Sc

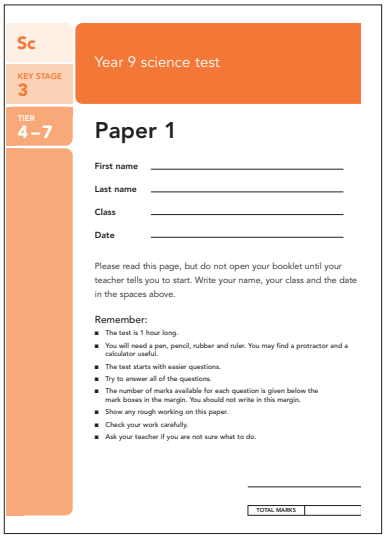
KEY STAGE 3

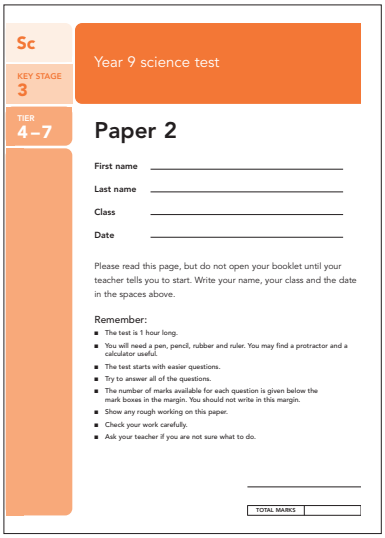
TIER 4–7

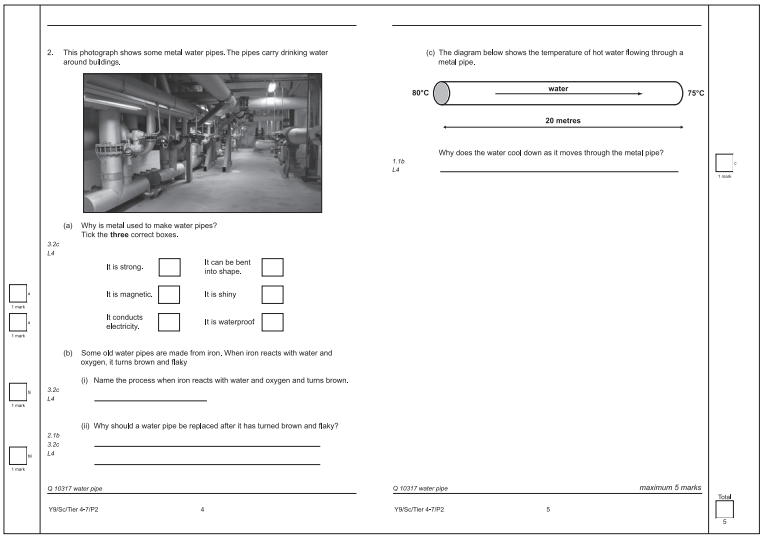
OPTIONAL

Year 9 optional science tests

Teacher's guide


Sc
KEY STAGE 3
TIER 4–7
Year 9 science test
Paper 1
First name
Last name
Class
Date
Please read this page, but do not open your booklet until your teacher tells you to start. Write your name, your class and the date in the spaces above.
Remember:
- The test is 1 hour long.
- You will need a pen, pencil, rubber and ruler. You may find a protractor and a calculator useful.
- The test starts with easier questions.
- Try to answer all of the questions.
- The number of marks available for each question is given below the mark boxes in the margin. You should not write in this margin.
- Show any rough working on this paper.
- Check your work carefully.
- Ask your teacher if you are not sure what to do.
TOTAL MARKS


Sc
KEY STAGE 3
TIER 4–7
Year 9 science test
Paper 2
First name
Last name
Class
Date
Please read this page, but do not open your booklet until your teacher tells you to start. Write your name, your class and the date in the spaces above.
Remember:
- The test is 1 hour long.
- You will need a pen, pencil, rubber and ruler. You may find a protractor and a calculator useful.
- The test starts with easier questions.
- Try to answer all of the questions.
- The number of marks available for each question is given below the mark boxes in the margin. You should not write in this margin.
- Show any rough working on this paper.
- Check your work carefully.
- Ask your teacher if you are not sure what to do.
TOTAL MARKS


2. This photograph shows some metal water pipes. The pipes carry drinking water around buildings.

(a) Why is metal used to make water pipes? Tick the **three** correct boxes.

3.2c L4

It is strong. It can be bent into shape.
It is magnetic. It is shiny
It conducts electricity. It is waterproof

(b) Some old water pipes are made from iron. When iron reacts with water and oxygen, it turns brown and flaky

(i) Name the process when iron reacts with water and oxygen and turns brown.

3.2c L4

(ii) Why should a water pipe be replaced after it has turned brown and flaky?

2.1b 3.2c L4

Q 10317 water pipe

YB/Sc/Tier 4-7/P2 4

(c) The diagram below shows the temperature of hot water flowing through a metal pipe.

80°C water 75°C

20 metres

Why does the water cool down as it moves through the metal pipe?

1.1b L4

Q 10317 water pipe maximum 5 marks

YB/Sc/Tier 4-7/P2 5

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The 2011 year 9 optional science tests and mark schemes were developed by the National Foundation for Educational Research (NFER) on behalf of QCDA.

Contents

Introduction

The year 9 optional science tests provide schools with a tool to help monitor pupils' progress against national standards at the end of key stage 3 and an instrument for gathering assessment evidence in support of teacher judgements.

The test materials may be used in whole or in part at any point during key stage 3 to provide valuable qualitative information about pupils' strengths and weaknesses. Teachers may choose to use the materials alongside written work, class discussions and group activities in a variety of contexts. When used in this way the materials can yield evidence in support of teacher assessment, including national curriculum level judgements.

The tests follow a similar structure to the previously statutory end of key stage 3 science tests taken by pupils in year 9. They can be administered and marked formally, and the results may be used to determine a national curriculum level. Even when used in this way, there is still useful additional information that can be discerned from pupils' responses. This guide explains the options in more detail.

The science tests are available in one tier only, covering levels 4–7.

Supporting teacher assessment

The optional year 9 science tests aim to be supportive of school assessment arrangements and can be used as part of an integrated approach to teacher assessment. Assessing Pupils' Progress (APP) materials are also available and may be used alongside these tests. APP is a structured approach to periodic assessment, enabling teachers to:

- use information about pupils' strengths and weaknesses to improve teaching, learning and rates of pupils' progress;
- track pupils' progress over a key stage or longer.

The optional test materials may be used in a variety of contexts in order to give pupils the broadest opportunities to show what they can do. Individual questions and pupil responses can be used to stimulate class discussions and group activities, contributing to a rich evidence-base for teacher assessment. The notes on individual questions make some specific suggestions for teaching and learning (see Section B).

Section A: Formal administration

The guidance in this section must be followed in order to produce a national curriculum level for each pupil using the level thresholds supplied on page 42.

There is one science test covering levels 4–7. The test is made up of two papers:

- Paper 1 (tier 4–7)
- Paper 2 (tier 4–7).

Pupils should take both Paper 1 and Paper 2.

Pupils' marks from both papers will be aggregated to calculate their overall science level:

- Paper 1 and Paper 2 have 60 marks each, giving a total of 120 marks.

Paper 1 and Paper 2

Pupils are allowed 60 minutes each for Paper 1 and Paper 2.

Pupils should have a break between each paper.

Teacher assessment will continue to be the only method of assessing the practical aspects of 1. Key processes, and 2. Key concepts.

What to do before the tests

- Remove or cover any displays or materials that could help pupils in the tests.
- Seating arrangements should allow all pupils to work quietly and independently.
- Having a clearly visible clock in the room will help pupils pace themselves during the tests.

What to do at the start of the tests

Examples of what might be said at the beginning of the tests are given below. Test administrators might find these useful when preparing opening comments for the science tests.

This is the key stage 3 science test Paper 1 (or Paper 2).

Each paper is one hour long.

You will need a pen, pencil, rubber and ruler. You may find a protractor and a calculator useful.

Write your name, your class and the date on the front of the test paper.

The test starts with easier questions. Try to answer all of the questions in the booklet.

Write all your answers and working on the test paper. Marks may be awarded for your working even if your final answer is wrong.

The number of marks allocated to each part of a question is indicated beneath each mark box. Where two or three marks are available, two or three distinct points are required for a full answer.

Remember to check your work carefully once you have completed the paper.

I will tell you when you are halfway through the test and also tell you when you are into the last five minutes. I will tell you when the test is over and when to stop writing.

If you have any urgent questions during the test, you should put your hand up and wait for someone to come to you. The administrator will only be able to read words or phrases from the test paper, not whole questions. You must not talk to each other.

You should now open your test booklet. The test has started.

Access arrangements

General advice

The year 9 optional science tests have been designed to ensure the majority of pupils working at the level of the tests can access them. A small number of pupils may require additional arrangements to access the tests.

For some pupils, for example those who suffer from attention-related difficulties, breaking the tests into shorter sessions may be beneficial. For others, working separately away from the main group with an assistant might aid concentration and more closely resemble their normal working conditions.

If you have chosen to use the year 9 optional science tests with the full cohort, you are free to make adaptations to the tests that will improve their accessibility for pupils with special educational needs and for pupils for whom English is an additional language. In making any changes to the way the tests are used, the focus should be on the assessment needs of the individual pupil. Any adaptations should be similar to those made to the materials which pupils work with in the classroom.

Examples of appropriate adaptations

School-based adaptations to the tests may include:

- allowance of up to 25% more time for pupils with a statement of special educational needs
- use of readers, prompters, sign language interpreters and scribes
- use of transcripts and word processors
- separating the tests into sections, taping, photocopying onto coloured paper, use of coloured overlays, use of apparatus
- enhancing the shading on diagrams, including charts and graphs, to increase visual clarity
- enlarging diagrams, cutting them out, embossing or mounting them on card or other material according to normal classroom practice
- translation of words or phrases in the test papers that are likely to prove difficult for pupils for whom English is an additional language, and also for pupils who use British Sign Language (BSL) or other sign-supported communication
- rephrasing of test instructions, including the use of gestures or drawings
- discussion of concepts that may be culturally unfamiliar to pupils when introducing the tests
- use of bilingual dictionaries.

Any access arrangements used should not alter the nature of the test questions and all answers given should be the pupil's own.

Modified versions of the tests

Modified large print, enlarged print and Braille test papers for visually impaired pupils are available from the QCDA modified test agency. Additional guidance notes for teachers administering the modified versions of the tests are supplied with the test papers. These include guidance for people administering the tests to pupils with hearing impairment and pupils who use sign language.

If you have any questions about ordering the modified tests, contact the QCDA modified test agency on: 0844 500 6727.

For further guidance on access arrangements please refer to *Access arrangements* available on the QCDA website at: www.qcda.gov.uk/assessment/3798.aspx

Marking the tests

About the mark scheme

The science mark scheme was devised after trialling the materials with pupils and contains some frequently occurring correct answers given in the trials. This booklet includes the mark scheme for Paper 1 and Paper 2.

The structure of the mark scheme

The mark scheme for each question shows:

- references to the key stage 3 programme of study
- the marks available for each part of the question
- the total marks available for the question
- the answer or expected answers indicated by an asterisk (marking point)
- additional guidance to assist markers in making professional judgements.

In the **Accept** column there may be:

- examples of answers which are acceptable, although they do not correspond exactly to the expected answers
- answers aligned to the main marking point which are equivalent and cannot be counted as a separate marking point in multiple-mark questions
- examples of higher-level answers, which could be given by higher-attaining pupils answering questions on the lower levels in the tier.

In the **Additional guidance** column there may be:

- examples of answers which are insufficient or not acceptable (see page 11)
- information on the general requirement of the question
- a reminder, in questions involving calculations, that consequential marking may be used
- instructions on action in the event of consequential marking (see page 13)
- guidance to markers where pupils have not followed the instructions in the question.

The first example shown below is from Paper 1 question 5.

Brackets indicate part of an answer that is not necessary for it to be creditworthy.
In the example below, 'volume in each test tube' is enough to gain a mark.

In the same example, an answer giving 'starting temperature' and 'size of test tubes' should be awarded two marks. However, an answer which gives 'volume in each test tube' and 'amount of water' should be given only one mark, as they refer to the same marking point.

Part	Mark	Answer	Accept	Additional guidance
c *2.1c*	2	any **two** from		
		* volume **or** mass (of water) in each test tube	• amount of water	
		* starting temperature (of water)	• measure for the same time	'temperature of (hot) water' is insufficient 'check at the same time **or** same amount of time' is insufficient 'the heat of starting water' is insufficient
		* surface area of water		
		* size of test tubes		
		* the temperature of the room	• keep in the same place • no draughts	'the heat of the room' is insufficient

Where more than one answer is acceptable, this is indicated in the mark scheme by 'any **one** from' or 'any **two** from'. Each possible correct answer (marking point) is marked with an asterisk. In some cases, alternative answers are indicated by '**or**'. This is shown in the example below and on the opposite page.

The additional guidance column shows which answers are insufficient or not acceptable. '**Do not accept**' answers will negate a mark if given with an otherwise creditworthy answer. In the example below, from Paper 1 question 1, the answer 'they had more food and more space' would not gain a mark. '**Insufficient**' answers do not provide enough information to be awarded the marking point on their own, but can be credited if given with a correct answer. For example 'they had more space because the pot is bigger' should be awarded one mark. Insufficient answers can also be irrelevant information.

Part	Mark	Answer	Accept	Additional guidance
b *3.3d* *1.1b*	1	* less **or** no competition	• they had more space **or** soil (for each plant) • they had plenty of room to grow • they had more minerals • they had more nutrients • they had more water • they had more light or Sun(light)	'the pot is bigger' is insufficient 'they grew outside' is insufficient *do **not** accept* 'they had more food' 'they had plenty of water **or** light' is insufficient 'more oxygen' is insufficient 'it has a lot of what it needs to grow' is insufficient

Marking

The number of marks available for each part of a question, and the maximum number of marks for the question as a whole, are shown on the question paper. Every part of a question which has been attempted by a pupil should be marked and the mark for each part recorded in the mark box alongside that part. Half marks should not be given in any question.

The total number of marks awarded for all the parts of questions on a double page should be written in the box at the bottom of the right-hand page. The total number of marks obtained on the paper can be recorded on the front of the test paper.

The total number of marks available is 120.

Using professional judgement in marking

The instructions given in the mark scheme will enable you to decide whether pupils have correctly answered a particular question. However, there will be instances where an answer given by a pupil does not correspond to any of the possible responses shown in the mark scheme. In such cases, you should apply your professional judgement to decide if credit should be given. You should consider whether the response:

- is equivalent to those listed
- conveys the correct scientific ideas and answers the question
- is an unambiguous indication of the correct answer where pupils are asked to select from a list.

Marking misspellings of words

If a pupil misspells a word, you should apply the following procedures:

- if it is clear that the pupil has made a simple error, eg 'tow' for 'two' or 'Son' for 'Sun', then the incorrect spelling should be accepted and the mark awarded
- if a pupil misspells a word copied from the text of the question or from a selection given, and the new word does not have any inappropriate meaning, the incorrect spelling should be accepted and the mark awarded
- if specific scientific vocabulary is required in the answer, a misspelling must, in order to be creditworthy, be a phonetic equivalent of the required word, with the major syllables of the correct word represented.

Marking lists of alternative answers

In some instances, pupils give more than one answer to a single question. If any of the answers given is incorrect (as indicated by 'do not accept' in the mark scheme) or contradicts the correct answer, the mark should not be awarded, irrespective of the order in which the answers are given. In some cases, a correct answer is given alongside other answers which, on their own, would be insufficient for the mark. In these cases, the mark should be given for the correct answer.

Marking questions containing calculations

Some questions require pupils to perform calculations. Where two marks are available, they are advised to show their working. Pupils who do not show their working but give the correct answer should be awarded full marks.

The result of one calculation may be required in order to carry out further calculations. In such instances:

- the term 'consequential marking' appears in the **Additional guidance**
- a pupil's result for the first calculation should be treated as the starting point for the second
- the pupil should be awarded full credit for the second calculation if it is carried out correctly, even if the result of the first calculation was wrong.

Marking answers given in the wrong place

In some cases, pupils may write correct answers in the wrong part of the question. You should use professional judgement to decide whether a pupil has correctly understood the question and simply written the answer in the wrong place. Similarly, if pupils identify an answer by a cross or other indication when a tick is required, they should be given credit for their responses. However, if there is any ambiguity in the pupil's meaning, the mark should not be awarded.

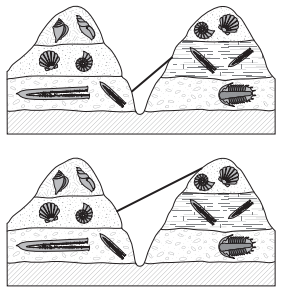
Definitions of terms

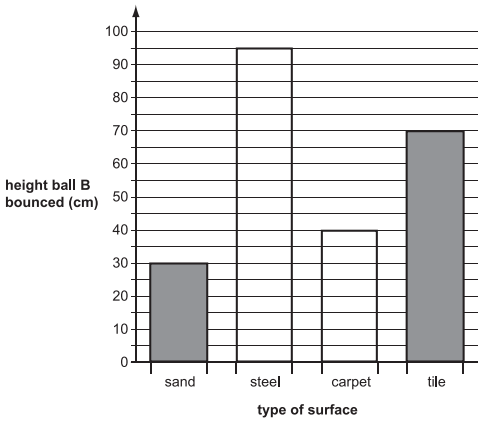
*'do **not** accept'* answers will negate a mark if given with an otherwise creditworthy answer
'insufficient' answers do not provide enough information to be awarded the marking point on their own, but can be credited if given with a correct answer
'**or**' indicates alternative answers
(For examples of the use of these terms please refer to pages 10 and 11.)

Paper 1 mark scheme

Tier 4–7	Q No. 1

Part	Mark	Answer	Accept	Additional guidance
a i *3.3d*	1	* light ✔		if more than one box is ticked, award no mark
a ii *3.3d*	1	* water ✔		if more than one box is ticked, award no mark
b *3.3d* *1.1b*	1	less **or** no competition	• they had more space **or** soil (for each plant) • they had plenty of room to grow • they had more minerals • they had more nutrients • they had more water • they had more light or Sun(light)	'the pot is bigger' is insufficient 'they grew outside' is insufficient *do **not** accept* 'they had more food' 'they had plenty of water **or** light' is insufficient 'more oxygen' is insufficient 'it has a lot of what it needs to grow' is insufficient
c *3.3d*	2	any **two** from * water * minerals * oxygen	• nutrients accept a named mineral such as 'nitrate' accept for two marks, two named minerals	answers can be in either order *do **not** accept* 'food' 'carbon dioxide' is insufficient
Total	**5**			

Tier 4–7	Q No. 2			
Part	**Mark**	**Answer**	**Accept**	**Additional guidance**
a *3.4a* *1.1a*	1	3 1 2		
b *3.4a*	1	* sedimentary rocks ✔		if more than one box is ticked, award no mark
c i *1.1a*	1	* a line pointing to any two layers containing the same fossils eg 		if more than one line is drawn, award no mark
c ii *1.1a*	1	*  ✔		if more than one box is ticked, award no mark
d *3.4a*	1	* rain ✔ wind ✔		**both** answers are required for the mark
Total	**5**			

Tier 4–7	Q No. 3			
Part	**Mark**	**Answer**	**Accept**	**Additional guidance**
a i *2.2a*	1	* steel		
a ii *2.2a*	1	* 0, 16		answers may be given in any order
b *2.3a*	1	* 		**both** bars must be correct in order to award one mark bars may **or** may not be shaded
c *2.2b* *2.2a*	1	* the higher the drop, the higher the bounce. ✔		if more than one box is ticked, award no mark

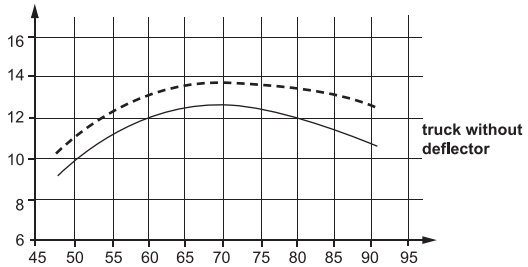
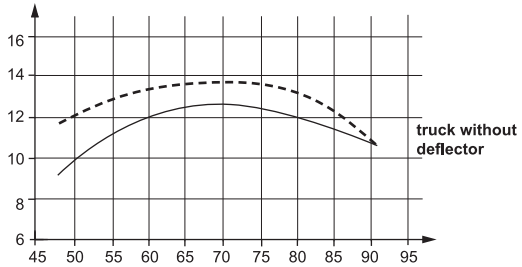
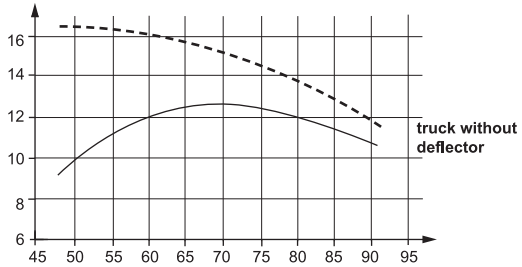
Tier 4–7	Q No. 3

Part	Mark	Answer	Accept	Additional guidance
d *2.2b*	1	any **one** from * difficult to carry out the experiment at different gravities in real life * more accurate * easy to change variables * difficult to heat the ball up in real life	• more precise • more reliable	accept examples of 'real' experiments when the practical may be affected by random variations eg 'if you are doing the experiment outside, the wind may interfere with the ball' accept references to the variables that may be changed eg surface, height from which ball is dropped etc.
Total	**5**			

Tier 4–7	Q No. 4

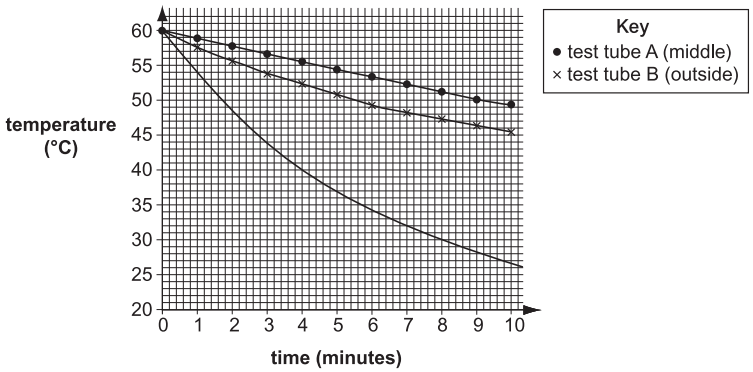
Part	Mark	Answer	Accept	Additional guidance
a i *3.1b*	1	* friction between the wheels and the ground	• the tyres **or** wheels • the ground • the engine	'chemical energy in the fuel' is insufficient 'friction' (alone) is insufficient
a ii *3.1b*	1	* friction	• air resistance • drag	'wind resistance' is insufficient
a iii *3.1b*	1	* 1000 *N*	• –1000 *N*	
b *3.1b*	1	* X is less than Y ✔		if more than one box is ticked, award no mark
c i *3.1b*	1	* increase		
c ii *3.1b*	1	* decrease		

Tier 4–7	Q No. 4

Part	Mark	Answer	Accept	Additional guidance
d i *2.2a*	1	* any number from 68 to 72 *km per hour*		
d ii *3.1b*	2	* a curved line that follows the drawn line and is entirely above it and covers the full range from 50-90 km 	accept, for one mark, a line that is above the drawn line but that touches it on either end at 50 km/hr **or** 90 km/hr.  accept, for two marks, a straight line that is above the curved line or a line above the curved line that slopes downwards from left to right and ends at 90 km 	*do **not** accept* a line that touches the drawn line on both ends *do **not** accept* a line that goes below the given line, over the range 50 km/hr to 90 km/hr
Total	**9**			

Tier 4–7	Q No. 5			
Part	**Mark**	**Answer**	**Accept**	**Additional guidance**
a *1.1a*	1	* the penguins	• body heat	'the penguins' blood' is insufficient 'heat' is insufficient 'the huddle' **or** 'huddling' are insufficient
b *1.1a*	1	* to represent the body heat of the penguins	• penguins are warm blooded • so it cools • you can see the change in temperature • so that it is warmer than the air	'their blood' is insufficient 'to see if it helps keep it warm' is insufficient
c *2.1c*	2	any **two** from * volume **or** mass (of water) in each test tube * starting temperature (of water) * surface area of water * size of test tubes * the temperature of the room	 • amount of water • measure for the same time • keep in the same place • no draughts	 'temperature of (hot) water' is insufficient 'check at the same time **or** same amount of time' is insufficient 'the heat of starting water' is insufficient 'the heat of the room' is insufficient
d *2.3a* *1.1b*	1	* test tube A loses heat more slowly	• the middle test tube's temperature line **or** line is higher • it starts at the same temperature and its temperature stays higher • the outside test tube **or** B cools down faster (than test tube A)	'the temperature is higher' is insufficient the response must refer to the experiment

Tier 4–7	Q No. 5

Part	Mark	Answer	Accept	Additional guidance
e *3.3e* *2.2a*	1 1	* a line starting at the same temperature * a line continuing below the two plotted lines and going down more steeply (for an example see below)  		*do **not** accept* a line that shows a clear discontinuity *do **not** accept* a line that shows any increase in temperature over the time shown line must cover the range 0-10 minutes
f *3.3e* *1.1a*	1	any **one** from * they lose more heat on the outside * so the ones on the outside do not freeze **or** get (too) cold	• they lose less heat in the middle • the penguins on the outside will return to their normal temperature (on the inside)	'so they are all warm' is insufficient 'they give heat from the middle to the penguins on the outside' is insufficient 'more will survive this way' is insufficient 'penguins on the outside will die' is insufficient 'it's fair for the penguins' is insufficient
Total	**8**			

Tier 4–7	Q No. 6			
Part	**Mark**	**Answer**	**Accept**	**Additional guidance**
a *3.1a*	1	* reflection **or** reflected	• it (**or** the light) bounces off	
b *1.1a* *1.2a* *3.1a*	2	any **two** from: * to track the position of the Sun * the receiver gets the maximum amount of solar energy **or** heat energy * the mirrors will reflect the maximum amount of solar energy **or** heat energy **or** light	 • they follow the Sun • more solar power • to reflect the rays onto the receiver • so they reflect the most energy • it works for longer during the day	
c *3.1a* *1.2a*	1	* black will absorb the most heat energy **or** radiation	• a dark colour • absorbs the most heat **or** energy	**both** the colour and the explanation are required for the mark *do **not** accept* 'attracts heat energy **or** heat' 'traps heat' is insufficient 'absorbs heat' is insufficient as other colours also absorb heat
d *3.1a*	2	* kinetic * electrical		answers must be in the correct order

Tier 4–7	Q No. 6			
Part	**Mark**	**Answer**	**Accept**	**Additional guidance**
e *1.1a* *1.2a*	1	any **one** from: * when it is dark **or** the Sun is not shining * to be used at peak times	• when it is night **or** when the Sun has gone down • on cloudy days • when there is no sunlight	
f *1.2a* *3.4c*	1	any **one** from: * solar power stations do not produce **or** produce less carbon dioxide * they use renewable energy * they do not pollute the air with smoke **or** ash	• coal burning power stations produce carbon dioxide • when burnt, coal produces greenhouse gases • coal is non-renewable	'coal burning power stations produce harmful gases' is insufficient 'burning fossil fuels produces harmful gases' is insufficient 'they do not damage the environment' is insufficient 'coal burning power stations use fossil fuels' is insufficient 'when burnt, coal produces emissions' is insufficient 'solar power stations do not pollute the air **or** Earth' is insufficient
Total	**8**			

Tier 4–7	Q No. 7			
Part	**Mark**	**Answer**	**Accept**	**Additional guidance**
a *2.3a*	1	* H_2		*do **not** accept* 'hydrogen' *do **not** accept* '2H' *do **not** accept* 'H H'
b i *3.2b*	1	* hydrogen chloride	• hydrochloric acid	*do **not** accept* 'hydrochloride' *do **not** accept* 'hydrogen chlorine'
b ii *3.2b*	1	* CH_4	• H_4C	*do **not** accept* 'CH4' *do **not** accept* 'CH^4'
b iii *3.2b*	1	* 	accept the correct symbols in any other arrangement	the circles must touch allow stick and ball representations of molecules
c i *3.2b*	1	* 2		
c ii *3.2b*	1	any **one** from * there is one carbon atom, four oxygen atoms and four hydrogen atoms on each side (of the equation) * the products have the same atoms as the reactants * no atoms are lost **or** gained (only rearranged)	• the same number of each type of atom **or** particle is there before and after • there is the same number of atoms on each side • there are no new particles **or** none disappear (in the reaction)	'nothing was added or taken away' is insufficient 'the same number of atoms' is insufficient 'the same number of diagrams on each side' is insufficient
Total	**6**			

Tier 4–7	Q No. 8

Part	Mark	Answer	Accept	Additional guidance
a *3.3a*	2	<table><tr><th>cell part</th><th>description</th></tr><tr><td>* cell membrane</td><td>B</td></tr><tr><td>* cell wall</td><td>D</td></tr><tr><td>* cytoplasm</td><td>C</td></tr><tr><td>* chloroplast</td><td>A</td></tr></table>		for **all four** correct, award two marks for any **two or three** correct, award one mark
b *3.3d*	2	* carbon dioxide * water	• CO_2 • hydrogen oxide • H_2O	answers can be in either order award one mark for each correct reactant symbols must be written correctly in order to award marks. For example *do **not** accept* 'CO^2', 'CO2', 'HO^2', 'H2O' 'CO' is insufficient *do **not** accept* 'sunlight' **or** 'energy' **or** 'chloroplasts' **or** 'chlorophyll'
c *3.3e*	2	any **two** from * this is where photosynthesis takes place * oxygen is produced here	• light is needed for photosynthesis	'photosynthesis' is insufficient 'bacteria are attracted by light' is insufficient 'bacteria need **or** like **or** are attracted to heat' is insufficient 'attracted by oxygen' is insufficient because this is taken directly from the question
Total	**6**			

Tier 4–7	Q No. 9			
Part	**Mark**	**Answer**	**Accept**	**Additional guidance**
a i *2.1a* *2.3a*	1	* 25	• $\frac{5000}{200}$	do **not** award the mark if the number has been calculated incorrectly
	1	any **one** from * m/s * metres per second	• ms^{-1}	for two marks accept '90 km per hour' 'mps' **or** 'mph' are insufficient
a ii *1.1b*	1	any **one** from * the car may have travelled faster for only a short distance **or** time	• the speed of the car may have varied • the car kept below the speed limit for most of the time	'it could have gone a different or faster way' is insufficient
b i *2.1a* *2.2a*	1	* 3 *hours*	• $\frac{120}{40}$	units are not required *do **not** accept* '4 hours'
b ii *2.1a* *2.2a*	1	* 50	accept correct answers that are consistent with alternative units	award **one** mark for correct calculation of total distance (200 km) and total time (4 hours) eg 200/4 accept an answer where the total hours are consistent with the time calculated in part (bi) (error carried forward)
	1	any **one** from * km/hr * km/h * kilometres per hour		*do **not** accept* 'kph'

Tier 4–7	Q No. 9			
Part	**Mark**	**Answer**	**Accept**	**Additional guidance**
c *1.1a* *2.1a* *2.2a*	1	* measure the distance between each pair of lamp posts and the time the car takes to travel that distance	• measure the time taken between different pairs of posts	'use a speed camera' is insufficient 'the time taken to travel between two lamp posts' is insufficient as they need to measure the time between more than two
	1	* calculate distance divided by time, the speed will increase	• time is less at the end compared with the start • time gets shorter	'it was speeding up' is insufficient 'its time gets quicker' is insufficient 'she counts the number of lamp posts' is insufficient 'the car passes in a given time' is insufficient as this on its own does not tell you if the car is speeding up
Total	**8**			

Paper 2 mark scheme

Tier 4–7	Q No. 1

Part	Mark	Answer	Accept	Additional guidance
a i *3.3b* *2.2a*	1	* 11 *years*		
a ii *3.3b* *2.2a*	1	any **one** from * growth spurt and muscle development * growth of hair on the face and pubic hair	• growth spurt • muscle development • growth of hair on face • growth of pubic hair	'growth' is insufficient 'muscles' is insufficient 'hair' is insufficient
a iii *3.3b* *2.2a*	1	* (over)active oil glands	• oil glands • oily skin	'oil' is insufficient 'skin becomes more active' is insufficient
a iv *3.3b* *2.2a*	1	* growth spurt **or** muscle development **or** acne **or** oil glands active **or** growth of hair on face **or** growth of pubic hair	• some of the changes can start after boys turn 16 years old • the chart goes up to 20 • three bars continue past the age of 16 • these are only start dates	

Tier 4–7	Q No. 1

Part	Mark	Answer	Accept	Additional guidance
b *3.3b* *2.2a*	1	* no ✔		if more than one box is ticked, award no mark both the answer and the explanation are required for the mark if 'yes' is ticked **do not** award the mark
		any **one** from * face and pubic hair may not start growing until they are 14 * they may not have a growth spurt until they are older than 12 * some boys' voices do not break until they are much older * some people may have a growth spurt when they are 10 years old * increased growth of penis does not happen until 13	accept other examples from the table • growth spurt **or** muscle development **or** growth of pubic hair etc can happen before or after they are 12 • you can start growing quickly at 10	statements copied from table are insufficient eg 'growth spurt and muscle development' there needs to be a reference to age need to refer to change and age for mark eg 'two of the changes start at 10' is insufficient because it does not refer to a specific change
Total	**5**			

Tier 4–7	Q No. 2

Part	Mark	Answer	Accept	Additional guidance
a *3.2c*	2	* It is strong ✔ * It can be bent into shape ✔ * It is waterproof ✔		for all **three** correct, award two marks for any **two** correct, award one mark if more than three boxes are ticked, deduct one mark for each incorrect tick minimum mark zero
b i *3.2c*	1	any **one** from * rusting **or** rusted **or** it rusts * oxidation	• rusty • corrosion	'reacting' is insufficient
b ii *2.1b* *3.2c*	1	any **one** from * the pipes are weaker **or** less strong * there may be rust **or** flakes in the water * the water could be unfit to drink	• they will crumble **or** leak • the water would be dirty **or** the converse • the pipes **or** water are contaminated **or** polluted	'poisonous' is insufficient 'the water is dangerous' **or** 'unhygienic' is insufficient 'the pipes are rusty' is insufficient 'the water would be infected' is insufficient
c *1.1b*	1	any **one** from * metals are (good) conductors * heat moves to **or** is absorbed by the metal * it loses heat to its surroundings	• it conducts heat well • metal heats up • water loses heat • the pipe is cold • the water is warmer than the surroundings	*do **not** accept* 'copper conducts electricity' 'the water is warm' is insufficient references to 'time' are insufficient, eg 'it was in the pipe for a long time'
Total	**5**			

Tier 4–7	Q No. 3

Part	Mark	Answer	Accept	Additional guidance
a *2.1c*	1	* ***B*** E A C D	• ***B*** E A D C	**all four** letters must be in one of the orders shown
b *2.1c*	2	any **two** from * same size pot * same size plant * same weather conditions * she did it at the same time	 • same pots • used 50 cm plants • same (sunny) spot in the garden • make sure the plant pots are at the same temperature • filled both pots with soil • same amount of soil	 'pot' is insufficient 'same type of plant' is insufficient 'same amount of water' is insufficient *do* ***not*** *accept* 'same soil'
c i *3.2c*	1	* indicator ✔		
c ii *1.1b* *2.2a*	1	* blue ✔ her soil is acidic	 • her soil is pH 5.5 • a pH of 6 or less means it is acidic	**both** answers are required for one mark
c iii *3.2c* *3.4c*	1	* add alkali	• lime • any named alkali	if a formula is given for an alkali instead of a name, the mark can only be awarded if the formula is correct *do* ***not*** *accept* 'fertiliser'
Total	**6**			

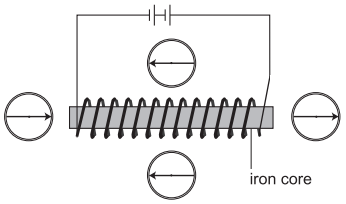
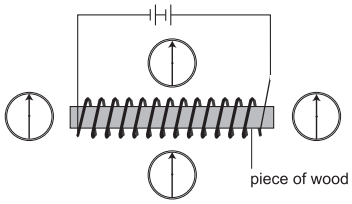
Tier 4–7	Q No. 4			
Part	**Mark**	**Answer**	**Accept**	**Additional guidance**
a i *3.1a*	1 1	* gravitational potential * kinetic	• gravitational **or** potential	answers must be in the correct order
a ii *3.1a*	1 1	* chemical * kinetic		answers must be in the correct order 'heat' is insufficient
b i *3.1a*	1	* light travels faster than sound	• light is faster than sound • light energy is faster than sound energy accept the converse • sound takes longer than light to reach us	'light reaches the person before sound' is insufficient 'light is faster' is insufficient 'sound takes longer to reach us' is insufficient
b ii *3.1b*	1	* *A*: air resistance	• friction • drag • upthrust	'wind resistance' is insufficient 'thrust' is insufficient
	1	* *B*: weight	• gravity • gravitational (force)	*do **not** accept* 'gravitational potential'
Total	**7**			

Tier 4–7	Q No. 5			
Part	**Mark**	**Answer**	**Accept**	**Additional guidance**
a *1.1a*	1	**award one mark** for identifying the independent variable eg with **and** without puddles	• with **or** without buckets **or** containers of water (in place of puddles) • hang the washing out with and without puddles	for **two** marks accept 'time how long it takes the washing to dry when there are puddles on the ground and when there are not' 'on wet days and dry days' is insufficient for the independent variable
	1	**award one mark** for identifying the dependent variable eg time to dry		for **one** mark accept, 'time with no puddles' for **two** marks accept, 'time **again** with no puddles'
b *1.1a*	2	any **two** from		
		* how rainy it is **or** is it raining	• rain **or** raining **or** snowing **or** sleet **or** hail	'damp' is insufficient
		* how humid **or** foggy the weather is		if 'the weather' is given with any of the first **four** points, award one mark only
		* how windy the weather is	• wind **or** wind speed **or** windy	'climate' is insufficient
		* (air) temperature	• how sunny it is **or** amount of sunlight **or** how cloudy it is • how hot or cold it is	'heat of surroundings' is insufficient 'Sun' is insufficient 'time of day' is insufficient
		* how spread out the clothes are * how wet the clothes are (from the washing machine)	• clothes	any variable to do with puddles is insufficient
		* the size **or** area of cloth **or** clothes	• the fabric **or** material the clothes are made from	'type of clothes' is insufficient
c *3.2c* *1.1a*	1	* it evaporates	• it turns to (water) vapour **or** a gas • it boils	'it dries up' is insufficient 'it drips off' is insufficient

Tier 4–7	Q No. 5

Part	Mark	Answer	Accept	Additional guidance
d i *3.2a*	1	* B ✔		if more than one box is ticked, award no mark
d ii *3.1a* *3.2a*	1	* A and B ✔		if more than one box is ticked, award no mark
Total	**7**			

Tier 4–7	Q No. 6

Part	Mark	Answer	Accept	Additional guidance
a i *3.1b* *1.1b*	1	* the arrows **or** compasses point in the same direction (for the bar magnet and the coil)	• they have not moved • they look the same as before • they have not changed direction	'because of the arrows' is insufficient 'they look the same' is insufficient 'same pattern' is insufficient
a ii *3.1c* *1.1b*	1	* 		all four arrows are required for the mark arrows must be within 30° of the correct direction
a iii *3.1c* *3.1b*	1	any **one** from * he reversed the battery * he changed the cells around	• change or turn the battery around • he changed the terminals around • swap positive and negative around • turn the coils the other way around	'he reversed the current' is insufficient 'changing **or** switching the cells **or** batteries' is insufficient 'turnover battery' is insufficient
b *3.1c* *3.1b*	1	* 		all four arrows are required for the mark arrows must be within 30° of the correct direction
Total	**4**			

Tier 4–7	Q No. 7			
Part	**Mark**	**Answer**	**Accept**	**Additional guidance**
a *1.2a*	1	any **one** from * do not have to build rocket every time * each 'launch' costs less than a rocket * (the space lift) can be used continually * there is less space junk * (the space lift) does not burn as much fuel * less carbon dioxide produced		'it' refers to the space lift 'it's cheaper' is insufficient *do **not** accept* 'does not burn fuel' 'less pollution produced' is insufficient
b i *4.3c*	1	* 24 hours	• 1 day	
b ii *4.3c*	2	any **two** from * satellite TV * weather monitoring * spying * telecommunications * tracking animals * produce maps * sat nav * observe planets and stars	• TV • take photos • mobile phones • Internet • international space station • radio	accept named satellite TV for one mark *accept* 'communication' if mobile phones or Internet given as well 'planets' is insufficient

Tier 4–7	Q No. 7			
Part	**Mark**	**Answer**	**Accept**	**Additional guidance**
c *3.2b*	2	* *carbon dioxide* ⟶ *carbon* + oxygen CO_2 C O_2		for all four **parts** correct, award two marks for any **three** parts correct, award one mark symbols must be written correctly in order to award mark. For example do not accept 'CO^2, CO2, O^2' 'O' is insufficient 'CO' is insufficient
d i *1.4a*	1	any **one** from: * sharing costs * sharing expertise * sharing staff * sharing technology * sharing resources * building relationships **or** uniting countries		'it is cheaper' is insufficient 'it is quicker' is insufficient as it could actually be slower
d ii *1.4a*	1	any **one** from: * language problems * arguments over workload, cost, where base station should be, etc		'arguments' is insufficient 'it could start a war' is insufficient
Total	**8**			

Tier 4–7	Q No. 8			
Part	**Mark**	**Answer**	**Accept**	**Additional guidance**
a *3.3d*	1	any **one** from * predators * wave action * sunlight * drying out	• being eaten	'getting hurt **or** broken **or** damaged' is insufficient 'fish' is insufficient 'other sea creatures' is insufficient 'being attacked' is insufficient
b *3.3d*	1	* light will only penetrate a short way into water	• there is more light (at the surface) • there is no light in deep water	
	1	* the green plant requires light for photosynthesis	• they need light to produce their own food • so they can photosynthesise	'they need light' is insufficient 'they need light to survive' is insufficient 'sunlight is needed for plants to grow' is insufficient
c i *3.4a*	1	* 2 3 1		**all three** answers are required for the mark
c ii *3.4a*	1	* the coral grows around the volcano (which sinks)	• it grows all around a volcano • volcanoes are circular • the volcanic rock has eroded	'there used to be a volcano there' is insufficient
d *3.4a* *1.1b*	1	* igneous ✔ any **one** from igneous rock is cooled magma **or** lava volcanoes produce igneous rock	 • it is made from lava • it comes from a volcano	**both** the type of rock and correct explanation are required for the mark 'it is a volcano' is insufficient
Total	**6**			

Tier 4–7	Q No. 9			
Part	**Mark**	**Answer**	**Accept**	**Additional guidance**
a *2.2a*	1	* 5000 ✔ / 0.1		if more than one box is ticked, award no mark
b i *2.2a*	1	* 4700°*C*	accept a number from 4600°*C* to 4800°*C* inclusive	
b ii *2.2a*	1	* it increases	• it goes up • it is at higher temperatures	
c *1.1b*	1	any **one** from * if changes from a solid to a liquid * it becomes a liquid	• it melts • turns into a liquid	'it is liquid' is insufficient as the answer must refer to a change
d *2.2a*	1	* a number greater than or equal to 100		
e *3.4a*	1	any **one** from * the weight of the rocks (above) * the force of the rocks (above)	• the mass of the rocks • the weight of everything above it	'they are deep underground' **or** 'the rocks above' are insufficient 'gravity' is insufficient

Tier 4–7	Q No. 9			
Part	**Mark**	**Answer**	**Accept**	**Additional guidance**
f *3.4a*	1	any **one** from * natural diamonds are cooled **or** formed slowly * the pressures are greater * more time to cool **or** form	• artificial diamonds are formed quickly • more pressure • when making artificial diamonds not much carbon dissolves in the iron	'more heat' is insufficient 'only small amounts used in the lab' is insufficient
g *3.2c*	1	* float ✔ it is less dense (than the liquid)	• it has a larger volume (than the liquid) • its density is less	**both** the answer and the correct explanation are required for the mark 'it is lighter' is insufficient
Total	**8**			

Tier 4–7	Q No. 10			
Part	**Mark**	**Answer**	**Accept**	**Additional guidance**
a *3.3a*	1	any **one** from * it contains genetic information * it controls the cell(s' activities)	• contains chromosomes • contains DNA • tells the cell what to do	'contains information' is insufficient 'it is the brain of the cell' is insufficient 'it controls what goes in and out of the cell' is insufficient
b i *3.3a*	1	any **one** from * to push **or** move food **or** waste along * to churn food	• for peristalsis • to squeeze food along • mechanical digestion • to mix in enzymes • push food through the intestine • squeeze water from the waste **or** food	answer must have reference to mechanical digestion 'for excretion' is insufficient 'to digest food' **or** 'break down food' is insufficient 'it enables it to stretch' is insufficient 'to push it along' is insufficient as it refers to intestine
b ii *3.3a*	1	any **one** from * they digest it * they break it down	• they speed up digestion • they break it up (the food)	'dissolves food' is insufficient 'it breaks down cell walls' is insufficient 'it breaks down larger pieces of food' is insufficient as this describes mechanical digestion not chemical
b iii *3.3a*	1	any **one** from * the folds help them to absorb food faster * it has greater surface area	• it **or** the cell can absorb more food	'helps the food pass through' is insufficient *do **not** accept* 'folds catch food' 'it can absorb food' is insufficient
Total	**4**			

Section B: Using the outcomes of the tests

The following pages provide information about interpreting the outcomes of the year 9 optional science tests. They explain how teachers can use the test scores to find out more about pupils' attainment in the national curriculum. They also present a number of key findings and useful information obtained during the development of the tests that may be used in support of teacher judgements.

Level thresholds

In order to make use of the information in this section, you should administer the tests according to the guidance in Section A: Formal administration. It is particularly important that you observe the time limits given, follow the test instructions, and mark the questions according to the mark scheme. If you have used the tests in a different context to provide qualitative information about pupils' strengths and weaknesses then the information derived from this section will not be applicable and you should refer to the Key findings and useful information section.

In a formal administration pupils need to take both test booklets in order for the total marks to be translated reliably into a national curriculum level for science overall.

The following table gives an indication of the national curriculum levels for pupils attaining each of the mark ranges in the tests.

Level	Mark range
Below level 4	0–32
4	33–49
5	50–70
6	71–89
7	90–120

Variability of the results

Any scores derived from a test are subject to some variation according to the precise circumstances under which the test has been sat and marked. This does not mean that pupils get 'incorrect' test results, but it does mean that some caution should be exercised in translating scores which are very close to the threshold mark into an overall science level for the pupil. The level thresholds provided are indicative, but teachers should be aware that differences in the status, administration and marking procedures open the tests to a potentially broader range of variation than the former statutory national curriculum tests.

Key findings and useful information

This section provides further support to teachers in making level-related judgements based on the outcomes of these tests.

Paper number	Question number	Question name	Highlighted issue and implication(s) for teaching and learning	Teaching suggestion(s) – if appropriate
1	3d	Computer model	This question requires pupils to suggest an advantage of using a computer model to carry out the investigation described in the question instead of doing the experiment in real life. Possible answers for this question include 'more reliable', 'more accurate' and 'more precise'. These are terms with which pupils should be familiar.	Clear definitions of these words can be found in the book *The Language of Measurement – Terminology used in school science investigations*, an ASE publication (ISBN 978 0 86357 424 5). Look at different situations where pupils are required to use each of these words and discuss instances where each word is relevant, identifying why use of the other words would not be scientifically accurate.
1	5f	Huddling penguins	This question asks pupils to suggest why huddling helps a group of penguins to survive. It requires pupils to apply their scientific understanding to a new situation. Answers such as 'So they are all warm' are insufficient, as the penguins on the outside of the huddle clearly are not as warm as those in the middle, hence why the penguins take it in turns to go on the outside. This question highlights the importance of pupils ensuring they communicate their answers effectively and do not expect the marker 'to know what they mean'.	Look at the difference between living organisms generating their own body heat, how they are able to keep warm and the process of equalising temperature by which they are kept warm in a group.
1	6b	Solar power tower	This question requires pupils to explain how the mirrors turning during the day make the solar power station more efficient. It is a two-mark question. In order to be awarded the marks pupils need to indicate that they understand the mirrors turn because the Sun is not in a fixed position in the sky. Secondly, pupils need to show their understanding that the movement of mirrors means the maximum amount of light/solar/heat energy is reflected onto the receiver at the top of the tower. When trialled, pupils struggled to obtain the second marking point – 66 percent of pupils scored at least one mark; however only 16 percent of pupils scored both marks. This question is a good example of pupils having to apply their knowledge about sunlight and movement of the Earth to an unfamiliar situation.	Find other examples of unfamiliar situations eg how a solar power cooker works, and have the pupils work together to apply their scientific knowledge. Use flow diagrams to help pupils work logically through scientific problems to identify each step.

Paper number	Question number	Question name	Highlighted issue and implication(s) for teaching and learning	Teaching suggestion(s) – if appropriate
1	6c	Solar power tower	This question requires pupils to identify firstly what colour the pipes at the top of the solar power station should be so that water heats up quickly, and then to explain their answer. Pupils must answer both parts of the question correctly in order to be awarded one mark. When trialled the percentage of pupils correctly answering the first part was 73 percent, but the percentage also getting the second part correct was only 10 percent. When marking the second part creditworthy responses include: *will absorb the most heat energy **or** radiation *absorbs the most heat **or** energy Insufficient responses include 'traps heat' and 'absorbs heat', as these responses are too vague for a level 6 answer. 'Absorbs heat' is non-creditworthy as other colours, in addition to black, absorb heat; black, however, absorbs the most heat. The second part of the question addresses a pupil's ability, when asked to make comparisons, to structure their response using key operating words: least, most, less, more.	When pupils are investigating problems make sure they are given opportunities to discuss and reflect on any findings so they understand how these link to the underlying scientific knowledge. Furthermore, it may be beneficial to focus on activities which require pupils to use operating words: least, most, less, more.
1	6f	Solar power tower	This question requires pupils to explain why solar power stations are considered to be more environmentally friendly than coal burning power stations. It discriminated relatively well between higher and lower ability pupils when trialled. However, a number of more able pupils seemed to struggle with this question. This was because pupils answered this question with vague answers such as 'solar power stations do not pollute the air' and 'coal burning power stations produce harmful gases'. In order to be awarded the mark pupils at level 5 need to explain the impact on the environment explicitly, showing their scientific understanding. For example, 'solar power stations do not produce carbon dioxide' is creditworthy.	When teaching about the environmental impact of burning fossil fuels, encourage pupils to refer to the specific gases produced eg carbon dioxide, sulphur dioxide, rather than referring to them generically as 'pollution'.

Paper number	Question number	Question name	Highlighted issue and implication(s) for teaching and learning	Teaching suggestion(s) – if appropriate
1	8a	Spirogyra	This question requires pupils to match the name of a plant cell part to its correct description. When trialled the number of pupils able to achieve two marks was much lower than those achieving one mark. This is because pupils seemed to struggle to distinguish between the cell membrane and cell wall, and often got these mixed up. For example, 45 percent of pupils selected the correct answer of 'allows substances in and out of the cell' for the membrane, but 19 percent selected the incorrect answer of 'helps to give the cell shape and supports it'. This highlights that pupils are confused by the function of the cell wall and cell membrane.	Have pupils make a model plant and animal cell, so they can label the different parts with the correct names and functions. Make comparisons between the greater rigidity of plant cells, which have a cell wall, and animal cells which don't.
1	8b	Spirogyra	This two-mark question asks pupils to identify the reactants in photosynthesis by completing a word equation. When trialled quite a large proportion of pupils gave 'energy' or 'sunlight' as one of the answers, identifying a common mistake some pupils make. A much smaller proportion identified 'chloroplasts' or 'chlorophyll'.	Help pupils to understand the chemical process of photosynthesis by having them think about the reactants and products individually in terms of where they come from or what their role in photosynthesis is. Teachers should be encouraged to highlight that chlorophyll sits over the arrow and is not part of the reaction, but works as a catalyst.
1	9bii	Speed camera	This question requires pupils to use the information provided in the table to calculate the average speed of a car for the total journey from Birmingham to London. This is a two-mark question: one mark for the correct answer, and one mark for the correct units. When answering this question, pupils often focus on the word 'average' in the question rather than spending their time interrogating the question and the words involved, eg total.	Give pupils challenging questions where time is needed in order to gauge what the question is really asking. Teach pupils techniques which allow them to break down questions, allow them to interrogate what is being asked for, and access relevant signposts in questions, such as words in bold.

Paper number	Question number	Question name	Highlighted issue and implication(s) for teaching and learning	Teaching suggestion(s) – if appropriate
2	**3cii**	Hydrangeas	This question requires pupils to suggest what could be done to change the pH of soil from pH 5.5 to between pH 6.0 and pH 7.0, so sunflowers can grow at their best. When trialled similar numbers of pupils working at both level 6 and level 7 answered this question correctly – this is unusual, as pupils working at level 7 would normally be expected to perform better. It was noted during the marking of this question that a number of pupils gave a common incorrect answer of 'vinegar' or 'acid'. This highlights that some pupils are confused by how the pH scale works, and do not understand that pH 6 is less acidic than pH 5.5, or that in order to make the pH less acidic you need to add an alkali. Another common incorrect answer given by some pupils was water. Pupils giving this answer are either thinking generally about what plants need to grow well, and are not considering the influence of the pH of the soil on plant growth, or are perhaps under the impression that the pH number is diluted (gets lower) by adding water.	It may be beneficial to focus some attention on how the pH scale works by devising simple rules (eg 'add acid and the pH number gets smaller; add alkali and the pH number gets bigger'), and testing the rules by looking at the effect, on pH, of adding an alkali to an acid, and vice versa, and also of adding water. Pupils could refer to the pH scale to respond to a range of questions devised to demonstrate their understanding; for example, 'pH of solution X starts at pH 8.0. A pupil adds an acid. What will happen to the pH?'
2	**7di**, **7dii**	Space elevator	These questions relate to one another and require pupils to present both sides of an argument. When trialled pupils were able to answer part di, which was about the possible benefits of countries working together to produce a space lift. However, pupils struggled with part dii, which required them to identify potential problems. The crux of this question is a pupil's ability to structure their response to compare and contrast two positions.	Provide pupils with topical issues which require them to compare and contrast two positions. Discuss the best approach to structure their response.
2	**9g**	Diamonds	This question requires pupils to identify whether solid iron would sink or float in liquid iron and then to explain why. Both a choice and explanation were required for one mark. Pupils found this question very challenging but it did discriminate very well between the most able pupils in the trial, with 37 percent able to identify that the iron would float, but only 6 percent able to explain why. Density is a very difficult concept at key stage 3. This question asks pupils to apply their knowledge of density, and assesses an important area of the 2008 Programme of Study which has not been tested much previously.	Provide pupils with examples of different materials eg a rock and a crumpled piece of paper of the same size, and discuss differences in density. Other examples could be a polystyrene cup and a ceramic cup. Ask the pupils to identify the most and least dense materials. This could then lead into a discussion about oil spills and what happens when an oil tanker/oil rig leaks in the ocean – the oil floats on the water since it is less dense, and this provides some opportunity to clean up the oil spills by skimming the oil from the surface of the water.

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