GCSE
Science

Hub schools network – summer update

Booklet 1 – examples and accompanying documents

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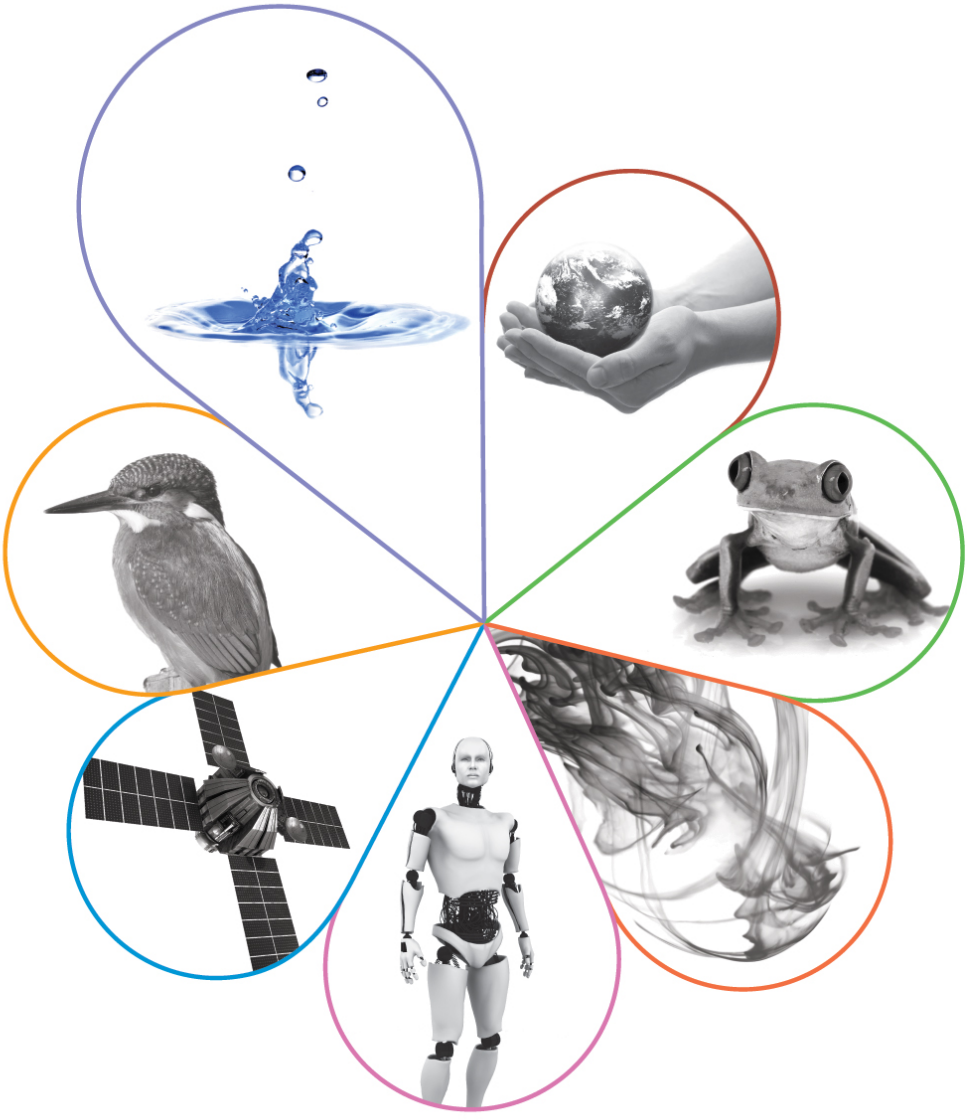


Contents

AO3: Regulatory requirements

AO3: Analyse information and ideas to: ▪ interpret and evaluate ▪ make judgements and draw conclusions ▪ develop and improve experimental procedures.			*20%*
Strands	**Elements**	**Coverage**	**Interpretations and definitions**
1 – Analyse information and ideas to interpret and evaluate.	1a – Analyse information and ideas to interpret.	▪ Full coverage in each set of assessments (but not in every assessment). ▪ A reasonable balance between the strands within this assessment objective, and between the elements within each strand.	▪ **Develop and improve** covers a range of approaches to assessment, including questions related to adapting, modifying and enhancing experimental procedures. Learners should not be expected to develop their own procedures. ▪ **Experimental procedures** encompasses, but is broader than, the core practical activities. In the context of this assessment objective, questions/tasks should take an analytical form such as suggesting the limitations of a particular method. ▪ The emphasis here is on the outcome that Learners produce through the analysis of information – for instance, the interpreting, evaluating, judgement, conclusion or modification/improvement of procedures that stems from their reasoning and synthesis of skills. The abilities to interpret and evaluate in this context are both linked and complementary. ▪ Questions/tasks should address a range of sources here – for example, written, numerical, theoretical, practical, ethical, social, economic and environmental.
	1b – Analyse information and ideas to evaluate.		
2 – Analyse information and ideas to make judgements and draw conclusions.	2a – Analyse information and ideas to make judgements.		
	2b – Analyse information and ideas to draw conclusions.		
3 – Analyse information and ideas to develop and improve experimental procedures.	3a – Analyse information and ideas to develop experimental procedures.		
	3b – Analyse information and ideas to improve experimental procedures.		

2 Working scientifically

Science is a set of ideas about the material world. We have included all the parts of what good science is at GCSE level: whether it be investigating, observing, experimenting or testing out ideas and thinking about them. The way scientific ideas flow through the specification will support you in building a deep understanding of science with your students. We know this will involve talking about, reading and writing about science plus the actual doing, as well as representing science in its many forms both mathematically and visually through models.

This specification encourages the development of knowledge and understanding in science through opportunities for working scientifically. Working scientifically is the sum of all the activities that scientists do. We feel it is so important that we have woven it throughout our specification and written papers.

Our schemes of work will take this further for you and signpost a range of ways to navigate through this qualification so your students are engaged and enthused. These free resources support the use of mathematics as a tool for thinking through the use of mathematical language in explanations, applications and evaluations.

The tables below show examples of the ways working scientifically could be assessed.

1 Development of scientific thinking

Students should be able to:	Examples of what students could be asked to do in an exam
WS 1.1 Understand how scientific methods and theories develop over time.	Give examples to show how scientific methods and theories have changed over time. Explain, with an example, why new data from experiments or observations led to changes in models or theories. Decide whether or not given data supports a particular theory.
WS 1.2 Use a variety of models such as representational, spatial, descriptive, computational and mathematical to solve problems, make predictions and to develop scientific explanations and understanding of familiar and unfamiliar facts.	Recognise/draw/interpret diagrams. Translate from data to a representation with a model. Use models in explanations, or match features of a model to the data from experiments or observations that the model describes or explains. Make predictions or calculate quantities based on the model or show its limitations. Give examples of ways in which a model can be tested by observation or experiment.
WS 1.3 Appreciate the power and limitations of science and consider any ethical issues which may arise.	Explain why data is needed to answer scientific questions, and why it may be uncertain, incomplete or not available. Outline a simple ethical argument about the rights and wrongs of a new technology.
WS 1.4 Explain everyday and technological applications of science; evaluate associated personal, social, economic and environmental implications; and make decisions based on the evaluation of evidence and arguments.	Describe and explain specified examples of the technological applications of science. Describe and evaluate, with the help of data, methods that can be used to tackle problems caused by human impacts on the environment.
WS 1.5 Evaluate risks both in practical science and the wider societal context, including perception of risk in relation to data and consequences.	Give examples to show that there are hazards associated with science-based technologies which have to be considered alongside the benefits. Suggest reasons why the perception of risk is often very different from the measured risk (eg voluntary vs imposed risks, familiar vs unfamiliar risks, visible vs invisible hazards).
WS 1.6 Recognise the importance of peer review of results and of communicating results to a range of audiences.	Explain that the process of peer review helps to detect false claims and to establish a consensus about which claims should be regarded as valid. Explain that reports of scientific developments in the popular media are not subject to peer review and may be oversimplified, inaccurate or biased.

2 Experimental skills and strategies

Students should be able to:	Examples of what students could be asked to do in an exam
WS 2.1 Use scientific theories and explanations to develop hypotheses.	Suggest a hypothesis to explain given observations or data.
WS 2.2 Plan experiments or devise procedures to make observations, produce or characterise a substance, test hypotheses, check data or explore phenomena.	Describe a practical procedure for a specified purpose. Explain why a given practical procedure is well designed for its specified purpose. Explain the need to manipulate and control variables. Identify in a given context: • the independent variable as the one that is changed or selected by the investigator • the dependent variable that is measured for each change in the independent variable • control variables and be able to explain why they are kept the same. Apply understanding of apparatus and techniques to suggest a procedure for a specified purpose.
WS 2.3 Apply a knowledge of a range of techniques, instruments, apparatus, and materials to select those appropriate to the experiment.	Describe/suggest/select the technique, instrument, apparatus or material that should be used for a particular purpose, and explain why.
WS 2.4 Carry out experiments appropriately having due regard for the correct manipulation of apparatus, the accuracy of measurements and health and safety considerations.	Identify the main hazards in specified practical contexts. Suggest methods of reducing the risk of harm in practical contexts.
WS 2.5 Recognise when to apply a knowledge of sampling techniques to ensure any samples collected are representative.	Suggest and describe an appropriate sampling technique in a given context.
WS 2.6 Make and record observations and measurements using a range of apparatus and methods.	Read measurements off a scale in a practical context and record appropriately.
WS 2.7 Evaluate methods and suggest possible improvements and further investigations.	Assess whether sufficient, precise measurements have been taken in an experiment. Evaluate methods with a view to determining whether or not they are valid.

3 Analysis and evaluation

Apply the cycle of collecting, presenting and analysing data, including:

Students should be able to:	Examples of what students could be asked to do in an exam
WS 3.1 Presenting observations and other data using appropriate methods.	Construct and interpret frequency tables and diagrams, bar charts and histograms. Plot two variables from experimental or other data.
WS 3.2 Translating data from one form to another.	Translate data between graphical and numeric form.
WS 3.3 Carrying out and represent mathematical and statistical analysis.	For example: • use an appropriate number of significant figures • find the arithmetic mean and range of a set of data • construct and interpret frequency tables and diagrams, bar charts and histograms • make order of magnitude calculations • change the subject of an equation • substitute numerical values into algebraic equations using appropriate units for physical quantities • determine the slope and intercept of a linear graph • draw and use the slope of a tangent to a curve as a measure of rate of change • understand the physical significance of area between a curve and the x-axis and measure it by counting squares as appropriate.
WS 3.4 Representing distributions of results and make estimations of uncertainty.	Apply the idea that whenever a measurement is made, there is always some uncertainty about the result obtained. Use the range of a set of measurements about the mean as a measure of uncertainty.
WS 3.5 Interpreting observations and other data (presented in verbal, diagrammatic, graphical, symbolic or numerical form), including identifying patterns and trends, making inferences and drawing conclusions.	Use data to make predictions. Recognise or describe patterns and trends in data presented in a variety of tabular, graphical and other forms. Draw conclusions from given observations.
WS 3.6 Presenting reasoned explanations including relating data to hypotheses.	Comment on the extent to which data is consistent with a given hypothesis. Identify which of two or more hypotheses provides a better explanation of data in a given context.

Students should be able to:	Examples of what students could be asked to do in an exam
WS 3.7 Being objective, evaluating data in terms of accuracy, precision, repeatability and reproducibility and identifying potential sources of random and systematic error.	Apply the following ideas to evaluate data to suggest improvements to procedures and techniques. • An accurate measurement is one that is close to the true value. • Measurements are precise if they cluster closely. • Measurements are repeatable when repetition, under the same conditions by the same investigator, gives similar results. • Measurements are reproducible if similar results are obtained by different investigators with different equipment. • Measurements are affected by random error due to results varying in unpredictable ways; these errors can be reduced by making more measurements and reporting a mean value. • Systematic error is due to measurement results differing from the true value by a consistent amount each time. • Any anomalous values should be examined to try to identify the cause and, if a product of a poor measurement, ignored.
WS 3.8 Communicating the scientific rationale for investigations, methods used, findings and reasoned conclusions through paper-based and electronic reports and presentations using verbal, diagrammatic, graphical, numerical and symbolic forms.	Present coherent and logically structured responses, using the ideas in 2 Experimental skills and strategies and 3 Analysis and evaluation, applied to the required practicals, and other practical investigations given appropriate information.

4 Scientific vocabulary, quantities, units, symbols and nomenclature

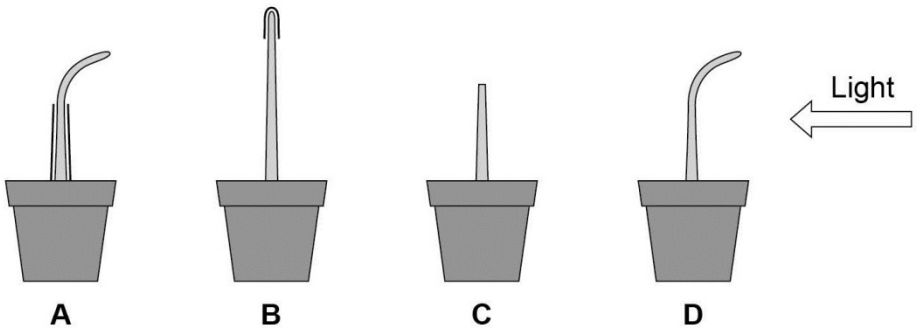
Students should be able to:	Examples of what students could be asked to do in an exam
WS 4.1 Use scientific vocabulary, terminology and definitions. WS 4.2 Recognise the importance of scientific quantities and understand how they are determined. WS 4.3 Use SI units (eg kg, g, mg; km, m, mm; kJ, J) and IUPAC chemical nomenclature unless inappropriate. WS 4.4 Use prefixes and powers of ten for orders of magnitude (eg tera, giga, mega, kilo, centi, milli, micro and nano). WS 4.5 Interconvert units. WS 4.6 Use an appropriate number of significant figures in calculation.	The knowledge and skills in this section apply across the specification, including the required practicals.

Examples for discussion activity

Example 1

Figure 11 shows the students' results.

Figure 11



	A	B	C	D
Mean length of shoot at start in mm	23	24	21	25
Mean length of shoot after 1 day in mm	28	30	23	30
Mean change in length of shoot in mm	5	6	2	5

0 8 . 4 The students concluded that the **tip** of the shoot is needed for the plant to respond to light.

Give evidence for this conclusion from **Figure 11**.

[2 marks]

08.4	tip covered / B / removed / C grows straight up **or** does not bend (towards light) tip exposed / A / not covered / D bends (towards light)	allow tip covered / B / removed / C does not respond (to light) tip exposed / A / not covered / D does respond (to light) allow only the ones with exposed tips or only A **and** D bend towards the light for **2** marks	1 1	AO3 4.5.4.1

Example 2

Interpret and evaluate – low demand: Physics 1F Question 6.4

0 6 . 4 The UK currently generates a lot of electricity by burning natural gas. This process releases carbon dioxide into the atmosphere.

Figure 7 shows how the concentration of carbon dioxide in the atmosphere has changed over the past 115 years.

Figure 7

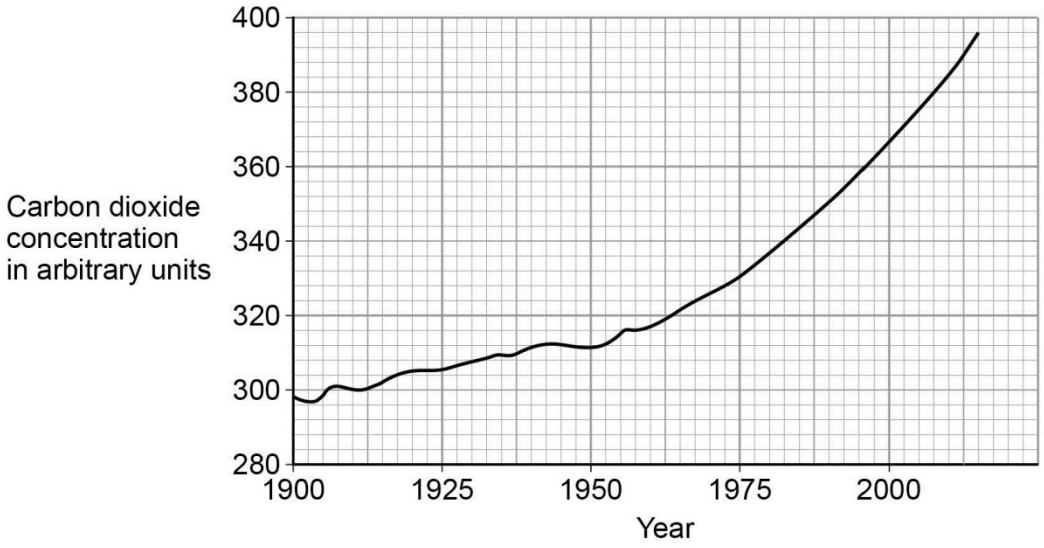
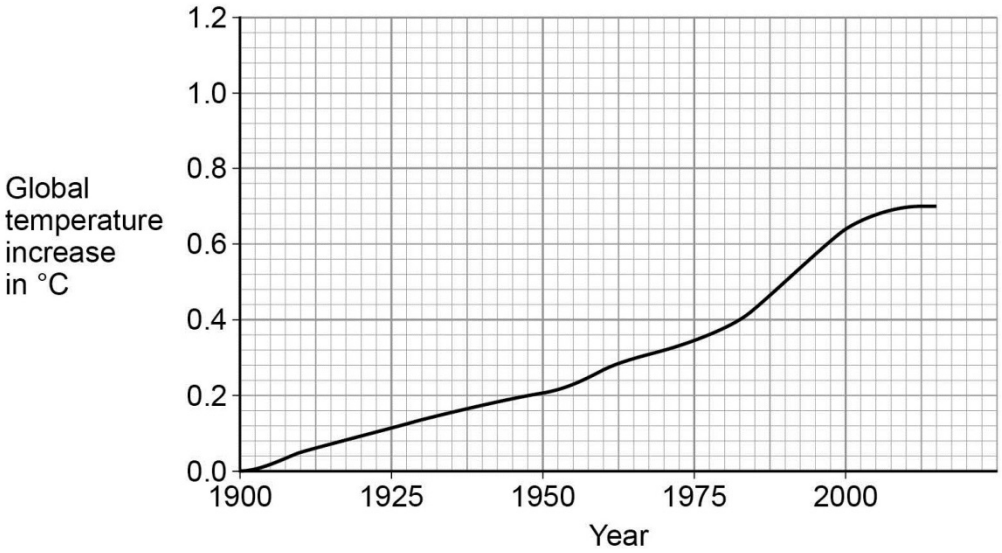


Figure 8 shows how the global temperature has changed over the past 115 years.

Figure 8



Give **one** similarity and **one** difference between the data in **Figure 7** and **Figure 8**.

[2 marks]

Similarity _____

_____

_____

Difference _____

_____

_____

06.4	**similarity:** (carbon dioxide concentration and global temperature have) both increased **difference:** the carbon dioxide (concentration) continues to increase whereas temperature (increase) levels off	allow they both show a positive correlation allow carbon dioxide (concentration) increases more quickly than temperature (increase)	1 1	AO3 4.1.3

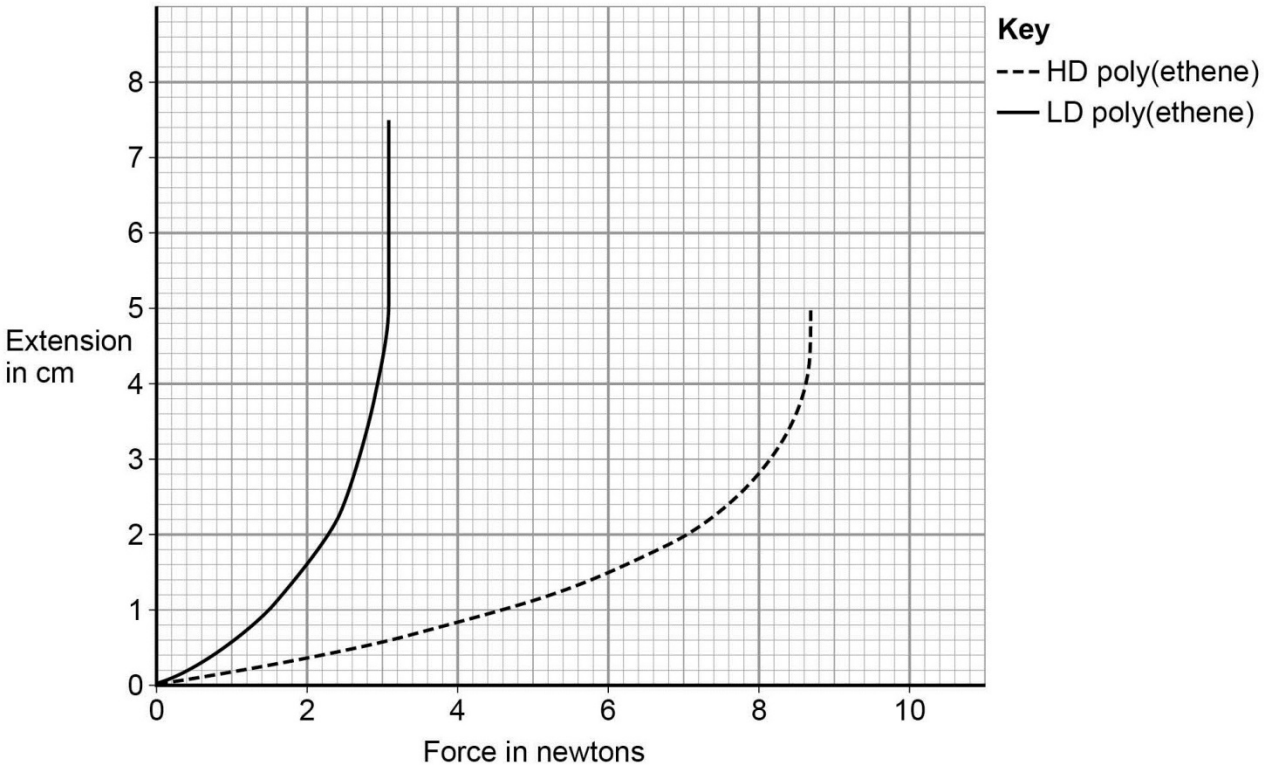
Example 3

Interpret and evaluate – standard demand: Synergy 4F Question 9.4

The subject content covered by this question is common with Combined Science: Trilogy 6.5.3 (Forces and elasticity).

Figure 14 shows the results for HD poly(ethene) and LD poly(ethene).

Figure 14



0 9 . 4 Give **two** comparisons between the results for HD poly(ethene) and for LD poly(ethene).

Use **Figure 14**.

[2 marks]

1 _____

_____

2 _____

_____

09.4	any **two** from: • both have increasing extension with increasing force • both extend non-linearly • HD poly(ethene) has a smaller extension (than LD poly(ethene)) for a given force • HD poly(ethene) has a smaller maximum extension (than LD poly(ethene))	allow LD poly(ethene) stretches more for a given force allow correct readings of extension for a given force for both polymers allow HD poly(ethene) breaks at a greater (maximum) force ignore references to strong / weak	2	AO3 4.6.1.6

Example 4

Interpret and evaluate – high demand: Synergy 2H Question 6.5

The subject content covered by this question is common with Combined Science: Trilogy 4.5.2 (The human nervous system) and 6.5.4.3.2 (Reaction time).

Scientists investigated the effect of lack of sleep and the effect of alcohol consumption on the human nervous system.

This is the method used.

1. Each person completes an accuracy test using a computer.
2. Their average score is taken as 100%.
3. Half of the group are kept awake for 24 hours.
4. The other half of the group drink alcohol until their blood alcohol level reaches 0.12%.
5. Each person repeats the accuracy test at regular intervals using a computer.

Figure 4 and **Figure 5** show the results of the investigation.

Figure 4

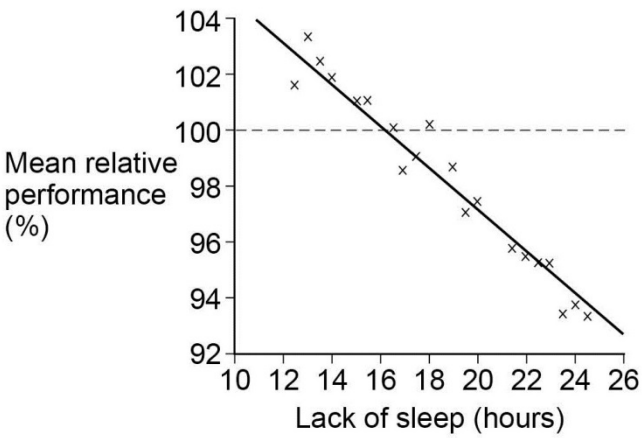
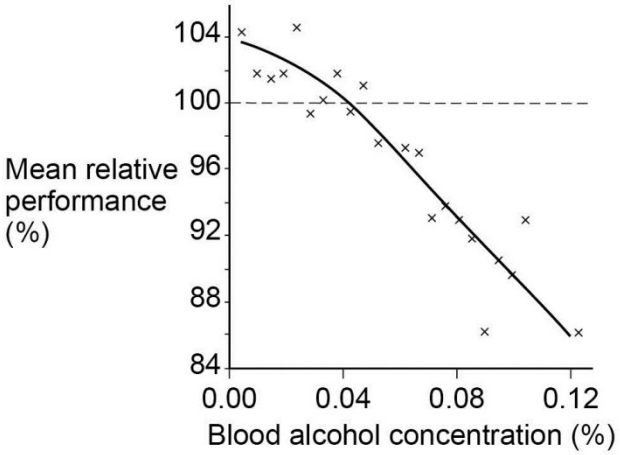


Figure 5



0 6 . 5 Mean relative performance is a comparison with the person's original score. For example, 50% means their accuracy on the test was half of their original score.

If your blood alcohol concentration is above 0.08% it is against the law to drive in the UK.

A newspaper states the following:

Driving whilst tired is as dangerous as driving after drinking alcohol.

Evaluate the newspaper's statement.

Use information from **Figure 4** and **Figure 5**.

[4 marks]

06.5	**reasons in support:** • performance / accuracy decreases with increasing alcohol concentration **and** performance / accuracy decreases as lack of sleep increases • reduction in performance at the legal alcohol limit / 0.08% (for driving) is the same as (more than) 24 hours without sleep **reasons against:** • idea that the statement is sensationalised and does not use (quantifiable) data • the (performance) scales are different, so difficult to make comparison **or** the (performance) scales are different so the data is misleading • being tired is subjective / different for everyone • there is wide variation in the data • (the graph shows that) some people have 16 / 18 hours without sleep and don't have a drop in performance • at alcohol levels of 0.09% some people have a 14% drop in performance (which is much higher than lack of sleep) • (data contradicts the statement because) for some a small amount of alcohol improves performance	**max 3** marks if only reasons in support or reasons against given ignore study design allow idea that lack of sleep does not necessarily correlate with tiredness allow other correct points of comparison	4	AO3 4.2.1.6

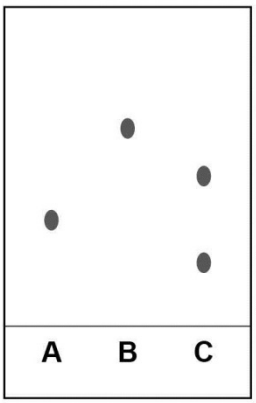
Example 5

Make judgements and draw conclusions – Low demand: Chemistry 2F Question 5.3

0 5 . 3 Another student sets up the apparatus correctly.

Figure 3 represents the student's results.

Figure 3



What **two** conclusions can be made from **Figure 3**?

[2 marks]

Tick **two** boxes.

Flower **A** contains a single pure colour ☐

Flowers **A** and **B** contain the same colours ☐

The colour in flower **C** is a mixture ☐

The colour in flower **B** was the least soluble ☐

Two of the colours have the same R_f value ☐

05.3	flower A contains a single pure colour the colour in flower C is a mixture		1 1	AO3 4.8.1.3

Example 6

Make judgements and draw conclusions – Standard demand: Trilogy Biology 2F Question 6.7

Table 7 shows the results.

Table 7

	Distance from tree in metres					
	0	**2**	**4**	**6**	**8**	**10**
Percentage cover of grass	15	50	35	16	15	15
Percentage cover of plantain	0	5	10	40	25	30
Percentage cover of daisy	0	0	0	4	20	10
Percentage cover of clover	1	10	25	40	40	45
Total percentage cover of plants	16	65	70	100	100	100
Light intensity in arbitrary units	37	59	150	175	>200	>200

0 6 . 7 Which plant species in **Table 7** will only grow at high light intensity?

[1 mark]

06.7	daisy		1	AO3 4.7.2.1

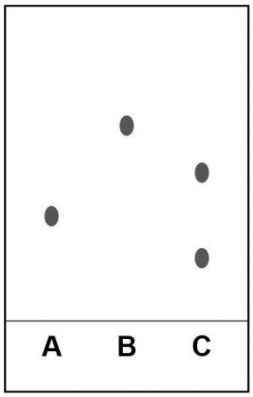
Example 7

Make judgements and draw conclusions – High demand: Chemistry 2H Question 4.2

0 4 . 2 Another student set up the apparatus correctly.

Figure 5 represents the student's results.

Figure 5



Give **two** conclusions you can make from **Figure 5**.

[2 marks]

1 _____

_____

2 _____

_____

04.2	any **two** from: • the flowers have no colours in common • A / B contain one colour • C contains two colours • (the colour in) B is most soluble	allow the flowers are not the same colour allow C is a mixture of colours allow (the colour in) B has the highest R_f value allow one of the colours in C is the least soluble	2	AO3 4.8.1.3

Example 8

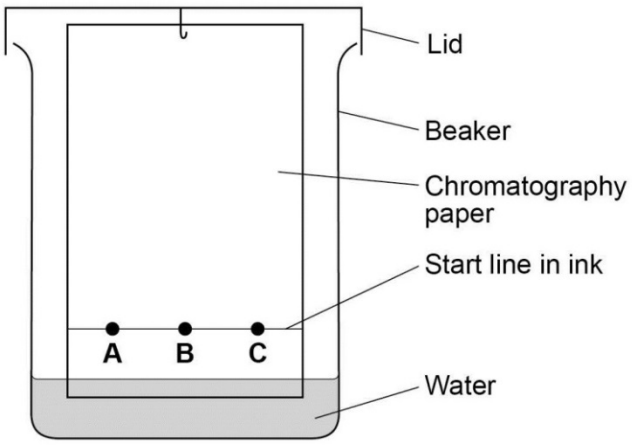
Develop and improve experimental procedures – Low demand: Chemistry 2F Question 5.2

0 5 A student investigated the colours in three different flowers, **A**, **B** and **C**, using paper chromatography.

The colours are soluble in ethanol but are insoluble in water.

0 5 . 2 **Figure 2** shows the apparatus used.

Figure 2



What **two** mistakes did the student make in setting up the apparatus?

[2 marks]

Tick **two** boxes.

- The paper does not touch the beaker ☐
- The start line is drawn in ink ☐
- The water level is below the start line ☐
- Uses a lid on the beaker ☐
- Uses water as the solvent ☐

05.2	the start line is drawn in ink uses water as the solvent		1 1	AO3 4.8.1.3

Example 9

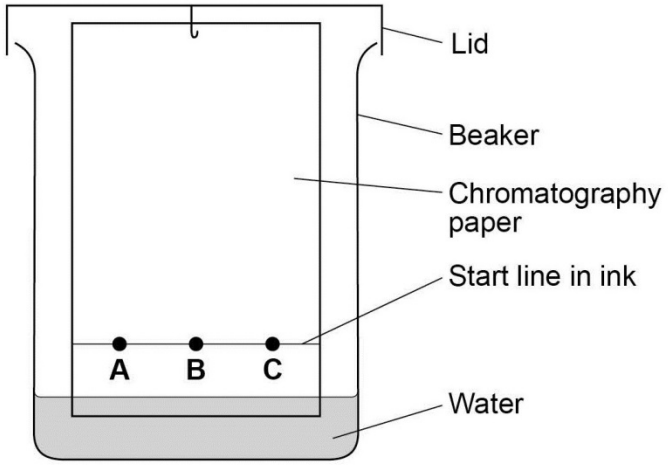
Develop and improve experimental procedures – High demand: Chemistry 2H Question 4.1

0 4 A student investigated the colours in three different flowers, **A**, **B** and **C**.

The colours are soluble in ethanol but are insoluble in water.

Figure 4 shows the apparatus used.

Figure 4



0 4 . 1 The student made **two** mistakes in setting up the apparatus.

Give **one** problem caused by each mistake.

[4 marks]

Mistake 1 _____

Problem caused _____

_____

Mistake 2 _____

Problem caused _____

04.1	start line drawn in ink	allow start line should have been drawn in pencil	1	AO3 4.8.1.3
	(so) ink dissolves **or** ink runs in solvent / water	(as) pencil does not dissolve **or** pencil does not run in solvent / water	1	
	water used (as solvent) **or** water in beaker	allow ethanol not used	1	
	(so) colours will not dissolve / move		1	

AO3 questions at different levels of demand

Interpret and evaluate

Low-demand questions

Example 10: Physics 2F Question 4.3

Table 2 shows the student's results.

Table 2

Number of turns of wire on the electromagnet	Number of paper clips held
10	3
20	6
30	9
40	12

0 4 . 3 Describe the pattern shown in **Table 2**.

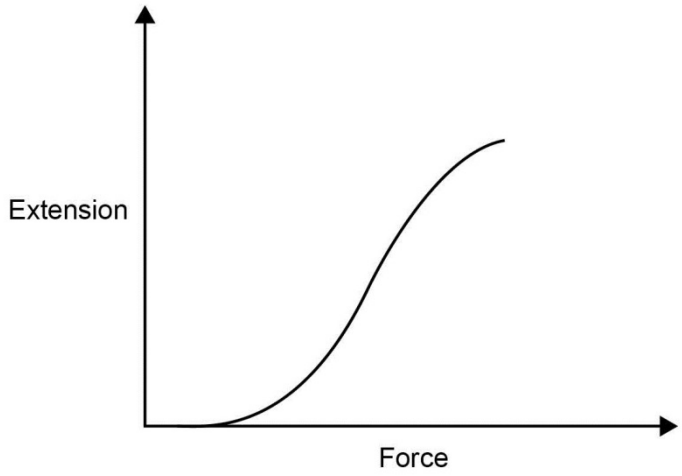
[2 marks]

04.3	as the number of turns increases so does the number of paper clips (held) in a linear pattern	allow positive correlation directly proportional scores **2** marks allow a correct description of directly proportional for **2** marks	1 1	AO3 4.7.2.1

Example 11: Trilogy Physics 2F Question 5.3

0 5 . 3 **Figure 7** shows how the extension of the resistance band changes as the force applied changes.

Figure 7



Describe the trend shown in the graph.

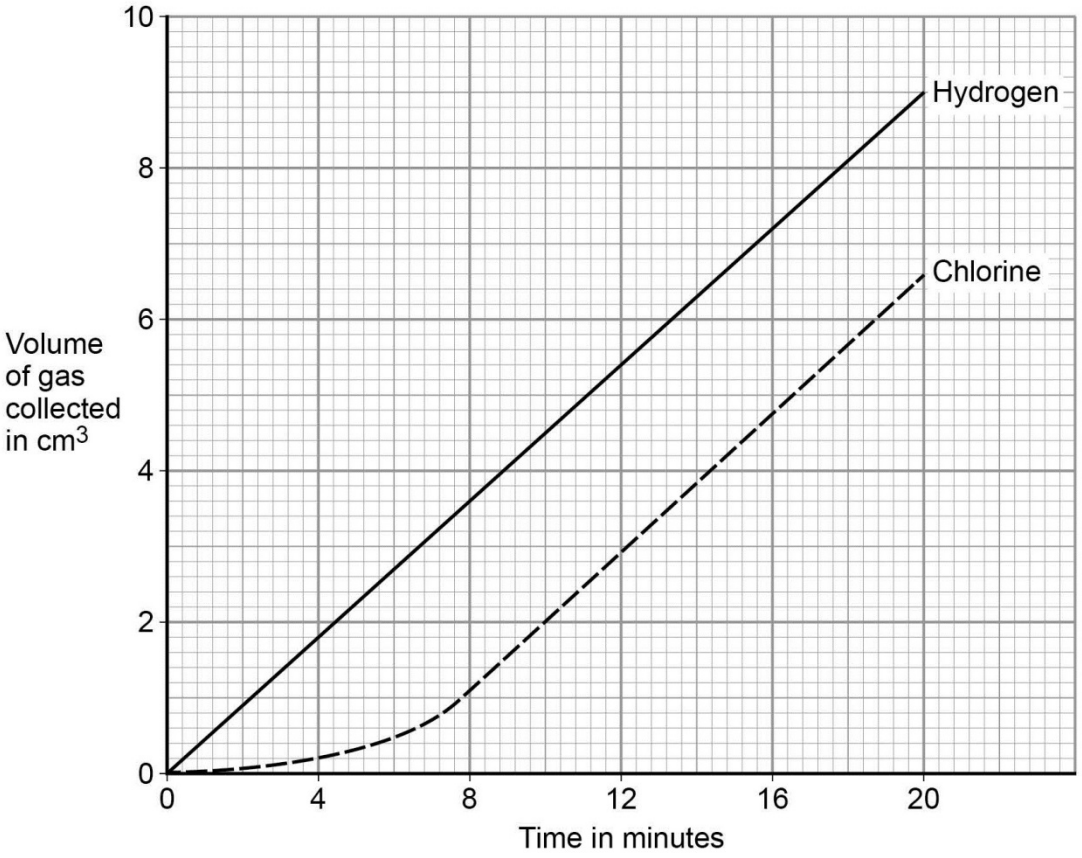
[2 marks]

05.3	any **two** from: • initially the band does not stretch when a force is applied • (when extending) as force increases the extension increases • the relationship is non-linear	allow a certain force is needed before the band extends allow the increase is not proportional do **not** accept directly proportional	2	AO3 6.5.3

Example 12: Chemistry 1F Questions 4.2 and 4.3

Figure 6 shows the results of the investigation.

Figure 6



0 4 . 2 Which of the lines on **Figure 6** show that the volume of gas collected is directly proportional to the time?

[1 mark]

Tick **one** box.

- Both lines ☐
- Chlorine line only ☐
- Hydrogen line only ☐
- Neither line ☐

0 4 . 3 Which of the lines on **Figure 6** show a positive correlation between the volume of gas collected and time?

[1 mark]

Tick **one** box.

Both lines ☐

Chlorine line only ☐

Hydrogen line only ☐

Neither line ☐

04.2	hydrogen line only		1	AO3 4.4.3.4
04.3	both lines		1	AO3 4.4.3.4

Example 13: Biology 2F Question 2.5

0 2 . 5 **Table 2** gives information about some different methods of contraception.

Table 2

Method	Number of pregnancies per 100 women in one year	Possible Side effects
Diaphragm and spermicidal cream	8	Usually none, but can cause bladder infection in some women
Condom	2	None
Contraceptive pill	1	Mood swings, headaches, high blood pressure, blood clots, breast cancer

A man and a woman decide to use the condom as their method of contraception.

Suggest **three** reasons for this decision.

Use information from **Table 2** and your own knowledge.

[3 marks]

1 _____

_____

2 _____

_____

3 _____

_____

02.5	more reliable than diaphragm / spermicidal cream low chance of pregnancy no side effects	allow fewer pregnancies than diaphragm / spermicidal cream allow only 1 more pregnancy than the pill (per 100 women per year) allow almost as good as the pill allow reference to one named example allow easy to get / buy allow easy to use allow prevent / reduce spread of STDs / gonorrhoea / HIV ignore cost	1 1 1	AO3 4.5.3.5

Example 14: Biology 1F Question 4.7

Coronary heart disease can be treated by:

- inserting a stent
- using a Coronary Artery Bypass Graft (CABG).

Table 2 gives information about each method.

Table 2

	Stent	**CABG**
Procedure	The patient is awake during the procedure. A small cut is made in the skin. A wire mesh is inserted into the coronary artery via a blood vessel in the arm or leg.	The patient is not awake during the procedure. The chest is cut open. A section of blood vessel from the arm or leg is removed. It is used to create a new channel for blood to bypass the blockage in the coronary artery.
When procedure is recommended	When only one blockage is present	When multiple blockages are present
Time spent in hospital after procedure	2-3 hours	at least 7 days
Recovery time after procedure	7 days	12 weeks
Risk of heart attack during procedure	1%	2%
Chance of failure within one year	40%	5%

0 4 . 7 Give **two** advantages of using a stent instead of CABG.

[2 marks]

1 _____

_____

2 _____

_____

04.7	any **two** from: • no need to stay as long in hospital (after procedure) **or** can go home sooner / same day • not as / less invasive **or** no need for a major operation **or** no need for general anaesthetic • shorter recovery time **or** can get back to normal lifestyle quicker **or** less time needed off work • lower risk of a heart attack (during procedure)	allow only need to stay 2–3 hours in hospital (after procedure) allow less scarring allow less chance of infection allow only a small cut needed allow only 7 days recovery ignore reference to cost ignore idea that it takes less time overall	2	AO3 4.2.2.4

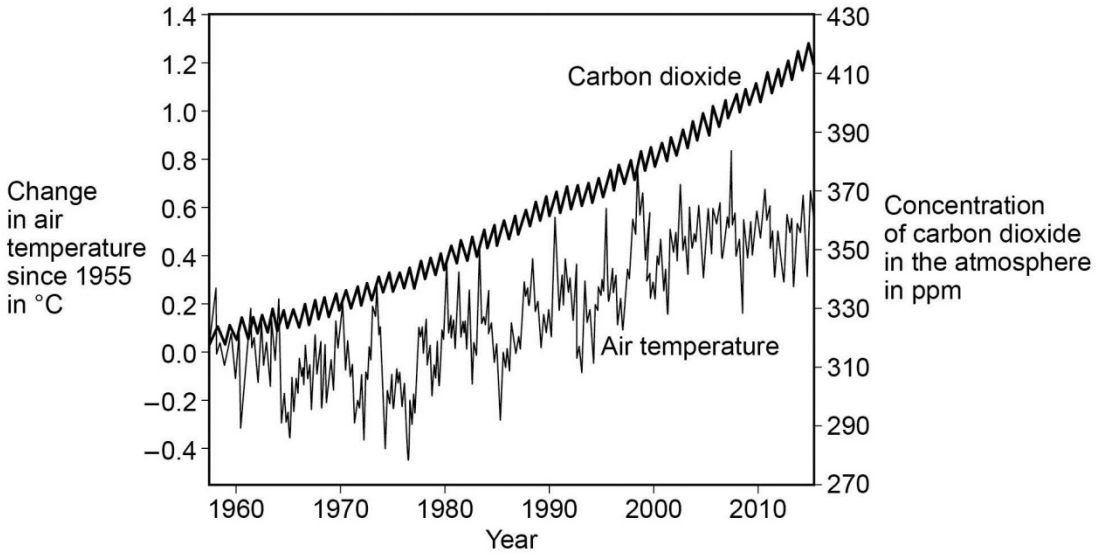
Standard-demand questions

Example 15: Biology 2F Question 10.1

1 0 Many scientists think that global air temperature is related to the concentration of carbon dioxide in the atmosphere.

Figure 14 shows changes in global air temperature and changes in the concentration of carbon dioxide in the atmosphere.

Figure 14



1 0 . 1 Complete **Table 4**.

Use information from **Figure 14**.

[2 marks]

Choose answers from the box.

You may use each answer once, more than once or not at all.

constant	**decreasing**	**increasing**

Table 4

	1960 – 1977	**1977 – 2003**	**2003 – 2015**
Trend in carbon dioxide concentration	Increasing		
Trend in air temperature			

<table>
<tr>
<td>10.1</td>
<td>
<table>
<tr><th></th><th>1960–1977</th><th>1977–2003</th><th>2003–2015</th></tr>
<tr><td>trend in carbon dioxide concentration</td><td></td><td>increasing</td><td>increasing</td></tr>
<tr><td>trend in air temperature</td><td>decreasing</td><td>increasing</td><td>constant / decreasing</td></tr>
</table>
allow synonyms eg level / goes up / goes down
</td>
<td>1

1</td>
<td>AO3
4.7.3.5</td>
</tr>
</table>

Example 16: Biology 1F Question 8.4

Regular exercise can increase metabolic rate.

Two people did five minutes of gentle exercise from rest.

Table 6 shows the effect of the exercise on their heart rates.

Table 6

Time in minutes	Heart rate in beats per minute	
	Person R	Person S
0 (at rest)	60	78
1	76	100
2	85	110
3	91	119
4	99	129
5	99	132

0 8 . 4 Describe **two** differences in the response of person **R** and person **S** to the exercise.

Use information from **Table 6**.

[2 marks]

1 _____

_____

2 _____

_____

08.4	any **two** from: • (person) R heart rate rose / increased more slowly than (person) S • (person) R heart rate levelled off whereas (person) S continued to increase • (person) R heart rate rose less (overall / after 5 minutes of exercise) than S	allow converse allow correct use of figures eg R increased (overall) by 39 bpm / 65% and S by 54 bpm / 69% ignore lack of units	2	AO3 4.4.2.2

Example 17: Synergy 2F Question 8.5

The subject content covered by this question is common with Combined Science: Trilogy 5.10.1.2 (Potable water).

Another method of purifying water is Solar Disinfection (SODIS).

Table 4 gives some information about both methods.

Table 4

Method	Description	Percentage reduction in pathogens that cause diarrhoea
Biosand unit	Before use, it needs to be left for 2 weeks for the bacteria in the unit to grow. Can treat 40 litres of water per hour. Made of concrete. Needs replacing every 10 years.	47
SODIS	Plastic bottles are filled with water and left in sunlight. Ultraviolet (UV) kills bacteria. Bottles need to be left in sunlight for at least 8 hours. Bottles have to be replaced every 6 months.	31

0 8 . 5 Give **two** advantages of using the Biosand unit instead of SODIS.

[2 marks]

1 _____

_____

2 _____

08.5	any **two** from: • filters a lot of water per hour **or** high filtration rate • (concrete) heavy so cannot be knocked over / stolen • higher reduction in pathogens (that cause diarrhoea) • low maintenance • faster (than SODIS) **or** don't have to wait 8 hours • not weather dependent (like SODIS) • needs replacing less frequently	allow produces more clean water (in a given time) allow 47% reduction instead of 31% reduction	2	AO3 4.4.1.8

Example 18: Trilogy Physics 1F Question 7.3

0 7 . 3 The student is given a piece of a different plastic material.

The student determined the density of the material three times.

Table 4 shows the results.

Table 4

	Density in kg/m^3
1	960
2	1120
3	1040

Determine the uncertainty in the student's results.

[2 marks]

Uncertainty = _____ kg/m^3

07.3	$\frac{(1120 - 960)}{2}$ = 80 (kg/m^3)	an answer of 80 scores **2** marks ignore + and / or − signs an answer of 160 scores **1** mark	 1 1	AO3 6.3.1.1

High-demand questions

Example 19: Physics 2H Question 5.4

Table 2

	Angle of reflection			
Angle of incidence	**Test 1**	**Test 2**	**Test 3**	**Test 4**
20°	19°	22°	20°	19°
30°	31°	28°	32°	30°
40°	42°	40°	43°	41°
50°	56°	49°	53°	46°

0 5 . 3 Estimate the uncertainty in the angle of reflection when the angle of incidence is 50°.

Show how you determine your estimate.

[2 marks]

Uncertainty = ± _____ °

05.3	range = 10 **or** mean of 51 calculated 5(°)	an answer of 5(°) scores **2** marks	1 1	AO3 4.6.1.3

Make judgements and draw conclusions

Low-demand questions

Example 20: Synergy 4F Question 2.7

Table 3 shows the diameter of atoms of Group 1 elements.

Table 3

Element	Diameter of atom in nanometres
Lithium	0.304
Sodium	0.372
Potassium	X
Rubidium	0.496
Caesium	0.530

0 2 . 7 Predict value **X** in **Table 3**.

[1 mark]

X = _____ nanometres

02.7	an answer in the range 0.373–0.495 (nanometres)		1	AO3 4.5.1.4

Example 21: Chemistry 2F Question 3.1

Polymers are used to make fabrics.

Table 1 shows some properties of two polymers.

Table 1

Property	Polymer J	Polymer K
Density in g/cm^3	0.9	1.4
Melting point in °C	165	260
Flame resistance	Poor	Good
Water absorption	Low	High

0 3 . 1 Polymer fabrics are used to make firefighter uniforms.

Complete **Table 2** by deciding for each property whether polymer **J** or polymer **K** is **best** for firefighter uniforms.

Use **Table 1**.

Density has been completed for you.

[2 marks]

Tick **three** boxes.

Table 2

Property	Polymer J	Polymer K
Density in g/cm^3	✓	
Melting point in °C		
Flame resistance		
Water absorption		

03.1	<table><tr><th>property</th><th>J</th><th>K</th></tr><tr><td>density in g/cm^3</td><td></td><td></td></tr><tr><td>melting point in °C</td><td></td><td>✓</td></tr><tr><td>flame resistance</td><td></td><td>✓</td></tr><tr><td>water absorption</td><td>✓</td><td></td></tr></table>	three correct = **2** marks one or two correct = **1** mark	2	AO3 4.10.1.1 4.10.3.3

Standard-demand questions

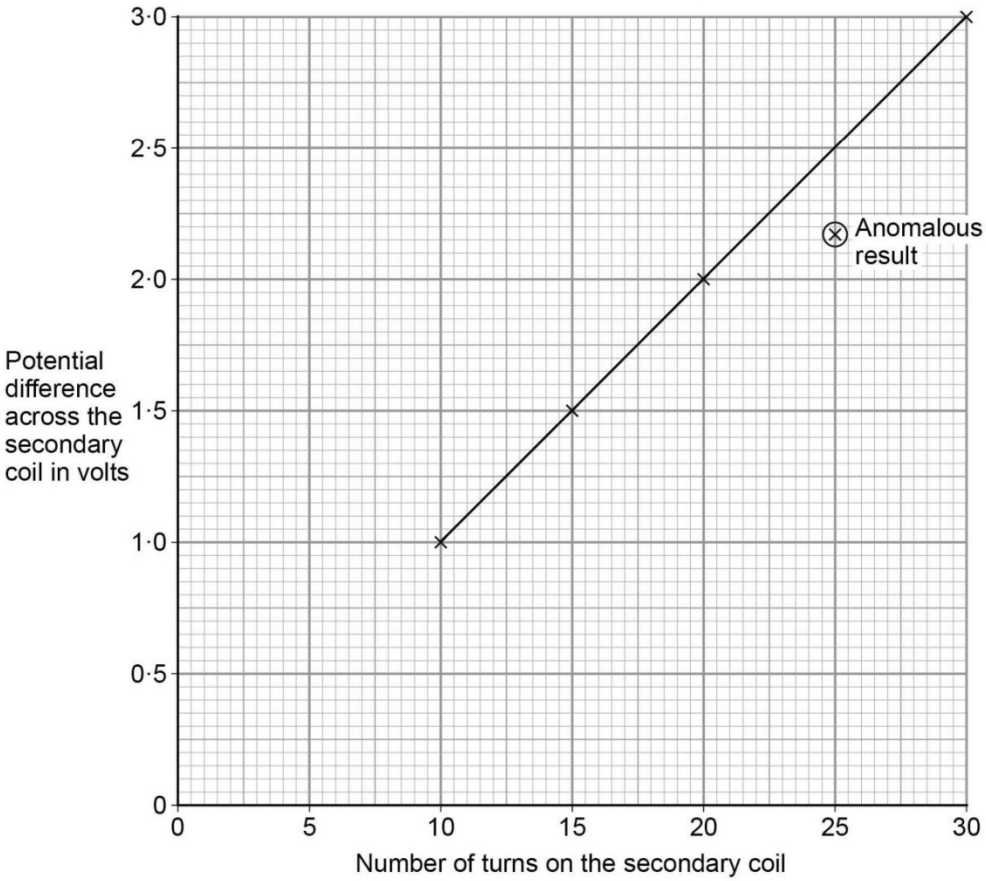
Example 22: Physics 2H Question 7.2

0 7 A student used a simple transformer to investigate how the number of turns on the secondary coil affects the potential difference (p.d.) across the secondary coil.

The student kept the p.d. across the primary coil fixed at 2V.

Figure 12 shows the results collected by the student.

Figure 12



0 7 . 2 The transformer changes from being a step-down to a step-up transformer.

How can you tell from **Figure 12** that this happens?

[1 mark]

07.2	the p.d. (across the secondary) goes above 2V	allow p.d. across secondary is higher than p.d. across primary after 20 turns	1	AO3 4.7.3.4

High-demand questions

Example 23: Synergy 4H Question 5.3

The subject content covered by this question is common with Combined Science: Trilogy 5.4.3.4 (Electrolysis of aqueous solutions).

The students made the following hypothesis:

'The mass of copper deposited on the negative electrode will be directly proportional to the current.'

Table 4 shows the students' results.

Table 4

Current in amps	Mass of copper deposited on the negative electrode in grams
0.12	0.024
0.24	0.047
0.36	0.057
0.48	0.095
0.60	0.118
0.72	0.142

0 5 . 3 Student **A** said that the results did support the hypothesis.

Student **B** said that the results did **not** support the hypothesis.

Explain the extent to which the data in **Table 4** supports the students' hypothesis.

[4 marks]

05.3	calculation / statement including data to show effect of doubling current on mass of copper deposited **or** calculation of **two** quotients, eg $\frac{0.24}{0.047} = 5.11$ $\frac{0.48}{0.095} = 5.05$	allow **1** mark for recognising that comparing doubling of one quantity to doubling of another is needed **or** allow **1** mark for recognising that a scaling factor needs to be applied could be opposite way round (giving around 0.2)	2	AO3 4.7.5.3
	(therefore) results support student **A** **or** results show direct proportionality	this mark must be supported by relevant calculations / statements	1	
	(however) there is an anomalous result at 0.36 A, 0.057 g	allow in terms of quotient (6.32 instead of ~5 or 0.16 instead of ~0.2)	1	

Example 24: Trilogy Physics 1H Question 4.4

Table 3 shows the half-lives of two of the radioactive isotopes that contaminated the environment.

Table 3

Isotope	Half-life
Caesium–137	30 years
Iodine–131	8 days

0 4 . 4 A soil sample was taken from the area around Chernobyl in 1986

The soil sample was contaminated with equal amounts of caesium–137 and iodine–131

Explain how the risk linked to each isotope has changed between 1986 and 2018

Both isotopes emit the same type of radiation.

[4 marks]

04.4	risk / activity associated with iodine-131 has decreased by a large amount		1	AO3 6.4.2.3
	because of short half-life	allow many half-lives have passed allow half-life is only 8 days 2nd marking point dependent on 1st marking point	1	
	risk / activity associated with caesium-137 will not have decreased by much	allow activity has halved	1	
	because of long half-life	allow only one half-life has passed 4th marking point dependent on 3rd marking point	1	

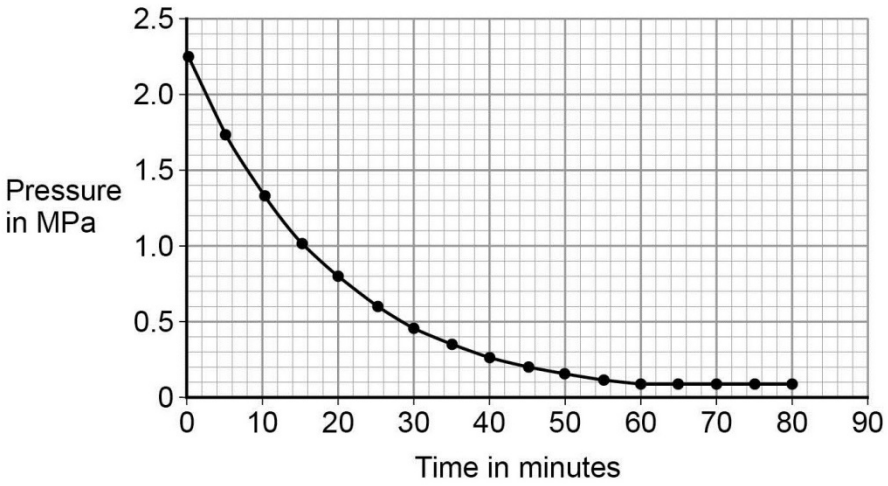
Example 25: Trilogy Physics 1H Question 3.5

A canister of air was tested to find out how the pressure changed when it was used by a diver.

- Air was allowed to escape from the canister.
- The pressure of the air in the canister was recorded every 5 minutes for 80 minutes.

Figure 6 shows the results.

Figure 6



0 3 . 5 Divers can safely stay underwater until the pressure of the air in the canister has reduced to 25% of its original value.

Determine the maximum time the diver can safely stay underwater.

Use **Figure 6**

[3 marks]

Time = _____ minutes

03.5	$p = 2.25 \times \left(\frac{25}{100}\right)$ $p = 0.56$ t = 27 (minutes)	an answer of 27 scores **3** marks allow any correct method of determining 25% of 2.25 allow use of 2.2–2.3 allow 0.55–0.575 allow 26–28 minutes allow correct value of t using their calculated value of p	 1 1 1	AO3 6.3.3.1

Develop and improve experimental procedures

Low-demand questions

Example 26: Chemistry 1F Question 6.6

0 6 A student investigated the temperature change in displacement reactions between metals and copper sulfate solution.

This is the method used.

1. Measure 50 cm^3 of the copper sulfate solution into a polystyrene cup.
2. Record the starting temperature of the copper sulfate solution.
3. Add the metal and stir the solution.
4. Record the highest temperature the mixture reaches.
5. Calculate the temperature increase for the reaction.
6. Repeat steps 1-5 with different metals.

0 6 . 6 Y is an unknown metal.

Describe a method to find the position of Y in the reactivity series in Question **06.5**

[3 marks]

06.6	suitable method described the observations / measurements required to place in order an indication of how results would be used to place the unknown metal in the reactivity series		1 1 1	AO3 4.4.1.2 4.5.1.1
	approaches that could be used: **approach 1:** add the unknown metal to copper sulfate solution (1) measure temperature change (1) place the metals in order of temperature change (1)			

06.6 cont.	**approach 2:** add the metal to salt solutions of the other metals **or** heat the metal with oxides of the other metals (1) measure temperature change (only if salt solutions used) **or** observe whether a chemical change occurs (1) compare temperature change or whether there is a reaction to place in correct order (1) **approach 3:** add all of the metals to an acid (1) measure temperature change or means of comparing rate of reaction (1) place the metals in order of temperature change or rate of reaction (1) **approach 4:** set up electrochemical cells with the unknown metal as one electrode and each of the other metals as the other electrode (1) measure the voltage of the cell (1) place the metals in order of voltage (1)		

Example 27: Biology 2F Question 8.1

0 8 Some students investigated phototropism in plant seedlings.

This is the method used.

1. Measure the lengths of the shoots of 20 seedlings.
2. Set up four groups of seedlings as follows:
   - **A** – bottom of shoot covered in aluminium foil
   - **B** – tip covered in aluminium foil
   - **C** – tip removed
   - **D** – no changes.
3. Put the seedlings in a cardboard box.
4. Use a lamp to shine a light into the box through a hole in one side.
5. After one day, re-measure the lengths of the shoots.
6. Make a drawing of the appearance of one seedling from each group.

0 8 . 1 Which **two** conditions should the students have kept constant for each group of seedlings?

[2 marks]

Tick **two** boxes.

- The length of the roots ☐
- The number of seedlings in each group ☐
- The temperature ☐
- The thickness of the aluminium foil ☐
- The volume of water added to the soil ☐

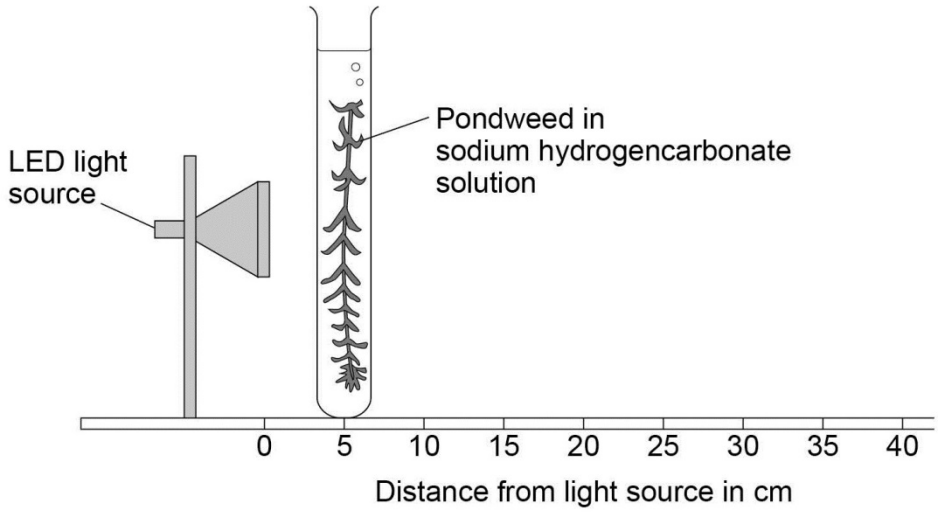
08.1	the temperature the volume of water added to the soil		1 1	AO3 4.5.4.1

Example 28: Trilogy Biology 1F Question 2.2

A student investigated the effect of light intensity on the rate of photosynthesis.

Figure 4 shows the apparatus.

Figure 4



This is the method used.

1. Place the pondweed at 5 cm from the light source.
2. Measure the rate of photosynthesis by counting the number of bubbles produced in 30 seconds.
3. Repeat the investigation with the pondweed at different distances from the light source.

0 2 . 2 How could the student measure the rate of photosynthesis more accurately?

[2 marks]

Tick **two** boxes.

- Count the number of bubbles produced in 1 minute ☐
- Measure the change in mass of the pondweed in 30 seconds ☐
- Measure the volume of gas produced in 30 seconds ☐
- Place the pondweed further from the light source ☐
- Use water instead of sodium hydrogencarbonate solution ☐

02.2	count the number of bubbles produced in 1 minute measure the volume of gas produced in 30 seconds	extra ticks negates marks	1 1	AO3 4.4.1.2

Standard-demand questions

Example 29: Synergy 2F Question 9.1

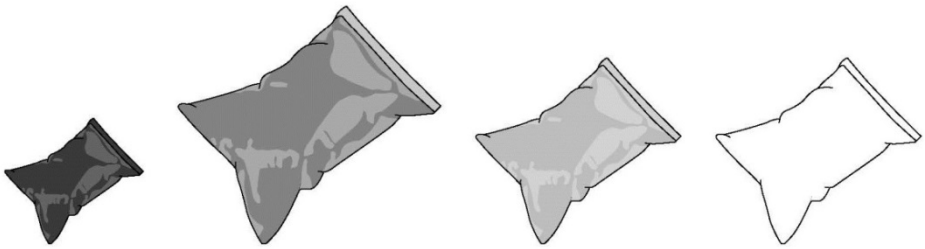
The subject content covered by this question is common with Combined Science: Trilogy 6.6.2 (Electromagnetic waves).

0 9 A solar water bag can be used to heat water for an outdoor swimming pool.

A student wanted to find out if the colour of the solar water bag affects the temperature increase of the water inside the bag.

Figure 12 shows some of the equipment used.

Figure 12



Black bag **Pale blue bag** **Pale green bag** **White bag**

This is the method used.

1. Fill each bag with water.
2. Place the four bags on the ground outside.
3. After three hours, measure the temperature of the water inside each bag.
4. Repeat steps 1–3 on the next two days.

0 9 . 1 Suggest **three** changes the student should make to this method to get valid results.

[3 marks]

1 _____

_____

2 _____

_____

3 _____

_____

09.1	any **three** from: • same surface area of bag (exposed to sun) • same volume / mass of water • use same starting temperature of water • place all bags out at the same time • place all bags out in same area / conditions • same thickness of material / bag • same type of material (for each bag) • use IR lamp in a lab	allow same sized bag allow same amount of water allow measure temperature at the start	3	AO3 4.1.4.3

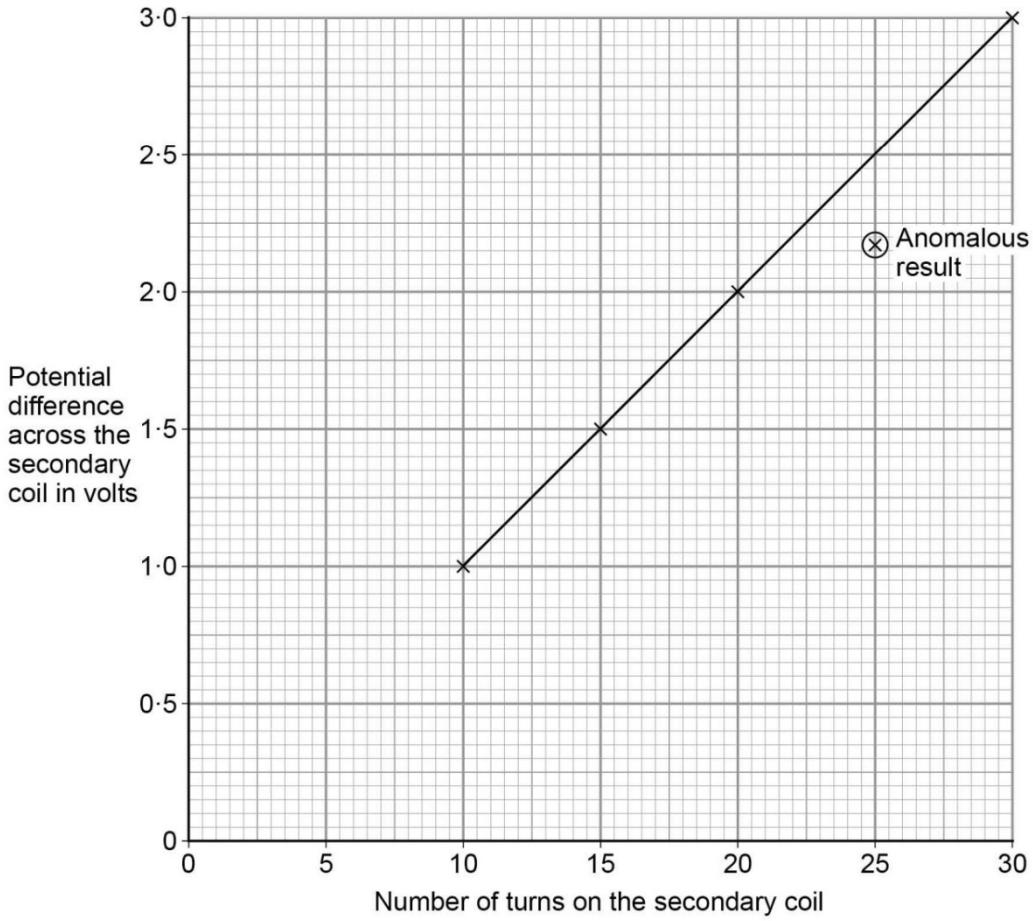
Example 30: Physics 2H Question 7.1

0 7 A student used a simple transformer to investigate how the number of turns on the secondary coil affects the potential difference (p.d.) across the secondary coil.

The student kept the p.d. across the primary coil fixed at 2V.

Figure 12 shows the results collected by the student.

Figure 12



0 7 . 1 **Figure 12** contains one anomalous result.

Suggest **one** possible reason why this anomalous result occurred.

[1 mark]

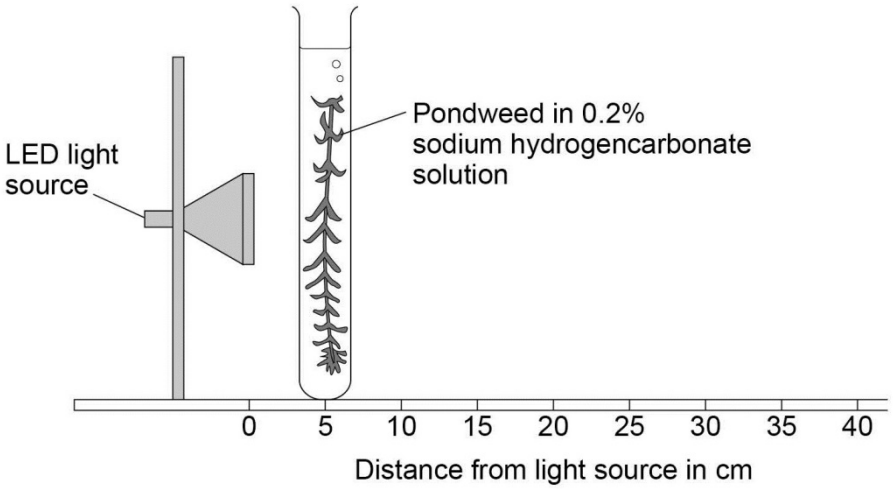
07.1	any **one** from: • too few turns / coils on the secondary • p.d. across the primary was reduced	allow number of turns / coils on the primary was increased ignore human error	1	AO3 4.7.3.4

Example 31: Trilogy Biology 1H Question 3.3

A student investigated the effect of light intensity on the rate of photosynthesis.

Figure 5 shows the apparatus used.

Figure 5



Sodium hydrogencarbonate solution releases carbon dioxide gas for the pondweed.

This is the method used.

1. Place the pondweed at 5 cm from the light source.
2. Measure the rate of photosynthesis by counting the number of bubbles produced in 1 minute.
3. Repeat with the pondweed at 10 cm and at 20 cm from the light source.

0 3 . 3 Counting the number of bubbles produced in 1 minute is **not** an accurate way to measure the rate of photosynthesis.

Suggest **two** ways the method could be improved to measure the rate of photosynthesis more accurately.

[2 marks]

1 _____

_____

2 _____

_____

03.3	measure the volume of gas released increase length of time	allow use a measuring cylinder / capillary tube / (gas) syringe allow sensible length of time allow video the investigation so you could re-count the bubbles later allow repeat the measurement at each distance several times **and** calculate a mean ignore references to using other distances	1 1	AO3 4.4.1.2

High-demand questions

Example 32: Biology 1H Question 4.4

0 4 A student carried out an investigation using chicken eggs.

This is the method used.

1. Place 5 eggs in acid for 24 hours to dissolve the egg shell.
2. Measure and record the mass of each egg.
3. Place each egg into a separate beaker containing 200 cm^3 of distilled water.
4. After 20 minutes, remove the eggs from the beakers and dry them gently with a paper towel.
5. Measure and record the mass of each egg.

0 4 . 4 Explain how the student could modify the investigation to determine the concentration of the solution inside each egg.

[3 marks]

04.4	use five (or more) different concentrations of salt / sugar solution (in beakers) (by) plotting percentage change (in mass / volume) on / using a graph determine the concentration where the curve / line crosses the zero percentage change (in mass / volume)	allow any number of concentrations provided it is more than four	1 1 1	AO3 4.1.3.2

Example 33: Synergy 4H Question 3.5

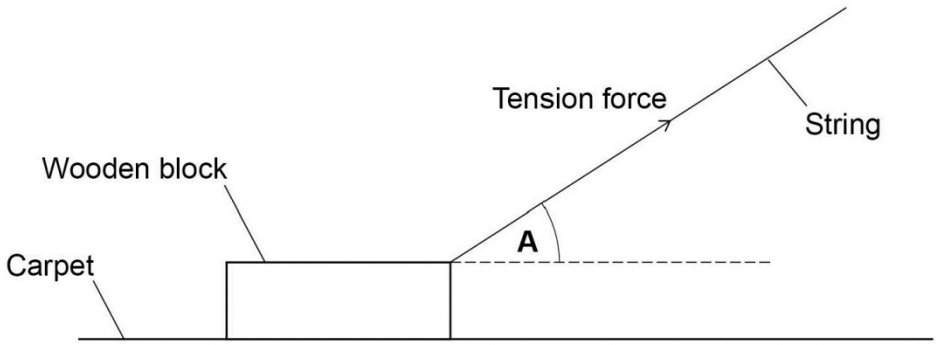
The subject content covered by this question is common with Combined Science: Trilogy 6.5.1.1 (Scalar and vector quantities) and 6.5.1.2 (Contact and non-contact forces).

Figure 4 represents a wooden block being pulled across a surface at a constant speed in a straight line.

The block is in contact with the surface.

The arrow in **Figure 4** represents the tension force in the string pulling the block.

Figure 4



A student collects data on the size of the force required to pull the block across different surfaces at a constant speed.

Table 2 shows the results.

Table 2

Type of surface	Force in N			Mean force in N
	Trial 1	Trial 2	Trial 3	
Cardboard	1.4	1.6	1.5	1.5
Carpet	2.6	3.1	3.9	3.2
Glass	0.7	0.8	0.6	0.7
Sandpaper	5.2	X	5.3	5.4

0 3 . 5 Give **three** control variables for this investigation.

[3 marks]

1 _____

_____

2 _____

_____

3 _____

_____

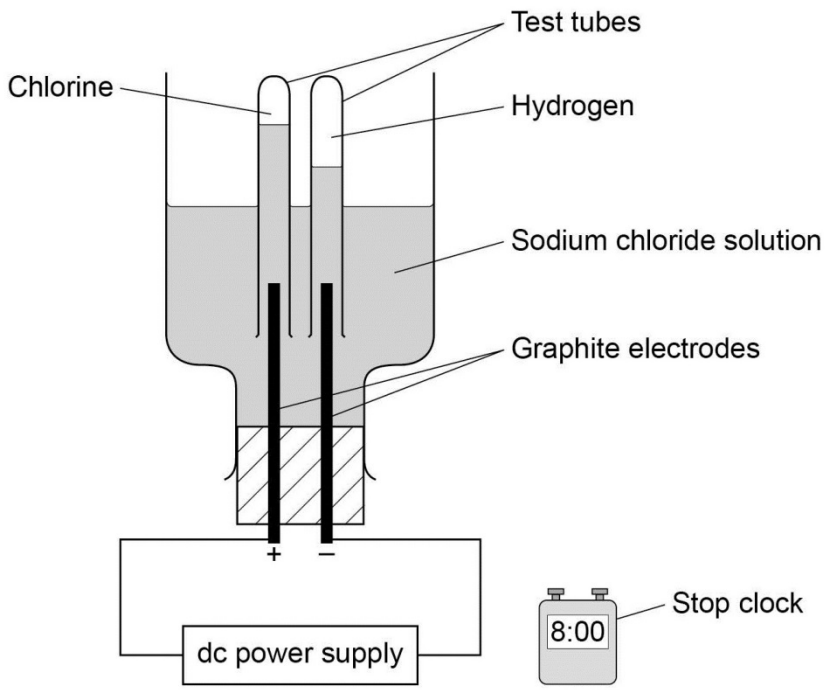
03.5	any **three** from: • angle (of string) • speed (at which block is pulled) • area of block in contact with surface • mass / weight of block	allow velocity (at which block is pulled) ignore same block	3	AO3 4.6.1.1

Example 34: Chemistry 1H Question 6.3

The student investigated how the volume of gases produced changes with time in the electrolysis of sodium chloride solution.

Figure 7 shows the apparatus.

Figure 7



0 6 . 3 The student made an error in selecting the apparatus for this investigation.

How should the apparatus be changed?

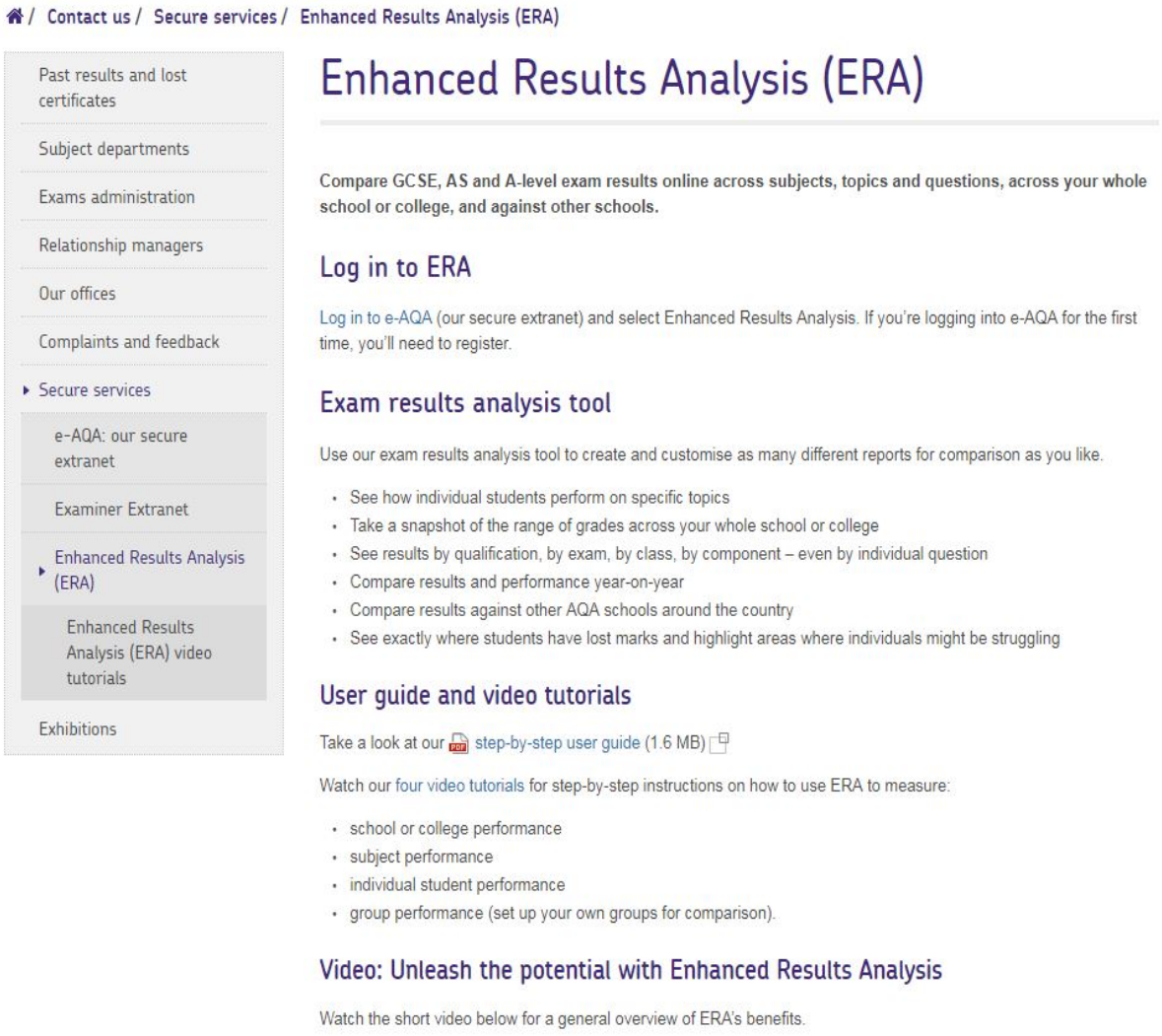
Give **one** reason for your answer.

[2 marks]

06.3	use measuring cylinders (instead of test tubes) (because) test tubes cannot measure volume **or** (because) test tubes have no graduations / scale	allow use burettes allow use (gas) syringes allow Hoffmann voltameter allow (so that) volume can be measured	1 1	AO3 4.4.3.4

Making the best use of ERA

Accessing ERA

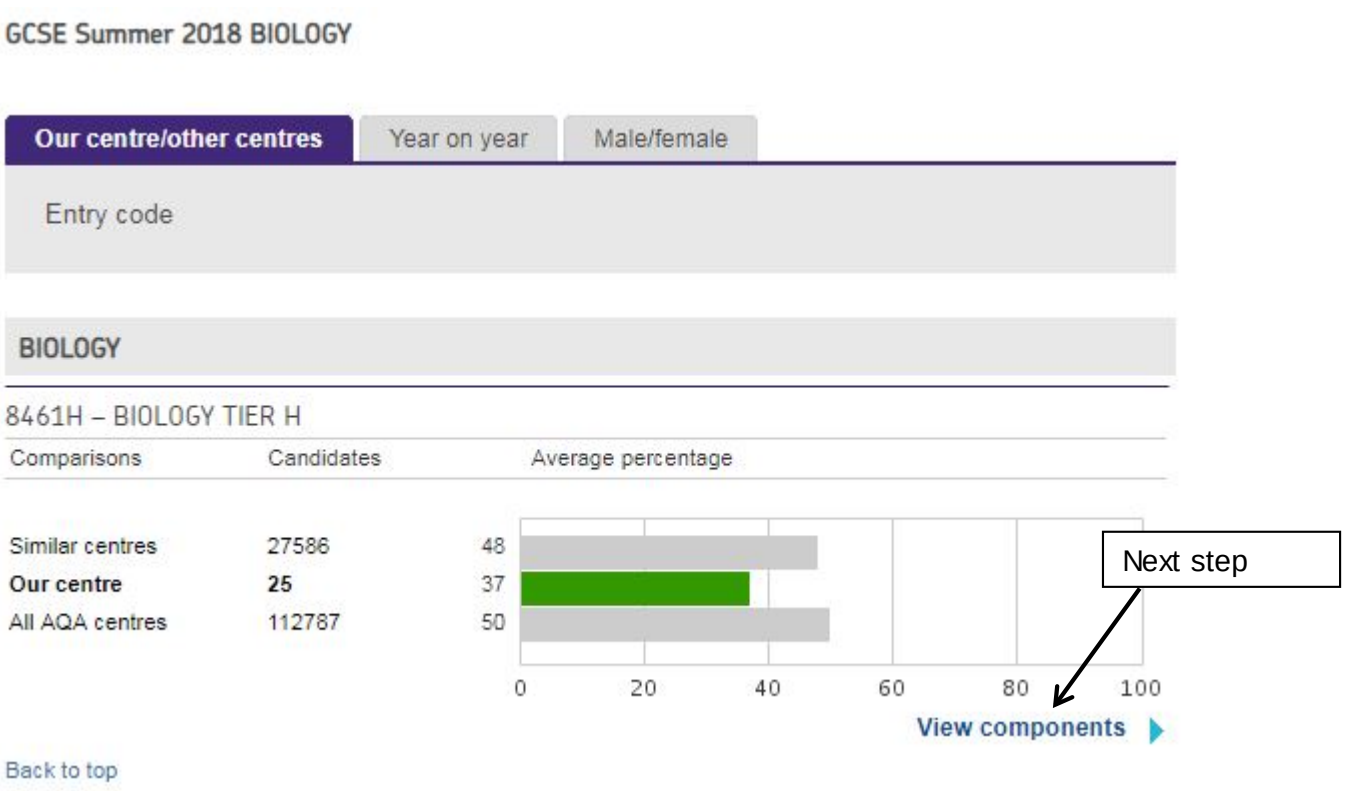


What does ERA give you?

- Evidence of perceived weakness
- Evidence for exams report to head of school
- Measure of impact of targeted intervention to specific groups
- Enable targeted amends to SOW and topic tests
- Identify sources of good practice in the department
- Recognise inconsistencies in teaching and learning approaches
- Using year-on-year analysis means can see any effects of interventions

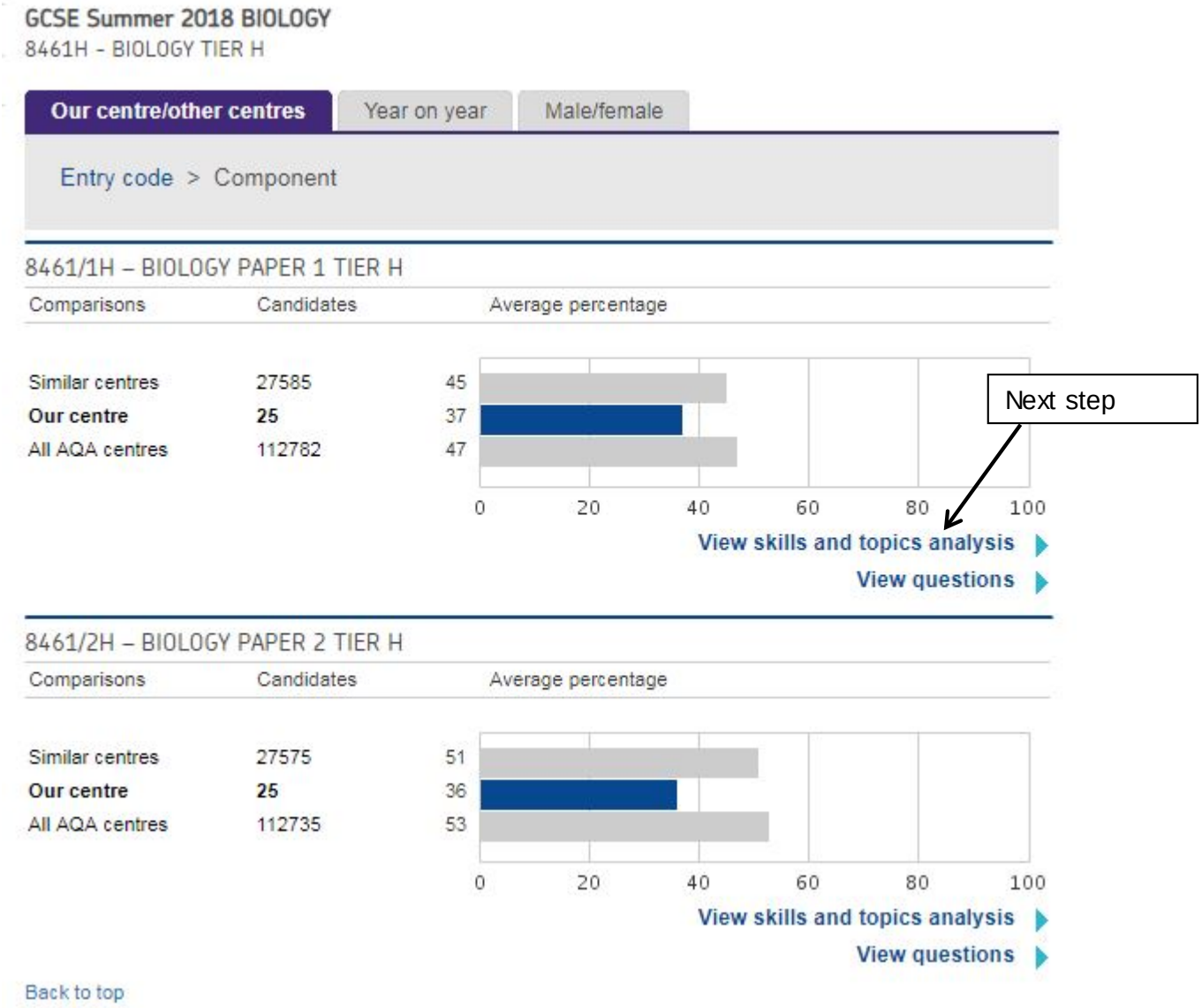
Drilling down through ERA data

Look at data by subject or paper

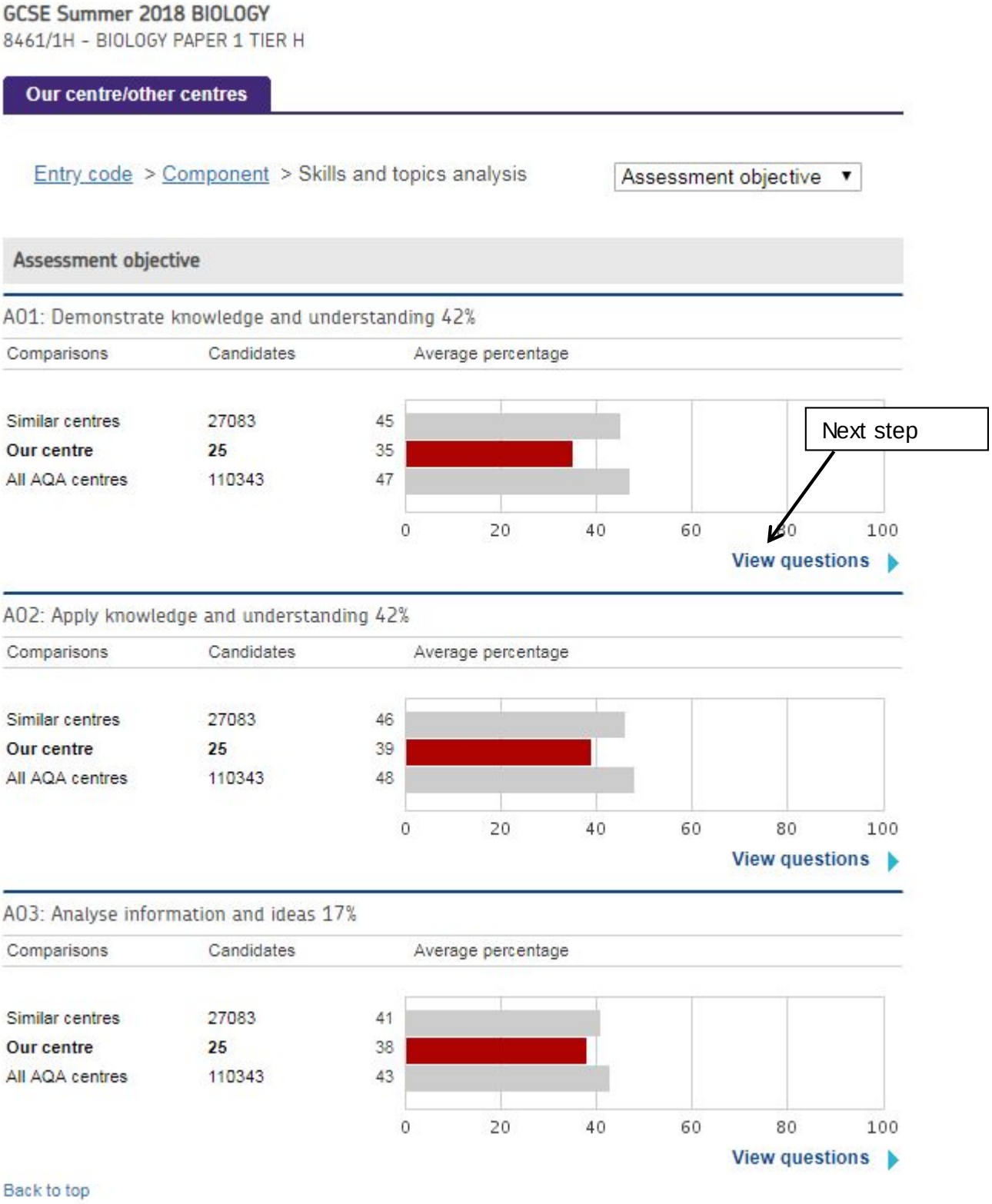


The next step takes you to a more detailed breakdown of the components for the specification. In this case, Paper 1 and Paper 2.

Skills and topics analysis

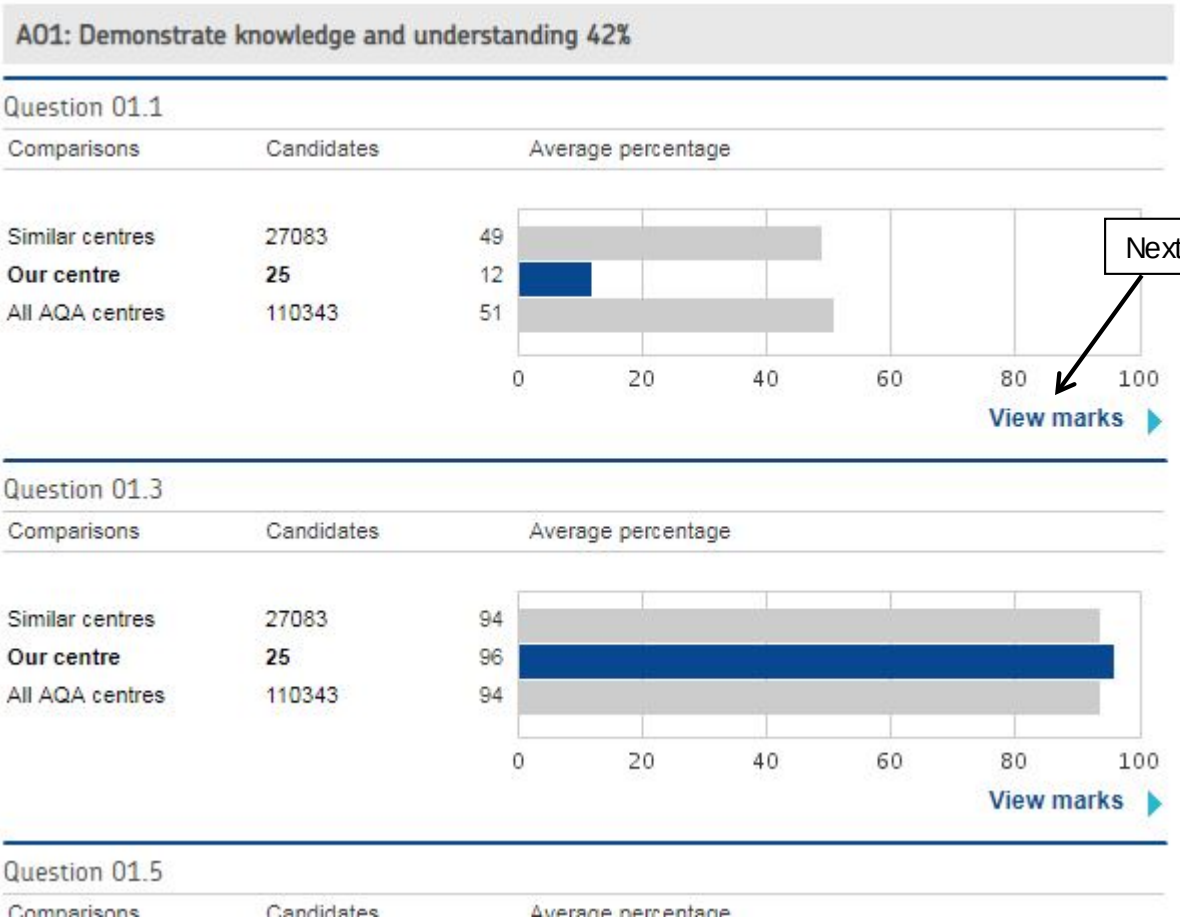


Choosing View skills and topics analysis takes you to the screen where you can see how your students have performed with regards to Assessment Objective, Specification reference, Skill (Extended response, Maths, Required practical), Topic. Comparison is shown with other centres.



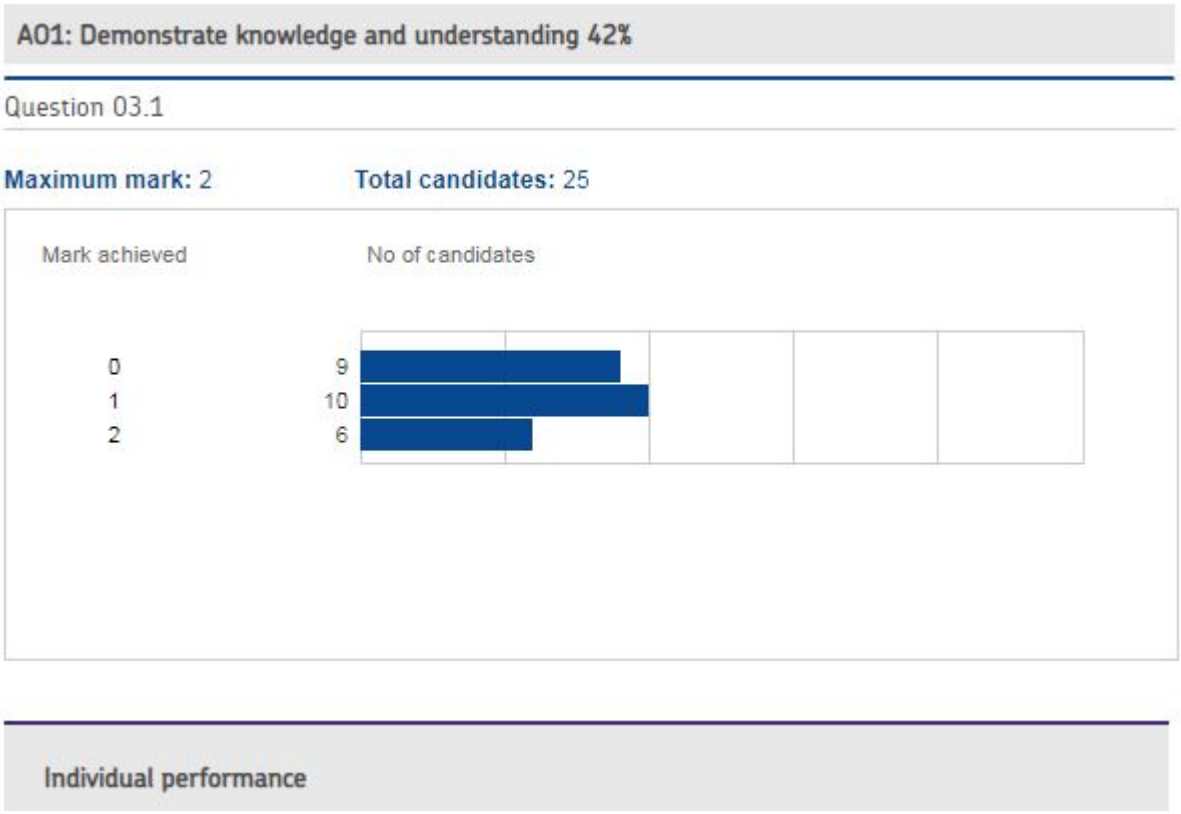
From here you can drill down to get question level data, where you will find your school's average marks compared with other AQA centres against the AO, skill area or topic area.

Question level data



Mark distributions by question

This final screen shows the mark distribution by question for your students. It also shows individual student data (not included as this is live data).



Download ERA data

You can download any or all of your results and analyse them in applications, such as Microsoft Excel.

The download option allows you to:

- perform your own analysis
- copy the data into existing spreadsheets
- create your own graphs
- save the graphs as images and insert them into your own reports.

Resources

Changes from the spring update are highlighted. New tables outlining the resources available for Entry Level Certificate and some information from Ofqual that may be of interest have also been added.

Previous Hub meetings

Meeting session	Material covered	Location
Spring 2019	Marking extended response questions using student examples from Summer 2018	Available on current Hub page aqa.org.uk/subjects/science/hub-schools-network
Autumn 2018	Discussion of student work from summer 2018 exams covering marking of complex calculations	Available on current Hub page: aqa.org.uk/subjects/science/hub-schools-network
Spring 2018	Marking extended response questions	Available on current Hub page: aqa.org.uk/subjects/science/hub-schools-network
Autumn 2017	Discussion of practical work and AO2-focused questions	Archive of Hub materials: access from link on current Hub page or directly: aqa.org.uk/subjects/science/hub-schools-network/science-meeting-materials-archive
Summer 2017	Discussions on maths in science, Required practicals, stretch and challenge	Archive of Hub materials: access from link on current Hub page or directly: aqa.org.uk/subjects/science/hub-schools-network/science-meeting-materials-archive
Spring 2017	Sample high-demand questions, practical work, structure of the new papers, which includes explanation of how physics equations will be assessed	Archive of Hub materials: access from link on current Hub page or directly: aqa.org.uk/subjects/science/hub-schools-network/science-meeting-materials-archive

General information and guidance

Resource	Description	Location Plan/Teach/Assess are all found on the subject page of our website
Guidance on tiering	Ofqual's tiering decisions for 2019. Link to specific guidance on choosing the appropriate tier for your students	aqa.org.uk/news/updated-science-tiering-guide-foundation-or-higher Tiering guide and poster also available on Plan
How the 9 to 1 grading scale is applied to GCSE Combined Science	Updated information on awarding grades for the GCSE Combined Science specifications A similar document is available directed at the separate science GCSEs	Assess
Navigation guide to exam preparation	Poster outlining resources and links to help with exam preparation	Assess
Co-teaching combined science and separate sciences	List of topics common between combined science and each separate science. Shows extra content that is separates only	Plan
Command word document	List of command words and an explanation of what is expected in a response	Teach
Subject-specific vocabulary	Definitions of working scientifically terms	Teach
Steps to success	Resources to support literacy, working scientifically, revision and exam techniques	Teach
Our exams explained	Booklet covering the different types of questions used in our papers	Assess
Making questions clear	Booklet covering how we make our assessments accessible to students and how we develop questions during the question paper process	Assess
Teaching guide: sample AO2 questions and mark	A simple explanation of what AO2 is and the type of questions that cover AO2. There are some suggestions	Teach

schemes	on how teachers might approach integrating it into lessons	
Schemes of work	Schemes of work for all GCSE Sciences. NB for Combined Science: Trilogy there are also schemes of work for Foundation Tier only	Teach

Maths in science

Resource	Description	Location
Maths PowerPoints	Slides to incorporate into lessons to support the teaching of the maths skills	Teach/Maths skills in GCSE
Sample questions: maths in science	Selection of questions taken from the 1st set of SAM which illustrate how the range of maths skills might be assessed at different levels of demand	Teach/Maths skills in GCSE
GCSE Science: Delivering the mathematical requirements	Powerpoint looking at basic maths skills and putting them into a science context	Teacher support tab of any of the GCSE sciences on Secure Key Materials (e-AQA)
The Language of Mathematics in Science: A guide for teachers of 11-16 science	Guidance produced by the Association for Science Education, in conjunction with the Nuffield Foundation, intended to achieve common understanding of important terms and techniques related to the use of mathematics in the science curriculum. There is an associated book on teaching approaches	Free to download from the ASE website: ase.org.uk/mathsinscience

Practical work

Resource	Description	Location
Technician Advisors	Practical experts with classroom experience, who can answer questions on setting up practical work-based lessons	Teach/Practicals/Technician Advisors
Practical handbooks	Teacher and technician notes and student worksheets covering suggested methods for the required practicals	Teach/Practicals
Practical work and learning outcomes	This summary shows possible aims and learning outcomes which teachers could use for each of the RPAs	Spring 2017 Hub meeting
Teaching guide: effective use of practicals	Series of slides summarising all our information about practical requirements and a suggested teaching approach to make the most out of practical lessons	Teach/Practicals
How practical skills are assessed	Selection of questions taken from the 1st set of SAM which illustrate how practical skills may be assessed for each of the AOs	Teach/Practicals
Supporting effective practical work	Presentation on practical work based on the Combined Science practicals, which could also be used for separate sciences	Teacher support tab for Combined Science on Secure Key Materials (e-AQA)

Entry Level Certificate

Resource	Description	Location
ELC getting started	CPD training for teachers new to ELC Science : online training	aqa.org.uk/professional-development/course-details?meta_E=SCIEGW2
Co-teaching ELC and Combined Science: Trilogy, Co-teaching ELC and Combined Science: Synergy	Guidance on teaching ELC science with Foundation tier Combined Science	Plan
ELC teaching guide	Background information on the course, suggestions for practical activities, supporting information on outcomes, keywords	Teach
ELC Schemes of work	Guidance on teaching the individual components	Teach
Specimen Teacher Devised Assignments	Example writing frames for TDAs for each component	Assess
Maximising outcomes for Foundation learners	Guidance on co-teaching ELC with Foundation tier Combined Science	Teacher support tab for ELC Science on Secure Key Materials (e-AQA)

Ofqual resources

Resource	Description	Location
Ofqual blog: 11 things we know about marking and 2 we don't … yet	Ofqual blog gives some insights into marking in UK exams from the regulator's point of view	ofqual.blog.gov.uk/2019/03/05/14572/
Ofqual blog: how do we achieve fairness in exams?	Gives some insights on how Ofqual ensures that the qualifications system is fair	ofqual.blog.gov.uk/2019/04/26/how-do-we-achieve-fairness-in-exams/
How grade boundaries are set	Video from Ofqual outlining the awarding process	twitter.com/ofqual/status/1122417684946268160

Notes

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