GCSE and A-level

Science

Hub schools network, autumn 2017

Accompanying materials

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Contents

About the session

The autumn meeting will look to address some of the challenges teachers have raised in the last few months. This will include a discussion on some of the points Heads of science need to consider when making tier of entry decisions. This decision making process is focused on which tier to enter students you consider are working at a grade 5 (top C, low B). There is a greater need now to look at the individual student and how they are dealing with a number of different skill areas including practical, maths and application of knowledge and understanding. The students' resilience to tackling the new exams structure will be key in the decision making progress.

Teachers have expressed their concern about how to address AO2 in the teaching time available, owing to the pressures of increased content and practical requirements. A session looks at this and suggests a teaching approach and strategies that could be used to enable opportunities to develop students' confidence and ability to answer questions aimed at AO2.

The practical session picks up this theme and develops further previous work covered on making the most of practical lessons.

There will be a brief outline of the awarding process to keep teachers up to date with how this process works.

As always there are opportunities for question and answers and sharing good practice with your fellow colleagues.

Session slides

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Autumn 2017 Hub meeting

Agenda

- Entry decisions
- Discussion workshops
  - Practical questions
  - AO2 – balancing teaching and learning of AOs
- Outline of how awarding works
- GCSE and A-level updates
- Focus for Spring Hub

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GCSE tier of entry

Some points to consider:

- Shift from 'C/D border line' to 'C/B border line' as grade 5 is awarded on Foundation Tier paper
- Resilience – longer papers and 40:60 split standard to high demand
- No mixed tiers for Combined Science – need to perform in all sciences
- Performance on
  - standard demand SAMs
  - extended answer questions
- Maths GCSE performance
- Historic contribution of ISA marks
- We have seen a change in tier of entry in Maths GCSE

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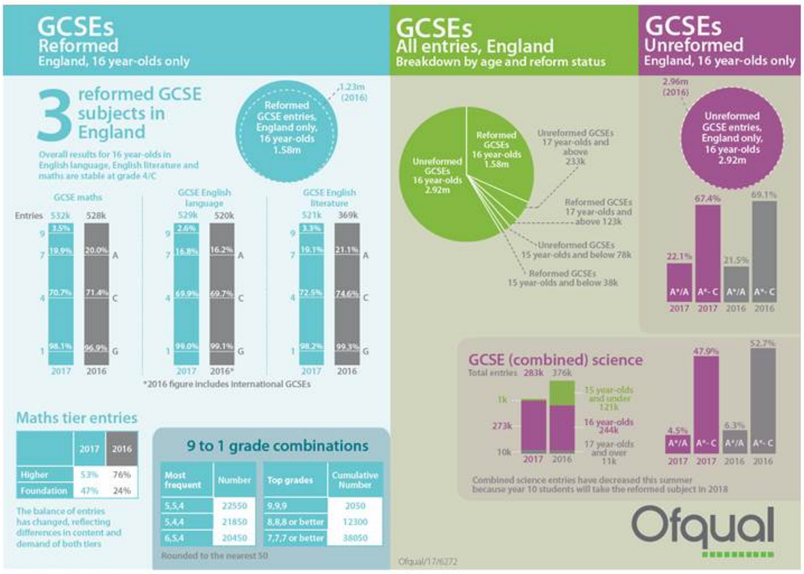
GCSE results 2017



gov.uk/government/publications/infographic-gcse-results-2017

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Entry fees

- Entries deadline **21 February**.
- It is free to change the tier of entry up to **21 April**. After 21 April an amendment fee will be charged.
- Change of entry from Separates to Combined up to **21 April** – a centre will be charged a new entry fee which is double the original one, but would receive the original fee back for the withdrawn subject.

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Discussion workshops

- Practical questions
- How to balance AO1 and AO2 teaching and learning

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Practical questions

- Look at the examples of the updated student sheets from the practical handbooks. We have added a few questions to help tie in the practical activity to the specification content, the ATs or some aspect of working scientifically.
- How would you improve or add to these questions?
- If you were teaching this RP what would be the context you could set it in?
- What working scientifically focus could you have for this lesson?
- Can you think of some generic questions you could use to address some of the subject specific vocabulary

accuracy precision uncertainty types of error

reproducible resolution control

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Student exemplars summer 2017

- Look at the student exemplars. How could you use these to reinforce good exam techniques?
- How could the executive summaries be used with your teachers to highlight areas of improvement needed in their practical teaching?

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Required practical handbook statement:

The required practical activities listed in the GCSE Combined Science specifications (8464 and 8465) have been written to ensure that students have the opportunity to experience all of the apparatus and techniques (AT) criteria required by Ofqual.

In this guide we suggest methods for carrying out the required practical activities to give ideas and guidance to help you plan the best experience for your students. None of these methods are compulsory. What you do have to do is make sure that you do a sufficient variety of practical work to give your students the opportunity to experience all aspects of the AT criteria required by Ofqual. The methods we have suggested will enable you to do this, but we strongly encourage you to adapt them to fit the needs of your students and the resources you have available.

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Teaching and learning: balance of AOs

- What does AO2 really mean ?

  It is a fundamental part of science. It is how scientists use knowledge to explain phenomena. It is not an 'add on' but something scientists do all the time.

- Look at some examples of questions that are assessing AO2
  - what aspect of AO2 is it assessing?
  - what would you have needed to have taught to enable your students to tackle the question with confidence?
  - how would you approach teaching this so students could confidently access this type of question?

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Some examples of types of AO2 questions

- applying knowledge and understanding to an unfamiliar context or an aspect of a required practical to explain phenomena or behaviour
  - command words – explain, suggest, give a reason
- calculations/equations/formula
- graph work
  - explaining why you have chosen a specific type of graph
  - drawing graphs and drawing lines of best fit
  - reading points off a graph
  - drawing tangents to the curve
  - analysing the pattern
- identifying variables
- using specialist diagrams

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Teaching strategies

- Think about the topic you are teaching at the moment.
- What different teaching strategies could teachers adopt to provide opportunities to support students with AO2?

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GCSE subject level guidance for Combined Science

AO2: Apply knowledge and understanding of: ▪ scientific ideas ▪ scientific enquiry, techniques and procedures.			*40%*
Strands	**Elements**	**Coverage**	**Interpretations and definitions**
1 – Apply knowledge and understanding of scientific ideas.	This strand is a single element.	▪ Full coverage in each set of assessments (but not in every assessment).	▪ **Scientific ideas** are aspects of the subject content. They include the subject-specific requirements and the requirements for Working Scientifically as set out in the Content Document – for example, theories, models and the use of relevant mathematics. ▪ **Scientific enquiry, techniques and procedures** encompasses, but is broader than, knowledge and understanding of the core practical activities. In the context of this assessment objective, it involves applying such knowledge and understanding to a given context. ▪ The emphasis in this assessment objective is on Learners applying their knowledge and understanding to provide meaning or explanation – for instance, to connect theory with particular contexts, stimuli or materials. This application should relate principally to: □ novel situations that are not clearly indicated in the specification; □ developing further material that is covered in the specification; □ making links between such types of material, which are not signalled in the specification. ▪ Application of knowledge should also involve determining how to make sense of connections and linkages within data, information and detail – although not to the extent of drawing conclusions or making judgements.
2 – Apply knowledge and understanding of scientific enquiry, techniques and procedures.	This strand is a single element.		

This information is lifted directly from Ofqual's GCSE Subject Level Guidance for Combined Science (July 2015) available in full here: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/443984/gcse-9-to-1-subject-level-guidance-for-combined-science.pdf

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How is a grade boundary decided?

The 'statistical' element

Our Centre for Education Research and Compliance (CERP) use a range of statistics to make predictions which suggest the most appropriate statistically recommended grade boundaries. These are based on how comparable students have performed in previous series, KS2 data and matched data.

The 'judgemental' element

The awarding meeting use a balance of judgemental and statistical evidence to make recommendations. The committee will look at a range of scripts for each 'judgemental grade boundary' (7, 4 and 1 for GCSE).

Making the grades - a guide to awarding

aqa.org.uk/about-us/what-we-do/getting-the-right-result/how-exams-work/making-the-grades-a-guide-to-awarding

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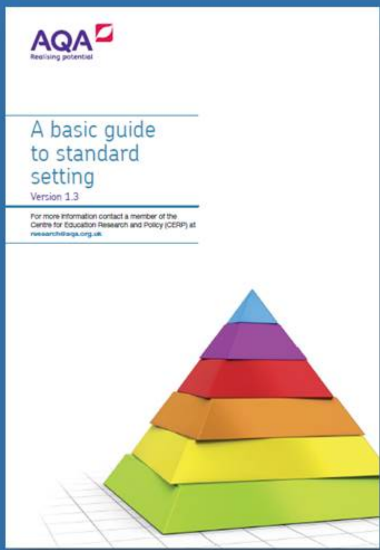
What exactly is awarding?

Awarding is the process by which the grade boundary marks are determined at subject level.

We do this in a way that ensures the standard will be comparable with previous series and with that of other awarding organisations.

aqa.org.uk/about-us/what-we-do/getting-the-right-result/how-exams-work/making-the-grades-a-guide-to-awarding



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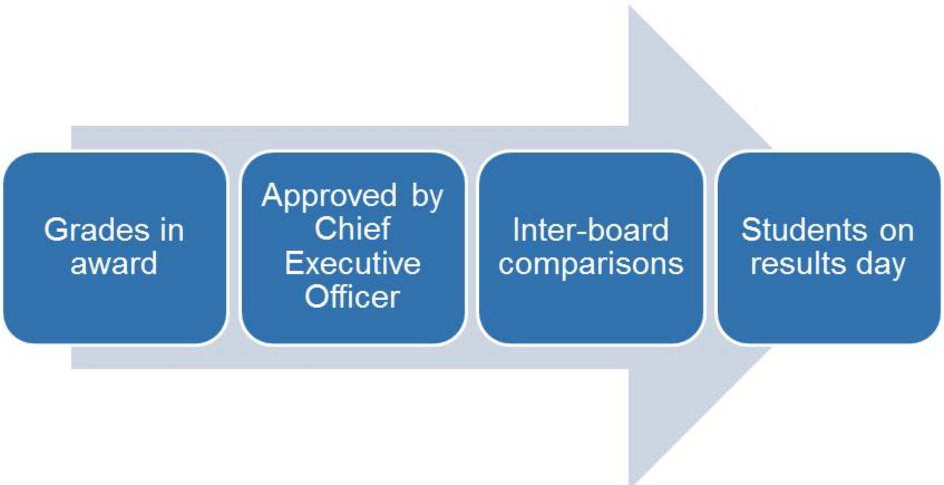
The bigger process



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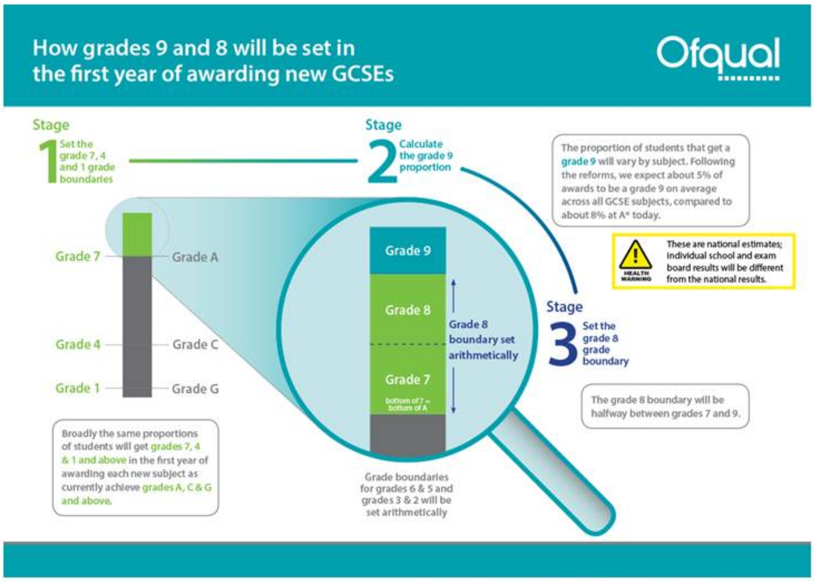
Setting grades 8 and 9 in the first year of new GCSEs



ofqual.blog.gov.uk/2017/04/05/setting-grade-9-in-new-gcses

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GCSE and A-level updates

- Arrangements for monitoring visits – timeline for practical work.
- Contact our technician advisers for any support with GCSE or A-level practical work delivery in the classroom.
- Second set of specimen assessment materials
  - Uploaded on to SKM on 30 November
  - Model live papers of summer 2018 - can cover any aspect of the spec
  - Use as staggered mock
    - Dec/Jan Paper 1
    - Spring term Paper 2
    - April final push using papers not previously used

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Updates: GCSE

Exam timetable now on the website (separates and Trilogy same sessions)

Paper	Date	Session
Biology P1 Synergy P1	15 May	pm
Chemistry P1	17 May	am
Physics P1 Synergy P2	23 May	pm
Biology P2 Synergy P3	11 June	am
Chemistry P2 Synergy P4	13 June	am
Physics P2	15 June	am

Entries deadline: 21 February.

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Provisional GCSE results summer 2017

Provisional GCSE results (All UK Candidates)

The figures in brackets are the final national figures for 2016 Ref: Ofqual/16/6094

	Number sat	C and above	A and above
Core Science	283390 (375654)	47.9 (52.7)	4.5 (6.3)
Additional	376347 (368033)	58.2 (59.7)	9.1 (9.4)
Biology	143340 (144148)	90.4 (90.5)	42.2 (41.4)
Chemistry	141867 (141245)	89.9 (90.3)	42.4 (42.3)
Physics	141977 (139805)	90.8 (90.9)	41.9 (42.8)

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Provisional outcomes summer 2017

A comparison of provisional 2017 GCE AS with 2016 AS results in the same subjects for 17 year olds.

The figures in brackets are the equivalent provisional figures for 2016.

	A	C	E
Biology	18 (18.9)	52.1 (57.8)	84.4 87
Chemistry	20.7 (22.4)	53.7 (61.5)	84.2 (87.5)
Physics	22.6 (22.9)	55 (59.5)	83.8 (86.4)

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Provisional outcomes summer 2017

A comparison of provisional 2017 GCE A-level results with 2016 GCE results (all UK Candidates).

The figures in brackets are the equivalent provisional figures for 2016.

	A	C	E
Biology	26.2 (27.1)	70.8 (72.6)	96.8 (97.2)
Chemistry	31.7 (31.9)	75.6 (77)	97.0 (97.3)
Physics	29.2 (29.6)	69.7 (71.4)	95.8 (96.4)

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Feedback from the summer 2017 end of Year 10 test

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Areas of challenge for students:

- revision of material
- basic exam techniques: repeating the information in the question not adding to it
- conversion of units
- not using equations given
- quality of written answers and precise use of language
- application of knowledge to unfamiliar context
- linking information given in a question to what they know and then constructing an answer

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Areas of challenge for students:

- may have carried out the practical work but learning is not embedded
- importance of the apparatus and techniques is being missed
- describing patterns
- lines of best fit can be a curve
- maths skills
  - not familiar with some of new applications of maths
  - not showing working out clearly

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Model of distribution for all papers

Trilogy Foundation mark (max 90)	Trilogy Higher mark (max 90)	Percentage of cohort
16	15	Top 80%
25	26	Top 50%
35	39	Top 20%
41	46	Top 10%

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Skills area

Marks can be assigned to more than one skill area and some marks don't cover one of the skills we have identified. Average marks have been rounded to a full mark.

	Foundation		Higher	
	Av mark	Total mark	Av mark	Total mark
AO1	12	39	8	28
AO2	10	38	13	38
AO3	4	13	6	24
Maths	5	18	6	18
WS	13	41	15	50
Practical	3	16	4	15
Extended response	1	10	5	18

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Useful Ofqual links

- Ofqual analytics – Variability in GCSE and A-level results, distribution of GCSE 9-1 grades: analytics.ofqual.gov.uk/
- Factsheet – new 9-1 grading scale: gov.uk/government/publications/gcse-new-grading-scale-factsheets
- Blog – Setting 9 for the new linear GCSEs: ofqual.blog.gov.uk/2017/04/05/setting-grade-9-in-new-gcses/
- Blog – Levelling the playing field, ensuring exam board outcomes are comparable: ofqual.blog.gov.uk/2017/03/24/levelling-the-playing-field/
- Downloadable graphics about reforms: gov.uk/government/publications/your-qualification-our-regulation-gcse-as-and-a-level-reforms

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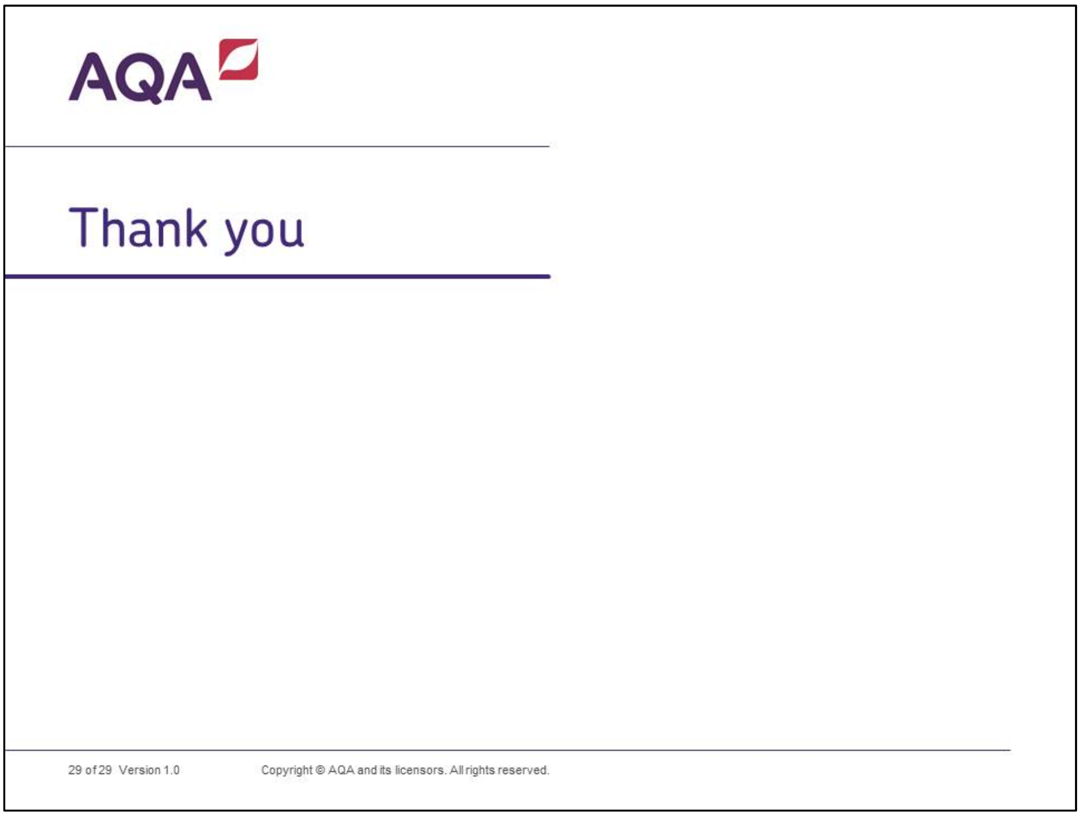
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Thank you
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Practical questions

These practical examples have been selected from the amended practical handbook, which will be available later this term. The purpose of this activity is to develop the questions within the student worksheets to integrate Working Scientifically, the scientific content and the Apparatus and Techniques requirement.

Teacher and technician notes: Biology

Reaction time

Plan and carry out an investigation into the effect of a factor on human reaction time

Trilogy RPA 6 **Synergy RPA 8**

Specification reference 4.5.2 **Specification reference 4.2.1.6**

By using this method your students will have the opportunity to develop the following aspects of the Biology AT skills	
AT 1	use of appropriate apparatus to make and record a range of measurements accurately including length
AT 3	use of appropriate apparatus and techniques for the observation and measurement of biological changes and/or processes
AT 4	safe and ethical use of a living organisms (plants or animals) to measure physiological functions and responses to the environment

Materials

Students work in pairs for this investigation. Each pair should have:

For the basic method

- a metre rule
- a chair
- a table.

Technical information

This method investigates the effect of practising an event on reaction time.

Ruler measurements can be converted to reaction times using the conversion table.

Additional information

Students can use the conversion table to calculate reaction time from their measurements. Pre-converted strips can be taped to metre rulers to save time.

This method has been trialled with students and the following results obtained.

Drop test attempt	Ruler measurements in cm		Reaction times in seconds	
	Person 1	Person 2	Person 1	Person 2
1	48	32	0.31	0.26
2	44	30	0.30	0.25
3	37	27	0.28	0.23
2	29	28	0.24	0.24
5	26	25	0.23	0.23
6	34	21	0.26	0.21
7	34	26	0.26	0.23
8	20	25	0.21	0.23
9	32	29	0.26	0.24
10	19	27	0.20	0.23

Relevant specimen questions from first set of SAMs

1. Trilogy Biology Paper 2 Foundation Q10 / Higher Q3 – standard demand
2. Separate Biology Paper 2 Foundation Q 10 /Q3 – standard demand

Student worksheets: Biology

Reaction time

Plan and carry out an investigation into the effect of a factor on human reaction time

In this practical you will:

- decide which factor you want to investigate that will have an effect on human reaction time
- work with a partner to use the ruler drop test
- use your results to calculate your reaction time before and after you made the change.

Apparatus

- a metre ruler
- a chair
- a table
- any further equipment needed depending on the factor you are changing

Investigation

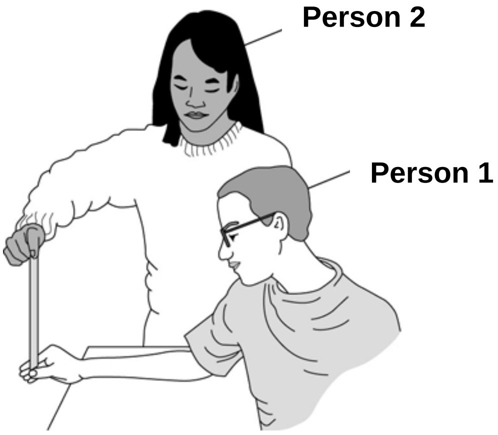
What factor have I decided to change?

How will I change it?

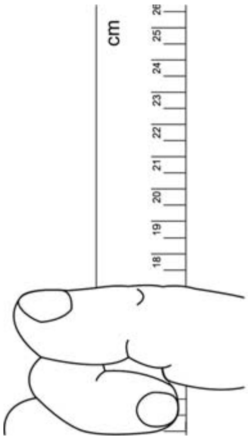
What effect do I think it will have on human reaction time?

Method for standard human reaction time test

1. Work with a partner to do this test. Choose who will be Person 1 and who will be Person 2.
2. Each of you should use your dominant hand to do this experiment. If you are right handed then your dominant hand is your right hand.
3. Person 1 sits down on the chair, with good upright posture and eyes looking across the room.
4. Person 1 puts the forearm of their dominant arm across the table with their hand overhanging the edge.
5. Person 2 holds a ruler vertically with the bottom end (the end with the 0 cm mark) in between Person 1’s thumb and first finger. They will tell Person 1 to prepare to catch the ruler.



6. Person 1 catches the ruler with their thumb and first finger as quickly as possible when it drops.
7. Record the number on the ruler that is level with the top of Person 1’s thumb.



8. Have a short rest, then repeat the test several times.

9. Record your results in a table.

Drop test attempt	Ruler measurements in cm				Reaction times in seconds			
	Person 1 Before	Person 2 Before	Person 1 After	Person 2 After	Person 1 Before	Person 2 Before	Person 1 After	Person 2 After
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

10. Repeat the test with Person 2 catching the ruler and Person 1 dropping it.
11. Record Person 2's results on the table.
12. Use a conversion table to convert your ruler measurements into reaction times.
13. Make the change that you are investigating to change human reaction time.
14. Repeat steps 1-9 for each person and record the results in your data table.

Analysing the data

Choose an appropriate way to display your results in a graphical way.

a. Why have you chosen this particular type of graph?
b. Do your results reflect your hypothesis? Did the factor you changed have any effect on your reaction time?
c. Consider your own and your partner's results. Are your reaction times similar? If not, can you explain why?
d. What type of errors might have happened to affect your results?

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Teacher and technician notes: Chemistry

Temperature changes

Investigate the variables that affect temperature change in chemical reactions eg acid plus alkali

Trilogy RPA 10 **Synergy RPA 18**

Spec. reference 5.5.1.1 **Spec. reference 4.7.3.3**

By using this method your students will have the opportunity to develop the following aspects of the Chemistry AT skills	
AT1	Use of appropriate apparatus to make and record a range of measurements accurately, including mass, temperature and volume of liquids
AT 5	Making and recording appropriate observations during chemical reactions including changes in temperature
AT 6	Safe and careful handling of gases, liquids and solids , including careful mixing of reagents under controlled conditions, using appropriate apparatus to explore chemical changes and /or products

Materials

For the basic method

- 2 M hydrochloric acid
- 2 M sodium hydroxide solution
- Expanded polystyrene cups and lids with thermometer holes
- 0-110 ^{o}C thermometers

Technical information

To prepare 2 M hydrochloric acid, consult CLEAPSS Recipe Book.

To prepare 2 M sodium hydroxide solution, consult CLEAPSS Recipe Book.

Additional information

Additional guidance may need to be provided to students regarding the drawing of the two lines of best fit so that they intersect.

The solutions used are fairly concentrated in order to produce reasonable temperature changes.

2 M sodium hydroxide is particularly hazardous to the eyes.

Results from our technician adviser trials

Total volume of sodium hydroxide added in cm^3	**Maximum temperature in ^oC**		
	First trial	**Second trial**	**Mean**
0	20.0	21.0	
5	24.0	24.6	
10	26.8	27.6	
15	28.6	29.6	
20	30.8	31.3	
25	31.8	32.8	
30	32.0	32.6	
35	31.6	31.8	
40	30.6	31.0	

Relevant specimen questions from first set of SAMs

1. Trilogy Chemistry Paper 1 Foundation Q3 – low demand
2. Trilogy Chemistry Paper 1 Higher Q6 – high demand

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Student worksheet: Chemistry

Temperature changes

Investigate the variables that affect temperature change in chemical reactions eg acid plus alkali

In this practical you will:

- react sodium hydroxide solution with hydrochloric acid
- measure the temperature changes during the reaction
- plot a graph of your results and record the temperature change

Apparatus

- dilute hydrochloric acid
- dilute sodium hydroxide solution
- an expanded polystyrene cup and lid
- 250 cm^3 beaker
- 10 cm^3 measuring cylinder
- 50 cm^3 measuring cylinder
- a thermometer.

Method

1. Measure 30 cm^3 dilute hydrochloric acid and put it into the polystyrene cup.
2. Stand the cup inside the beaker. This will make it more stable.

3. Use the thermometer to measure the temperature of the acid. Record your results in a table like this.

Total volume of sodium hydroxide added in cm^3	Maximum temperature in ^oC		
	First trial	**Second trial**	**Mean**
0			
5			
10			
15			
20			
25			
30			
35			
40			

4. Measure 5 cm^3 sodium hydroxide solution.
5. Pour the sodium hydroxide into the polystyrene cup. Fit the lid and gently stir the solution with the thermometer through the hole.
6. Look carefully at the temperature rise on the thermometer.
7. When the reading on the thermometer **stops changing**, record the highest temperature reached in the table.
8. Repeat steps 4–7 to add further 5 cm^3 amounts of sodium hydroxide to the cup each time, recording your temperature reading in the results table.
9. Repeat until a maximum of 40cm^3 of sodium hydroxide has been added.
10. Wash out all the equipment and repeat the experiment for your second trial.

Analysis and conclusion

a. Calculate the **mean** maximum temperature reached for each volume of sodium hydroxide. Record these means in your table.

b. Plot a graph from your results and draw two straight lines of best fit.

c. Describe the pattern of your results and explain what you have observed

d. How did you make sure you worked safely while carrying out this experiment?

Teacher and technician notes: Physics

Force and extension

Investigate the relationship between force and extension of a spring

Trilogy RPA 18 **Synergy RPA 13**

Spec. reference 6.5.3 **Spec. reference 4.6.1.6**

In the practical, students place known masses on a spring, measure the total resultant length of the spring and calculate its extension.

By using this method students will have the opportunity to develop the following aspects of the Physics AT skills	
AT 1	Use appropriate apparatus to make and record a range of measurements accurately including length.
AT 2	Use appropriate apparatus to measure and observe the effect of forces including the extension of springs

Materials

For the basic method

- a suitable spring capable of extending more than 1 cm under a load of 1 N with loops at each end
- metre ruler
- suitable pointer (eg splint and tape)
- weight stack appropriate for the spring (eg 10 N in steps of 1 N)
- clamp stand
- two clamps and bosses
- G-clamp or weight to prevent the apparatus tipping over the edge

Technical information

The pointer should be attached so that it doesn't slip or change angle. It is probably best attached to the bottom of the spring. Students will calculate the extension ie the increase in length. Many are likely to think that this is the incremental increase – in fact it is the total increase (ie from the original length). The students align the top of the ruler with the top of the spring – this isn't essential but it may help to emphasise this point about the extension.

Students may need to be told how to convert the mass (in grams) written on the weight stack into a weight in Newtons. (Using the equation weight (N) = mass (kg) x gravitational field strength (N/kg). This practical can be used to emphasise the difference between mass and weight.

Additional information

The proportional relationship between force and extension is known as Hooke's Law.

The students will record the reading on the metre ruler (which will be the length of the spring if set up that way) as the weights are added. They will then calculate the extension (ie the increase from the original reading). The extension should increase in proportion to the weight. A graph of extension against weight will be a straight line through the origin. The gradient of the line is 1/stiffness or 1/spring constant (ie the graph for a stiffer spring will have a lower gradient).

Relevant specimen questions from first set of SAMs

1. Trilogy Physics Paper 2 Foundation Q2 – low demand
2. Trilogy Physics Paper 2 Higher Q4 – standard/high demand
3. Physics Paper 2 Foundation Q4 – low demand
4. Physics Paper 2 Higher Q1 – standard demand

Student worksheets: Physics

Force and extension

Investigate the relationship between force and extension of a spring

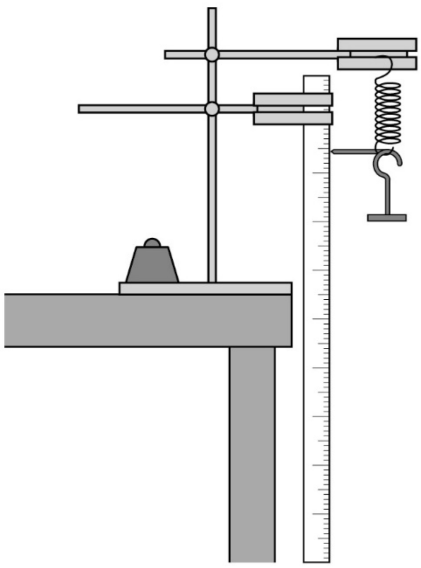
In this practical you will:

- hang different masses from a spring and measure the extension of the spring for each mass used
- convert mass into weight
- use your results to plot a graph of extension against weight

Apparatus

- a spring
- a metre ruler
- a splint and tape to act as a pointer
- a 10 N weight stack
- a clamp stand
- two clamps and bosses
- a heavy weight or G-clamp to prevent the apparatus tipping over
- safety goggles

Method



1. Set up your apparatus as in the diagram making sure that:
   - the ruler is vertical. The zero on the scale needs to be at the same height as the top of the spring
   - the splint is **attached securely to the bottom of the spring**. Make sure that the splint is horizontal and that it rests against the scale of the ruler.

2. Take a reading on the ruler – this is the length of the unstretched spring. Record this reading in your results table.

Weight in N	**Length of spring in cm**	**Extension of spring in cm**
0.0 (No weight stack added)		0
1.0 (weight stack added)		
2.0		

3. Carefully hook the base of the weight stack onto the bottom of the spring. This weighs 1.0 newton (1.0 N). Don't forget that the mass added will have to be converted to Newtons!
4. Take a reading on the ruler – this is the length of the spring when a force of 1.0 N is applied to it.
5. Add further weights. Measure and record the length of the spring each time.
6. Calculate the extension for each weight and record it on the table.

Analysis of results

Use your results to plot a graph with:

- 'extension of spring in cm' on the y-axis
- 'weight in N' on the x-axis.

a. State the relationship between force and extension of a wire
b. How did you make the measurements accurate
c. What types of errors might occur
d. Calculate the spring constant (force = spring constant x extension)

Subject specific vocabulary

The following subject specific vocabulary provides definitions of key terms used in our GCSE Science specifications.

Wherever possible we have used the definitions derived from a booklet created in a joint project of the Association for Science Education and the Nuffield Foundation, *The Language of Measurement: Terminology used in school science investigation,* ISBN 978 0 86357 424 5, Association for Science Education (ASE), 2010.

Accuracy

A measurement result is considered accurate if it is judged to be close to the true value.

Calibration

Marking a scale on a measuring instrument. This involves establishing the relationship between indications of a measuring instrument and standard or reference quantity values, which must be applied. For example, placing a thermometer in melting ice to see whether it reads zero, in order to check if it has been calibrated correctly.

Data

Information, either qualitative or quantitative, that has been collected.

Error

See also uncertainty.

Measurement error

The difference between a measured value and the true value.

Anomalies

These are values in a set of results which are judged not to be part of the variation caused by random uncertainty.

Random error

These cause readings to be spread about the true value, due to results varying in an unpredictable way from one measurement to the next. Random errors are present when any measurement is made, and cannot be corrected. The effect of random errors can be reduced by making more measurements and calculating a new mean.

Systematic error

These cause readings to differ from the true value by a consistent amount each time a measurement is made. Sources of systematic error can include the environment, methods of observation or instruments used. Systematic errors cannot be dealt with by simple repeats. If a systematic error is suspected, the data collection should be repeated using a different technique or a different set of equipment, and the results compared.

Zero error

Any indication that a measuring system gives a false reading when the true value of a measured quantity is zero, eg the needle on an ammeter failing to return to zero when no current flows. A zero error may result in a systematic uncertainty.

Evidence

Data which has been shown to be valid.

Fair test

A fair test is one in which only the independent variable has been allowed to affect the dependent variable.

Hypothesis

A proposal intended to explain certain facts or observations.

Interval

The quantity between readings, eg a set of 11 readings equally spaced over a distance of 1 metre would give an interval of 10 centimetres.

Precision

Precise measurements are ones in which there is very little spread about the mean value. Precision depends only on the extent of random errors – it gives no indication of how close results are to the true value.

Prediction

A prediction is a statement suggesting what will happen in the future, based on observation, experience or a hypothesis.

Range

The maximum and minimum values of the independent or dependent variables; important in ensuring that any pattern is detected. For example a range of distances may be quoted as either: 'From 10 cm to 50 cm' or 'From 50 cm to 10 cm'.

Repeatable

A measurement is repeatable if the original experimenter repeats the investigation using same method and equipment and obtains the same results. Previously known as reliable.

Reproducible

A measurement is reproducible if the investigation is repeated by another person, or by using different equipment or techniques, and the same results are obtained. Previously known as reliable.

Resolution

This is the smallest change in the quantity being measured (input) of a measuring instrument that gives a perceptible change in the reading.

Sketch graph

A line graph, not necessarily on a grid, that shows the general shape of the relationship between two variables. It will not have any points plotted and although the axes should be labelled they may not be scaled.

True value

This is the value that would be obtained in an ideal measurement.

Uncertainty

The interval within which the true value can be expected to lie, with a given level of confidence or probability, eg 'the temperature is 20 °C ± 2 °C, at a level of confidence of 95%'.

Validity

Suitability of the investigative procedure to answer the question being asked. For example, an investigation to find out if the rate of a chemical reaction depended upon the concentration of one of the reactants would not be a valid procedure if the temperature of the reactants was not controlled.

Valid conclusion

A conclusion supported by valid data, obtained from an appropriate experimental design and based on sound reasoning.

Variables

These are physical, chemical or biological quantities or characteristics.

Categoric

Categoric variables have values that are labels, eg names of plants or types of material.

Continuous

Continuous variables can have values (called a quantity) that can be given a magnitude either by counting (as in the case of the number of shrimp) or by measurement (eg light intensity, flow rate etc). Previously known as discrete variable.

Control

Control variable is one which may, in addition to the independent variable, affect the outcome of the investigation and therefore has to be kept constant or at least monitored.

Dependent

Dependent variable is the variable of which the value is measured for each and every change in the independent variable.

Independent

Independent variable is the variable for which values are changed or selected by the investigator.

Example student responses

These examples are taken from the summer 2017 series. The students' scripts show good answers and can be used with teachers and students to highlight good practice when answering exam questions.

The types of questions, although different from the reformed GCSEs science papers to be sat in summer 2018, reflect some of the structures found in the new question types.

The questions covered are

Biology

- quality of written communication
- practical method quality of written communication
- photosynthesis practical
- practical investigation involving enzymes

Chemistry

- quality of written communication
- analysing trends
- practical method in a quality of written communication question
- titration method
- titration calculation

Physics

- quality of written communication
- calculation with unit conversion
- calculation involving reflection
- describing the shape of a graph
- describing differences between two lines on a graph
- calculation with standard form and significant figures

Biology

BL1FP Q9b/BL1HP Q3b – quality of written communication

6 marks awarded – full marks

3 (b) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

Reflexes allow humans to respond to stimuli (changes in the environment).

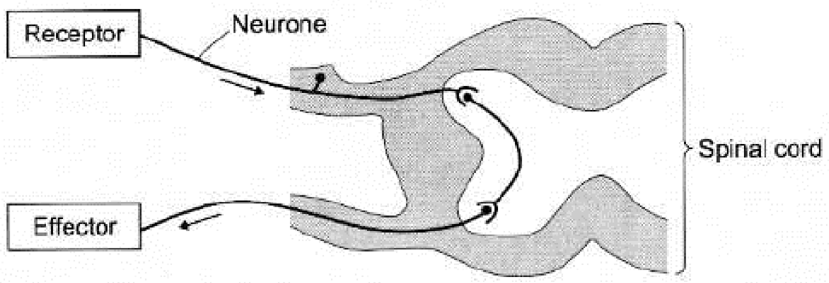
One example of a reflex is when a finger touches a hot kettle and the arm is pulled away.

Sense organs contain receptors that detect stimuli.

Effectors are muscles or glands which respond.

Figure 2 is a diagram of a simple reflex pathway.

Figure 2



Describe how a simple reflex works.

Your answer should include:

- one type of receptor and the stimulus that the receptor detects
- how information is passed from the receptor to the effector.

[6 marks]

Starting at the receptor, this detects the stimuli, change in the environment, such as heat, pain, light or sound. Different sensory organs such as the eye, detect light, but the skin detects pressure, pain, and the tongue and nose detect chemical. Once the receptor has detected the stimuli, it transmits an electrical impulse, to the sensory neurone (a nerve cell), which carries the electrical impulse to the CNS (central nervous system) in the spinal chord, to the relay neurone. the electrical impulse changes to a chemical form, and diffuses across the

Extra space synapse (gaps between 2 neurones), then carries on the electrical impulse to the motor neuron, where the impulse will be chemically diffused to the next neurone. At the end of the motor neurone, the impulse reaches the effector. once it has chemically diffused to the effector via the synapse.

Commentary

This response scored full marks and includes a good amount of detail, including definitions of terms such as 'neurone'. The question asks for one type of receptor, but the student has listed several. The student could have saved themselves time by referring only to one type of receptor and there was a risk the excess information they gave could have contradicted or confused their answer.

Mark scheme

3(b)			6	AO1 1.2.1a/b/c/d/e

Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5 and apply a 'best-fit' approach to the marking.

0 marks	**Level 1 (1–2 marks)**	**Level 2 (3–4 marks)**	**Level 3 (5–6 marks)**
No relevant content	identifies one type of receptor **or** the stimulus it detects **or** refers to at least one type of neurone **or** refers to passage of information **or** at least one response by an effector	identifies at least one link between: one type of receptor **and** the stimulus it detects **and / or** refers to at least one type of neurone **and / or** refers to passage of information **and / or** at least one response by an effector	identifies one type of receptor **and** the stimulus it detects **and** refers to different types of neurone **and** refers to passage of information **or** at least one response by an effector

examples of biology points made in the response:	**extra information:**
• *(R & S)* (receptors in) skin detects pressure / pain / change in temperature	*(R & S)* = receptor and stimulus
• *(R & S)* (receptors in) eyes detect light	*(P)* = passage of information
• *(R & S)* (receptors in) ears detect sound	*(N)* = type of neurone
• *(R& S)* (receptors in) ears detect changes in position	*(E)* = response by effector
• *(R& S)* (receptors on) tongue detects chemicals / taste	
• *(R & S)* (receptors in) nose detects chemicals / smell	
• *(N)* sensory / relay / motor neurone	
• *(P)* neurones carry impulses / electrical information	allow electrical signals ignore messages
• *(P)* ref to synapse	
• *(P)* (release of) chemical information at / across synapse	allow neurotransmitter or named neurotransmitter
• *(E)* muscle contracts	
• *(E)* gland releases hormone / chemical / enzyme	

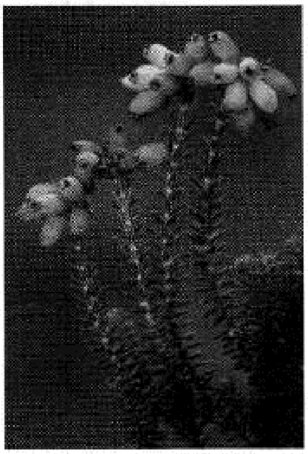
BL2FP Q7/BL2HP Q2 – Practical method QWC

6 marks – full marks awarded

7 **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

Figure 7 shows part of a plant called cross-leaved heath.

Figure 7



A student noticed that some areas of marshland contained cross-leaved heath plants and some areas did not.

The student made the following hypothesis:

'Soil pH affects the amount of cross-leaved heath plants that grow in an area.'

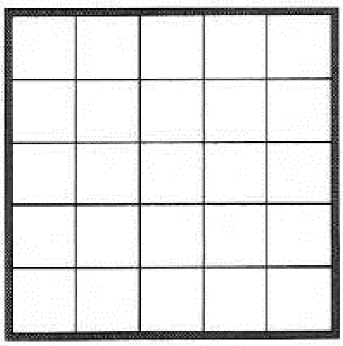
How could the student use apparatus, including the quadrat and pH meter shown in **Figure 8**, to find the range of pHs where the cross-leaved heath plants grew best?

You should include details of how the student could make sure the results are valid.

[6 marks]

Figure 8

1 m x 1 m quadrat



Not to scale

Soil pH meter

Step 1, use a ~~tape~~ tape mesure and
~~Sp~~ Line it across the Marshland.
Step 2, Place your quadrat ~~along~~ at the
one end of the line.
Step 3, Count the amount of Cross-
Leaved heath inside the quadrat
Step 4, ~~use~~ Place the Soil PH meter
in the Square in the ~~cent~~ Center of the
quadrat,
Step 5, ~~Rec~~ Record ~~your~~ [illegible] the PH of the soil and the amount of Cross leaved heath
Step6, Repeat Steps ~~2~~ 3 - 5, whilst
Moving the quadrat along the Line
1 meter at ~~a ti~~ a time.
Step 7, ~~Put~~ Plot your Results on a bar Chart

Extra space

Commentary

In this example, students are given some apparatus and a hypothesis and are asked to produce a method. Students are also asked how they could ensure the results are valid. The student here has underlined a few key words to help them. Their response is organised into steps in order and they have been able to score full marks without using any extra space. For this question, students could either use a transect or place their quadrat randomly. The mark scheme credited both approaches.

Here the student has made reference to using a bar chart, which has enabled them to score full marks in the top level. Students should be reminded to check they have answered the question fully as it is quite common that this kind of detail is missed in their responses.

<table>
<tr><td>7</td><td></td><td></td><td>6</td><td rowspan="4">AO1/2/3
2.4
2.4.1a/b
Prac</td></tr>
<tr><td colspan="4">Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5 and apply a ‘best-fit’ approach to the marking.</td></tr>
<tr><td>0 marks</td><td>Level 1 (1–2 marks)</td><td>Level 2 (3–4 marks)</td><td>Level 3 (5–6 marks)</td></tr>
<tr><td>No relevant content.</td><td>A simple correct statement is made about the investigation, e.g. counting plants in a quadrat
or measuring pH
or random placement of a quadrat.</td><td>There is a description of how a quadrat could be used to collect data at different location<u>s</u>.

or
how a pH meter could be used to collect data at different location<u>s</u>.

For four marks an additional point is made e.g. reference to randomness or compare to other’s results.</td><td>There is a description of how a quadrat and pH meter could be used to collect data at different location<u>s</u>.

For full marks an additional point to ensure validity is made e.g. repeat in a different marshland or randomness or measure pH at the same depth each time or large number of repeats or graph or correlate results.</td></tr>
<tr><td colspan="2">examples of points made in the response:
• placing of quadrat and measuring plants

• randomly in area where plant is growing
• randomly in area where plant is not growing

• many times
• score number or % cover or dry mass or heights of plants per quadrat
• measure soil pH in each quadrat
• control variables such as measurements at same depth
• repetition of pH measurements in a quadrat
• calculate mean pH for each quadrat
• relate quantity of plants to soil pH – e.g. graph</td><td colspan="2">extra information

allow
• regular intervals along a transect
• from an area where plants are growing to an area where plants are not growing

allow presence / absence</td><td></td></tr>
</table>

BL1HP Q8 – photosynthesis practical

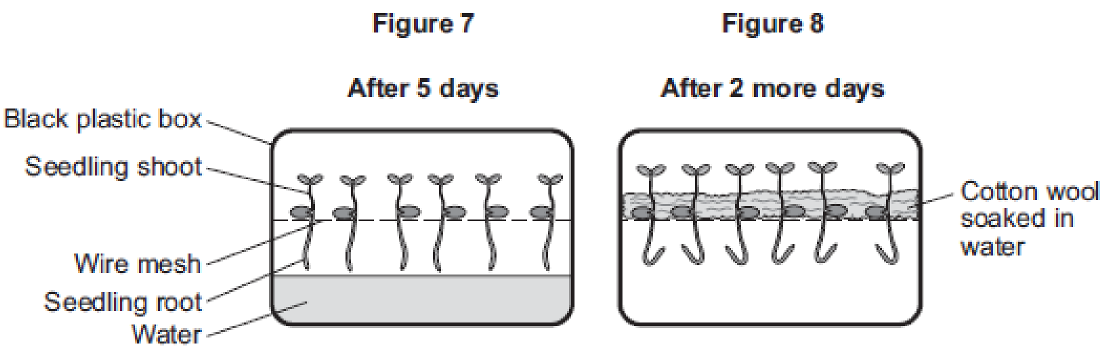
9 marks – full marks awarded

8 Students investigated the sensitivity of plants to different stimuli.

The students:

- put cress seeds onto wire mesh above some water in a black plastic box which did not allow light to enter
- left the seeds to grow in darkness for 5 days
- poured out the water after the 5 days
- then put cotton wool soaked in water on top of the wire mesh
- left the seedlings for 2 more days.

Figure 7 and **Figure 8** show the results of the investigation.



8 (a) Shoots are sensitive to light and gravity.

What conclusions can you make about the growth of the seedling shoots in response to light **and** gravity from the results shown in **Figure 7**?

Explain why you made these conclusions.

[3 marks]

A conclusion can be made that the Shoots grow ~~towards~~ away from gravity, ~~however~~ because they have grown upwards. However, no conclusion can be made for how the shoots grow towards light as there was no light let into the box.

8 (b) One student said:

"Roots are sensitive to the stimuli of gravity and moisture."

Explain which of these two stimuli is more important to the growth of roots.

Refer to the results shown in **Figure 7** and **Figure 8**.

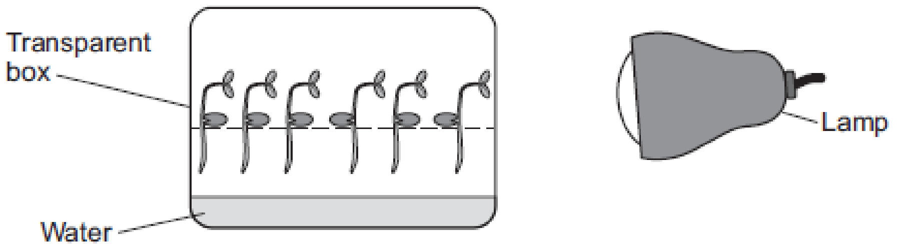
[2 marks]

I think that moisture is a more important stimuli because in figure 7, the root goes in the direction of water and gravity. Whereas, in figure 8 it only goes in the direction of water and away from gravity.

8 (c) In a different investigation students grew cress seeds in a transparent box. The students directed light from a lamp on to one side of the box.

Figure 9 shows the results after 7 days.

Figure 9



8 (c) (i) Explain what caused the seedling shoots to grow in the way shown in **Figure 9**.

[2 marks]

Plant growth hormones called Auxins garner in the shady side of the shoot and cause that side to grow faster which causes the shoot to curve towards the light.

8 (c) (ii) What is the advantage to the cress seedlings of the response to light shown in **Figure 9**?

[2 marks]

They are able to absorb more light for photosynthesis as the leaves at their tips are now facing the light.

Commentary

These questions covers an investigation into photosynthesis, requiring students to use their own knowledge of plant growth hormones and the data presented to make a number of conclusions/explanations.

In these responses, students have made reference to all of the relevant information, and have done so concisely. Part 8(b) refers to information earlier in the stem. Often, student responses indicate that they have not read question stems fully. Students should be reminded to read this information clearly as it can have an impact on how they answer the question.

Mark scheme

8(a)		ignore ref to roots / moisture		AO2/AO3
	(shoots) grow against (the force / direction of) gravity	allow negative geotropism / gravitropism	1	1.2.3a
	(gravity is down and) shoots are growing upwards		1	
	cannot conclude anything about light / phototropism as growth is in the dark		1	

8(b)		ignore shoots		AO3
		no mark for moisture unqualified		1.2.3a
		max **1** mark if moisture not stated as more important **or** if gravity given as more important		
	(after 5 days / Figure 7) when gravity and moisture are in the same direction / down the roots grow towards both / down	allow (after 5 days / Figure 7) roots grow towards moisture and gravity	1	
	(after 2 more days / Figure 8) when moisture and gravity are in opposite directions, the roots grow towards water	allow (after 2 more days / Figure 8) roots grow towards moisture and away from gravity	1	

8(c)(i)	unequal distribution of hormone / auxin (so there is) unequal growth rates	allow more hormone / auxin on darker side **or** converse allow more / faster growth on darker side **or** converse	1 1	AO1 1.2.3b/c

8(c)(ii)	more surface area exposed to light **or** more light absorbed (by leaves / plant) more photosynthesis	allow more glucose / carbohydrate / biomass produced for **2** marks there must be a reference to 'more' at least once	1 1	AO2 1.5.1a

BL2FP Q8/BL2HP Q3 – practical investigation involving enzymes

8 marks – full marks awarded

3 Amylase is an enzyme that breaks down starch.

3 (a) Complete the equation to show the breakdown of starch.

[1 mark]

Starch $\xrightarrow{\text{amylase}}$ Sugar

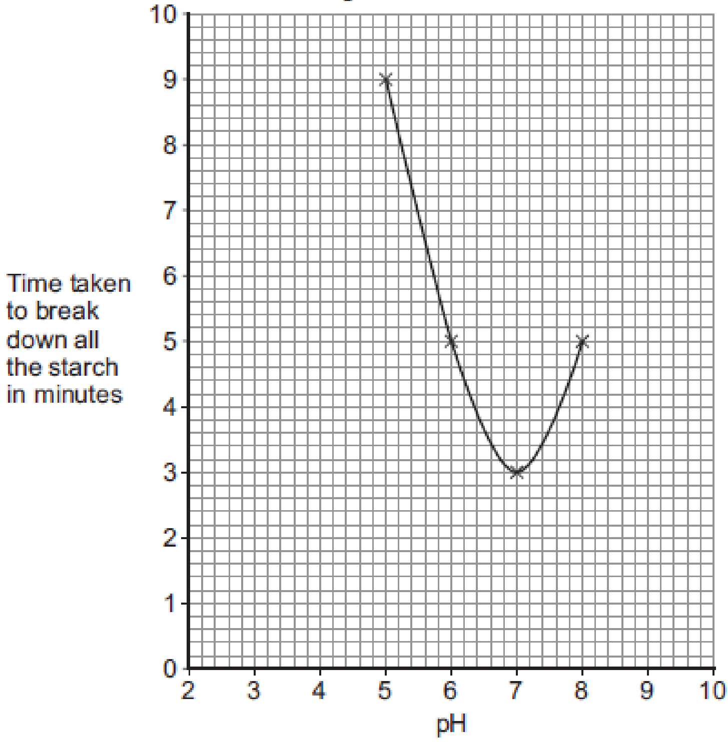
3 (b) Some students investigated the effect of pH on the activity of amylase.

The students:

- put 5 cm^3 of pH5 solution + 1 cm^3 of amylase solution into a test tube
- put 4 cm^3 of starch suspension into a second test tube
- left both test tubes at room temperature for 5 minutes
- mixed the contents of the two test tubes
- removed a small sample of the mixture at 1-minute intervals
- tested each sample for starch
- timed how long it took to break down all the starch
- repeated each of the above steps at pH6, pH7 and pH8.

Figure 4 shows the students' results.

Figure 4



3 (b) (i) Give **two** variables which were controlled in this investigation.

[2 marks]

1 the volume of pH solution

2 the volume of amylase solution.

3 (b) (ii) The students tested samples of the reaction mixture for starch.
In each test, they added one drop of the reaction mixture to one drop of iodine solution on a white tile.

- Iodine solution = light brown colour
- Iodine solution + starch = dark blue colour

Predict the colour seen in the iodine test on the samples of the pH6 reaction mixture at 4 minutes and at 6 minutes.

[1 mark]

4 minutes dark blue

6 minutes light brown

3 (b) (iii) The students concluded that amylase works best at pH7.
This may **not** be a valid conclusion.

Suggest **two** improvements to the investigation that would increase the validity of the students' conclusion.

[2 marks]

1 repeated each PH solution more than once

2 used smaller interval than 1 minute

3 (b) (iv) The students repeated the investigation at pH3.

What result would you expect at pH3?

Give a reason for your answer.

[2 marks]

I wouldn't expect the stach to break down at all, no matter how much time it has been left, as I think that at pH3 it would be so acidic that the enzyme amylase would denature and not work, so it couldn't breake down the starch.

Commentary

Another practical question, but this time the students are given a method. Many students fail to identify more than one control variable, or spoil their answers by using vague terms like 'amount of solution'. It is important that students are conversant in terminology such as 'valid conclusion'. In this case, students need to understand what makes a valid conclusion and what should be done with this method to ensure that one is given.

In the final response, students could have scored full marks for a response as short as 'no reaction because the enzyme is denatured'.

Mark scheme

3(a)	sugar(s) / glucose	allow maltose do not allow if extra incorrect answers	1	AO1 2.5.2d Prac
3(b)(i)	any **two** from: • volume of pH solution • volume of amylase / enzyme solution • volume of starch / suspension / substrate • time left (before mixing)	allow amount for volume if neither mark given allow 1 mark for volume(s) of solution(s) ignore time between samples ignore ref. to (room) temperature ignore ref. to concentration	2	AO2 2.5.2b Prac

3(b)(ii)	4 minutes: (dark) blue **and** 6 minutes: (light) brown	allow black ignore purple do **not** allow light blue allow yellow / orange	1	AO3 2.5.2b Prac
3(b)(iii)	any **two** from: • take each reading more than once • use colour standards for deciding end-point • test more pH values between 6 and 8 **or** test at smaller pH intervals • test at shorter intervals • same temperature (in a water bath)	 ignore take more readings allow compare with another group allow use a colorimeter ignore wider range of pH unqualified allow example – e.g. every half min	2	AO3 2.5.2b Prac
3(b)(iv)	no reaction **or** stays (dark) blue **or** takes >9 minutes enzyme denatured	allow takes longer allow description of denaturing, i.e. shape change allow description of trend on graph	1 1	AO2/3 2.5.2a/b

Chemistry

CH1FP Q7/CH1HP Q3 – quality of written communication

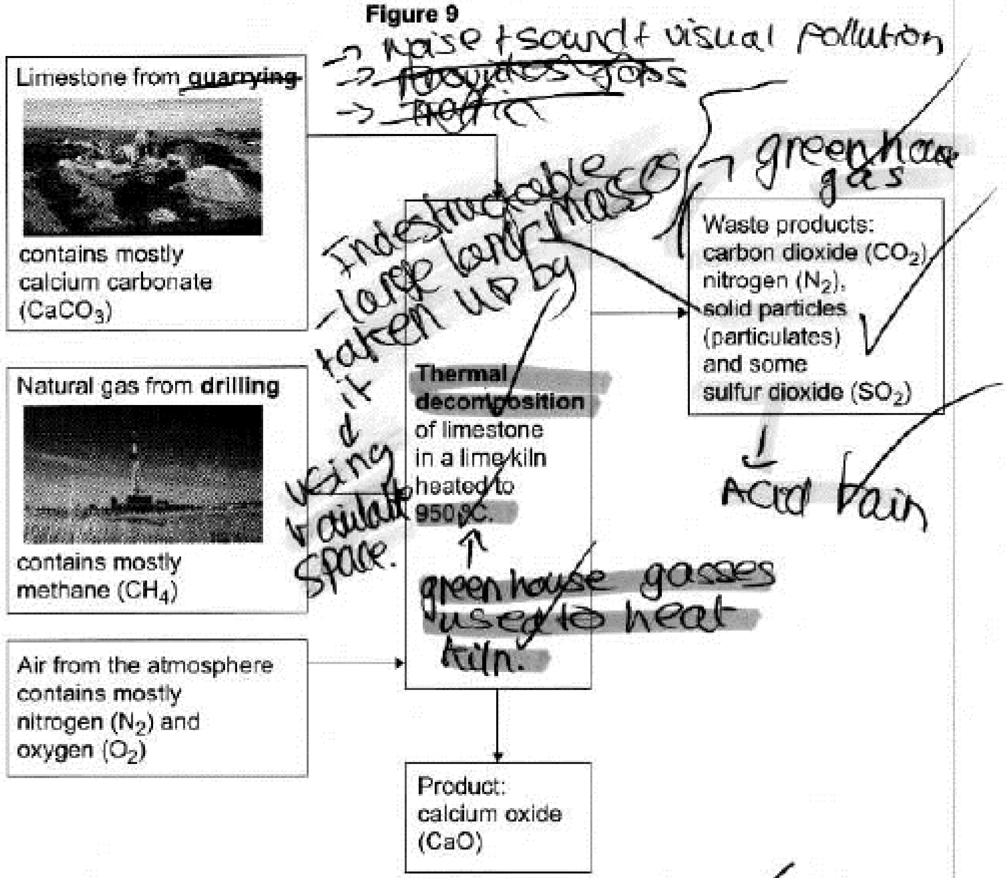
Second response 6 marks – full marks

7 **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

Limestone is heated in a lime kiln to produce calcium oxide.

Figure 9 shows the reactants used and the products made in a lime kiln.

Figure 9



Use information from **Figure 9** to explain the potential environmental impacts of quarrying, drilling and the thermal decomposition of limestone used in the production of calcium oxide.

[6 marks]

Commentary

Many students erroneously answered this question as an 'advantages and disadvantages' question, because they may have seen past paper questions like this.

In this first excerpt, the student has highlighted information in the question as well as annotating the environmental impacts. Each point has been ticked off as it is written about. In the full response (which has not been included here) the student filled all of the available answer space and continued onto additional pages. The next example shows it is possible – and expected – that students can score full marks with a more concise answer to this question.

Use information from **Figure 4** to explain the potential environmental impacts of quarrying, drilling and the thermal decomposition of limestone used in the production of calcium oxide.

[6 marks]

Quarrying can destroy habitats as quarries take up a large space and so, reduces biodiversity. Drilling may create noise pollution as well as the land pollution created from quarrying. Also, the thermal decomposition ~~from~~ of the limestone produces carbon dioxide which contributes to global warming, affecting climate and causing sea levels to rise. Thermal decomposition also produces particulates which contribute to global dimming and sulfur dioxide which contributes to acid rain, destroying buildings made of materials like limestone and acidifying

Extra space soil.

Mark scheme

3			6	AO2 AO3 1.2.1a;b 1.4.2a 1.4.3a;b;c 1.7.2a;i

Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 4 and apply a 'best-fit' approach to the marking.

0 marks	**Level 1 (1–2 marks)**	**Level 2 (3–4 marks)**	**Level 3 (5–6 marks)**
no relevant information given	discrete relevant points made about types of pollution **or** problematic effects **or** environmental impacts	an explanation of how an environmental impact is caused by the pollution from **or** the problematic effect of a linked process	detailed explanations of how environmental impacts are caused by the pollutions from **or** the problematic effects of linked processes

Examples of chemistry points made in the response could include:

Processes	**Types of pollution and problematic effects:**
• quarrying • drilling • thermal decomposition • combustion of fossil fuel • use of explosives	• visual pollution • noise pollution • dust pollution • destruction of land • air / atmospheric pollution (methane, carbon dioxide, sulfur dioxide, NO_x, particulates) • water (rivers / lakes / seas) pollution • earth tremors

Environmental impacts:

- destruction of areas of natural beauty
- disturbance of people and animals
- breathing problems **or** asthmatic attacks
- destruction of habitats **or** biodiversity or kills wildlife and plants
- (CH_4 ; CO_2) greenhouse gases → global warming → consequences
- (particulates) global dimming → consequences including breathing problems
- (SO_2 ; NO_x) acidic gas / rain → consequences including breathing problems
- damage to buildings / infrastructure

Total			**6**

CH1HP Q4(a)(ii), 4(a)(iii) – analysing trends

4 marks – full marks awarded

4 A polymer is used to make supermarket carrier bags.

4 (a) **Table 3** shows data about polymer bags used by customers of UK supermarkets.

Table 3

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014
Number of bags used in millions	12 419	11 346	9004	7570	7974	8392	8487	8759	8959
Mass of bags used in thousands of tonnes	109.8	104.7	83.4	65.6	68.3	72.3	70.4	67.3	66.1

4 (a) (ii) Describe the trend in the number of bags used per year between 2006 and 2014.

[2 marks]

Between 2006 and 2009 the number of bags used reduced from 12 419 to 7570 however began to increase slower ~~as~~ from 2009 – 2014 at 7570 to 8959.

4 (a) (iii) The trend in the number of bags used does **not** match the trend of the mass of bags used between 2012 and 2014.

Suggest **two** reasons why.

[2 marks]

They started using less ~~pot~~ material in the bags to save crude oil which made them lighter. The bags were made smaller/thinner.

Commentary

For 4(a)(ii), the student has referred to the data and described the changes. Around one third of students scored full marks for this question. For the second question, a large number of students attempted to answer this by identifying the values that did not match the trend, instead of suggesting reasons why the data might differ. Only 13% manages to score 2 marks for 4(a)(iii), with 30% scoring 1 mark.

Mark scheme

4(a)(ii)	(from 2006) until 2009 the number of bags used decreased from 2009 / 2010 (to 2014) the number of bags used increased	 if no other mark awarded allow one mark for the number of bags decreased and then increased	1 1	**AO2** 1.5.2

4(a)(iii)	any **two** from: • bags are thinner • bags are smaller • bags use less material • bags are lighter **or** less dense		2	**AO3** 1.5.2

CH2HP 4(c)(i) – identifying trends

2 marks – full marks awarded

4 (c) (i) **Table 1** shows data about wealth of countries, ethene production and sulfuric acid production.

Table 1

Country	Wealth of country in billions of dollars	Ethene production in kilotonnes	Sulfuric acid production in kilotonnes
A	4000	13 900	36 000
B	1300	4 400	6 600
C	1290	2 700	26 000
D	620	3 100	2 500
E	460	1 500	4 200
F	310	650	6 700

How does the wealth of countries relate to their production of ethene and sulfuric acid?

[2 marks]

In general, the wealthier the country the higher the amount of ethene production. However, although the wealthiest country produces the most sufuric acid (36,000kt) the poorest is the 3rd highest producer. Therefore there is no correlation between the wealth and sulphric acid production

Commentary

Only a quarter of students scored two marks for this question, with most failing to recognise that there was no correlation between wealth of a country and sulfuric acid production. This response makes reference to the data to justify their conclusion. Although not required for this question, this is encouraging to see.

Mark scheme

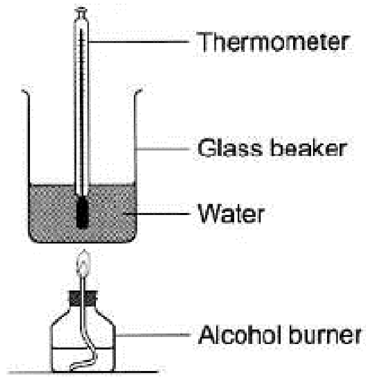
4(c)(i)	as wealth decreases, ethene production decreases (with the exception of country C or D)	accept converse	1	**AO2**
	sulfuric acid production is not linked to wealth		1	**AO3** 2.6

CH3FP Q6(c)(i) – practical method in a quality of written communication question

6 marks – full marks awarded

6 (c) **Figure 9** shows apparatus used to measure the energy released when an alcohol is burned.

Figure 9



6 (c) (i) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

Describe how a student could use the apparatus in **Figure 9** to compare the energy released when methanol and ethanol are burned.

You should include any measurements the student would need to make.

Do **not** describe how to do any calculations.

Do **not** describe any improvements to the apparatus.

[6 marks]

Firstly you should measure out $50 cm^3$ of water and pour that into your beaker. Now you should record the mass of the alcohol burner. Place your beaker above the alcohol burner. Make sure and record the temprature. you have a thermotier in the beaker. Now light the burner. Once the water has reached 60°C put out the burner and record the mass of the alcohol burner. Repeate the method with the two types of alcohols. Now you have the before and after masses of the burners. You should work out the differerkte in wieghts. The one that has lost the least amount of wieght is the more

Extra space effiant burner.

Commentary

The student has given a response worth 6 marks in 13 lines, with minimal use of the extra space. The answer has been well written with a logical flow. The small number of corrections indicates that the student may have planned what to write before beginning. Often, responses are seen which contain jumbled methods with events out of order. Students should be encouraged to think about their response before they begin writing.

Mark scheme

6(c)(i)				6	AO1 AO2 AO3 3.3.1a
Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5 and apply a 'best-fit' approach to the marking.					
0 marks	**Level 1 (1–2 marks)**	**Level 2 (3–4 marks)**	**Level 3 (5–6 marks)**		
no relevant content	some of the steps for a method **or** measurements are stated	a method **and** some measurements are described	a method **and** measurements are described which would allow a comparison to be made between the two alcohols		

Examples of chemistry points made in response:

- measure mass or volume of water
- measure initial mass of ethanol (and burner)
- measure initial temperature of water
- ignite alcohol to heat the water
- stir water
- after a suitable temperature rise **or** time (or after a given volume is burned)
- extinguish the flame
- measure final temperature of water
- measure final mass of ethanol (and burner)
- repeat with next alcohol
- calculate the energy released and compare or compare temperature rise (for given mass of alcohol burnt or for given time of burning).

CH3HP 4(b) – titration method

5 marks – full marks awarded

4 (b) Describe how a student could do titrations to find the mean volume of potassium hydroxide solution which would neutralise 25.00 cm^3 of nitric acid.

[5 marks]

Use a pipette to measure nitric acid and put it in a flask with a white tile under. Add indicator (methyl orange) to the acid. Then fill a burette with potassium hydroxide solution, measure its volume. Then slowly add the potassium hydroxide to the acid from the burette drop by drop, swirling continuously. Slowly when near end point. stop when indicator changes. Measure amount of potassium hydroxide used. Repeat multiple times and add volumes together and divide by number of trials to find mean.

Commentary

This student has clearly carried out this practical before and has produced a very detailed description. Students with direct practical experience like this are going to be better prepared for the Working Scientifically questions in the new science specifications.

Mark scheme

4(b)	add alkali to acid from burette	allow alternative apparatus for measuring volume	1	**AO1** **AO3** 3.4.1g
	until indicator changes colour	allow appropriate use of pH probe	1	
	take reading of volume at start and end	allow record the volume used	1	
	repeat (and find mean)		1	
	any **one** from • swirl / stir • add dropwise / slowly • white tile • rinse apparatus • meniscus • read at eye level		1	

CH3HP 4(c) – titration calculation

First response 1 mark, second response 3 marks

4 (c) The student found that 26.25 cm^3 of potassium hydroxide solution with a concentration of 0.20 moles per dm^3 neutralises 25.00 cm^3 of nitric acid.

The equation for the reaction is:

$$KOH + HNO_3 \longrightarrow KNO_3 + H_2O$$

Calculate the concentration of the nitric acid.

[3 marks]

$\frac{0.2}{1000} \times 25 = \frac{5\times10^{-3}}{26.25} = 0.000\dot{1}9047\dot{6} \times 1000 = 0.\dot{1}9047\dot{6}$

Concentration of nitric acid = 0.19 moles per dm^3

Commentary

This final answer was quite commonly seen and is because the student has mixed up the ratios. In the next response, the student has created a table to help them arrive at the final answer. This approach helps minimise the type of mistake seen in the first response as well as giving evidence of working.

4 (c) The student found that 26.25 cm^3 of potassium hydroxide solution with a concentration of 0.20 moles per dm^3 neutralises 25.00 cm^3 of nitric acid.

The equation for the reaction is:

$$KOH + HNO_3 \longrightarrow KNO_3 + H_2O$$

n
CV
0.005, 25

Calculate the concentration of the nitric acid.

[3 marks]

	KOH	HNO_3
C	0.2	
n	0.00525	0.00525
V	0.02625	0.025

26.25 ÷ 1000 = 0.02625
25 ÷ 1000 = 0.025

$n = 0.2 \times 0.02625$
$= 0.00525$

$c = \frac{0.00525}{0.025}$
$= 0.21$

Concentration of nitric acid = 0.21 moles per dm^3

Mark scheme

4(c)	0.21	if incorrect, 26.25 x 0.2/1000 or 0.00525 for 1 mark their moles x 1000/25.00 or their moles x 40 for 1 mark correct evaluation for 1 mark 0.19(0476…) gains only 1 mark with or without working	3	**AO2** 3.4.1h

Physics

PH1HP Q2 – quality of written communication

6 marks – full marks awarded

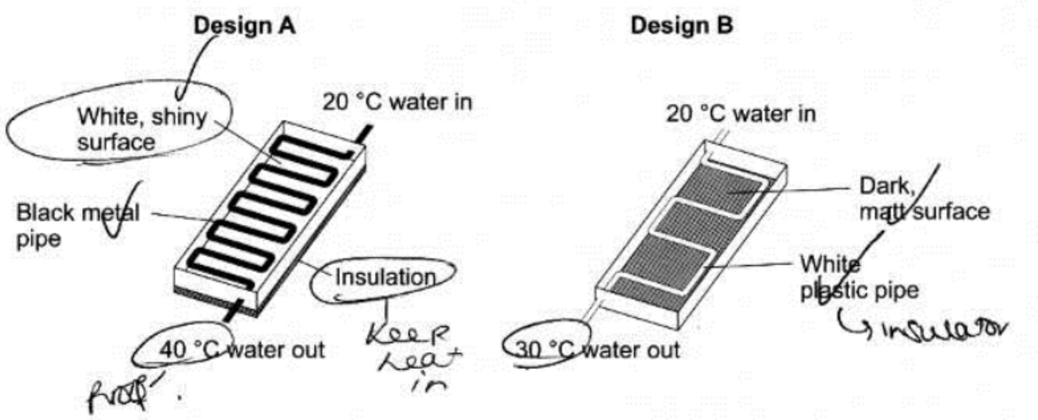
2 **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

Solar panels use energy from the Sun to heat water.

Two different designs of solar panel are shown in **Figure 1**.

Both designs have the same water flow rate.

Figure 1



Explain why **Design A** is better than **Design B** at heating water.

[6 marks]

Design A, firstly, uses ~~a~~ ~~b~~ black metal pipes in comparison with white plastic pipes in design B. This makes it better at heating water as ~~Black~~ ~~Dark~~, Dark surfaces are good absorbers and therefore will absorb ~~more~~ lots of heat from the sun. As well as this, it is made out of metal which is a good conductor, allowing heat to travel through the ~~water~~ pipes quickly, heating up the water. Design B uses plastic which is an insulator and therefore heat from the ~~sung~~ sun would take longer to get

Extra space through to the water. The white, in design A shiny surface below the pipes, is better that the ~~Bar~~ dark matt surface in design B, as the heat that passes beyond the pipes is reflected back allowing extra absorbtion of heat. Contrasting, the dark, matt surface would absorb the heat taking it away from the pipes.

Turn over for the next question

Commentary

In this example, the student has highlighted features they want to include in their answer and ticked them off as they have written about them. For this type of question it can really help students if they spend a little time thinking about what they will write about and how they can structure it before they begin writing. This kind of approach can really help with questions about practical methods, where the order of steps would be important.

Mark scheme

2	Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5 and apply a 'best-fit' approach to the marking.	6	AO1 AO2 AO3 1.1.1cde

0 marks	Level 1 (1-2 marks)	Level 2 (3-4 marks)	Level 3 (5-6 marks)
No relevant information	A description of how at least **one** feature makes design A better than design B.	A basic explanation in terms of physical processes of how some features of design A make it better than design B.	A clear and correct explanation in terms of physical processes, including direct comparisons, of how most features of design A make it better than design B.

examples of physics points made in the response	extra information
colour of pipe: • black (pipe) surface is a good absorber of IR radiation / energy **material of pipe:** • metal pipes are good conductors **or** • metal pipes are better conductors than plastic pipes • higher rate of energy transfer through metal pipe **colour of surface:** • (inside of solar panel is) white / shiny surface which is a good reflector of IR radiation to the pipe • (inside of solar panel is) white / shiny surface which is a poor absorber of IR radiation **Insulation:** • layer of insulation reduces conduction through base of solar panel **length of pipe / surface area of pipe:** • water is in solar panel for longer time • water absorbs more energy • pipe absorbs more IR design A has a greater water temperature increase (could be linked to any feature)	accept converse answers in terms of why design B is worse than design A allow heat / radiation for IR throughout

PH1HP Q6(b) – calculation with unit conversion

4 marks – full marks awarded

6 (b) The mobile phone battery can store 36 kJ of energy and was initially uncharged.

Calculate the minimum time, in hours, it would take to fully charge the mobile phone battery using these solar cells.

Use the correct equation from the Physics Equations Sheet.

[3 marks]

pa Energy = Power x time

36kJ = 2.5W x time

36000 = 2.5 x time

$\frac{36000}{2.5} = \frac{14400}{60}$ sec $= \frac{240\text{mins}}{60} = 4$

Time = 4 hours

Commentary

Here the student has underlined and circled important information in the question to ensure they understand what is being asked of them. They have also shown detailed working, which means that if they had made a simple mistake with their calculator, they could still have been awarded compensation marks.

Mark scheme

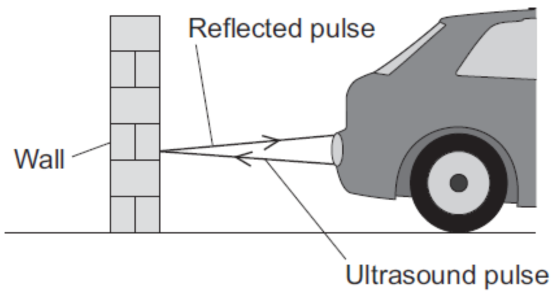
6(b)	4 (hours)	allow **2** marks for an answer of 14 400 (seconds) **or** allow **2** marks for an answer of 240 (minutes) allow **1** mark for correct substitution ie 36 000 = 2.5 x t allow **2** marks for an answer of 0.004 allow **1** mark for an answer of 14.4 for a student who uses 6.3 W or 6.25 W allow **2** marks for an answer of 1.6 hours allow **1** mark for an answer of 5714 or 5760 or 5.71 or 5.76	3	AO2 1.3.1c

PH3FP Q4c – calculation involving reflection

2 marks awarded out of 3

4 (b) A parking sensor on the back of a car emits an ultrasound pulse and receives the reflected pulse as shown in **Figure 7**.

Figure 7



4 (c) The parking sensor emits an ultrasound pulse. The reflected pulse is received 0.006 seconds later.

The speed of ultrasound in air is 330 m/s.

Calculate the distance from the car to the wall.

Use the correct equation from the Physics Equations Sheet.

[3 marks]

$S = v \times t$

$0.006 \times 330 = 1.98$

Distance from the car to the wall = 1.98 m

Commentary

Although the student underlined the key information in the question, they did not realise that they would need to halve the distance as the time given is for a reflected pulse. Only 3.5% of students scored full marks for this question, with 84% scoring 2 marks, most likely for missing the need to halve the distance.

Mark scheme

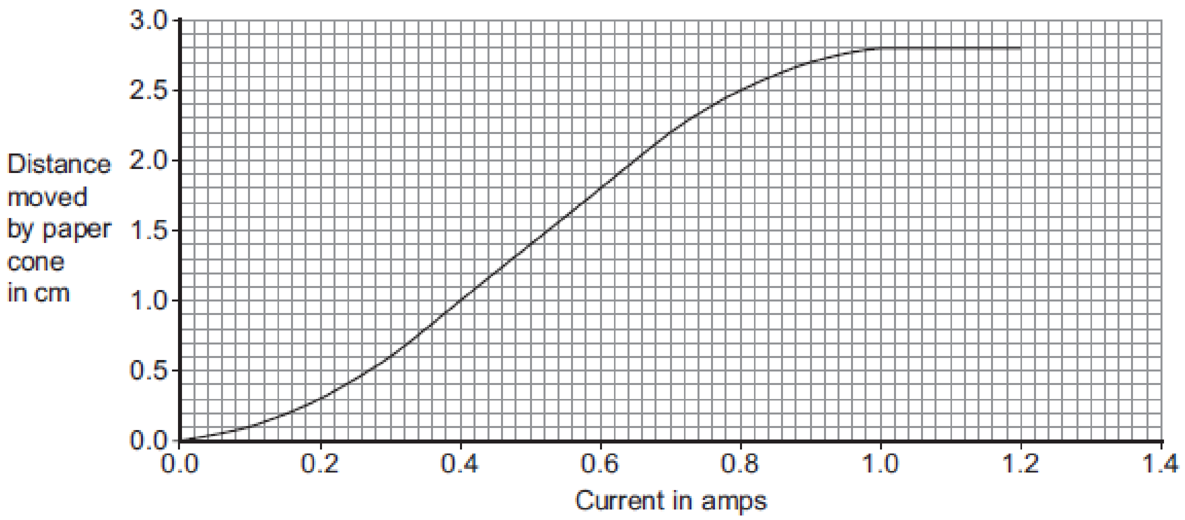
4(c)	0.99	allow **2** marks for 1.98 allow **2** marks for (330×0.006)/2 **or** for 330×0.003 If no other marks allow **1** mark for substitution of 330×0.006 **or** for halving the time	3	AO2 3.1.2c

PH3HP Q1(b)(ii) – describing the shape of a graph

2 marks – full marks awarded

1 (b) The results of the student's investigation are shown in **Figure 2**.

Figure 2



1 (b) (ii) State **two** conclusions that can be made from the graph.

[2 marks]

1 As the current increases, so does the distance moved by the paper cone

2 After 1 amps, the cone cannot move beyond 2.8 cm (it's the maximum it can move)

Commentary

There are three conclusions that could be given for this graph. Students need to be familiar with describing how the nature of the line changes over the range of data, which this student has done. This student has referred to the variables by name and has linked to points on the graph.

Mark scheme

1(b)(ii)	any **two** from: • (Below 1A) as the current increases the distance increases • Above 1A the distance does not change (with current) • Between 0.3A and 0.7A the relationship is linear	accept the maximum distance (that the cone can move) is 2.8 cm accept between 0.6 cm and 2.2 cm the relationship is linear ignore references to positive correlation and direct proportionality a description of the shape of the graph is insufficient eg the line levels off after 1A	2	AO3 3.3.1c

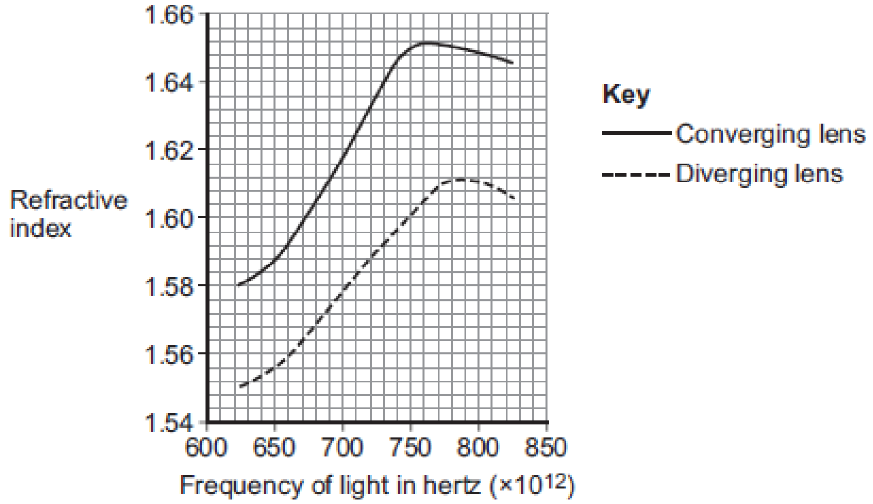
PH3HP 4(c) – describing differences between two lines on a graph

3 marks – full marks awarded

4 (c) Each lens in the digital camera is made from a different type of glass.

Figure 3 shows the relationship between the frequency of light and the refractive index of the glass used to make each lens.

Figure 3



Describe **three differences** between the refractive index of the glass used for the converging lens compared to the glass used for the diverging lens as the frequency of light increases.

[3 marks]

1 The refractive index of the converging lens is always higher than that of the diverging lens as the frequency of light increases.

2 As frequency of light increases, there is a much higher increase in refractive index for the converging lens (around 0.072) compared to the diverging lens (around 0.061)

3 The refractive index of a converging lens begins to decrease at a lower frequency of light (760×10^{12} Hz) compared to the diverging lens, which begins decreasing at around 790×10^{12} Hz

Commentary

Half of the students answering this question only scored 1 mark, likely for stating that the refractive index for the converging lens is always greater than for the diverging lens. This student has used the variable names and has used data points to refer to changes in the nature of the line. One common mistake is to simply describe data in isolation, eg to say that at 650 the refractive index is 1.58, but without making any comparison with the other line.

Mark scheme

4(c)	The refractive index of the converging lens is greater (for all frequencies) The refractive index of the converging lens increases more than that of the diverging lens The refractive index of the converging lens reaches a maximum at a lower frequency than that of the diverging lens	use of data without comparison is insufficient	1 1 1	AO2 3.1.3c

PH3HP 5(b) – calculation with standard form and significant figures

2 marks awarded out of 3

5 (b) The pressure in the liquid in the hydraulic system in the jaws is 5.2 × 10^8 Pa
The cross-sectional area of the load piston in the jaws is 4.1 × 10^{-4} m^2

Calculate the force at the load piston.

Use the correct equation from the Physics Equations Sheet.

Give your answer to two significant figures.

[3 marks]

$P = \frac{F}{A}$ $F = P \times A$

$(4.1 \times 10^{-4}) \times (5.2 \times 10^{8}) =$

213200

Force = 213200 newtons

Commentary

Again the student has underlined figures and has correctly worked with standard form. Unfortunately, they did not follow the instruction to give an answer to 2 significant figures. 29% of responses scored full marks for this question, with marks being dropped invariably for incorrect rounding or mistakes in working with figures in standard form.

Mark scheme

5(b)	2.1 × 10^5	accept 210 000 for **3** marks allow **1** mark for correct substitution ie 5.2 × 10^8 = F / 4.1 × 10^{-4} allow **2** marks for an answer of 213200 **or** one that rounds to 2.1 × 10^5	3	AO2 3.2.3c

Executive summaries

Summaries covering Science A (route 1), Additional Science (route 1), Biology, Chemistry and Physics.

Lessons from summer 2017

Grade boundaries

To view grade boundaries, visit aqa.org.uk/gradeboundaries

For results statistics, visit aqa.org.uk/exams-administration/results-days/results-statistics

Qualification summary

There are some key overarching points which are relevant to all science disciplines. Unlike in previous years, we have referred to all the sciences within the key heading, as in the new GCSEs these assessment points will be valid for all.

It is important to note that the assessment structure, weighting of AOs, maths skills and practical skills, including working scientifically, are different in the new GCSE papers. However, there are some very useful lessons which can be carried over from the previous assessments.

To exemplify some of these key assessments points we have put together a number of student responses with commentaries to illustrate good answers. These can be used in conjunction with this document and the detailed examiners report

Final resit opportunity

In line with Ofqual's recommendations, we will be offering resits for the following specifications only:

- GCSE Science A (4405) – route 1
- GCSE Science B (4500)
- GCSE Additional Science (4408) – route 1
- GCSE Biology (4401)
- GCSE Chemistry (4402)
- GCSE Physics (4403).

As with the current resit rules, students will be able to carry forward Unit 4, ie the controlled assessment they certificated with previously.

In line with Ofqual's requirements, we will be producing one new controlled assessment for each of the specifications included in the list above. These will be available from the Secure Key Materials (SKM) area of e-AQA from September 2017.

Entry deadline 21 October 2017

General remarks

Students appeared to be able to complete the papers in the time available, and most attempted all parts.

Response to some of the practical and Working Scientifically questions suggest students are getting practical experience, but some of the finer details are being missed in responses to questions. Some were hindered by following a whole school/college approach/structure which did not always elicit the best responses. Students need to carefully read the questions and ensure they are addressing any bullet points which are given to guide their response.

Exam technique

There is increasing evidence of students highlighting what they consider to be key words in the question – both the command word and important scientific terms. This is excellent practice and should be encouraged.

Small changes to how students approach a question paper can help them demonstrate their knowledge and understanding better:

- **command words** – know what they mean, particularly the difference between describe and explain. For example:
  - in BLH16(a)(ii), 7(b)(i), 8(a) many students described rather than explained and vice versa
  - in CH1FP 7 many students wrote an advantages/disadvantages response to a question asking for explanations about environmental impact
  - in PH3FP 2(e) asked students to state the power output of a transformer, given the power input and assuming it is 100% efficient. Many tried to calculate the output
- understand **key terms** and their precise use, (eg precision and accuracy) validity, repeatability, reproducibility and anomalies. For example, in PH2HP 6(c)(ii) students wrote about anomalies and reliability when the question was about the validity of the conclusion
- express ideas **clearly and unambiguously**
- be familiar with the **name, spelling and uses** of common experimental apparatus. This was particularly evident in CH3FP 4bi
- the **inclusion of extra, incorrect information** in addition to the correct answer **can cancel a potential mark**. For example, in BLF1(c)(iii) students added incorrect information eg 'vitamins' which disqualified any credit already gained
- **use a pencil to plot graphs** or complete dot-cross diagrams so that mistakes can be corrected easily. This was particularly evident in CH2FP4(d)(iv)
- ensure students have **scientific calculators** and are comfortable using them. This was particularly evident in PH1FP and PH3HP4(d)
- **don't just repeat information** from the stem of a question. For example:
  - in CH3FP3(a)(iii) when asked to describe how ammonia is separated from natural gas, many simply quoted 'it turns into liquid,' which was given in the diagram in the stem
  - in PH2HP1(a) when asked for manmade sources of radiation, many students gave examples of natural radiation shown in the graph in the question
- simply **rephrasing the question** will rarely score marks. For example, in PH1FP3(c)(ii) students wrote that a burglar blocking light caused the alarm to sound, when this was given in the stem
- **read the whole question carefully** and answer what it asked. For example:
  - in BL1F9(b), students restricted their marks as they didn't address the bullet points in the question, ie didn't 'name one type of receptor and the stimulus that the receptor detects' as asked. Other examples were seen in BLH13(b),4 and 7

- in CH1FP6(c)(ii) and 6(c)(iii), when asked about the relationship between number of carbon atoms and boiling point of alkanes, many compared the boiling points of alkanes and alkenes, which was actually the next question
- in CH1HP4(a)(iii), the intention was for students to suggest what might have changed to cause a difference in a trend, but many students described differences in the trend instead

- **scan for marks** to ensure they don't miss any questions and look at the number of marks for the question to ensure they **give enough detail** in their answers – one short phrase is rarely enough for two marks.

Maths skills

Calculations have been generally well done in Chemistry but there are some weaknesses with skills such as analysing trends, Reassuringly in Physics, a large proportion of students showed their working with calculation questions. This is a good way to ensure marks can still be gained if a mistake is made. There were very limited maths skills assessed in Biology which will be a notable change in the 2018 papers.

Areas for attention/note:

- **practice plotting and describing graphs**, including those that are not a straight line
- more practice is needed with **calculations that involve significant figures and standard form**
- many Biology candidates were unable to calculate the **percentage increase in the rate of photosynthesis**. This was particularly evident in BL2HP4(b)(ii)
- students found interpreting the **amylase activity graph** and applying this knowledge in an unfamiliar way quite difficult. Many reversed the colours and some invented new colours. This was particularly evident in BL2FP8(b)(ii)
- when asked to describe a curved graph, many made no reference to **the gradient of the curve** (and hence the rate of reaction) decreasing as time increased. This was particularly evident in CH2FP 5(a)(iv)
- students need to be familiar with **drawing lines of best fit** for data sets that have anomalies and where the line may be a curve. This was particularly evident in CH2FP5(a)(i) and CH3FP 3(c)(ii)
- students need to remember to **exclude anomalies before calculating means**. This was particularly evident in CH3FP4(c)(i)
- students wrote about a **general trend** but did not notice that it was not the same for the **whole range of the data**. This was particularly evident in CH1HP4(a)(ii) and CH2HP2(e)(iii)
- students trying to **rearrange equations** when they don't have to, which was particularly evident in PH1FP1(c), or not rearranging correctly when they do need to, which was particularly evident in PH2FP6(b)
- poor performance in questions that ask for use of **significant figures** in the final answer. For example, in PH1HP1(b) and PH3HP5(b) many students did not give an answer to two significant figures despite being asked to
- there was some evidence that students could not use their **calculators to work out standard form**. For example, in PH2HP6(c)(i) students confused 3×10^{-3} with 3×10^{3}, entering the number into their calculators incorrectly
- **calculations involving unit conversions** were not always done well. For example:
  - in PH1HP6(b) and PH2HP4(b)(ii) not converting kJ,
  - in PH2HP5(a)(ii) very few managed to convert 40 milli watts
  - in PH1FP4(d) – not converting pounds into pence

- not realising the need to **halve numbers** for things like ultrasound reflections. For example:
  - PH3FP4(c) dealt with a reflected pulse of ultrasound
  - PH2HP4(b)(i) dealt with the area of a triangle
- using the **correct figures** and **thinking about what they mean**. For example:
  - in PH2HP7(b), many used an acceleration of 2500 m/s2 as the velocity when calculating a momentum
  - PH2FP3(a)(i) included three numbers to choose from
  - a pertinent example from our IGCSEs saw students estimating the distance between Saturn and the Earth. Answers in terms of μm probably should have raised doubts.

Working Scientifically

Students are generally able to access questions assessing practical skills; however vague language often limited marks. Good understanding of the basic principles of scientific investigation will enable students to access marks in questions even if they are not familiar with the practical.

- students appeared to have difficulty recognising or suggesting **control variables**. For example:
  - in1BL1FP4(c)(i), the frequent response of ‘repeating the experiment’ illustrates students’ misunderstanding of controlling factors to make the investigation valid
  - in CH3FP6(c)(i) students made vague references like ‘ensuring the same people do the experiment’ or used ‘amount’ instead of a measurable quantity such as ‘volume’
  - in PH3FP7(a) and PH3HP1(a)(i), very few gave two correct control variables
- when asked to **evaluate the validity of the method used and the evidence for** the scientists’ conclusion, students needed to make points both for and against the method and the conclusion. Many students simply addressed one side of the argument. Others, while making both positive and negative points, did not make it clear whether the point they were addressing supported or refuted the argument. This was particularly evident in BL2H5(b)(i)
- greater understanding is needed of what a **conclusion** is. For example:
  - in BLF15(b)(ii), when asked for the reason why a given student’s conclusion might not be correct they referred to methodology like ‘experimental errors’, not being’ fair’ having different strengths of antibiotic or different disc size rather than the scientific knowledge in the given conclusion
  - in CH1HP5(a)(i), when asked to give a conclusion for a table of data, many students described the data instead students were given a flawed conclusion but were not able to answer why it was not valid
- greater understanding is needed that **one theory is chosen over another because there is evidence to support it**. This was particularly evident in PH2FP8(c)
- understanding **why apparatus is used to improve accuracy**. For example:
  - in CH2FP4(c)(i),many made reference to insulation conducting heat or made vague references to reliability and accuracy with no reference to reduction of loss of thermal energy from a beaker
  - in CH2HP1(b)(iii), simply saying you would get ‘better readings’ is insufficient
- it is a common misconception that a **data logger** or **digital thermometer** will **give more accurate results**. This was particularly evident in CH3FP6(c)(ii)
- suggesting two improvements to the **amylase investigation** was problematic although nearly half were able to suggest one. This was particularly evident in BL2F8(b)(ii)
- students usually volunteer **suggestions for hazards and risks**, but need to ensure any precautions are valid. For example, in PH3FP9(b) suggestions that breathing masks and goggles should be worn if having a CT scan.

Use of language

Some of the better quality of written communication answers tended to include some indication that the students had planned what they were going to write – either using sub-headings to ensure the student attempted each part of the question, or something as simple as a list at the top of their answer and using this as a basis to structure their answer.

There were good responses to some of the quality of written communication questions, with students able to write concisely without irrelevant detail, for example in CH2HP2. Sometimes students give vague answers, or perhaps don't realise the significance of the words they choose:

- plan **extended response answers** before writing them – perhaps a bullet point list to help think about structure before the full answer
- precise use of **definitions and language**. For example:
  - in BL2F6 diffusion does not occur 'along' or 'across' a concentration gradient but down the gradient
  - many students missed marks because they did not define a hydrocarbon consisting of carbon and hydrogen only in CH1FP6(b) and CH1HP2(b)
  - in CH1FP7, when asked about pollution of quarrying, many wrote 'drilling or quarrying cause pollution' but did not state how
  - in PH1FP9, 'black attracts heat' or 'metals are good insulators', in reference to 'storing/trapping heat' and 'attracting heat' limited access to level 3
- some extended response questions include discussion about **methods**, for which the **order of events** is important. Some responses lacked structure and mixed stages, which can limit marks. This was particularly evident in CH1HP5(c)
- students need to recognise that many **common terms** such as 'power' and 'energy' have **specific meaning in science**. This was particularly evident in PH1HP6(c).

Subject content and misconceptions

Some topics will naturally be more challenging for students than others:

Biology

- There was a widespread misconception that neurones rather than impulses travel (BLFP9(b)).
- Students mistakenly wrote that 'chemicals/hormones/pulses pass through neurones (BL1FP9).
- Students did not know the function of ribosomes (BL2HP6b).
- Students found the application of sampling technique question challenging many having very little idea how the investigation should be carried out. As one of the required practicals is on sampling it would be useful to look again at this question (BL2H7).

Chemistry

- Although chemical formulae are generally acceptable as alternatives to the names of substances, they need to be correct, for example CO_2 is an acceptable alternative to carbon dioxide but CO^2 is not.
- Students should know that catalysts increase the rate of reaction but do not necessarily change the yield (CH2FP5(c)).
- Questions requiring an understanding of bonding were not well answered (CH2HP3(a)(iii), 3(c)).
- Evidence some students had no experience of making copper sulfate crystals, with limited understanding of steps such as filtration (CH2FP4(a)).

- Many thought a higher pH meant a stronger acid, there is also lack of precision with words with 'less acidic' being used in place of 'weaker acid'(CH3HP3(e)(ii)).
- Questions involving reversible reactions and equilibrium – many thought a higher temperature would increase the yield in an exothermic reaction (CH3HP5(a)(i), 5(a)(ii)).
- Negative temperatures are not well understood with many thinking –260 °C is a greater temperature than –33 °C (CH3HP6(a)(ii)).

Physics

- Practice rearranging equations so students understand how to use them.
- Students continue to find convection currents difficult to explain (PH1HP8(a)).
- Similarly, states of matter questions see answers such as 'water vapour particles turning into liquid' (PH1HP8(c)).
- Smaller parts of the specification tend to be answered less well. A question about pumped storage generation saw lots of detail about hydroelectric power stations, but little about the pumping part (PH1HP7(b)(i)).
- Thinking, braking and stopping distances are often confused, with many students using 'reaction time' to mean the time taken to stop the car (PH2FP2(b)(i)).
- Students thought that increased reaction time meant you could react faster (PH2FP2(b)(ii)).

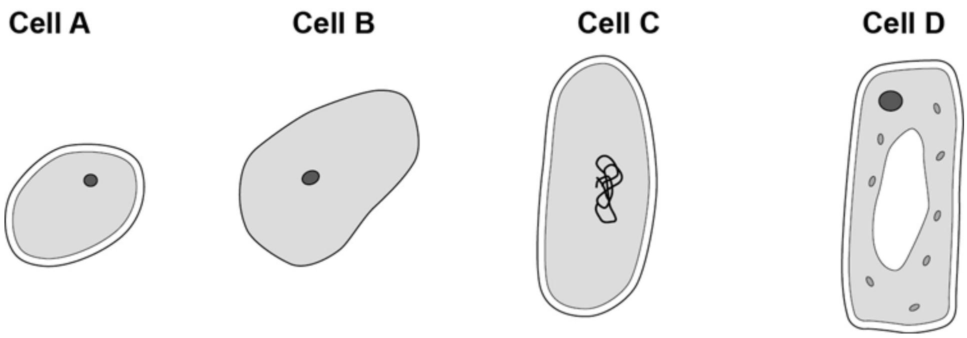
Find more observations from the first series in the full examiner reports available at [aqa.org.uk/log-in](aqa.org.uk/log-in)

AO2 example questions and mark schemes

Combined Science Biology Higher Tier Paper 1
Standard demand

0 1 **Figure 1** shows four different types of cell.

Figure 1



0 1 . 1 Which cell is a plant cell?

Give **one** reason for your answer.

[2 marks]

Cell ____________

Reason ____

AO2/1 (S)

0 1 . 2 Which cell is an animal cell?

Give **one** reason for your answer.

[2 marks]

Cell ____________

Reason ____

AO2/1 (S)

0 1 . 3 Which cell is a prokaryotic cell?

Give **one** reason for your answer.

[2 marks]

Cell ____________

Reason ____

AO2/1 (S)

0 1 . 4 A scientist observed a cell using an electron microscope.

The size of the image was 25 mm.

The magnification was $\times$ 100 000

Calculate the real size of the cell.

Use the equation:

$$\text{magnification} = \frac{\text{image size}}{\text{real size}}$$

Give your answer in micrometres.

[3 marks]

____

____

____

Real size = ____________________ micrometres

AO2/1 (S)

Question 1

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
01.1	**D**		1	AO2/1 4.1.1.2
	any **one** from: • has chloroplasts • has a (large) vacuole	ignore has a (cell) wall	1	AO2/1 4.1.1.2
01.2	**B**		1	AO2/1 4.1.1.2
	does **not** have a (cell) wall	allow has <u>only</u> a nucleus, (cell) membrane **and** cytoplasm	1	AO2/1 4.1.1.2
01.3	**C**		1	AO2/1 4.1.1.1
	any **one** from: • genetic material is not in a nucleus • has a single loop of DNA	allow no nucleus	1	AO2/1 4.1.1.1
01.4	real size = 25 / 100 000		1	AO2/2 4.1.1.5
	0.00025		1	AO2/2 4.1.1.5
	(conversion to) 0.25 (μm)	allow 0.25 (μm) with no working shown for **3** marks	1	AO2/2 4.1.1.5
Total			**9**	

0 6 In 2014 there was an outbreak of Ebola virus disease (EVD) in Africa.

At the time of the outbreak there were:

- no drugs to treat the disease
- no vaccines to prevent infection.

0 6 . 1 By March 2015 there were an estimated 9 850 deaths worldwide from EVD.

The number of deaths is an estimate.

Suggest why it is an estimate rather than an exact number.

[1 mark]

AO3 (S)

0 6 . 2 Why were antibiotics **not** used to treat EVD?

[1 mark]

AO1 (S)

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After the outbreak began, drug companies started to develop drugs and vaccines for EVD.

A drug has to be thoroughly tested and trialled before it is licensed for use.

Testing, trialling and licensing new drugs usually takes several years.

0 6 . 3 Draw **one** line from each word about drug testing to the definition of the word.

[2 marks]

Word about drug testing	Definition
Dose	Side effects making the person ill
Efficacy	The concentration of the drug to be used and how often the drug should be given
Toxicity	Whether the drug works to treat the illness

AO2/2 (S)

0 6 . 4 The results of drug testing and drug trials are studied in detail by other scientists.

Only then can the results be published by the drug company.

Suggest **one** reason why the results are studied by other scientists.

[1 mark]

AO2/2 (S)

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The number of deaths from EVD continued to increase.

The World Health Organization (WHO) decided it was ethical to use unlicensed drugs.

The WHO said unlicensed drugs could only be given to people who gave their permission.

Also, any results had to be shared with other researchers and drug companies.

Some vaccines had shown positive results in animal testing, but the vaccines had not been tested and trialled in humans.

The supplies of the vaccine were low.

At first the vaccines were only used for health workers.

0 6 . 5 How would the use of a vaccine **reduce the spread** of EVD?

[2 marks]

AO1 (H)

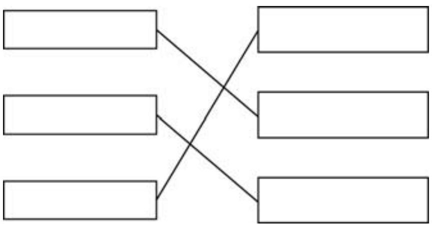
0 6 . 6 Evaluate the use of unlicensed drugs and vaccines during the EVD outbreak.

Give a conclusion.

[6 marks]

AO2/2 and AO3 (S and H)

Question 6

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
06.1	any **one** from: • not all deaths recorded • not all causes of deaths recorded	allow cause may not be known	1	AO3/1b 4.3.1.1
06.2	antibiotics do not kill viruses	allow antibiotics <u>only</u> kill bacteria	1	AO1/1 4.3.1.8
06.3		all correct for **2** marks 1 or 2 correct for **1** mark	2	AO2/2 4.3.1.9
06.4	any **one** from: • to prevent false claims • to make sure the conclusions are correct / valid • to avoid bias		1	AO1/2 4.3.1.9
06.5	some people would be immune to EVD	allow those vaccinated would not contract the disease	1	AO1/1 4.3.1.7
	if less people (in a population) have EVD less chance of it being passed on		1	AO1/1 4.3.1.7

Question 6 continued

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
06.6	**Level 3:** A detailed and coherent evaluation is provided which considers a range of arguments for and against the use of unlicensed drugs and comes to a conclusion consistent with the reasoning.		5–6	AO3/1b 4.3.1.1 4.3.1.7 4.3.1.9
	Level 2: An attempt to give arguments for and against the use of unlicensed drugs is made. The logic may be inconsistent at times but builds towards a coherent argument.		3–4	AO3/1b 4.3.1.1 4.3.1.7 4.3.1.9
	Level 1: Discrete relevant points made. The logic may be unclear and the conclusion, if present, may not be consistent with the reasoning.		1–2	AO2/2 4.3.1.1 4.3.1.7 4.3.1.9
	No relevant content		0	
	Indicative content **pros** • might save some lives • vaccine could reduce chance of future outbreaks • patient made aware of risk and agreed to use of drug • sharing of results could speed up development of effective vaccines / drugs • used mainly for health workers who were risking their lives to help **cons** • could be dangerous **or** vaccine could harm a healthy person • goes against legislation / laws governing drug development • might set a precedent for other drugs not to be fully tested • unfair as not available to the African people a justified conclusion			

Total			**13**

Combined Science Chemistry Higher Tier Paper 1
Standard (S) and Higher (H) demand

0 4 Copper can be produced from copper(II) sulfate solution by two different methods.

Method 1 – Electrolysis

0 4 . 1 To produce copper by electrolysis a student has inert electrodes, a d.c. power supply, a switch and electrical wires for the external circuit.

Draw and label the apparatus set up to produce copper from copper(II) sulfate solution by electrolysis.

[2 marks]

AO1 (S)

0 4 . 2 Suggest why the colour of the copper(II) sulfate solution fades during the electrolysis.

[3 marks]

AO1 and AO2/1 (H)

0 4 . 3 Explain how copper is produced from copper(II) sulfate solution by electrolysis.

AO1 AO2 (S 2 marks and H 2 marks)

Method 2 – Displacement

0 4 . 4 The chemical equation for the displacement of copper using iron is:

$$CuSO_4 + Fe \rightarrow Cu + FeSO_4$$

Calculate the minimum mass of iron needed to displace all of the copper from 50 cm^3 of copper(II) sulfate solution.

The concentration of the copper(II) sulfate solution is 80 g $CuSO_4$ per dm^3.

Relative atomic masses (A_r): O = 16; S = 32; Fe = 56; Cu = 63.5

Give your answer to 2 significant figures.

[4 marks]

Mass of iron = g

AO2/1 (H)

Question 4

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
04.1	electrodes connected to d.c. power supply by wires electrodes labelled anode (+) and cathode (−)	for this diagram ignore the material used for the electrodes as long as they are made from carbon or metals that are inert	1 1	AO1/2 5.4.3.1, 4
04.2	copper ions cause the blue colour copper ions are reduced/converted to copper ions so the concentration of copper ions decreased	answer must be in terms on copper ions if no other mark awarded allow **1** mark for copper ions are used up during electrolysis	1 1 1	AO1/1 AO2/1 AO2/1 5.4.3.1, 4 5.10.1.4
04.3	copper ions are positive so are attracted to the inert cathode **or** inert negative electrode copper ions gain electrons at the inert cathode **or** inert negative electrode so they are reduced to form copper atoms		1 1 1 1	AO1/1 AO2/1 AO1/1 AO2/1 5.4.3.1, 4

04.4	50 cm3 contains 4 g CuSO4 Mr CuSO4 = 159.5 4 g CuSO4 reacts with $\frac{4}{159.5}$ × 56 g Fe = 1.40(43877) = 1.4 (g)	**accept 1.4(g) with no working shown for 4 marks** **allow 1.40(43887) without working shown for 3 marks**	1 1 1 1	AO2/1 5.3.2.1, 2, 3, 5

Combined Science Chemistry Foundation Tier Paper 2 Low (L) and Standard (S) demand

Q5.0 (part)

05.2

The student then set up the apparatus without making any mistakes.
Figure 6 shows his results.

0 5 . 3 Which of the inks is the most soluble in the solvent?

Give a reason for your answer.

[2 marks]

Ink ____

Reason ____

____

AO2/2 (L)

0 5 . 4 Use **Figure 6** to complete **Table 4**, then calculate the R_f value for red ink.

[5 marks]

Table 4

	Distance in mm
Distance moved by red ink	....
Distance from start line to solvent front	....

The R_f value for red ink is calculated using the equation.

$$R_f = \frac{\text{distance moved by red ink from the start line}}{\text{distance moved by solvent from the start line}}$$

Give your answer to two significant figures.

R_f value = ____________

AO2/2 (L 2 and S 2)

0 5 . 5 How can you tell from **Figure 6** that the R_f value for the blue ink is greater than the R_f value for the red ink?

[1 mark]

AO2/2 (L)

Question 5

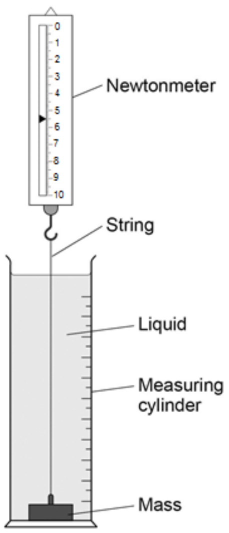
Question	Answers	Extra information	Mark	AO/ Spec. Ref.
05.1	start line drawn in ink (so) line would run start line below solvent level (so) samples would wash off		1 1 1 1	AO3/2b 5.8.1.3
05.2	red **and** blue	both colours needed	1	AO2/2 5.8.1.3
05.3	yellow travels furthest up the paper		1 1	AO2/2 5.8.1.3
05.4	distance moved by red ink 13 ±1 distance from start line to solvent front 44 ±1 correct substitution correct answer to 2 significant figures	measurements in cm max **1** mark for mps 1 and 2 allow ecf from Table 4 range if correct is 0.27 to 0.33	1 1 1 1 1	AO2/2 5.8.1.3
05.5	moves further **or** nearer the top of the paper		1	AO2/2 5.8.1.3
Total			**13**	

Combined Science Physics Foundation Tier Paper 2
Low demand

0 3 A student investigated the force needed to raise a mass through different liquids at a constant speed.

She set up the apparatus shown in **Figure 5**.

Figure 5



0 3 . 1 In the investigation there are several variables.

Draw **one** line from each variable to the correct description for this investigation.

[3 marks]

Variable	Description
Control	Distance the mass was lifted
Dependent	Value of force on the newtonmeter
Independent	Mass
	Type of liquid

AO2/2 (L)

Table 2 shows the student's results.

Table 2

Liquid	**Force in N**
Water	10.0
Washing up liquid	11.1
Glycerol	11.5
Syrup	13.8

0 3 . 2 What was the resolution of the newtonmeter?

Tick **one** box.

[1 mark]

0.1 N ☐

0.5 N ☐

1 N ☐

10 N ☐

AO2/2 (L)

0 3 . 3 The student wanted to display her results.

How should she display her results?

[1 mark]

Tick **one** box.

A bar chart ☐

A line graph ☐

A pie chart ☐

AO2/2 (L)

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0 3 . 4 Give a reason for your answer to part **03.3**.

[1 mark]

AO2/2 (L)

0 3 . 5 A force of 13.8 N was used to lift the mass 30 cm vertically through the liquid.

Use the following equation to calculate the work done in lifting the mass.

$$\text{Work done} = \text{force} \times \text{distance}$$

Choose the correct unit from the box.

[3 marks]

J	**m/s**	**N**

Work done = ____________________

Unit = ____________________

AO2/1 (L)

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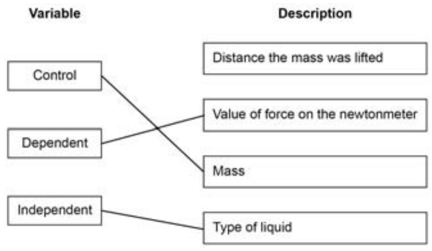
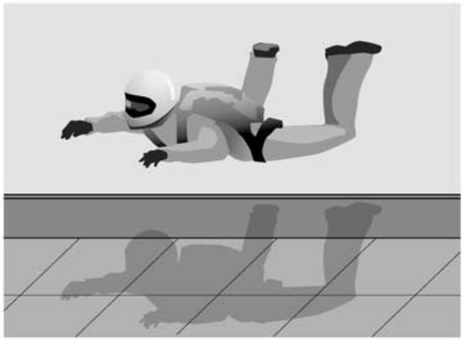
Question 3

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
03.1		allow **one** mark for each correct line if more than one line is drawn from any variable then all of those lines are wrong	1 1 1	AO3/3a AO2/2 AO2/2 6.5.1.2 WS2.2, 4.1
03.2	0.1 N	if more than **one** box ticked apply list principle	1	AO2/2 6.5.1.2 WS2.3
03.3	A bar chart	if more than **one** box ticked apply list principle	1	AO2/2 6.5.1.2 WS3.1
03.4	some of the data is categoric		1	AO2/2 6.5.1.2 WS3.1
03.5	13.8 × 0.30 4.14 J	allow 4.14 without working shown for **2** marks	1 1 1	AO2/1 AO2/1 AO1/1 6.5.2 WS4.3
Total			**9**	

0 5 **Figure 4** shows a skydiver training in an indoor wind tunnel.

Large fans below the skydiver blow air upwards.

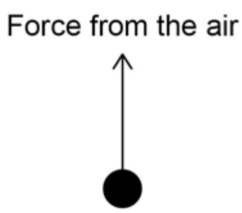
Figure 4



0 5 . 1 The skydiver is in a stationary position.

Complete the free body diagram for the skydiver.

[2 marks]



AO2/1 (S)

0 5 . 2 The skydiver now straightens his legs to increase his surface area.

This causes the skydiver to accelerate upwards.

Explain why straightening his legs cause the skydiver to accelerate upwards.

[2 marks]

AO2/1 (H)

0 5 . 3 A small aeroplane used for skydiving moves along a runway.

The aeroplane accelerates at 2 m/s^2 from a velocity of 8 m/s.

After a distance of 209 m it reaches its take-off velocity.

Calculate the take-off velocity of the aeroplane.

[3 marks]

Take-off velocity = ____________ m/s

AO2/1 (H)

0 5 . 4 A skydiver jumps from an aeroplane.

There is a resultant vertical force of 300 N on the skydiver.

There is a horizontal force from the wind of 60 N.

Draw a vector diagram on **Figure 5** to determine the magnitude and direction of the resultant force on the skydiver.

[4 marks]

AO2/1 (H)

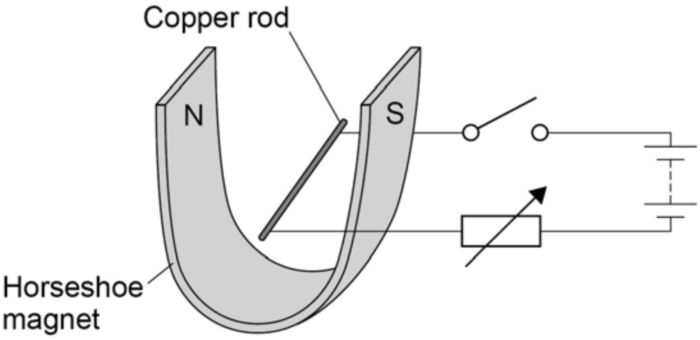
Magnitude of resultant force = ____________ N

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	arrow of equal size pointing vertically downwards	judged by eye	1	AO2/1
	labelled 'weight'		1	AO1/1 6.5.1.1/2/3
05.2	the upwards force is greater than the downwards force		1	AO2/1
	because air resistance increases		1	6.5.4.2.2
05.3	$v^2 = (2 \times 2 \times 209) + 8^2$		1	AO2/1 6.5.4.1.5
	$v = \sqrt{900}$		1	WS3.3
	v = 30 (m/s)		1	
		allow 30 (m/s) without working shown for **3** calculation marks		
05.4	vertical force (300 N) drawn with a suitable scale		1	AO2/1
	horizontal force (60 N) drawn to the same scale		1	6.5.1.4
	resultant force drawn in correct direction		1	
	value of resultant in the range 304 N – 308 N		1	
Total			**11**	

0 6 A teacher used the equipment shown in **Figure 6** to demonstrate the motor effect.

Figure 6



0 6 . 1 Describe how Fleming's left-hand rule can be used to determine the direction in which the rod will move when the switch is closed, and state the direction.

[4 marks]

AO1 (H)

0 6 . 2 Increasing the current can increase the force acting on the copper rod.

Give **one** other way in which the size of the force acting on the copper rod could be increased.

[1 mark]

AO2/2 (H)

0 6 . 3 The copper rod in **Figure 6** has a length of 7 cm and a mass of 4×10^{-4} kg.

When there is a current of 1.12 A the resultant force on the copper rod is 0 N.

Calculate the magnetic flux density.

Gravitational field strength = 9.8 N/kg

[5 marks]

Magnetic flux density = ____________ T

AO2/1 (H)

Question 6

Question	Answers	Extra information	Mark	AO/Spec. Ref.
06.1	thumb, index finger and third finger are held mutually at right angles index finger shows the direction of the magnetic field from North to South, third finger shows the direction of the current from positive to negative terminal the thumb then shows the direction of the force acting on the copper rod so the copper rod will move from left to right		1 1 1 1	AO1/2 6.7.2.2
06.2	any **one** from: use a stronger magnet increase the magnetic flux density increase the length of the copper rod in the magnetic field coil the copper rod		1	AO2/2 6.7.2.2
06.3	$W = 9.8 \times 4\times10^{-4} = 3.92 \times 10^{-3}$ conversion of the length 7cm to 0.07m $3.92 \times 10^{-3} = B \times 1.12 \times 0.07$ $B = 3.92 \times 10^{-3} / 0.0784$ B = 0.05 (T)	allow 0.05 (T) without working shown for the **5** calculation marks	1 1 1 1 1	AO2/2 6.5.1.3 6.7.2.2 WS4.5
Total			**10**	

Ofqual GCSE 9–1 subject level guidance for combined science

This information is lifted directly from Ofqual's GCSE Subject Level Guidance for Combined Science (July 2015) available in full here: gov.uk/government/uploads/system/uploads/attachment_data/file/443984/gcse-9-to-1-subject-level-guidance-for-combined-science.pdf

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AO2: Apply knowledge and understanding of: ▪ scientific ideas ▪ scientific enquiry, techniques and procedures.			40%
Strands	**Elements**	**Coverage**	**Interpretations and definitions**
1 – Apply knowledge and understanding of scientific ideas.	This strand is a single element.	▪ Full coverage in each set of assessments (but not in every assessment).	▪ **Scientific ideas** are aspects of the subject content. They include the subject-specific requirements and the requirements for Working Scientifically as set out in the Content Document – for example, theories, models and the use of relevant mathematics. ▪ **Scientific enquiry, techniques and procedures** encompasses, but is broader than, knowledge and understanding of the core practical activities. In the context of this assessment objective, it involves applying such knowledge and understanding to a given context. ▪ The emphasis in this assessment objective is on Learners applying their knowledge and understanding to provide meaning or explanation – for instance, to connect theory with particular contexts, stimuli or materials. This application should relate principally to: ▫ novel situations that are not clearly indicated in the specification; ▫ developing further material that is covered in the specification; ▫ making links between such types of material, which are not signalled in the specification. ▪ Application of knowledge should also involve determining how to make sense of connections and linkages within data, information and detail – although not to the extent of drawing conclusions or making judgements.
2 – Apply knowledge and understanding of scientific enquiry, techniques and procedures.	This strand is a single element.		

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. 1b – Analyse information and ideas to evaluate.	▪ 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.
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.		

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A-level sciences timeline for practical work monitoring

A-level sciences
Timeline for practical work monitoring

The monitoring timeline supporting the practical endorsement for science A-levels has been confirmed for the next examination series. We've summarised the main dates for you to keep in mind.

Sep 2017
Updated Practicals webpage available, including our evaluated free online practical endorsement Lead Teacher training.

Oct 2017
All schools allocated to AQA will have had notice of their next visit.

Nov 2017 to early Feb 2018
First wave of practical advisory visits to schools take place*.

Late Feb 2018 to Mar 2018
Second wave of practical advisory visits to schools take place*. Repeat advisory visits to schools take place if needed.

15 May 2018
Schools must report students' pass/non-classified in the endorsement to exam boards by 15 May 2018.

May 2018 to Jul 2018
Recruitment of 2018 – 2019 advisers.

Oct 2018 to Dec 2018
Third and final wave of practical advisory visits to schools take place this series*. Repeat advisory visits to schools to take place if needed.

Feb 2019 to Apr 2019
Repeat advisory visits to schools take place if needed.

15 May 2019
Schools must report students' pass/non-classified in the endorsement to exam boards by 15 May 2019.

* We're splitting the monitoring visits into three waves to avoid the start of the academic year or times when you're concentrating on preparing students for exams. Your Visiting Practical Adviser will give you at least two weeks' notice of their visit and will try to be flexible around your teaching timetable.

AQA Realising potential

Find out more at aqa.org.uk/science

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Notes

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