The National Strategies
Secondary

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

Pupil D

department for children, schools and families

QCA Qualifications and Curriculum Authority

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

Pupil D

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Pupil D Year 9 Secure level 7 Science Standards File

Pupil profile

Pupil D is an outgoing pupil working in a group who are mostly working at level 6 to level 7. He is one of the more able in the group, in terms of both thoughtfulness and presentation. The work here was collected during three separate assessment periods each of two to three weeks in duration.

The evidence

1. Investigating speed
2. The physics of sky diving
3. How satellites affect our lives - homework task
4. Investigating rates of photosynthesis
5. Presentation on designer babies

00057-2009BKT-EN

1. Investigating speed

Assessment focuses

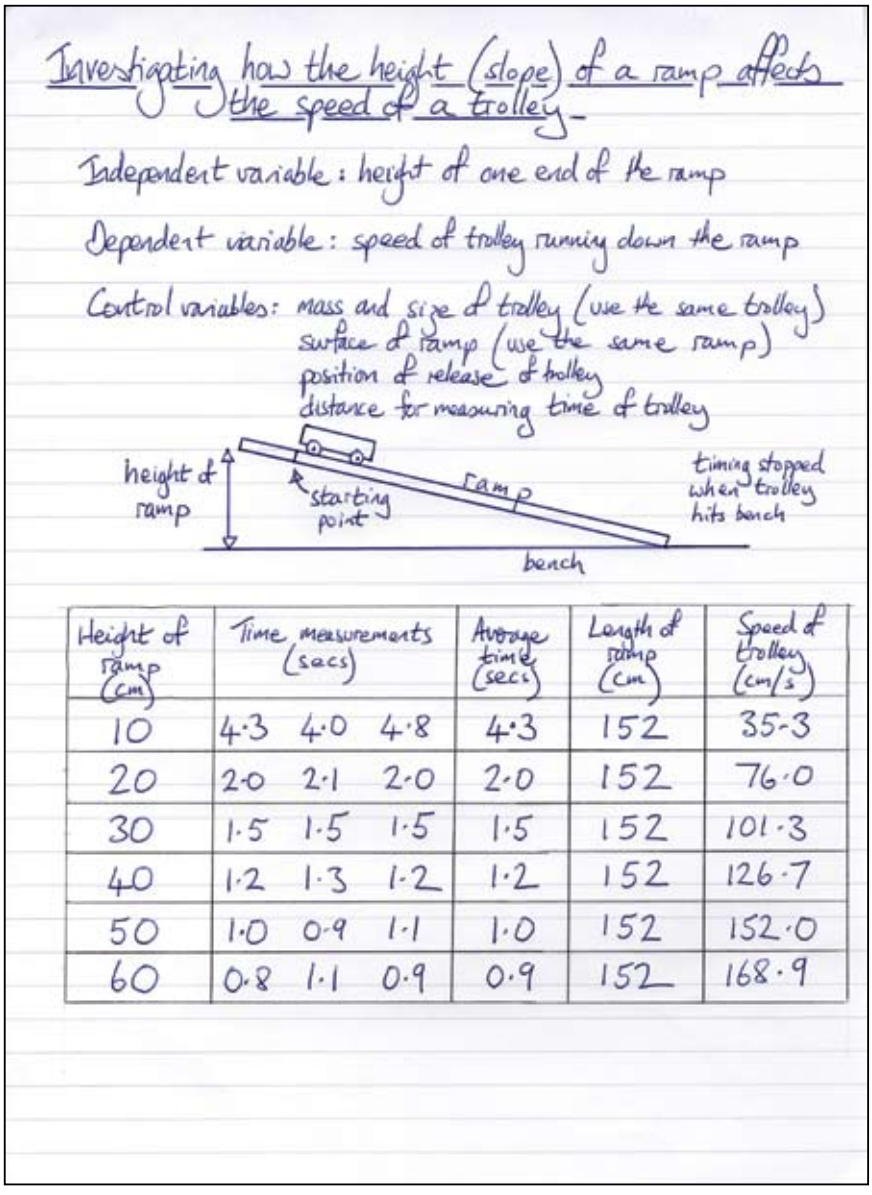
AF3, AF4, AF5

Context

The class was working on an extended topic on forces, motion and the science of the solar system.

The teacher gave pupils a number of different options for investigations involving the calculation of speed. Options included investigating running, wind-up toys and trolleys on ramps. Pupil D chose the final option and planned and carried out an open-ended investigation with no specific guidance from the teacher.

Pupil D's work



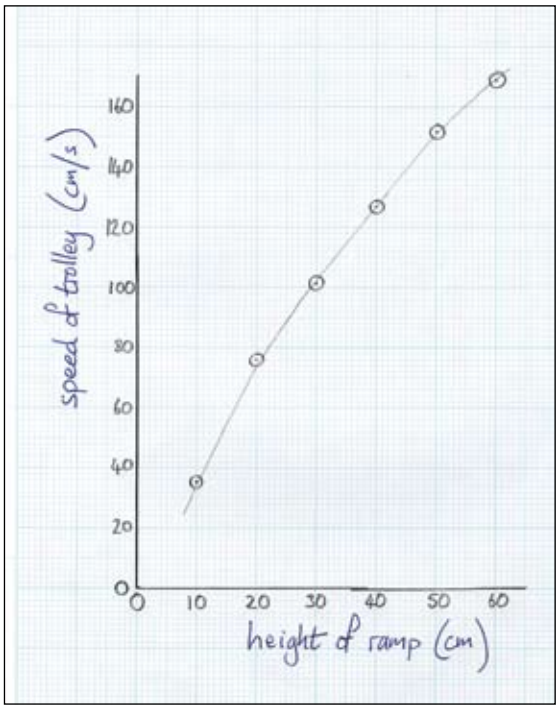
Investigating how the height (slope) of a ramp affects the speed of a trolley.

Independent variable: height of one end of the ramp

Dependent variable: speed of trolley running down the ramp

Control variables: mass and size of trolley (use the same trolley)
surface of ramp (use the same ramp)
position of release of trolley
distance for measuring time of trolley

Height of ramp (cm)	Time measurements (secs)			Average time (secs)	Length of ramp (cm)	Speed of trolley (cm/s)
10	4·3	4·0	4·8	4·3	152	35·3
20	2·0	2·1	2·0	2·0	152	76·0
30	1·5	1·5	1·5	1·5	152	101·3
40	1·2	1·3	1·2	1·2	152	126·7
50	1·0	0·9	1·1	1·0	152	152·0
60	0·8	1·1	0·9	0·9	152	168·9



My conclusion

The higher the ramp the faster the trolley goes. The pattern of the points on the graph make a curve but only slightly curved. Some of my results might be 'anomalous' but it is hard to tell. I wouldn't expect the line to go through (0,0) because the trolley won't move at all until the height is a few cm. So a curve is likely to be more correct than a straight line. I have tried to draw a smooth curve that passes close to the points so that it follows the general pattern but it doesn't have to go through all the points.

My evaluation

The different time measurements for each height are almost the same for most heights of the trolley. There is most variation for the first height (10cm.) and the last height (60cm.). It would have been a good idea to repeat these timings at least one more, especially for 10cm. since the trolley needed a nudge to start it and timing was hard to get right. More reliable measurements for 10cm. and 60cm. would make it more clear whether the line is straight or curved.

Teacher's notes

AF3

Pupil D showed that he could produce graphs proficiently, recognising that a graph helps to reveal an overall pattern and making a thoughtful assessment of the pattern in this case.

AF4

Pupil D formulated a question that could be answered realistically in the time available through a practical investigation of his own devising, and identified the key variables before proceeding to a sound process of reliable data collection. He worked with an appropriate and consistent level of precision, rounding times to the nearest tenth of a second, and repeated measurements to calculate averages. He was not required to provide a risk assessment, but demonstrated good working practice.

AF5

When discussing the shape of the graph, Pupil D was able to identify a quantitative relationship, explaining that the height of the ramp and the speed of the trolley were more or less directly proportional when the ramp was low, but not when the ramp was higher. He took account, and offered valid discussion, of uncertainty, assessing the strength of the evidence. He provided some explanation of a possible modification to his working method.

Next steps

- Consideration of methods to reduce measurement errors in such an investigation, such as using dataloggers and light gates.
- Graph extrapolation exercises to predict results from an established relationship between two variables.

Assessment commentary

Pupil D's work illustrates a methodical investigative approach with competent data organisation and the use of a graph. A strong feature is the mature and thoughtful reflection that provides a very good critical approach to interpretation and evaluation of the evidence.

00057-2009BKT-EN

2. The physics of sky diving

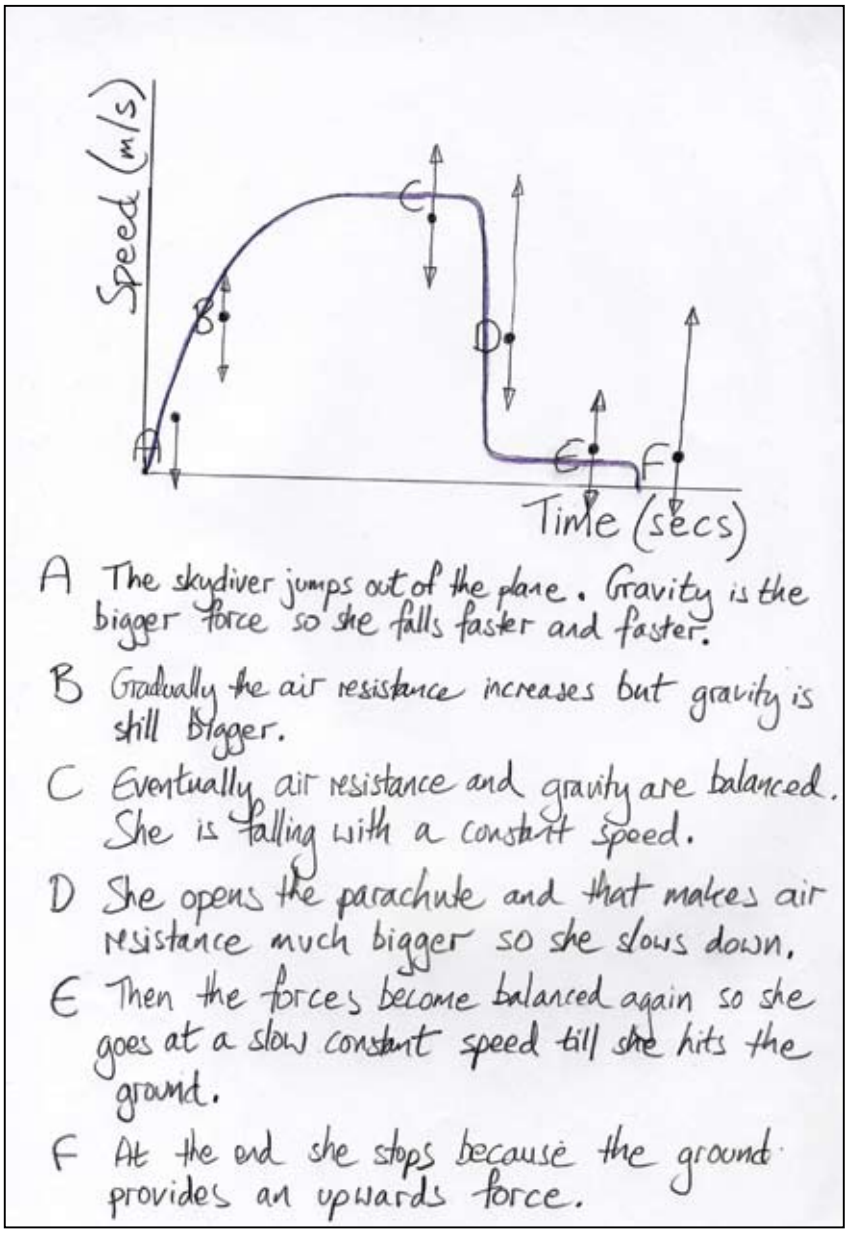
Assessment focuses

AF1, AF3

Context

Pupils had reviewed earlier work on balanced and unbalanced forces and were relating this to a range of speed-time graphs that had either been obtained directly from a datalogger activity or had been presented from a published resource. The teacher then provided pupils with a speed-time graph for a sky diver and asked them to produce an annotated version that they could use as the basis for explanation of the motion and the forces acting on the sky diver at different stages in her descent.

Pupil D's work



Teacher's notes

AF1

Pupil D wrote a concise step-by-step account of the motion and forces acting on the sky diver. His explanation connects ideas of balanced and unbalanced forces with overall net force, and consequent acceleration or deceleration.

AF3

The class had previously used vector representation of balanced and unbalanced combinations of forces in a wide variety of contexts. Here, Pupil D applied these ideas, effectively and without prompting, to communicate key points. He could have improved these representations with labels for the arrows themselves, perhaps, but the match to the written explanations makes their meaning and relevance clear.

Next steps

- Consideration of aspects of Newton's laws of motion and how they apply in various contexts such as this one.

Assessment commentary

Pupil D takes a systematic approach in explaining the processes of freefalling and descending using a parachute, making explicit connections between forces and changes in motion. He represents abstract ideas using combinations of force vectors of appropriate relative length.

00057-2009BKT-EN

3. How satellites affect our lives - homework task

Assessment focuses

AF1, AF2

Context

Pupils considered satellite launching rockets as an example of a situation involving unbalanced forces. This provided an opportunity for some individual internet research aimed at identifying as many different uses of satellites as possible. It also led to discussion and individual pupil work on the broad economic, ethical, social and cultural arguments for and against satellite technologies. The pupil work is based on a template with specific questions that the teacher devised. Pupil D did the work as a homework exercise.

Pupil D's work

Gravity and Space – what did satellites ever do for us?

There were no satellites 100 years ago. What modern technologies are needed so that we can launch and use satellites?

Fuel technology, balancing technology so that a rocked doesn't become have an unstable launch, materials technology for things like heat shields and solar cells, radio for communication

The weight of a satellite is an unbalanced force. What change happens to the motion of a satellite because the force is unbalanced?

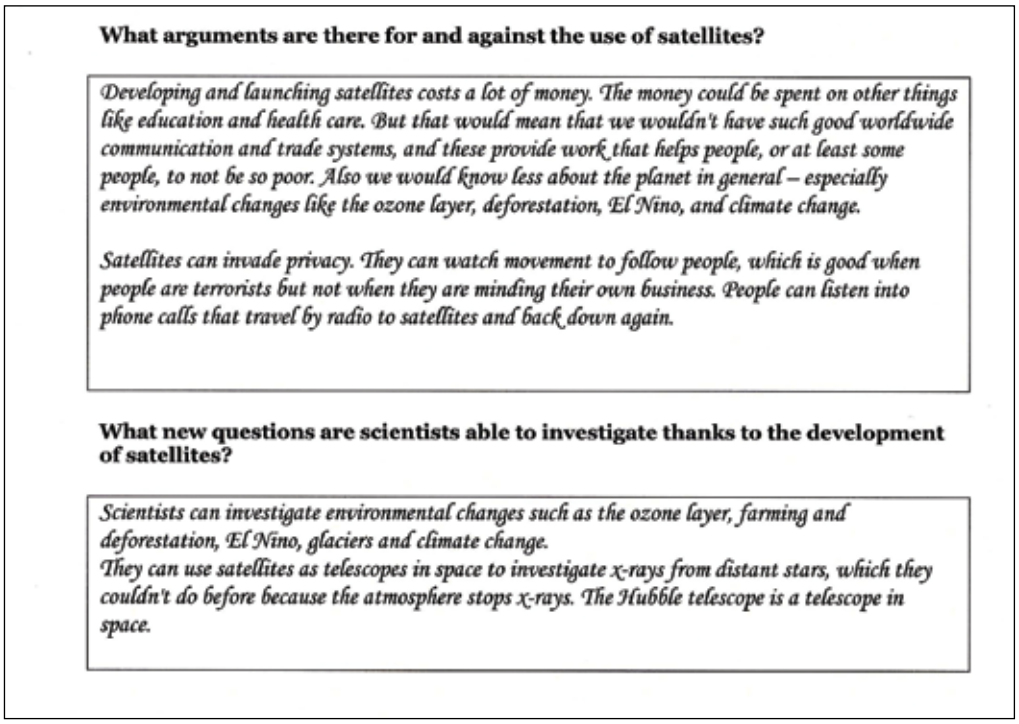
The unbalanced force stops the satellite shooting off in a straight line. It makes it change direction to go round the earth.

How has the development of satellites changed society?

We are better at predicting the weather and at watching the earth for signs of climate change. We can watch sports events, and other things happening like news, from around the world. There are more TV channels. People can keep in touch with friends and family in other parts of the globe. Satellites help us to navigate, especially ships and planes. Countries can use satellites to spy on each other so that it is harder to build weapons in secret.

Overall, it is easier to understand the global environment and to travel and communicate around the world than it used to be. It makes the world smaller.

Gravity and Space Illustration © Eastnine Inc./Z Z V E Illustrations/Getty Images. Used with kind permission.



What arguments are there for and against the use of satellites?

Developing and launching satellites costs a lot of money. The money could be spent on other things like education and health care. But that would mean that we wouldn't have such good worldwide communication and trade systems, and these provide work that helps people, or at least some people, to not be so poor. Also we would know less about the planet in general – especially environmental changes like the ozone layer, deforestation, El Nino, and climate change.

Satellites can invade privacy. They can watch movement to follow people, which is good when people are terrorists but not when they are minding their own business. People can listen into phone calls that travel by radio to satellites and back down again.

What new questions are scientists able to investigate thanks to the development of satellites?

Scientists can investigate environmental changes such as the ozone layer, farming and deforestation, El Nino, glaciers and climate change.
They can use satellites as telescopes in space to investigate x-rays from distant stars, which they couldn't do before because the atmosphere stops x-rays. The Hubble telescope is a telescope in space.

Teacher's notes

AF1

Pupil D made a connection between unbalanced forces and orbital motion.

AF2

He listed several types of impact associated with satellite technology and identified new opportunities for answering scientific questions. He also included a brief but significant statement about the impact of satellite technology on general worldview, in making 'the world seem smaller'. He provided economic, ethical and social arguments for and against satellite use but did not present a final balanced view.

Next steps

- Further consideration of scientific uncertainty using contemporary and historical examples.
- Exploration of how scientific knowledge develops as further evidence becomes available, using contemporary and historical examples.
- Discussion of the different specialisms and skills required in the development of satellite technologies.

Assessment commentary

Pupil D has the opportunity here to provide some brief explanation of scientific principles, but the focus is on the applications and implications of science. He recognises and explains that satellite technology and associated further scientific research can change worldviews and social and cultural behaviour at a global level, and suggests some arguments for and against use of the technology. He could have gone further by providing a synthesis of the arguments to provide a balanced judgement, by considering unintended consequences of change more explicitly, and by a more full evaluation of the effects of the scientific and technological developments on society as a whole.

00057-2009BKT-EN

4. Investigating rates of photosynthesis

Assessment focuses

AF1, AF5

Context

Pupils had previously carried out an investigation on the effect of temperature on the rate of photosynthesis. They then used a commercial computer simulation to gather relevant data on the effect of light intensity and carbon dioxide concentration, produced graphs, and analysed and interpreted the results.

Pupil D's work

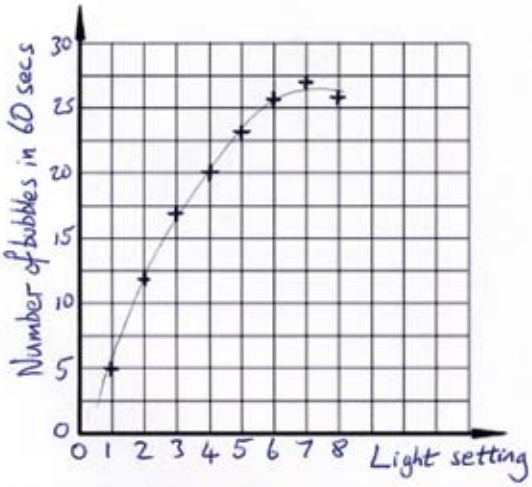
Changing the rate of photosynthesis

Pondweed experiment – light

Data

Light setting	Number of bubbles in 60 seconds
1	5
2	12
3	17
4	20
5	23
6	26
7	27
8	26

Graph



Commentary

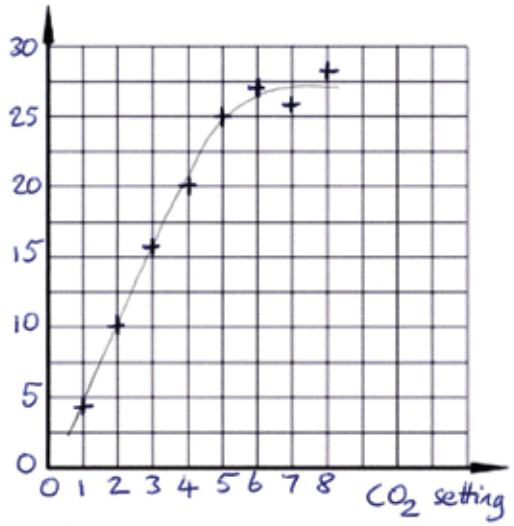
Number of bubbles in 60 seconds is a measurement of the rate of photosynthesis.
The graph is a curve that levels out. From the graph it is not possible to tell whether the rate of photosynthesis will stay levelled out. I would expect it to since light reaches a level where making it brighter does not speed up photosynthesis unless other limiting factors change such as temperature and carbon dioxide level.

Pondweed experiment – carbon dioxide

Data

Carbon dioxide setting	Number of bubbles in 60 seconds
1	4
2	10
3	16
4	20
5	25
6	27
7	26
8	28

Graph



Commentary

The shape of the graph is the same as for the 'light' experiment. This time the light setting stays the same so that rate of photosynthesis first increases as the CO_2 goes up but eventually the CO_2 makes no more difference. The light is then a limiting factor.

Teacher's notes

AF1

Pupil D used a thoughtful approach in explaining the shape of the graph, recognising the relative importance of 'limiting factors'.

AF5

Pupil D identified and discussed quite complex quantitative relationships between the different variables affecting the rate of photosynthesis.

Next steps

- Application of the knowledge of the importance of light intensity, carbon dioxide level and temperature in the design of sustainable greenhouse systems for growth of food.
- Consideration of whether changes to the rate of photosynthesis of global flora might result from global climate change with increased temperatures and carbon dioxide levels, and whether any such changes promote or oppose further change.

Assessment commentary

This is a concise but valid assessment exercise, providing the opportunity to work critically with evidence and to associate the evidence with scientific explanation. Pupil D shows competent use of graphs (although omitting a label on one y-axis) and relates the evidence to scientific understanding.

00057-2009BKT-EN

5. Presentation on designer babies

Assessment focuses

AF1, AF2, AF3

Context

The class had an opportunity to review topics with a variety of economic, ethical, moral, social or cultural impacts. The class discussed alternative forms of presentation, including newspaper and magazine articles, posters, leaflets and spoken presentations. They then assessed the characteristics of good presentations by looking at the examples provided. The teacher asked each pupil to choose from a list of topics and to produce a presentation using the following general guidelines:

- explain the key technical terms that you use;
- consider the past, present and future as appropriate;
- present arguments in favour of the science and its impact;
- present arguments against the science and its impact;
- explain whether information is sometimes manipulated in order to influence how people feel about the impacts;
- try to identify some 'facts' and some 'opinions';
- provide and justify your own balanced judgement.

An additional requirement was that presentations should be interesting, with a level of explanation and conclusion matched to the audience's initial level of understanding.

Pupil D produced a presentation on designer babies.

Pupil D's work

Slide 1

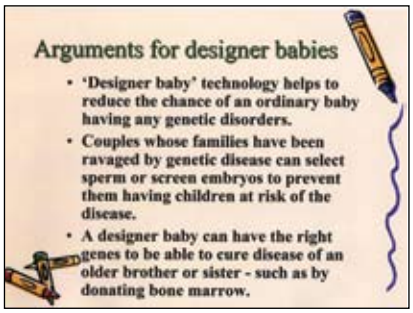
Slide 2

Slide 3

Slide 4

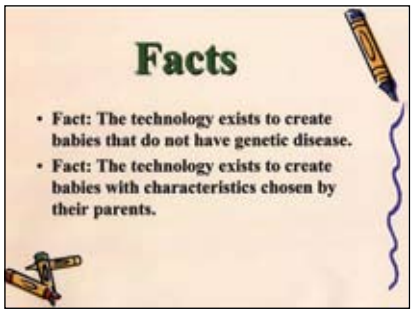
Slide 5

Slide 6



Slide 7

Slide 8



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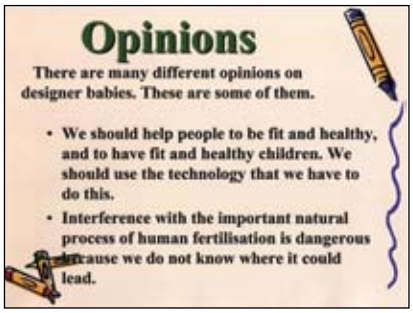
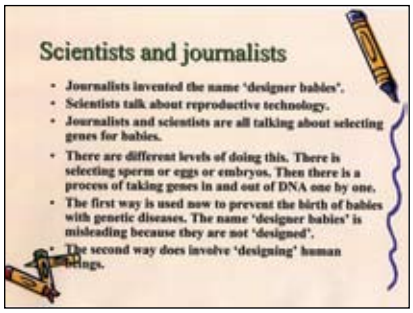


Slide 10



Slide 11

Slide 12

Slide 1, Baby Boy Crawling © Sarah Monte/Westend 61/Getty Images. Used with kind permission.

Teacher's notes

AF1

Pupil D explained various terms, taking a coherent view of connected abstract ideas.

AF2

He mentioned the role of the media in devising the term 'designer babies' and showed that this is misleading in some ways, suggesting that scientific and technological developments may be influenced by the media. He presented arguments for and against the use of reproductive technology, and distinguishes successfully between some facts and opinions, making a final balanced judgement through the consideration of ethical implications.

AF3

Pupil D produced an effective form of communication, with technical terms well-explained and with issues explored, resulting in a presentation that was interesting and matched to the audience. He touched on the manipulation of ideas in order to influence developments, but did not explore this in detail.

Next steps

- Presentation to the class, and observation of peers' presentations, with an end-of-year prize awarded to the best presentation, judged by pupils according to criteria based on the initial briefing.

Assessment commentary

This evidence provides a limited opportunity for pupil D's ability to think scientifically, but the general quality of the communication suggests aspects of the highest level, with a presentation that offers a robust and well-structured explanation of reproductive technology. Pupil D also includes a balanced judgement based on the presentation of opposing arguments and on some modest consideration of the influence of the media.

Assessment summary

AF1 Thinking scientifically

Pupil D is able to explain connections between abstract ideas (such as between forces and change in motion or between factors influencing rate of photosynthesis). He is able to sort concepts to produce a well-organised written explanation, consistent with a pupil working at secure level 7.

AF2 Understanding the applications and implications of science

Pupil D has two opportunities in the work shown here to demonstrate understanding of the applications and implications of science. Pupil D is able to describe varied impact of technologies and to present arguments for and against them. In one case he makes his own balanced judgement based on the information and arguments he has summarised, suggesting work at high level 7.

AF3 Communicating and collaborating in science

Pupil D shows strong general communication skills, and in particular the ability to construct a concise presentation of a complex issue, with key points selected for inclusion and terms explained well. The work he did provides the opportunity to use just one type of graph, and to organise data into a table, and this is done proficiently. The use of vectors to show relative sizes of force lacks explanatory labelling, but their significance is explained and used. Some expansion of issues relating to the manipulation of evidence in order to influence interpretation would add further strength. Pupil D is working at secure level 7 for AF3 with some aspects of level 8.

AF4 Using investigative approaches

Pupil D works with variables in complex contexts and formulates a question that he investigates. He chooses his own data collection methods to produce reliable data and begins to touch level 8 on this, but without sufficient justification for a judgement to go beyond high level 7.

AF5 Working critically with evidence

Pupil D's conclusions and evaluations show good independent thought. He is able to make a statement of a quantitative relationship from the evidence in a graph. By dealing with the uncertainty of his conclusion, he shows that the data are subject to different interpretations, and he assesses the strength of the evidence to suggest how the uncertainty might be reduced. In this way, he begins to interpret and evaluate the evidence critically. His work for AF5 as indicated here is at high level 7.

Overall assessment judgement

Pupil D makes achievements across all assessment focuses at level 7, and a significant proportion of his work can be judged to be high level 7. There is, though, in the opportunities presented here, only a very modest impact on the level 8 criteria. With a little more such impact, and with more opportunities offered to him to show further progress, he could be judged confidently to be working at high level 7. As it is, a cautious judgement places him at secure level 7.

00057-2009BKT-EN

APP science assessment guidelines: levels 7 and 8

Name…D……

	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 8	**Across a range of contexts and practical situations pupils:** ● Describe or explain processes or phenomena, logically and in detail, making use of abstract ideas and models from different areas of science ● Select and justify an appropriate approach to evaluating the relative importance of a number of different factors in explanations or arguments ● Analyse the development of scientific theories through the emergence of new, accepted ideas and evidence ☐	**Across a range of contexts and practical situations pupils:** ● Describe ways in which the values of a society influence the nature of the science developed in that society or period of history ● Evaluate the effects of scientific or technological developments on society as a whole ● Explain the unintended consequences that may arise from scientific and technological developments ● Make balanced judgements about particular scientific or technological developments by evaluating the economic, ethical/moral, social or cultural implications ☐	**Across a range of contexts and practical situations pupils:** ● Critically evaluate information and evidence from various sources, explaining limitations, misrepresentation or lack of balance ● Present robust and well structured explanations, arguments or counter arguments in a variety of ways ● Suggest the specialisms and skills that would be needed to solve particular scientific problems or to generate particular new scientific or technological developments ☐	**Across a range of contexts and practical situations pupils:** ● Justify their choice of strategies for investigating different kinds of scientific questions, using scientific knowledge and understanding ● Choose and justify data collection methods that minimise error, and produce precise and reliable data ● Adapt their approaches to practical work to control risk by consulting appropriate resources and expert advice ☐	**Across a range of contexts and practical situations pupils:** ● Propose scientific explanations for unexpected observations or measurements, making allowances for anomalies ● Process data, including using multi-step calculations and compound measures, to identify complex relationships between variables ● Critically interpret, evaluate and synthesise conflicting evidence ● Suggest and justify improvements to experimental procedures using detailed scientific knowledge and understanding and suggest coherent strategies to take particular investigations further ☐
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 ☑
BL	☐	☐	☐	☐	☐
IE	☐	☐	☐	☐	☐

Key: BL-Below Level IE-Insufficient Evidence

Overall assessment (tick one box only) Low 7 ☐ Secure 7 ☑ High 7 ☐ Low 8 ☐ Secure 8 ☐ High 8 ☐

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