Questions matter

Summer series 2023

Areas of challenge

Examples from Combined Science: Trilogy

Version 1.0
September 2023

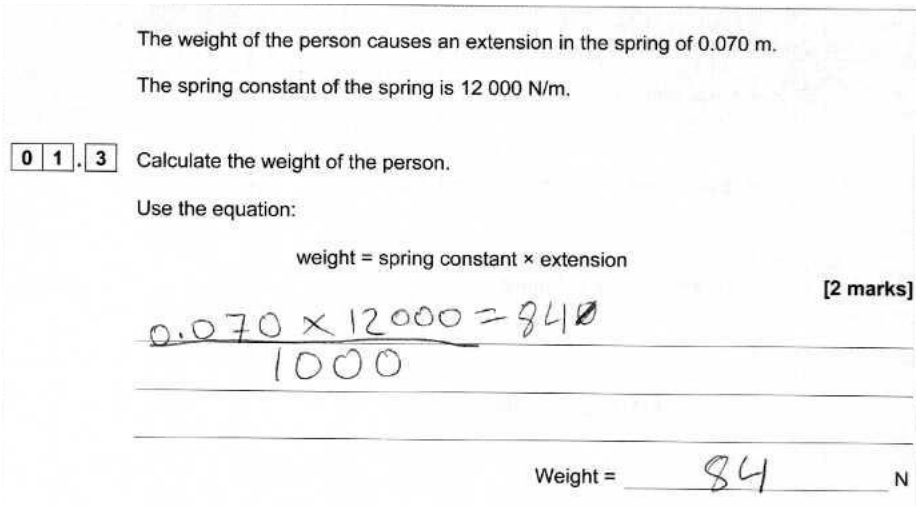
Introduction

The following are examples of questions that students found particularly challenging this summer series. All examples are taken from Trilogy papers.

Papers are ramped and the level of demand changes from low demand (60% of the marks) through to standard demand (40% of the marks) on the foundation tier and 40% standard demand to 60% high demand on the Higher tier. Students will naturally find the questions progressively challenging.

Physics equations: mathematical processes

Physics 2F Q1.3 and 1.4



The weight of the person causes an extension in the spring of 0.070 m.

The spring constant of the spring is 12 000 N/m.

0 1 . 3 Calculate the weight of the person.

Use the equation:

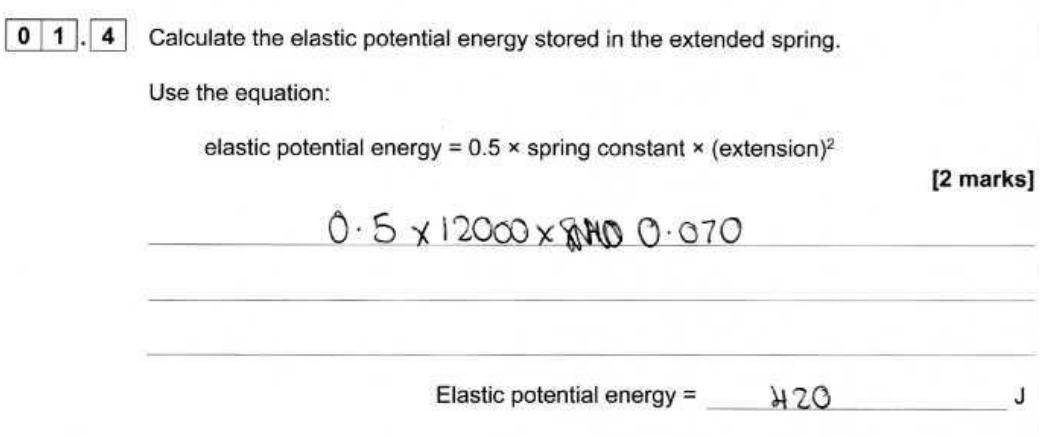
weight = spring constant × extension

[2 marks]

$\frac{0.070 \times 12000}{1000} = 840$

Weight = 84 N

No marks awarded: as incorrect substitution and calculation.



0 1 . 4 Calculate the elastic potential energy stored in the extended spring.

Use the equation:

elastic potential energy = 0.5 × spring constant × (extension)^2

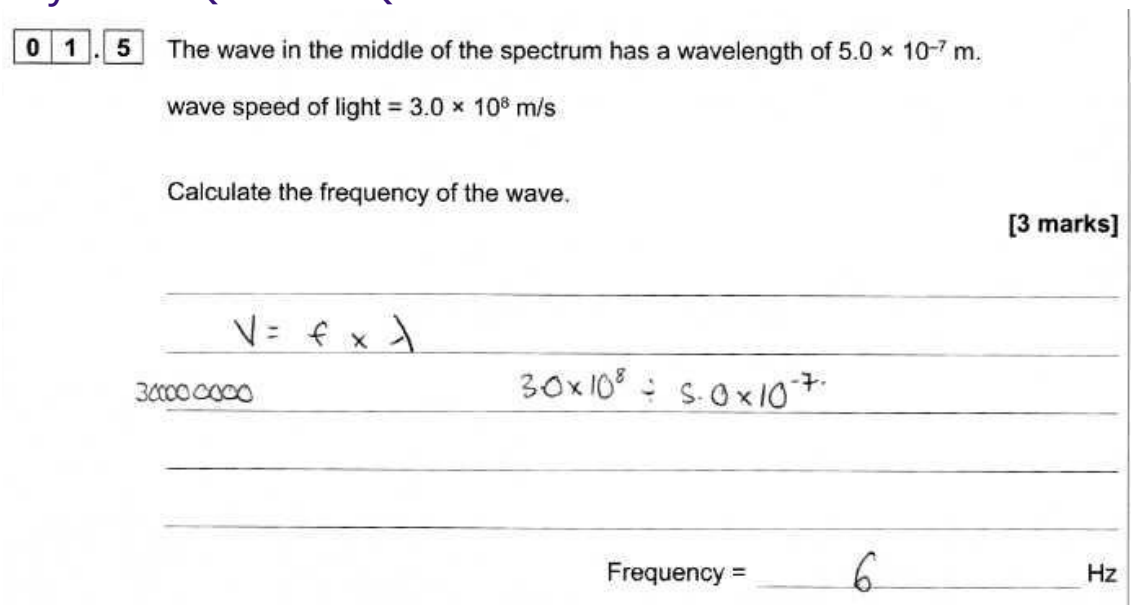
[2 marks]

$0.5 \times 12000 \times 840 \quad 0.070$

Elastic potential energy = 420 J

No marks awarded: missed the need to square the extension.

Physics 2F Q6.5 / 2H Q1.5



0 1 . 5 The wave in the middle of the spectrum has a wavelength of 5.0×10^{-7} m.

wave speed of light = 3.0×10^{8} m/s

Calculate the frequency of the wave.

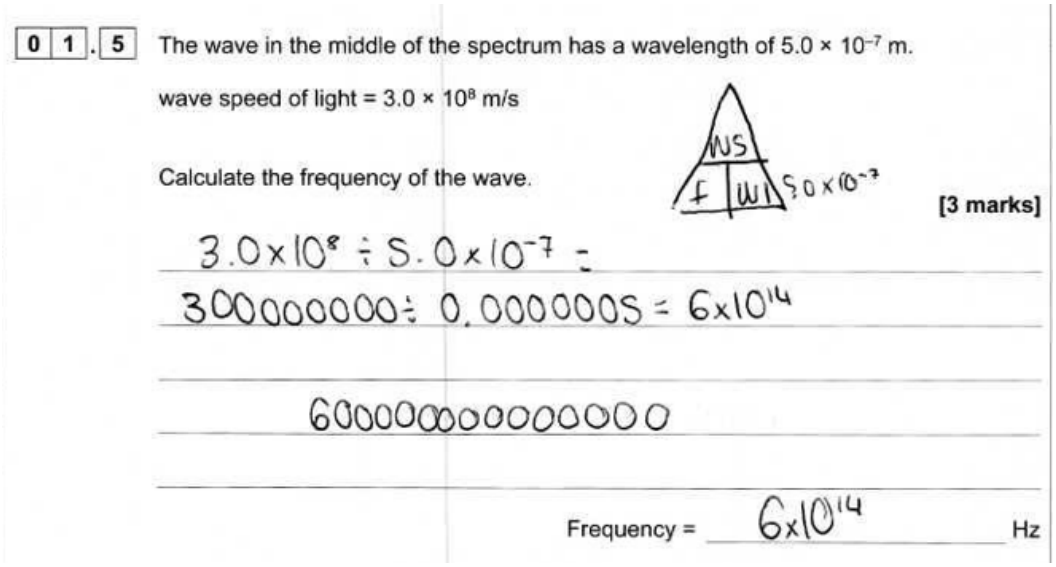
[3 marks]

$V = f \times \lambda$

30000000 $3.0 \times 10^{8} \div 5.0 \times 10^{-7}$

Frequency = 6 Hz

2 marks for substitution and rearrangement. Incorrect calculation ignored the final mark for powers.



0 1 . 5 The wave in the middle of the spectrum has a wavelength of 5.0×10^{-7} m.

wave speed of light = 3.0×10^{8} m/s

Calculate the frequency of the wave.

[3 marks]

$3.0 \times 10^{8} \div 5.0 \times 10^{-7} =$

$300000000 \div 0.0000005 = 6 \times 10^{14}$

60000000000000

Frequency = 6×10^{14} Hz

Correct calculation and correct answer: 3 marks

Physics 2H Q5.5

0 5 . 5 Evaluate the suitability of the new spring to hang the chair.

maximum elastic potential energy = 1800 J

spring constant = 225 N/m

weight of person = 750 N

distance between the bottom of the chair and the ground = 30 cm

Include a calculation in your answer.

Use the Physics Equations Sheet.

[3 marks]

elastic potential energy =
0.5 x spring constant x (extension)^2

1800 J = 0.5 x 225 x (4)^2
~~4800~~ 46m
750 N ÷ 225 N/m = 3.3m
The new spring is very suitable to hang the chair.

Correct calculation carried out so marking points 1 and 2 are awarded. However, they have come to the wrong conclusion for the calculation. 2 marks.

Physics 2H Q6.1

0 6 . 1 When the child drops the stone it passes the child's feet with a velocity of 3.1 m/s.

The child's feet are 6.3 m above the water.

acceleration due to gravity = 9.8 m/s^2

Calculate the velocity of the stone as it hits the water.

Use the Physics Equations Sheet.

Give your answer to 2 significant figures.

[4 marks]

(final velocity)^2 - 3.1^2 = 2 x 9.8 x 6.3
v^2 - 3.1^2 = 123.48
v^2 = $\sqrt{113.87}$
v = 10.67
2sf = 11

Velocity (2 significant figures) = 11 m/s

Complex rearrangement and maths.

MP1 given for correct substitution, but they have subtracted instead of added 3.12 so the calculation incorrect and MP2 and MP3 not awarded. They have put their incorrect answer to correct number of sig figs to gain MP4 (this mark can only be awarded if the correct equation is used and a value of v is calculated).

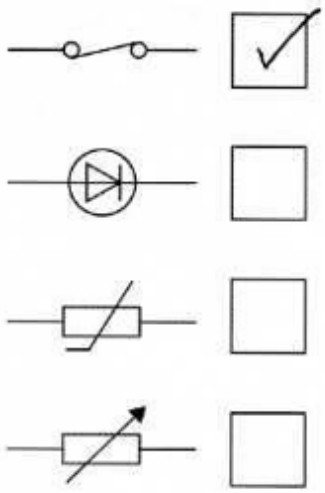
Physics: basic knowledge

Physics 1F Q4.1

0 4 . 1 Which symbol represents an electrical component with a resistance that decreases as its temperature increases?

[1 mark]

Tick (✓) **one** box.



Incorrect answer

Physics 1F Q4.2

0 4 . 2 When the resistance of an electrical circuit decreases, the current in the circuit increases.

Complete the sentence.

Choose the answer from the box.

[1 mark]

charge	energy	potential difference	power

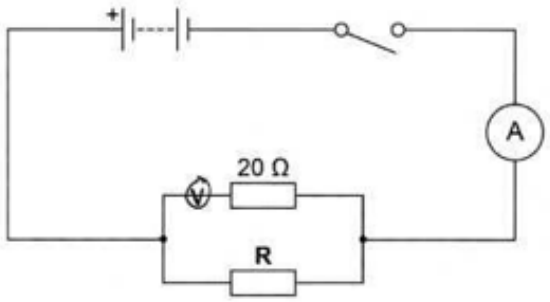
Electrical current is a flow of energy .

Incorrect answer

Physics 1F Q6.1

Figure 9 shows the circuit diagram.

Figure 9



0 6 . 1 To determine the total resistance of both resistors, a voltmeter must be connected into the circuit.

Complete **Figure 9** to show where the voltmeter should be connected.

[1 mark]

Incorrect answer

Physics 1F Q6.7

0 6 . 7 Complete the sentence.

[1 mark]

The difference between the two values given by the scales is due to a _____syntax_____ error.

Incorrect answer

Physics 2F Q3.2

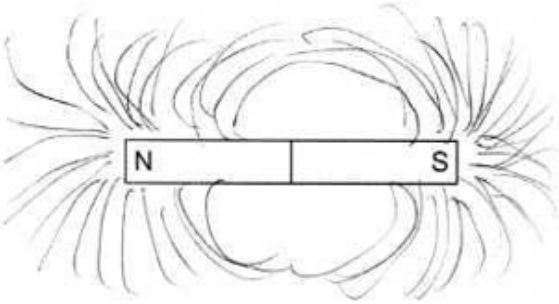
0 3 . 2 **Figure 5** shows a bar magnet.

Draw magnetic field lines to show the magnetic field pattern around the bar magnet.

You should add arrows to the field lines to show the direction of the magnetic field.

[2 marks]

Figure 5



No marks awarded.

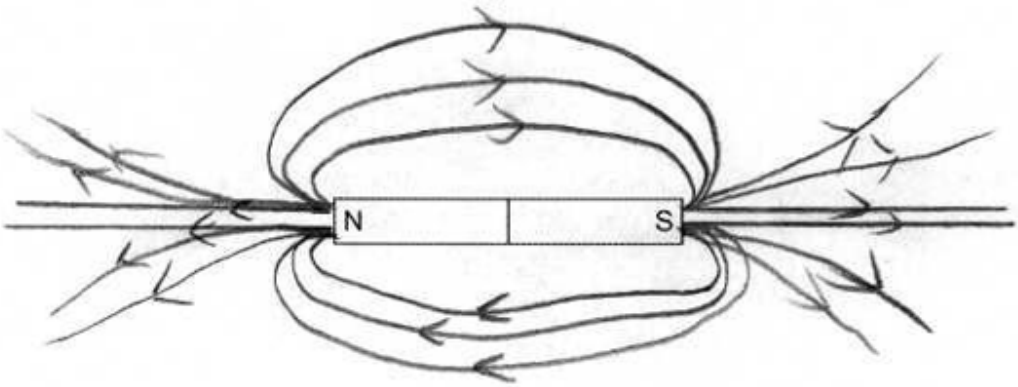
0 3 . 2 **Figure 5** shows a bar magnet.

Draw magnetic field lines to show the magnetic field pattern around the bar magnet.

You should add arrows to the field lines to show the direction of the magnetic field.

[2 marks]

Figure 5



1 mark awarded. Incorrect direction of arrows beneath the bar magnet means that the second MP not given

Physics 2F Q6.3

0 6 . 3 Light changes direction when it enters the glass prism.

What name is given to this process?

[1 mark]

degraction

No mark awarded.

Chemistry: balancing equations

Paper 2F/H

0 5 . 1 Methane is a fuel.

Balance the equation for the combustion of methane.

[1 mark]

$CH_4 + \underline{2}\ O_2 \rightarrow CO_2 + \underline{6}\ H_2O$

0

0 1 . 1 Methane is a fuel.

Balance the equation for the combustion of methane.

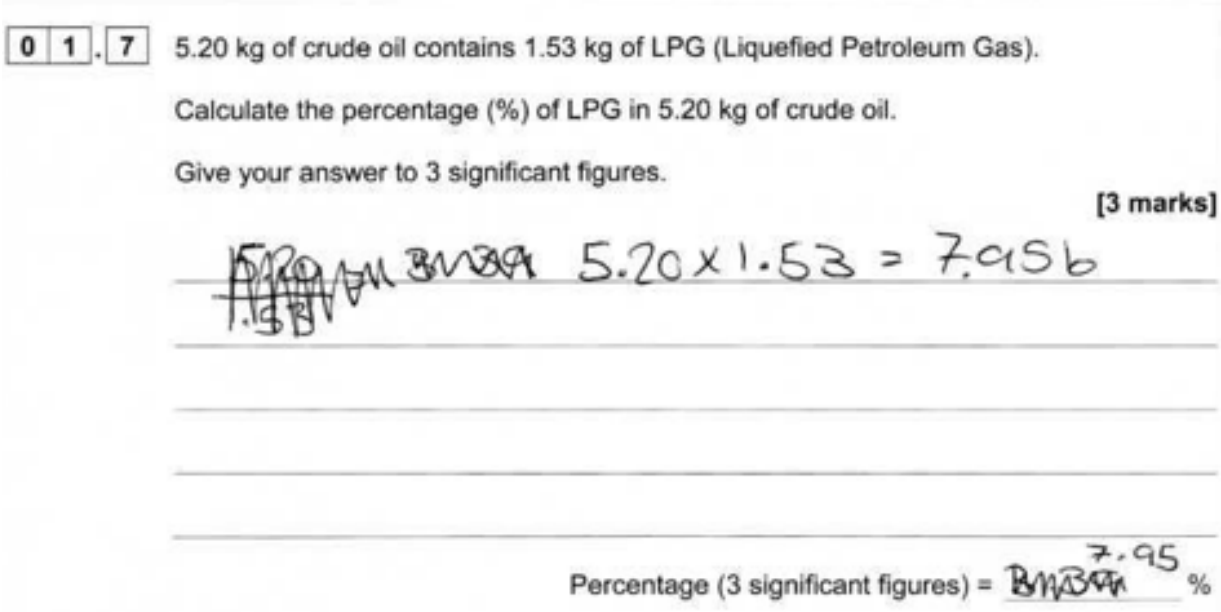
[1 mark]

$CH_4 + \underline{C}\ O_2 \rightarrow CO_2 + \underline{4}\ H_2O$

Both of these score zero marks

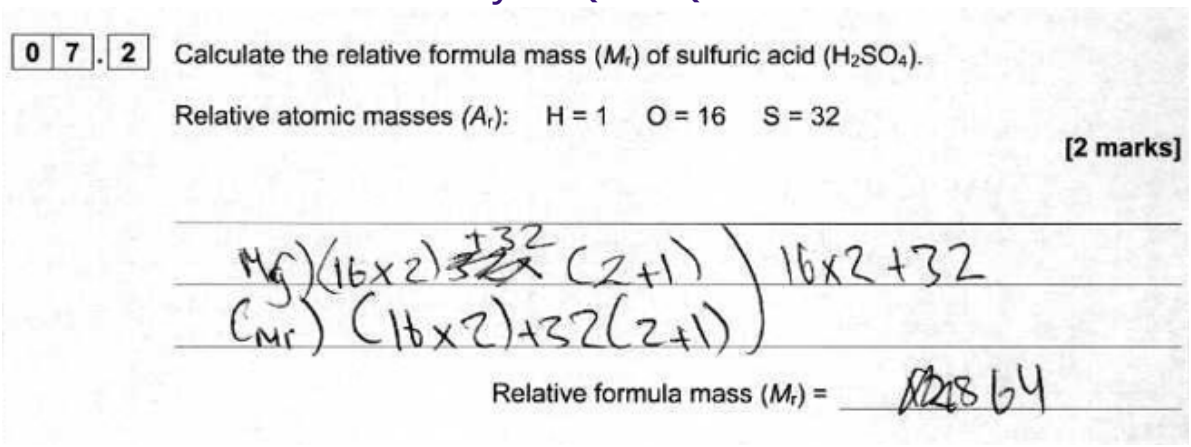
Chemistry: classic calculations

Low demand Chemistry 2F Q1.7



Incorrect calculation

Standard demand Chemistry 1F Q7/H Q2



No marks awarded: incorrect number of oxygens

0 7 . 3 Calculate the percentage by mass of oxygen in lithium sulfate (Li_2SO_4).

Relative atomic mass (A_r): O = 16

Relative formula mass (M_r): Li_2SO_4 = 110

Give your answer to 2 significant figures.

[4 marks]

16 x 4 = 64

110 x 64

= 7040

100

70.4

Percentage by mass of oxygen (2 significant figures) = 70.4 %

MP1 correct. MP2 not awarded because calculation of percentage incorrect. MP3 sig figs incorrect. 1 mark.

0 2 . 4 A solution of lithium sulfate contains 0.30 g of lithium sulfate in 25 cm^3.

Calculate the concentration of lithium sulfate in g/dm^3.

[3 marks]

concentration = mass / volume

= 0.30 / 0.25 = 1.2

$25 cm^3 = 0.25 dm^3$

Concentration = 1.2 g/dm^3

Clearly set out so easy to see where marks are gained. MP1 not given because unit conversion is incorrect. But MP2 and MP 3 given for correctly using the incorrectly converted unit.

Chemistry: using percentages

Chemistry 1H Q4

0 4 . 2 **Table 1** shows the mass of a proton and of an electron.

Table 1

Name of particle	Mass in kg
Proton	1.673×10^{-27}
Electron	9.109×10^{-31}

Calculate how many times heavier a proton is than an electron.

[2 marks]

1673 0

1673 ÷ 9.109

1673 0 ÷ 9.109 = 1836.7

Times heavier a proton is than an electron = 1836.7

1 mark. MP1 is given for a correct calculation (the student has cancelled out the standard forms before working out the answer). Their rounding is incorrect, so the second mark is not awarded.

0 4 . 5 Chlorine has two isotopes.

Table 2 shows the percentage abundance of the two isotopes of chlorine.

Table 2

Isotope	Percentage (%) abundance
$^{35}_{17}Cl$	75.77
$^{37}_{17}Cl$	24.23

Calculate the relative atomic mass (A_r) of chlorine.

Give your answer to 2 decimal places.

[3 marks]

(37 × 24.23) + (35 × 75.77)

896.51 + 2651.95 = 3548.46

↑ 3548.5

Relative atomic mass (2 decimal places) = 3548.5

No marks: didn't divide by 100 so incorrect calculation and answer not to 2 decimal places

Biology examples

Biology 1F – understanding standard form

0 4 . 7 Person **W** has 5 000 000 red blood cells in 1 mm^3 of blood.

What is 5 000 000 written in standard form?

[1 mark]

Tick (✓) **one** box.

- 5 × 1 000 000 ☐
- 5 × 10^6 ☐ ✓
- 5 × 10^7 ☑
- 50 × 10^5 ☐

EG

Incorrect answer

Biology 1F – explain differences between inhaled and exhaled air

0 5 . 4 Explain the **differences** in the air breathed into the lungs and the air breathed out of the lungs.

[4 marks]

- there is less oxygen coming out which means the lungs keep 5% of oxygen.
- more carbon dioxide gets released, of nearly 4%. (3.95%.)
- nitrogen is the same in and out so the lungs just need nitrogen for transpotation not respiration.
- the lungs need oxygen the most.

Level 1, 2 marks – student has described the three differences but for Level 2, explanation(s) and difference(s) must be given.

Biology 1F Q6/1H Q1 – 'suggest' question

0 6 . 3 National policies are used to help people who are obese to lose weight.

One national policy is to reduce the amount of sugar added to food and drinks.

Suggest **one other** national policy that could help people to lose weight.

[1 mark]

exercise.

No mark: too vague and not a campaign/ policy that is being introduced and implemented

Biology 2F: plotting data

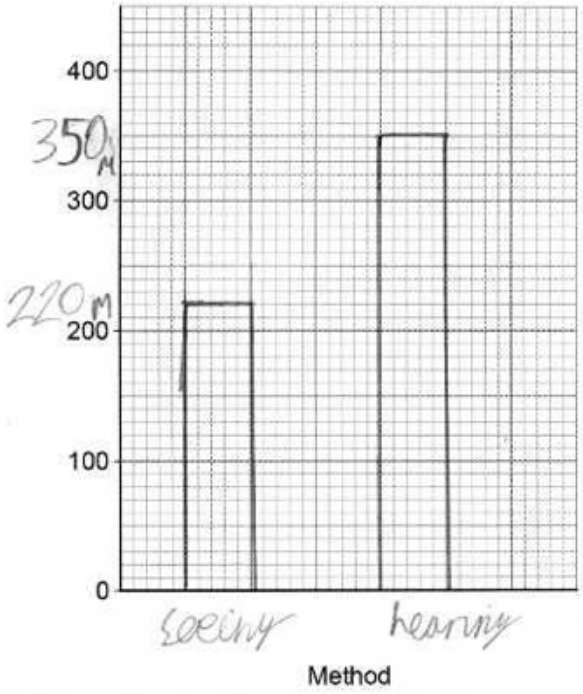
0 2 . 4 Complete **Figure 2**.

You should:

- plot the data from **Table 2** as a bar chart
- label each bar
- label the y-axis.

[2 marks]

Figure 2



No marks awarded: the bars are labelled the wrong way around and the axis has no label.

Working scientifically: Biology 2F

0 3 . 5 The minimum and maximum values on **Figure 4** show the range of results at each distance from the river.

Why is it useful to know the range of results?

[1 mark]

Tick (✓) **one** box.

- To calculate the mean result ✓
- To know the uncertainty of the mean
- To show the mode of the results

Incorrect answer

Planning/describing a method

Chemistry 1F Q6.6/1H Q1.6 Extended response

The student investigated the volume of carbon dioxide produced when different masses of calcium carbonate react with hydrochloric acid.

Describe a method the student could use.

[6 marks]

1) The student should fill the beaker with 10cm^3 of hydrochloric acid
2) The student should then measure the mass of calcium carbonate to be 5grams (each time) (x2)
3) Place the calcium carbonate into the beaker and cover with lid with a hole where the gas syringe is placed.
4) Wait until the calcium carbonate stops reacting (fizzing etc) and collect and records the volume of CO_2 from the gas syringe.
5) Repeat steps 1-4 (4 times)

Describe a method the student could use.

[6 marks]

The student could start by measuring a fixed amount of Hydrochloric acid using the measuring cylinder and then pouring that into the beaker. Then they should measure [redacted] around 5g of calcium carbonate using a balance then put that into the beaker as well. The mixture should be gently stirred and the gas syringe should be put on top of the beaker. When the gas has stopped being produced, the student should record the amount of CO_2 production. The student should then repeat the experiment while adding 5g more of calcium carbonate each time and comparing the results at the end.

Both of these examples are Level 2, 4 marks, the reason being that to get into Level 3 the method needs to lead to a valid outcome – collecting the gas is problematic in each.

Questions based on practical work Chemistry 2F/H: Chromatography

0 6 . 2 Why do the substances in the mixture separate in the mobile phase?

[1 mark]

As is when the water is moving up the paper.

Incorrect answer – why is the command word

0 6 . 3 How many spots will be produced on the chromatogram of a pure compound?

[1 mark]

Number of spots = 7

It's not clear what number this is – 1 or 7? Mark not awarded.

0 6 . 4 In a chromatography experiment, a blue colour moved 4.77 cm.

The solvent moved 5.30 cm.

Calculate the R_f value for the blue colour.

[2 marks]

5.30-4.77 4.77 - 5.30 = -0.53

R_f value = -0.53

Incorrect calculation

0 6 . 5 Black ink is a mixture of several colours.

Plan an experiment using paper chromatography to:

- separate the colours in black ink
- identify the colours from their R_f values.

[6 marks]

take some chromatography paper and draw a line near the bottom, in pencil so that it doesn't react with the water and dissolve. place the bottom of the paper in a shallow bowl of water and mark some spots on the pencil line with black ink. As the water starts to travel up the paper the ink will seperate and travel up aswell revealing the individual colours in the mixture of ink. make sure not to let the paper submerge in the water past the pencil line

Level 2, 3 marks

0 6 . 5 Black ink is a mixture of several colours.

Plan an experiment using paper chromatography to:

- separate the colours in black ink
- identify the colours from their R_f values.

[6 marks]

• get a beaker and a sheet of chromatography paper.
• Draw a line 2 or 3 cm from the bottom of the line in pencil as pencil won't separate
• put 4 dots of black in on the line
• put the paper up so that just under the line is touching.
• record how far each colour travelled.
• Divide the total travel by the travel of one colour to find the R_f value.

Level 2, 3 marks.

Mock analysis of generic skills and fundamental subject-specific skills

Across the science GCSE suite there are generic skills that are assessed in each of the science disciplines . These tend to be either working scientifically or maths skills. There are also fundamental subject specific skills / knowledge that some students also struggle with each year. By analysing student performance in items that assess these points in their mock paper it can give teachers useful insight to help support targeted intervention.

Below we have identified a number of items in the 2023 Combined Trilogy science GCSE papers to **model** this.

By having a small number of specific items students or teachers can use them as part of their AfL This is just our example, it is **not a definitive list** or revision programme .Other areas or question types you know your students find particularly challenging can be added .

8464B1F 1H *Common questions shaded

Item	Description	Mark
2.4	Identifying independent variable	1
3.6	**Suggest** a change to an investigation	1
4.7	Write a number in standard form	1
5.4	Explain the differences in the air breathed into the lungs and the air breathed out of the lungs. (Data given)	4
6.3	**Suggest** one other national policy that could help people to lose weight.	1
Higher only		
5	Extended response linking respiration and photosynthesis – overall exchange at different light intensities	6
6.4	Understanding experimental procedure – giving time to adjust solution to start temp	1
6.5	Calculate the mean rate of starch digestion for the first 3 minutes. Data table and graph – pagination issue but good question	4
6.6	Students are required to explain results if variables are changed	3
7.3	**Suggest** how method could be developed	2
7.4	Identify Independent variable	1

8464 B2F 2H

Item	Description	Mark
2.1	Identify variables	3
2.2	How could the method be improved	1
2.3	**Suggest** one reason why the student's reactions got faster	1
2.4	Plot bar chart	2
3.5	Why is it useful to know the range of results	1
Higher only		
3.1	Describe a method of using a transect to investigate a variable	4
3.2	Interpret an unfamiliar graph	1
6.3	Calculate the mean rate from a graph	2

8464 C1F 1H

Item	Description	Mark
2.4	Calculation temperature rise	2
3.6	Basic chemistry on molecular structure	1
3.7	Describe the trend shown in a graph	3
Q4	All items on electrolysis	9
5.5	Balancing an equation	1
5.6	Calculate mass of carbon dioxide produced in an experiment. Assessing basic understanding of conservation of mass	1
6.2	Test for acidity (knowledge of indicators)	1
6.4	Interpretation of graphical data (understanding of solubility and acidity)	1
7.3	Calculation of percentage by mass of oxygen in lithium sulfate. Multi-step Inc. use of sig figs	4
7.4	Concentration calculation inc. unit conversion	3
Higher only		Mark
4.4	Number of electrons in an **ion** given the mass and atomic number	1
4.5	Percentage abundance of isotopes given calculate RAM	3
5.4	Half equation for production of chlorine at positive electrode	2
6.3	Reacting masses multi-step calculation of concentration of magnesium chloride produced given concentration and amount of magnesium. Includes unit conversion. in chemistry	6
7.3	Explanations of high melting point in terms of structure and bonding.	3
7.4	Explanation of low melting point in terms of structure and bonding	3

8464 C2F 2H

Item	Description	Mark
1.6	Test for hydrogen gas.	1
1.7	Percentage mass calculation. Includes significant figs.	3
2.3	Calculation, including giving answer in standard form	3
3.7	Comparing two sets of data from a graph	4
4.3	Plotting data including drawing a line of best fit (curve)	3
5.1	Balancing an equation	
6.5	Plan a chromatography experiment	6
Higher only		Mark
3.4	Test for hydrogen (also involves understanding of state symbols)	2
4.1	How to improve a method	1
4.6	Test for chlorine.	2
6.1	Test for oxygen (also involves understanding of equation)	2
6.7	Multistep calculation involving drawing a tangent to a curve and sig figs	5

8464 P1F 1H

Item	Description	Mark
4.3	Plan a method to find out how resistance of a component varies with temperature in a context	4
4.4	Identifying the type of relationship shown on a graph	1
4.5	Reading a value off a graph and using it in a calculation	2
5.3	Using graphical data from two different types of graphs to explain a changes (power output)	6
6.2	Understand the relationship between the total resistance of the resistors (in parallel) and the resistance of the smallest resistor	2
6.5	Plotting a graph of resistance of a component and the total resistance in a circuit	3
6.8	Using data from a graph to evaluate a situation	3
Higher only		
Q4	Knowledge and understanding of Radioactivity and medical use – all items	11
5.2	Multistep calculation with sig figs (gravitational potential energy)	5

8464 P2F 2H

Item	Description	Mark
1.3	Equation given – calculation	2
1.4	Equation given – calculation - need to square a number **compare** to similar calculation Q1.3	2
1.8	Improvements to data	2
3.6	Understanding types of variable control /dependent / independent	1
4.6	Applying understanding - linking temp and speed of sound particles	2
5.1	Converting cm to meters	1
5.6	Equation - calculation plus sig figs	4
6.5	Equation - calculate frequency of wave using powers	3
7.5	Equation - calculation - substitution & rearrange of previous questions answer	3
Higher only		
3.1	Ripple tank (RP) work out wavelength from diagram	3
3.3	Definition of precise	1
5.4	Identify the equation, substitution, rearrange square root and 1/2	3
5.5	Calculate a value and then apply to situation and make an evaluation different type of question - get some examples	3
6.1	Calculate velocity , sig fig, square roots	4

7.1	Determine the deceleration of the car by reading figures off a graph and applying them to equation differentiated well	3
7.2	Complex multi step calculation could do it do it or couldn't	5

Questions for interrogating an experimental method

Here are some suggestions for questions you could use with any given method (familiar or unfamiliar) and which you could adapt for the specific method or level of demand. You don't have to ask questions about every aspect of the practical – you could just use one or two to focus understanding.

Category of question	Questions that could be asked
Content being covered	• What is being investigated? • What is it in the wording that tells you this? • Does this method relate to a practical you have done? • Is it the same or is it slightly different? • How is it different from what you have done? • What topic you have studied is this practical about?
Hypotheses	• Is the student/scientist testing a hypothesis? • What hypothesis are they testing? • Suggest a hypothesis for this investigation. • Do the results support this hypothesis?
Variables	• Is the student changing any variables in this investigation? • What variables are they changing? • Why are they changing that variable? • What is the independent variable? • What is the dependent variable? • What variables to they need to keep the same?
Sampling/controls	• What would you use as a control sample in this experiment? • What would be a suitable range of measurements to use? • What other things could you measure? • How could you change the method to determine … ?
Measurements and types of error	• One of the results is anomalous. What could have caused this anomaly? • Give a reason why the measurement(s) may not be accurate. • The student made a mistake setting up the apparatus. What mistake did they make? What problem could this cause?
Accuracy/resolution	• What was the resolution of the [instrument used]? • What could the student do to make their results more accurate?

Results	• What results do you predict? Why? • What would getting results that don't match your prediction tell you? • Do the results confirm the hypothesis? If not, what **are** they showing? • Explain the result for [X] • One of the results is anomalous. How do you know which result is anomalous? What could have caused the anomalous result?
Evaluating methods/validity	• How could the student improve the method to get more valid results? • The method will produce qualitative results. How could you change the method to produce accurate, quantitative results? • How could the method be changed to ensure that results are repeatable? • What mistake did the student make when setting up the apparatus? • The student concludes that the results are valid. Is the student correct? Why?

Hub/Virtual Communities resources on the website

The following table summarises the topics covered in the GCSE science Hub and Virtual communities meetings, from spring 2020 to spring 2023.

All resources can be downloaded from the science virtual communities pages on our website. Usually only materials from the most recent three meetings are on this page, but all other materials (including pre-2020 materials) can be found on the Hub archive page.

Meeting session	Summary of session content
Spring 2023	**Supporting students with extended prose questions** • What we mean by extended prose; Points-based and levels of response mark schemes; Applying a levels mark scheme; Answering extended prose questions; Features of a good response
Autumn 2022	**Revisiting AO2** • Differentiating between AO1, AO2 and AO3 questions; Understanding the Ofqual requirements for AO2; Assessment in relation to maths, practical and working scientifically skills; Levels of demand; Unfamiliar contexts

Summer 2022	**Progression in practical skills** • DfE criteria at each key stage; How the demand progresses through the stages; Identifying key skills at each stage to build competence; Skills to look at in benchmarking; Using questions to help the transition from KS3 to GCSE; AQA resources for supporting development
Spring 2022	**Supporting students in understanding subject content using AO1 questions** • Understanding the different 'flavours' of AO1; Identifying the different types; Common mistakes students make in answering AO1 questions; Using the Advance Information, past papers and examiner reports to help students improve their confidence; Developing strategies to dispel misconceptions and misunderstandings; Developing formative questions to support learning and revision
Autumn 2021	**Supporting students in their application of practical skills in unfamiliar contexts** • Understanding the differences between 'hands-on' and 'minds-on'; Advantages of using a 'minds-on'approach; Working scientifically 'hands-on' and 'minds-on' criteria; Developing a framework of questions to encourage 'minds-on' approach to practical work; Suggested questions for interrogating an experimental method; Introducing Project Calibrate
Summer 2021	**Supporting transition from KS3 to GCSE and from GCSE to A-level using a key transferrable maths skill in science (use of standard form) as an example** • The requirements for the skill and how they are assessed at the different key stages; Ideas for how you can enable student progression and AQA resources to aid this progression; Links to online resources; Example questions used in the activities; Starter activity flowchart; Example lesson activities; Information on progression in two other key maths skills not covered in the presentation
Spring 2021	**Understanding the requirements of some key command words in exam papers using student responses** • Definitions, what examiners are looking for and examples of student responses for the command words describe, explain, compare, evaluate; Comments on the student responses regarding how they have, or have not, addressed the requirements of the command word;
Autumn 2020	**Reminder of situation for 2020/2021 as known at the time** • Points to consider in breakout groups for discussions on practical work and importance of mock exams; Details of Apparatus and Techniques criteria covered in the Required

	Practical Activities for each GCSE science
Spring 2020	**How we assess maths skills in GCSE sciences at different levels of demand, using examples of student work** • Discussion activity on ways of including opportunities for development of particular maths skills in schemes of work (using AQA schemes as examples); Guidance on assessment of particular maths skills; Student examples and commentaries for discussion in meeting and in school

Contact us

Our friendly team will be happy to support you between 8am and 4pm, Monday to Friday.

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