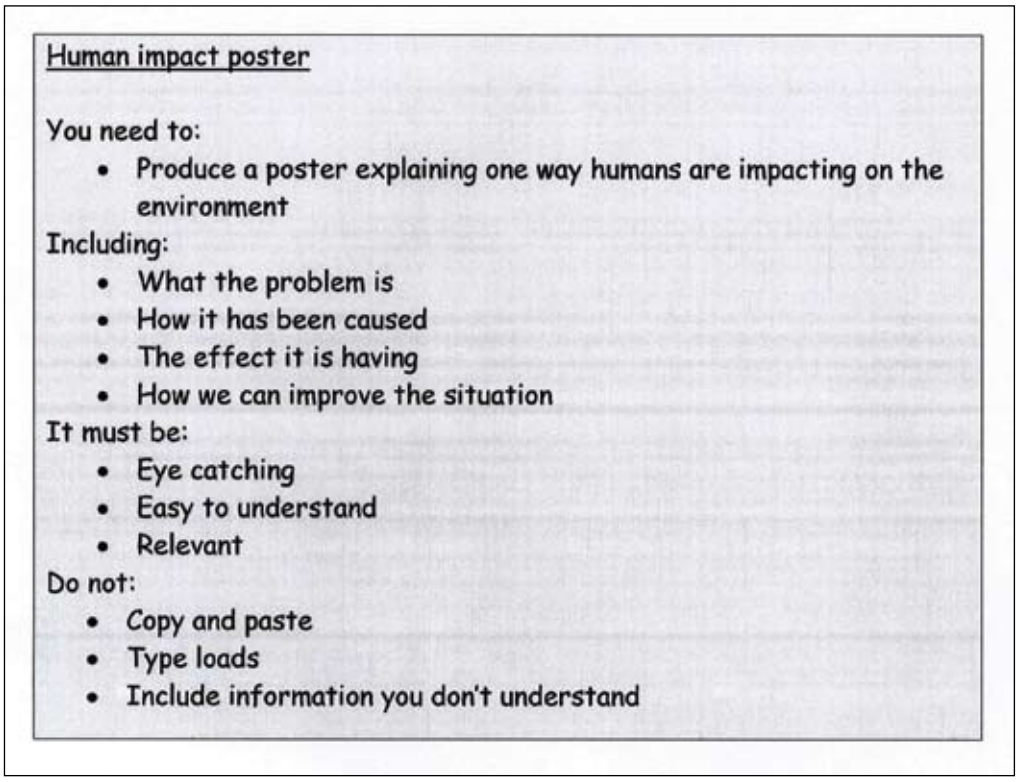
AF2, AF3

Context

Pupils worked in pairs to create a poster to summarise a negative impact of humans on the environment and possible solutions to the problem. This was a scene-setting activity at the start of a topic on 'Earth and environment'.

The teacher gave the pupils a briefing sheet and they had access to a variety of resources such as the internet and a range of key stage 3 text books. They sourced the information themselves and expressed themselves in their own words. No copying was permitted.

Pupil briefing sheet



Human impact poster

You need to:

- Produce a poster explaining one way humans are impacting on the environment

Including:

- What the problem is
- How it has been caused
- The effect it is having
- How we can improve the situation

It must be:

- Eye catching
- Easy to understand
- Relevant

Do not:

- Copy and paste
- Type loads
- Include information you don't understand

Pupil A's work

Global Warming

liz Shepherd -k
Amy Gunning -k

What is global warming?

Global warming is the rising temperature of the earths atmosphere.

How the government can help?

- Make alternative sources of fuel cheaper
- Introduce new fuels
- Make us recycle more
- Provide us with thing to help.

What allegedly causes global warming?

Global warming is caused by greenhouse gases. They are produced through activities which release carbon dioxide, methane, nitrous oxide and ozone CFC's.

The arguments for and against?

- If the fuel was made cheaper it might run out.
- It could be very expensive
- We are saving the planet.
- Save wildlife and make the environment healthier

Possible short & long term effects of Global warming?

- Sea levels would rise
- Citys and coast would flood
- lakes and rivers could dry up
- Some plants & animals might become extinct

How we can we help reduce the effects?

- Re-use plastic Shopping bags & recycle.
- Have a compost heap
- Cycle instead of driving
- Dont leave things on Standby

Save the planet!

Recycle!

Teacher's notes

AF1

The pupils used abstract ideas of global climate change and its association with rising sea levels.

AF2

The pupils selected ideas and information and successfully considered some personal ("How can we help?") and political ("How can the government help?") perspectives alongside the science, and applied their scientific understanding to suggest solutions. The distinction between short and long term effects is left unclear, but this is often the case in sources of information on the subject.

AF3

The information was gathered and selected from a range of sources, and presented in the pupils' own chosen way, resulting in a concise presentation. The heading "The arguments for and against" is not well explained, relative to the list that follows it.

The pupils worked collaboratively, and observation of their activity showed that they each made due contribution.

Next steps

- Presentation of work to peers and discussion of key issues raised.
- Exploring issues of changes caused by human and non-human activity and the validity of competing ideas about the causes (human or non-human) of current climate change.
- Review of professionally produced posters to consider how scientific information is presented to various audiences.

Assessment commentary

The two pupils described processes related to the Earth, using abstract ideas and appropriate terminology. They explained the importance of scientific knowledge and understanding on personal and collective levels, and suggested solutions to global climate change.

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5 Presentation on sustainable development

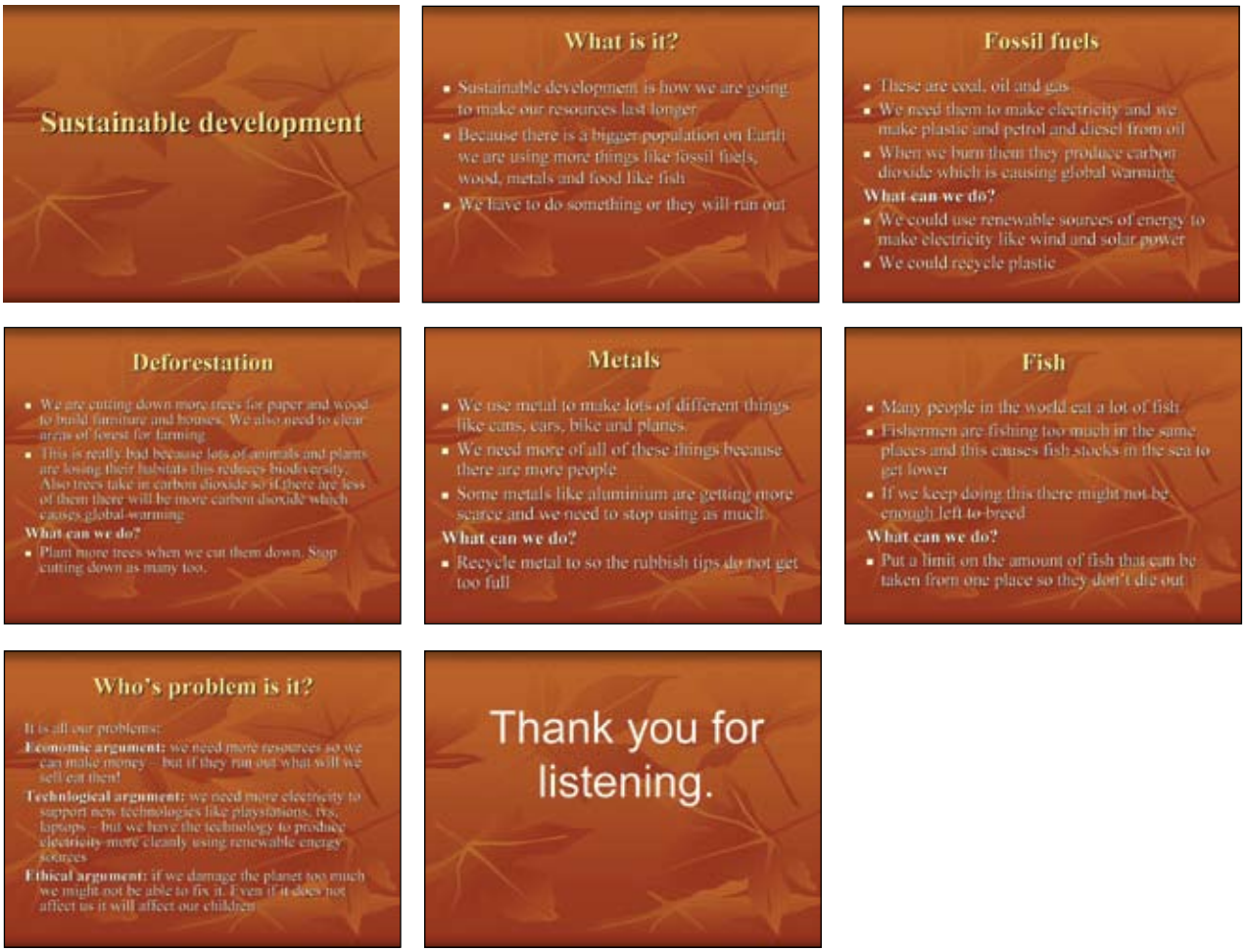
Assessment focuses

AF1, AF2, AF3

Context

The work was done as an exercise at the end of a topic on 'Earth and environment'. Pupils were asked to produce a presentation on 'Science and the environment' using secondary sources that included the internet, books and magazines. Pupil A chose to produce a slide show presentation on 'Sustainable development'.

Pupil A's work



Teacher's notes

AF1

Pupil A used abstract ideas such as the impact of an increasing human population, and took account of several factors when describing and explaining sustainable development.

AF2

Pupil A identified a series of problems, described them concisely and applied scientific ideas to potential solutions. For example, she considered some scientific evidence for and against the use of fossil fuels and the process of deforestation, and was able to classify arguments as economic, technological or ethical.

AF3

This is a piece of work involving selection and sequencing of main points in a concise presentation format, using a range of scientific terminology. Pupil A used this terminology correctly in context. The consistent 'problem-solution' approach shown on slides 3 to 6 is a strong point.

Next steps

- Consideration of how different decisions on the use of scientific and technological developments are made.

Assessment commentary

Pupil A demonstrated her well-developed communication skills in this work. She incorporated her understanding of abstract ideas into an explanation of applications and implications of scientific knowledge and understanding. She chose a topic, researched information, selected and sorted the information, and presented it in a clear sequence with explanation of the significant items of scientific vocabulary.

She described a good range of processes and phenomena relating to organisms, materials and the Earth.

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6. How scientists affect our lives homework task

Assessment focuses

AF2, AF3

Context

The teacher asked the pupils to write about how scientists affect our lives on a side of A4. They could pick any area of science.

The guidance they were given was to:

- explain how some jobs involve science;
- explain how any questions linked to this area of science have been answered or have yet to be answered;
- describe any economic, social or cultural issues that are associated with this area of science.

Pupil A's work

How are scientists changing our lives?

Scientists are all around us finding new things out all the time.

One area where scientists could change our lives is in space. There are lots of different types of scientists that work in space exploration and travel . They are involved in the designing, building and testing space craft. They have also designed and built telescopes that can be used from Earth or in space to try and find evidence for life on other planets.

The Hubble Telescope has been used to find evidence for life in outer space. There have been some important discoveries on Mars where some pictures suggest there might have been water and that could mean there might be life.

It costs massive amounts of money to explore space. This is an economic issue. But, I think that scientists could also have a big social impact, they might find things on other planets that could cure disease.

We still don't know if there is life on other planets, scientists are still looking. I think most people think there isn't. If they find more evidence then maybe one day that will change.

Teacher's notes

AF2

Pupil A discussed how particular scientific or technological developments had provided evidence to help scientists pose and ask further questions. She described how some developments in space exploration technology had helped scientists to try to answer the question 'Is there life on other planets?' She considered economic and social issues in these developments.

AF3

Pupil A alluded to the discussion of scientific evidence by the science community and how it might lead to a change in ideas. In discussion, she was able to confirm that she understood this.

Next steps

- Consideration of the different types of scientists that contribute to this work, and possible career paths that would be required to fulfil these roles.

Assessment commentary

The work was done as homework, and based on the pupils' existing understanding with no requirement for additional research. There is limited detail but it addresses the key areas that pupils were directed towards and is further evidence of Pupil A's good communication ability.

Assessment summary

AF1 Thinking scientifically

Pupil A uses abstract ideas and takes account of more than one factor when explaining processes or phenomena. She lacks the depth of understanding of some scientific concepts to make explicit connections between complex ideas. She is working at a secure to high level 6 for AF1.

AF2 Understanding the applications and implications of science

She has a good ability to collate ideas about how scientific ideas relate to the place of science in the wider world. She is working within level 7 for AF2.

AF3 Communicating and collaborating in science

Pupil A communicates effectively, working well at selecting, sorting and presenting ideas and information using a range of scientific terminology. In her written work, however, there is some uncertainty in the terminology that she uses. She is working within level 6 for AF3.

AF4 Using investigative approaches

She plans investigations independently, identifying and working with key variables, collecting data and recognising and controlling risks. Her work for AF4 is at a high level 6.

AF5 Working critically with evidence

She uses her scientific knowledge and understanding to identify limitations in observational evidence, comment on the validity of data, and draw conclusions that are both consistent with data and backed up by explanation using scientific models. She works at a high level 6 for AF5.

Overall assessment judgement

Pupil A is making inroads into level 7, especially for AF2, and working securely at level 6 across all AFs. She is assessed overall as high level 6.

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APP science assessment guidelines: levels 6 and 7

Name…A……

	AF1 – Thinking scientifically	AF2 – Understanding the applications and implications of science	AF3 – Communicating and collaborating in science	AF4 – Using investigative approaches	AF5 – Working critically with evidence
Level 7	**Across a range of contexts and practical situations pupils:** ● Make explicit connections between abstract ideas and/or models in explaining processes or phenomena ● Employ a systematic approach in deciding the relative importance of a number of scientific factors when explaining processes or phenomena ● Explain how different pieces of evidence support accepted scientific ideas or contribute to questions that science cannot fully answer ● Explain the processes by which ideas and evidence are accepted or rejected by the scientific community ☐	**Across a range of contexts and practical situations pupils:** ● Suggest ways in which scientific and technological developments may be influenced ● Explain how scientific discoveries can change worldviews ● Suggest economic, ethical/moral, social or cultural arguments for and against scientific or technological developments ● Explain how creative thinking in science and technology generates ideas for future research and development ☑	**Across a range of contexts and practical situations pupils:** ● Explain how information or evidence from various sources may been manipulated in order to influence interpretation ● Effectively represent abstract ideas using appropriate symbols, flow diagrams and different kinds of graphs in presenting explanations and arguments ● Explain how scientists with different specialisms and skills have contributed to particular scientific or technological developments ☐	**Across a range of contexts and practical situations pupils:** ● Formulate questions or ideas that can be investigated by synthesising information from a range of sources ● Identify key variables in complex contexts, explaining why some cannot readily be controlled and planning appropriate approaches to investigations to take account of this ● Explain how to take account of sources of error in order to collect reliable data ● Recognise the need for risk assessments and consult, and act on, appropriate sources of information ☐	**Across a range of contexts and practical situations pupils:** ● Explain how data can be interpreted in different ways and how unexpected outcomes could be significant ● Identify quantitative relationships between variables, using them to inform conclusions and make further predictions ● Assess the strength of evidence, deciding whether it is sufficient to support a conclusion ● Explain ways of modifying working methods to improve reliability ☐
Level 6	**Across a range of contexts and practical situations pupils:** ● Use abstract ideas or models or multiple factors when explaining processes or phenomena ● Identify the strengths and weaknesses of particular models ● Describe some scientific evidence that supports or refutes particular ideas or arguments, including those in development ● Explain how new scientific evidence is discussed and interpreted by the scientific community and how this may lead to changes in scientific ideas ☑	**Across a range of contexts and practical situations pupils:** ● Describe how different decisions on the uses of scientific and technological developments may be made in different economic, social or cultural contexts ● Explain how societies are affected by particular scientific applications or ideas ● Describe how particular scientific or technological developments have provided evidence to help scientists pose and answer further questions ● Describe how aspects of science are applied in particular jobs or roles ☐	**Across a range of contexts and practical situations pupils:** ● Identify lack of balance in the presentation of information or evidence ● Choose forms to communicate qualitative or quantitative data appropriate to the data and the purpose of the communication ● Distinguish between data and information from primary sources, secondary sources and simulations, and present them in the most appropriate form ☑	**Across a range of contexts and practical situations pupils:** ● Apply scientific knowledge and understanding in the planning of investigations, identifying significant variables and recognising which are independent and which are dependent ● Justify their choices of data collection method and proposed number of observations and measurements ● Collect data choosing appropriate ranges, numbers and values for measurements and observations ● Independently recognise a range of familiar risks and take action to control them ☑	**Across a range of contexts and practical situations pupils:** ● Suggest reasons based on scientific knowledge and understanding for any limitations or inconsistencies in evidence collected ● Select and manipulate data and information and use them to contribute to conclusions ● Draw conclusions that are consistent with the evidence they have collected and explain them using scientific knowledge and understanding ● Make valid comments on the quality of their data ☑
BL	☐	☐	☐	☐	☐
IE	☐	☐	☐	☐	☐

Key: BL-Below Level IE-Insufficient Evidence

Overall assessment (tick one box only) Low 6 ☐ Secure 6 ☐ High 6 ☑ Low 7 ☐ Secure 7 ☐ High 7 ☐

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Date of issue: 01-2009
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