Pearson

Understanding Assessment and Improving Delivery in IAL Chemistry

Your Trainer Today is: CLIFF CURTIS BSc FRSC

Aims & Objectives

- introduce the concept of assessment objectives: what are they and why they are used when writing examination papers
- analyse recent question papers and learn which types of questions match the different assessment objectives
- investigate different assessment objectives, considering how questions have been answered by looking at feedback from the previous exam series
- discuss strategies for teaching to help students access questions targeting different assessment objectives
- review the support Pearson offers for teaching the qualification

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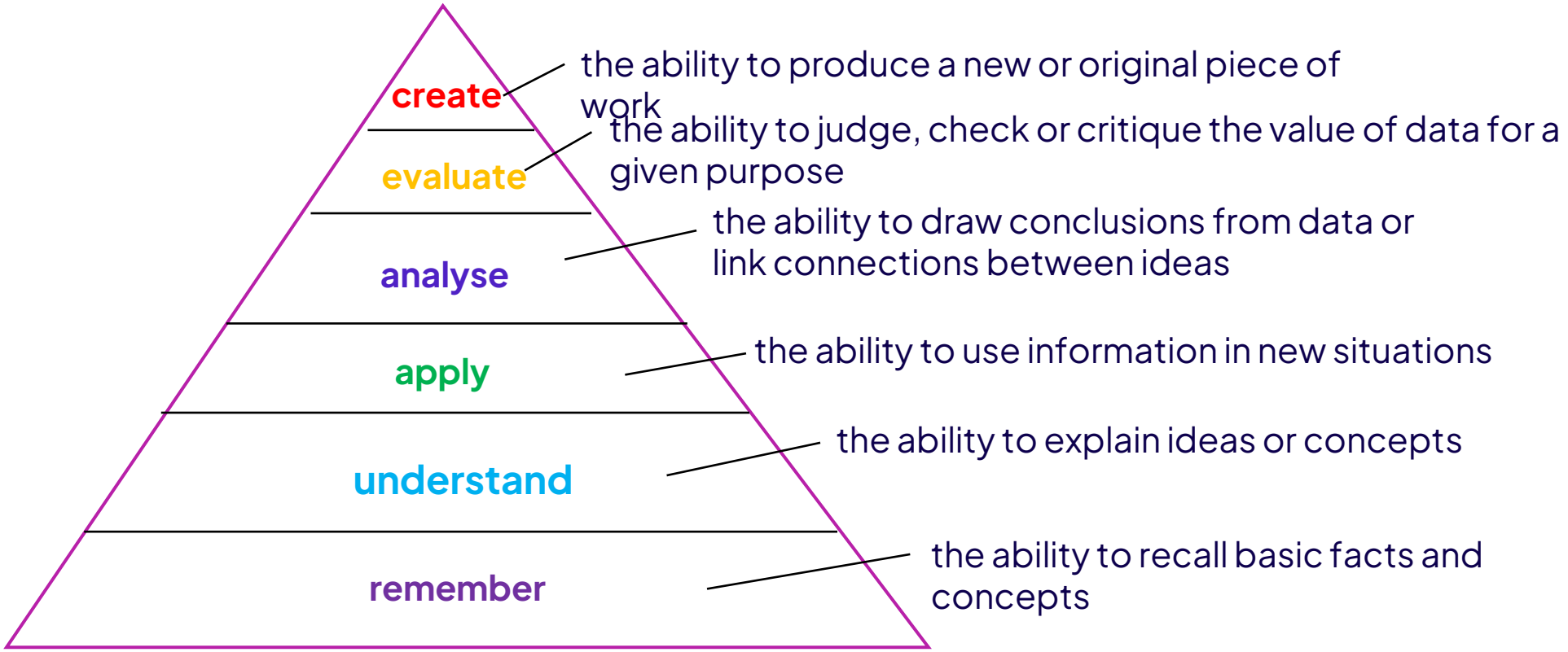
Assessment Objectives

Bloom's Taxonomy



Assessment Objectives

Every question or part question is linked to a particular assessment objective (AO)

There are three assessment objectives labelled AO1, AO2 and AO3

AO2 is further subdivided into AO2(a) and AO2(b)

The assessment objectives are closely lined to Bloom's Taxonomy and are given different weightings in the exam papers

This is shown on the next slide

Definitions of AOs

		% in IAS	% in IA2	% in IAL
AO1	Demonstrate knowledge and understanding of science.	34–36	29–31	32–34
AO2 (a)	Application of knowledge and understanding of science in familiar and unfamiliar contexts.	34–36	33–36	33–36
(b)	Analysis and evaluation of scientific information to make judgements and reach conclusions.	9–11	14–16	11–14
AO3	Experimental skills in science, including analysis and evaluation of data and methods.	20	20	20

Specification p75

Why do we have assessment objectives?

- Help make exams fairer year on year
- Provide structure for question paper writers
- Make sure that exams are about skills, not just about knowledge
- Can provide students with some reassurance about the types of questions they will be asked

Typical AO1 question

Propan-1-ol may be converted into propene.

$$CH_3CH_2CH_2OH \rightarrow CH_3CH{=}CH_2 + H_2O$$

Which reagent is used for this reaction?

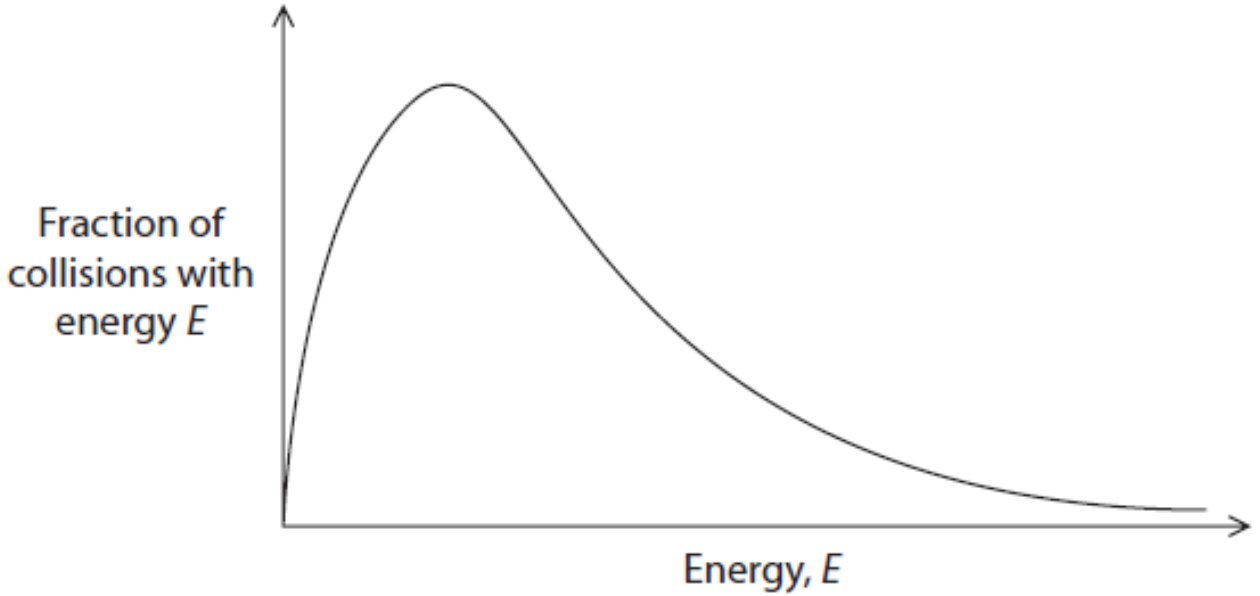
- ☒ **A** 50% sulfuric acid
- ☒ **B** ethanolic potassium hydroxide
- ☒ **C** phosphoric(V) acid
- ☒ **D** red phosphorus

Typical AO1 questions

Methanal is used in the production of many materials and chemical compounds. It is manufactured from methanol by reaction with oxygen at 300–400 °C using an iron-molybdenum oxide catalyst.

$$CH_3OH(g) + \tfrac{1}{2}O_2(g) \rightarrow HCHO(g) + H_2O(g)$$

(a) The Maxwell–Boltzmann distribution for the reaction mixture at 300 °C is shown.



(i) On the diagram, sketch the Maxwell–Boltzmann distribution for this reaction mixture at a **higher** temperature. (1)

(ii) Using the Maxwell–Boltzmann distributions, explain why increasing the temperature and adding a catalyst both increase the rate of reaction. (2)

Typical AO2a question

Which compound has the greatest covalent character?

☒ **A** $MgBr_2$

☒ **B** MgF_2

☒ **C** NaBr

☒ **D** NaF

Typical AO2a question

Barium chloride, $BaCl_2$, can be prepared by the reaction of barium carbonate with hydrochloric acid.

$$BaCO_3(s) + 2HCl(aq) \rightarrow BaCl_2(aq) + CO_2(g) + H_2O(l)$$

Write the ionic equation for this reaction.
State symbols are not required.

(1)

Typical AO2b question

0.15 mol of aluminium is added to 120 cm^3 of 1.50 mol dm^{-3} hydrochloric acid.

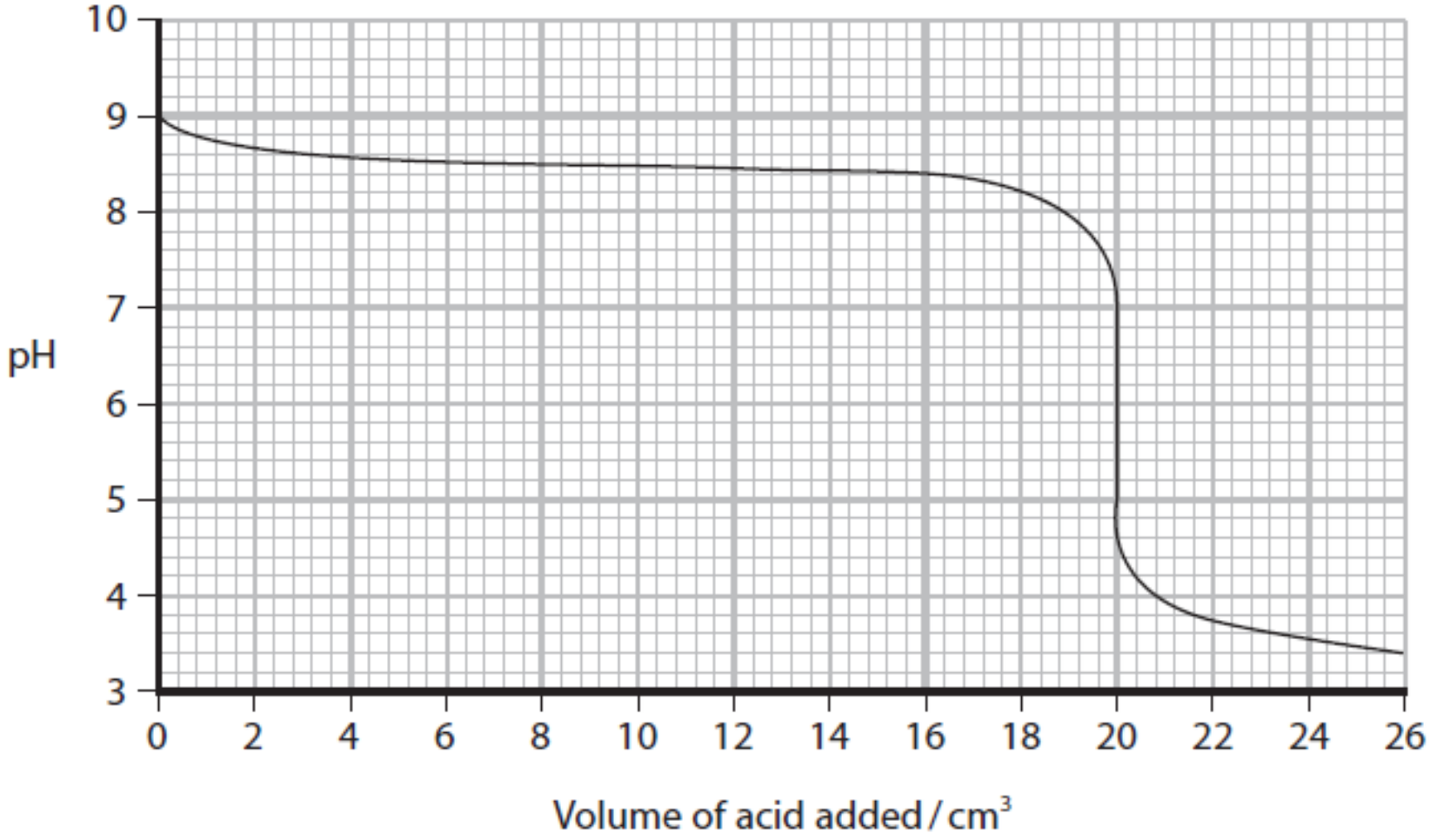
$$2Al(s) + 6H^+(aq) \rightarrow 2Al^{3+}(aq) + 3H_2(g)$$

The amount of **unused** reactant is

- ☒ **A** 0.06 mol aluminium
- ☒ **B** 0.09 mol aluminium
- ☒ **C** 0.03 mol hydrochloric acid
- ☒ **D** 0.13 mol hydrochloric acid

Typical AO2b question

A titration curve of Tris with chloroethanoic acid is shown.



Explain how this graph shows Tris and its conjugate acid act as a buffer.

Command Words

Command words

- All questions other than multiple choice questions, will be short open, open-response, calculations or extended writing questions
- All of these will only use the command words listed in Appendix 7 of the specification
- The depth of answer required will depend on the command word used and the number of marks available
- Command words also link to Bloom's taxonomy

Command words and Bloom's Taxonomy

Bloom's taxonomy	Command word(s)
Remember (Often AO1)	**Add** (e.g. units) **Complete** (e.g. a table or diagram) **Draw** (e.g. diagram of reflux apparatus) **Give / State / Name** (e.g. recall of one or more pieces of information) **Label** (e.g. a diagram) **State what is meant by** (i.e. the meaning of a term when there are different ways of expressing this)
Understand (Often AO1)	**Describe** (i.e. to give an account of something) **Explain** (i.e. the answer requires a point to be made **and** the reason(s) for it, this can include mathematical explanations) **Give a reason / reasons** (e.g. an explanation of a point that is given in the question – e.g. this happens because ….) **Show that** (i.e. verify a statement given in the question, this can include mathematical explanations – e.g. show that hydrochloric acid is in excess)

Command words and Bloom's Taxonomy

Bloom's taxonomy	Command word(s)
Apply (Often AO2)	**Calculate** (used for most calculations) **Determine** (used for some calculations) **Justify** (i.e. give evidence to prove a point made in a question or to prove a prediction that a candidate has made) **Plot** (used for graphs) **Sketch** (used for a freehand graph with axes and labels but no scale) **Write** (used for equations)
Analyse (AO2 or AO3)	**Compare and contrast** (i.e. looking for similarities **and** differences of two or more things) **Deduce** (i.e. use the information provided to draw or reach a conclusion) **Identify** (i.e. use the results of tests / spectra etc to identify an unknown substance) **Predict** (i.e. use the information given to give the expected result – e.g. looking at trends in data or the periodic table)

Command words and Bloom's Taxonomy

Bloom's taxonomy	Command word(s)
Evaluate (AO3)	**Assess** (i.e. consider all the factors that apply and identify which are the most important or relevant, make a judgement or come to a conclusion) **Comment on** (i.e. synthesise a number of variables from data / information to form a judgement) **Criticise** (i.e. inspect a set of data, an experimental plan or a scientific statement – look at the merits and faults of these and back judgements made by giving evidence) **Discuss** (i.e. identify the issue that is being assessed within the question or explore all aspects of it or investigate the issue by reasoning or argument) **Evaluate** (i.e. review information then bring it together to form a conclusion, drawing on evidence including strengths, weaknesses, alternative actions, relevant data or information. Come to a supported judgement of a subject's qualities and relation to it's context.)
Create (AO3)	**Devise** (i.e. plan or invent a procedure from existing principles / ideas)

ACTIVITY 1

Activity 1 – Assigning Command Words and AOs

For each question/part question on the next slides state the command word used and assign an assessment objective

We will go through each question/part question one at a time

Activity 1 – Assigning Command Words and AOs

Question 1

(a) (i) Define relative atomic mass. (2)

(ii) Calculate the relative atomic mass of a sample of silicon, using the isotopic abundance data provided.
Give your answer to 3 significant figures.

Isotope	Abundance (%)
^{28}Si	91.07
^{29}Si	4.62
^{30}Si	3.00
^{32}Si	1.31

(2)

(iii) In the mass spectrum of silicon, there is also a small peak at $m/z = 14$.
Deduce the formula of this particle. (1)

Activity 1 – Assigning Command Words and AOs

Question 2

Bromoethane was prepared from the reaction of ethanol with sulfuric acid and potassium bromide.

$$C_2H_5OH + H_2SO_4 + KBr \rightarrow C_2H_5Br + KHSO_4 + H_2O$$

Procedure

Step **1** 10.0 cm^3 of ethanol was placed in a round-bottomed flask.

Step **2** 10.0 cm^3 of concentrated sulfuric acid was added carefully and gradually to the ethanol in the flask.

Step **3** 12.0 g of potassium bromide was added to the reaction mixture in the flask.

Step **4** The flask was set up for distillation and heated gently.

Step **5** Water, ethanol and bromoethane were collected in a small beaker.

Step **6** The bromoethane was purified.

Step **7** The bromoethane was dried.

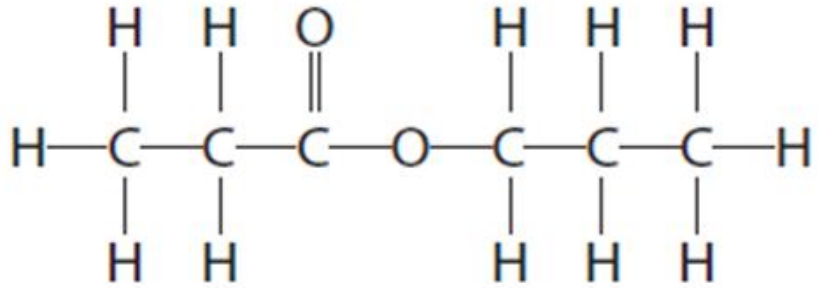
(a) Suggest why the flask in Step **2** was frequently placed in a stream of cold running water as the sulfuric acid was gradually added. **(1)**

(b) The potassium bromide used in Step **3** was initially lumpy and not a fine powder. State the apparatus that would be suitable for breaking up the lumps of potassium bromide into a powder. **(1)**

(c) Explain why an orange colour was seen in the round-bottomed flask when it was first gently heated in Step **4**. **(2)**

Activity 1 – Assigning Command Words and AOs

Question 3 Propyl propanoate has the structure shown.



Devise a synthetic pathway to prepare propyl propanoate starting with 1-bromopropane as the **only** organic compound.

Include the reagents for each step in the synthesis, and the names or structures of the intermediate compounds.

Maths Skills

Maths Skills

- The set of three IAS and IA2 papers must include questions that target mathematics at Level 2 or above
- A minimum of 20% of the marks must be awarded for mathematics at Level 2 or above
- Individual steps in a calculation may not be at Level 2, for example, calculating a relative formula mass, but this may be acceptable if it is a complex formula and part of an unstructured question
- The details of the mathematical skills that will be tested are listed in Appendix 6 of the specification

Example of a maths question

A student was given 50.0 cm^3 of a solution of sodium hydroxide.

The pH of this solution was 12.43

The student was asked to adjust the pH to 12.00, by dilution with deionised water. The student did **not** have access to a pH meter.

Calculate the volume of deionised water, **in cm^3**, the student should add to the original solution.

(5)

M1	calculation of $[H^+]$ at both pH values	**(1)**
M2	calculation of $[OH^-]$ at both pH values	**(1)**
M3	calculation of moles of NaOH in 50.0 cm^3 at pH 12.43	**(1)**
M4	calculation of volume of NaOH required at pH 12.00	**(1)**
M5	volume of water required in cm^3	**(1)**

AO2 Questions in Exams

Why not look at AO1?

- AO1 is all about knowledge – and basic understanding
- This is not something that teachers can influence much…
- … students either go away and learn what you teach them, or they do not!
- **BUT**… remember that students should still recognise AO1 questions and not spend time going beyond AO1

ACTIVITY 2

Activity 2 AO2a in exams

Use the mark schemes shown on-screen to mark the student responses on the next slides

We will go through each question one at a time

ACTIVITY 2 – AO2a in exams

Write the equation for the third ionisation energy of calcium.

Include state symbols. **(3)**

Answer		Additional Guidance
An answer that makes reference to the following points:		
• Ca 2+ ions to Ca 3+ ions (and 1 mol only)	**(1)**	$Ca^{2+}(g) \rightarrow Ca^{3+}(g) + e^-$
• one electron with charge **and** balanced ionisation equation	**(1)**	Allow $Ca^{2+}(g) - e^- \rightarrow Ca^{3+}(g)$
• correct state symbols	**(1)**	Ignore state symbol on electron

ACTIVITY 2 – AO2a in exams

Student 1

$Ca^{2-}(g) + e^- \rightarrow Ca^{3-}(g)$

Student 2

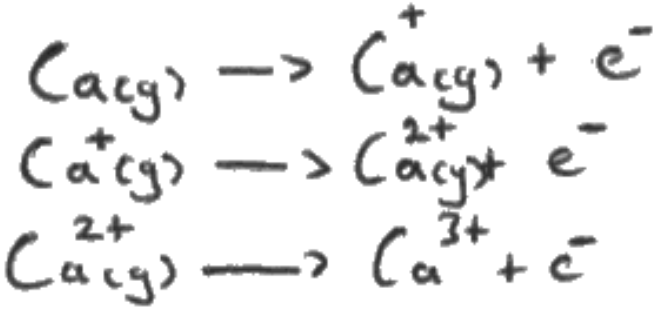
$Ca^{2+}_{(g)} - e^- = Ca^{3+}_{(g)}$

Answer		Additional Guidance
An answer that makes reference to the following points:		
• Ca 2+ ions to Ca 3+ ions (and 1 mol only)	**(1)**	$Ca^{2+}(g) \rightarrow Ca^{3+}(g) + e^-$
• one electron with charge **and** balanced ionisation equation	**(1)**	Allow $Ca^{2+}(g) - e^- \rightarrow Ca^{3+}(g)$
• correct state symbols	**(1)**	Ignore state symbol on electron

ACTIVITY 2 – AO2a in exams

Student 3

Student 4



Answer		Additional Guidance
An answer that makes reference to the following points:		
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• one electron with charge **and** balanced ionisation equation	**(1)**	Allow $Ca^{2+}(g) - e^- \rightarrow Ca^{3+}(g)$
• correct state symbols	**(1)**	Ignore state symbol on electron

ACTIVITY 2 – AO2a in exams

Element	Li	Be	B	C	N	O	F	Ne
1st ionisation energy / kJ mol^{-1}	520	900	801	1086	1402	1314	1681	2081

Explain the difference in first ionisation energies between beryllium and boron. (2)

Answer		Additional Guidance
An explanation that makes reference to the following points:		
(because beryllium has a higher first ionisation energy than boron)		Penalise any other shell once only
• the removal of the electron is from a (2)s orbital in beryllium rather than a (2)p orbital in boron	**(1)**	Ignore correct electronic configurations
• the (2)p orbital is higher in energy	**(1)**	Accept the (2)p orbital is more shielded Ignore further away from the nucleus

ACTIVITY 2 – AO2a in exams

Student 1

- there is a decrease the electron removal is on in a different orbital where beryllium is in s ~~block~~ orbital and boron is in p block. there is electron repulsion.

Answer		Additional Guidance
An explanation that makes reference to the following points: (because beryllium has a higher first ionisation energy than boron)		Penalise any other shell once only
• the removal of the electron is from a (2)s orbital in beryllium rather than a (2)p orbital in boron	**(1)**	Ignore correct electronic configurations
• the (2)p orbital is higher in energy	**(1)**	Accept the (2)p orbital is more shielded Ignore further away from the nucleus

ACTIVITY 2 – AO2a in exams

Student 2

(i) Boron has lower 1st ionisation energy than beryllium as its electron removed from 2p sub-shell rather than 2s sub-shell. (ii) 2p sub-shell is shielded by 2s (further from the nucleus), thus it requires less energy to remove an electron

Answer		Additional Guidance
An explanation that makes reference to the following points: (because beryllium has a higher first ionisation energy than boron)		Penalise any other shell once only
• the removal of the electron is from a (2)s orbital in beryllium rather than a (2)p orbital in boron	**(1)**	Ignore correct electronic configurations
• the (2)p orbital is higher in energy	**(1)**	Accept the (2)p orbital is more shielded Ignore further away from the nucleus

ACTIVITY 2 – AO2a in exams

Student 3

o ~~Boron~~ The electron in boron has ~~st~~ entered the 2p orbital which is a higher energy level that is further away from the nucleus, so the electrostatic force of ~~all~~ attraction is weak meaning less energy is required to remove this ~~first~~ first electron.

Answer		Additional Guidance
An explanation that makes reference to the following points: (because beryllium has a higher first ionisation energy than boron)		Penalise any other shell once only
• the removal of the electron is from a (2)s orbital in beryllium rather than a (2)p orbital in boron	**(1)**	Ignore correct electronic configurations
• the (2)p orbital is higher in energy	**(1)**	Accept the (2)p orbital is more shielded Ignore further away from the nucleus

ACTIVITY 2 – AO2a in exams

Student 4

Boron has electron in 2p subshell which is at a higher energy level than 2s sub~~-~~shell

Answer		Additional Guidance
An explanation that makes reference to the following points:		
(because beryllium has a higher first ionisation energy than boron)		Penalise any other shell once only
• the removal of the electron is from a (2)s orbital in beryllium rather than a (2)p orbital in boron	**(1)**	Ignore correct electronic configurations
• the (2)p orbital is higher in energy	**(1)**	Accept the (2)p orbital is more shielded Ignore further away from the nucleus

ACTIVITY 2 – AO2a in exams

Complete the table. (3)

molecule	shape	bond angle
methane		
ammonia		
water		

molecule	shape	bond angle	
methane	tetrahedral	109.5°	(1)
ammonia	(trigonal) pyramidal	107°	(1)
water	non-linear / bent / V-shaped	104.5°	(1)

If no other mark scored 1 mark for either three correct bond angles or three correct shapes

ACTIVITY 2 – AO2a in exams

Student 1

molecule	shape	bond angle
methane	tetrahedral	109.5
ammonia	pyramidal	107
water	Bent	104.5

molecule	shape	bond angle	
methane	tetrahedral	109.5°	**(1)**
ammonia	(trigonal) pyramidal	107°	**(1)**
water	non-linear / bent / V-shaped	104.5°	**(1)**

If no other mark scored 1 mark for either three correct bond angles or three correct shapes

ACTIVITY 2 – AO2a in exams

Student 2

molecule	shape	bond angle
methane	tetrahedral	109.5°
ammonia	pyramidal	107°
water	bent planar	104.5°

molecule	shape	bond angle	
methane	tetrahedral	109.5°	**(1)**
ammonia	(trigonal) pyramidal	107°	**(1)**
water	non-linear / bent / V-shaped	104.5°	**(1)**

If no other mark scored 1 mark for either three correct bond angles or three correct shapes

ACTIVITY 2 – AO2a in exams

Student 3

molecule	shape	bond angle
methane	~~tetrahedral~~ ~~tetrahedral~~	109°
ammonia	trigonal	107°
water	V ~~shape~~	104.5°

molecule	shape	bond angle	
methane	tetrahedral	109.5°	(1)
ammonia	(trigonal) pyramidal	107°	(1)
water	non-linear / bent / V-shaped	104.5°	(1)

If no other mark scored 1 mark for either three correct bond angles or three correct shapes

ACTIVITY 2 – AO2a in exams

Student 4

molecule	shape	bond angle
methane	tetrahedral	109°
ammonia	trigonal pyramidal	107.5°
water	bent v shape	104°

molecule	shape	bond angle	
methane	tetrahedral	109.5°	**(1)**
ammonia	(trigonal) pyramidal	107°	**(1)**
water	non-linear / bent / V-shaped	104.5°	**(1)**

If no other mark scored 1 mark for either three correct bond angles or three correct shapes

ACTIVITY 3

Activity 3 AO2b in exams

Use the mark schemes shown on-screen to mark the student responses on the next slides

We will go through each question one at a time

Activity 3 – AO2b in exams

Explain the differences between the molecular shapes and bond angles for ammonia and water. (2)

Answer	Additional Guidance
An answer that makes reference to the following points: (Both ammonia and water have four pairs of electrons around the central atom) • ammonia has one lone pair and water has two lone pairs **(1)** • lone pairs (of electrons) repel more than bonded pairs. **(1)**	Allow water has an extra lone pair Ignore bond angles even if incorrect.

Activity 3 – AO2b in exams

Student 1

Ammonia has 3 bonding pair and 1 lone pair whee electrons arrange themselves in an angle of 107 to minimize repulsion.

water has 2 ~~lone~~ bonding pairs and 2 lonepairs where electrons arrangetheselfs in an angle of 104.5 to minimize repulsion

Answer	Additional Guidance
An answer that makes reference to the following points: (Both ammonia and water have four pairs of electrons around the central atom) • ammonia has one lone pair and water has two lone pairs **(1)** • lone pairs (of electrons) repel more than bonded pairs. **(1)**	Allow water has an extra lone pair Ignore bond angles even if incorrect.

Activity 3 – AO2b in exams

Student 2

There are 4 ~~t~~ 3 bonding pairs about CH_4

There are 3 bonding pairs and 1 lone pair about NH_3

there are 2 bonding pairs and 2 lone pair about H_2O

which arrange to minimize the repulsion. lone pairs repel more than bonding pairs

Answer	Additional Guidance
An answer that makes reference to the following points: (Both ammonia and water have four pairs of electrons around the central atom) • ammonia has one lone pair and water has two lone pairs **(1)** • lone pairs (of electrons) repel more than bonded pairs. **(1)**	Allow water has an extra lone pair Ignore bond angles even if incorrect.

Activity 3 – AO2b in exams

Student 3

Ammonia has 1 lone pair and 3 bond pair of electrons while oxygen has 2 lone pairs and 2 bond pairs. The electron pairs seperate in a form to keep minimum repulsion. So ~~ten~~

Answer	Additional Guidance
An answer that makes reference to the following points: (Both ammonia and water have four pairs of electrons around the central atom) • ammonia has one lone pair and water has two lone pairs **(1)** • lone pairs (of electrons) repel more than bonded pairs. **(1)**	Allow water has an extra lone pair Ignore bond angles even if incorrect.

Activity 3 – AO2b in exams

Student 4

Ammonia has 3 bonding pairs and one lone pair, whereas water has 2 bonding pairs and 2 lone pairs. Both arrange in shapes to minimize electron pair repulsion.

Lone pair-lone pair repulsion is greater than electron pair-lone pair repulsion, and as water has more lone pairs than ammonia, it has a smaller bond angle.

Answer	Additional Guidance
An answer that makes reference to the following points: (Both ammonia and water have four pairs of electrons around the central atom) • ammonia has one lone pair and water has two lone pairs **(1)** • lone pairs (of electrons) repel more than bonded pairs. **(1)**	Allow water has an extra lone pair Ignore bond angles even if incorrect.

Activity 3 – AO2b in exams

Ethene and poly(ethene) have different melting temperatures.

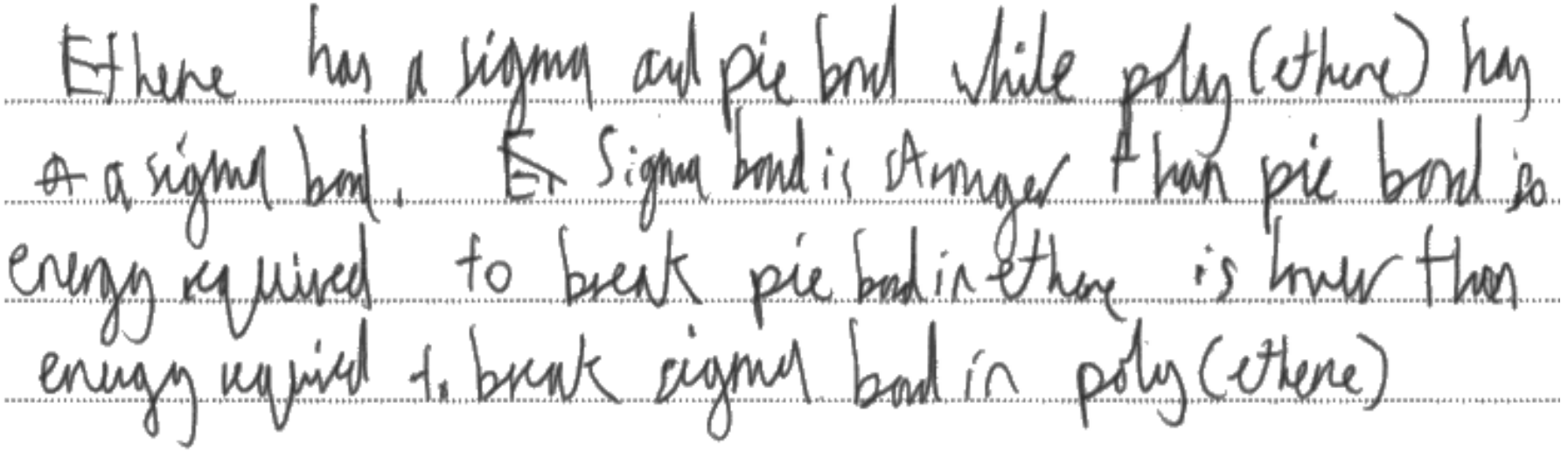
Molecule	Melting temperature (K)
ethene	104.1
poly(ethene)	400

Explain why their melting temperatures are different. (2)

Answer	Additional Guidance
An answer that makes reference to the following points:	Allow London / van der Waals / dispersion forces for intermolecular forces
• ethene is a simple molecule	Ignore monomer
• ethene has weak intermolecular forces	Do not award reference to breaking covalent bonds
• poly(ethene) is a polymer	Allow poly(ethene) is a macromolecule / giant molecule for polymer
• poly(ethene) strong intermolecular forces	Do not award reference to breaking covalent bonds
All four bullet points scores 2 Two or three bullet points scores 1	

Activity 3 – AO2b in exams

Student 1



Answer	Additional Guidance
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• ethene is a simple molecule	Ignore monomer
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• poly(ethene) is a polymer	Allow poly(ethene) is a macromolecule / giant molecule for polymer
• poly(ethene) strong intermolecular forces	Do not award reference to breaking covalent bonds
All four bullet points scores 2 Two or three bullet points scores 1	

Activity 3 – AO2b in exams

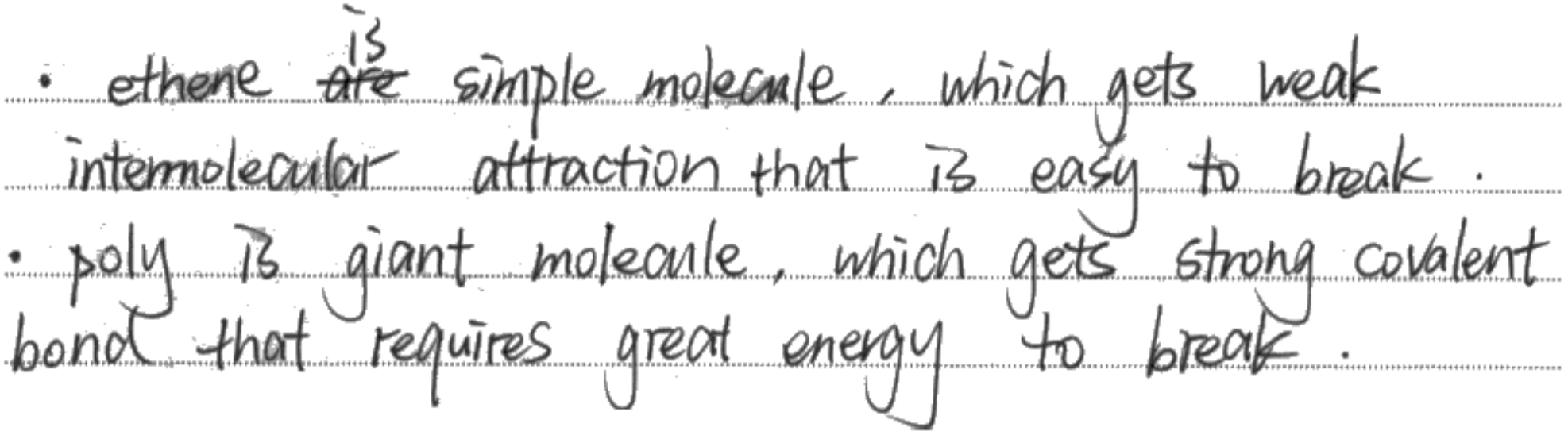
Student 2

① giant molecular structure. Strong intermolecular force in poly.
So need a lot of energy to break them.
② double bond easy to break.

Answer	Additional Guidance
An answer that makes reference to the following points:	Allow London / van der Waals / dispersion forces for intermolecular forces
• ethene is a simple molecule	Ignore monomer
• ethene has weak intermolecular forces	Do not award reference to breaking covalent bonds
• poly(ethene) is a polymer	Allow poly(ethene) is a macromolecule / giant molecule for polymer
• poly(ethene) strong intermolecular forces	Do not award reference to breaking covalent bonds
All four bullet points scores 2 Two or three bullet points scores 1	

Activity 3 – AO2b in exams

Student 3



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All four bullet points scores 2 Two or three bullet points scores 1	

Activity 3 – AO2b in exams

Student 4

Because there are weak intermolecular force for ethene But the attraction force is strong between the polyethene's long chains. So there's need more energy.

Answer	Additional Guidance
An answer that makes reference to the following points:	Allow London / van der Waals / dispersion forces for intermolecular forces
• ethene is a simple molecule	Ignore monomer
• ethene has weak intermolecular forces	Do not award reference to breaking covalent bonds
• poly(ethene) is a polymer	Allow poly(ethene) is a macromolecule / giant molecule for polymer
• poly(ethene) strong intermolecular forces	Do not award reference to breaking covalent bonds
All four bullet points scores 2 Two or three bullet points scores 1	

Improving Delivery in AO2

Teaching and Learning Strategies

- Focus on understanding the requirements of questions looking carefully at what marks are awarded for
- Students should practice examination questions focusing on the use of mark schemes to understand the requirements of the questions
- Look at the wording of the question to identify where the context needs to be addressed (AO2) rather than simply facts and statements (AO1)

Building more independent learners

- Encourage students to take responsibility for prior knowledge
- Consider using ‘Jigsaw’ tasks
- Try to make time in lessons to adopt more of a ‘coaching’ role, than a ‘director’ role
- C3B4UCM

Building more independent learners

- Consider using ‘Snowball’ techniques to develop an explanation

  This encourages peer to peer discussion / collaboration

- Provide access to reference material – hard copy or online

- Use open questioning

AO3 Questions in exams

Why do we ask AO3?

- While AO1 is focused on recall of knowledge and explanation and AO2 focuses on application, analysis and evaluation, AO3 is placed in a practical context
- Practical work is an important part of Chemistry A level and a student's familiarity with practical techniques is tested in AO3
- The practical work may be familiar or unfamiliar, but questions will focus on techniques and concepts

Types of Questions

- All the questions in papers WCH13 (Unit 3) and WCH16 (Unit 6)

- Many questions are similar to the questions from equivalent papers in the previous specification

ACTIVITY 4

Activity 3 AO3 in exams

Use the mark schemes shown on-screen to mark the student responses on the next slides

We will go through each question one at a time

ACTIVITY 4 – AO3 in exams

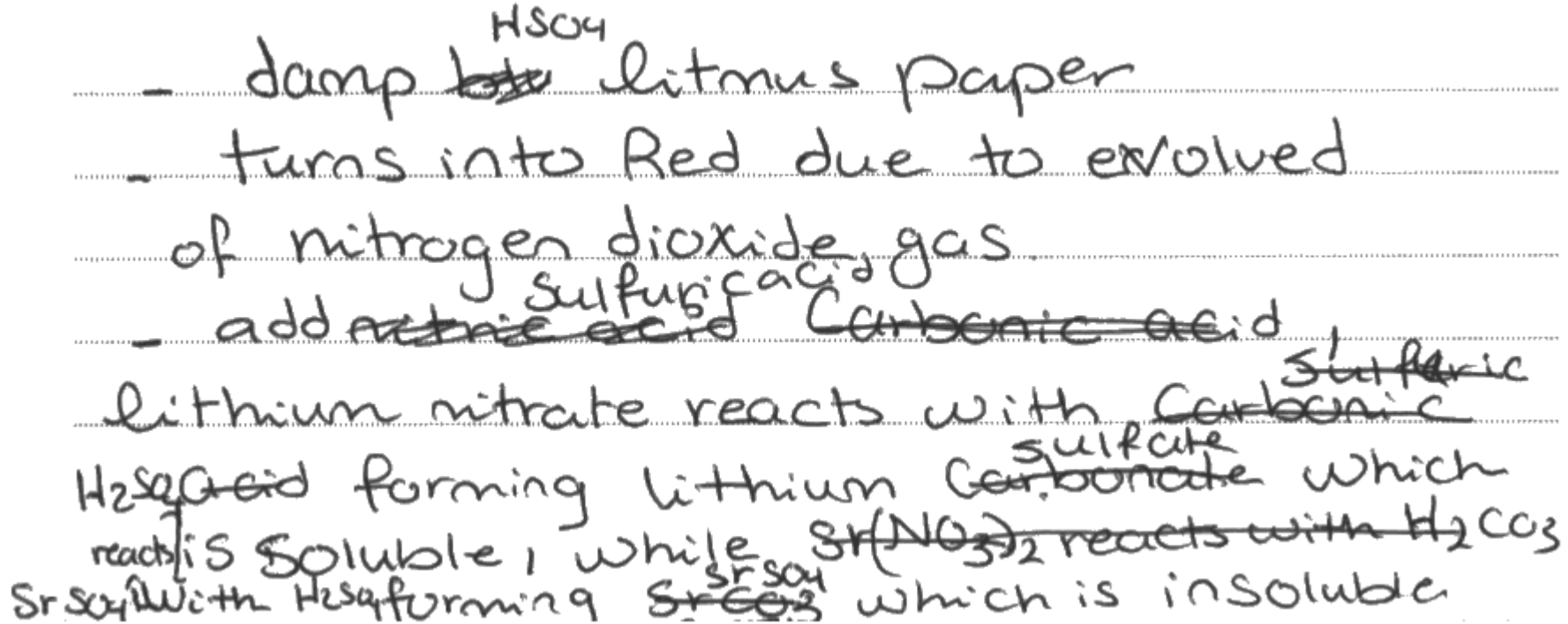
Both lithium ions and strontium ions produce red flame colours, so further tests are required to identify these cations.

Explain how a chemical test could be used to distinguish between two solutions, one of lithium nitrate and the other of strontium nitrate. **(2)**

Answer		Additional Guidance
An answer that makes reference to the following point:		
• addition of sodium / potassium sulfate solution	**(1)**	Allow any soluble sulfate Allow sulfuric acid Allow sodium / potassium carbonate Do not award hydroxide
• gives a precipitate with (the solution containing) strontium ions **and** no precipitate with (the solution containing) lithium ions	**(1)**	M2 dependent on M1 or near miss Allow strontium sulfate is insoluble **and** lithium sulfate is soluble

ACTIVITY 4 – AO3 in exams

Student 1



Answer		Additional Guidance
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ACTIVITY 4 – AO3 in exams

Student 2

By decomposing them as lithium nitrate will decompose faster than Strontium nitrate as ~~the bonds between~~ lithium is a smaller ion so it will polarise NO_3^- more making the N-O bonds ~~to~~ weaker so it is easily decomposed.

Answer		Additional Guidance
An answer that makes reference to the following point:		
• addition of sodium / potassium sulfate solution	**(1)**	Allow any soluble sulfate Allow sulfuric acid Allow sodium / potassium carbonate Do not award hydroxide
• gives a precipitate with (the solution containing) strontium ions **and** no precipitate with (the solution containing) lithium ions	**(1)**	M2 dependent on M1 or near miss Allow strontium sulfate is insoluble **and** lithium sulfate is soluble

ACTIVITY 4 – AO3 in exams

Student 3

~~Add nitric acid followed by silver~~ Add concentrated sulfuric acid, strontium will produce a white precipitate of $SrSO_4$

Answer		Additional Guidance
An answer that makes reference to the following point:		
• addition of sodium / potassium sulfate solution	**(1)**	Allow any soluble sulfate Allow sulfuric acid Allow sodium / potassium carbonate Do not award hydroxide
• gives a precipitate with (the solution containing) strontium ions **and** no precipitate with (the solution containing) lithium ions	**(1)**	M2 dependent on M1 or near miss Allow strontium sulfate is insoluble **and** lithium sulfate is soluble

ACTIVITY 4 – AO3 in exams

Student 4

Add a solution of $BaSO_{4(aq)}$. And to if white precipitates formed then strontium ions present as strontium sulfate is insoluble in water and lithium sulfate is soluble in water.

Answer		Additional Guidance
An answer that makes reference to the following point:		
• addition of sodium / potassium sulfate solution	**(1)**	Allow any soluble sulfate Allow sulfuric acid Allow sodium / potassium carbonate Do not award hydroxide
• gives a precipitate with (the solution containing) strontium ions **and** no precipitate with (the solution containing) lithium ions	**(1)**	M2 dependent on M1 or near miss Allow strontium sulfate is insoluble **and** lithium sulfate is soluble

ACTIVITY 4 – AO3 in exams

A student planned an experiment to determine the enthalpy change of reaction for the displacement of zinc from zinc sulfate solution by magnesium metal.

$$Mg(s) + Zn^{2+}(aq) \rightarrow Mg^{2+}(aq) + Zn(s)$$

Procedure

Step **1** Transfer 50.0 cm^3 of a 1.00 mol dm^{-3} aqueous solution of zinc sulfate into a glass beaker using a measuring cylinder.

Step **2** Put a thermometer in the beaker and leave it to stand for 5 minutes and then record the temperature.

Step **3** Add 2.20 g of magnesium metal powder to the beaker.

Step **4** Stir the mixture and record the maximum temperature reached.

(a) Show, by calculation, that magnesium was in excess. **(2)**

ACTIVITY 4 – AO3 in exams

Answer	Additional Guidance
• calculation of moles of zinc (ions) **(1)**	$50 \div 1000 \times 1.00 = 0.0500 / 0.05 / 5 \times 10^{-2}$
• calculation of moles of magnesium **and** moles Mg > moles Zn **(1)**	$2.20 \div 24.3 = 0.090535 / 9.0535 \times 10^{-2}$ Allow 0.09(05) > 0.05 for **(2)** marks
Alternative method	
• calculation of moles of zinc ions **(1)**	$50 \div 1000 \times 1.00 = 0.0500 / 0.05 / 5 \times 10^{-2}$
• calculation of mass of magnesium needed **and** 1.2(15)(g) < 2.20(g) **(1)**	0.05 x 24.3 = 1.2(15)(g) Allow TE on wrong moles of zinc Allow use of 24 for Mg Ignore SF

ACTIVITY 4 – AO3 in exams

Student 1

$\frac{50}{1000} \times 1 = 0.05$ mol of zinc sulfate.

Moles of Mg required is 0.05. Moles provided are $\frac{2.20}{24.3} = 0.0905$

$0.0905 > 0.05$, so Mg is in excess.

Student 2

moles of zinc: $\frac{50}{100} \times 1 =$ ~~0.5~~ 0.05

~~0.05~~ $= \frac{\text{mass}}{\text{mr}}$ $\quad$ $\text{Mg} = 0.05 \times 24.3 = 1.215\text{g}$ (needed)

2.2 ~~2.20~~ grams (used)

ACTIVITY 4 – AO3 in exams

Student 3

1) mol of zinc sulfate: $\frac{0.05 \times 1}{1000} = 5 \times 10^{-5}$ mol of zinc sulfate

2) Ratio of zinc to magnesium is 1:1 therefore mg mol = 5×10^{-5}

3) excess mass of mg $\Rightarrow mr \times n = 24.3 \times 5 \times 10^{-5} = 1.215 \times 10^{-3}$ g

Student 4

n mols of zinc sulfate: $n = CXV$

$1 \times \left(\frac{50}{1000}\right) = 0.05$ mols

Mr of Mg(s): 24.3

Zinc sulfate	Magnesium powder
Ratio 1	1

mass of Mg powder: mass $= \frac{n_{(mols)}}{Mr}$ $\frac{0.05}{24.3} = 2.05 \times 10^{-3}$

$2.20 - 2.05 \times 10^{-3} =$ **2.197 g** ← excess

ACTIVITY 4 – AO3 in exams

(c) A second student repeated the experiment using the procedure described.
The value obtained from this enthalpy change was considerably less exothermic than that quoted in a data book.

Suggest the most likely reason for this large difference in values.

(1)

Answer	Additional Guidance
An answer that makes reference to the following point: • heat loss (to the surroundings)	Ignore references to non-standard conditions

ACTIVITY 4 – AO3 in exams

Student 1

Heat loss in the air as ~~their~~ there is no lid.

Student 2

Value in data book is taken for reactants and products in the gas phase.

Answer	Additional Guidance
An answer that makes reference to the following point: • heat loss (to the surroundings)	Ignore references to non-standard conditions

ACTIVITY 4 – AO3 in exams

Student 3 The procedure was done in a glass beaker instead of an insulated cup such as polystyrene, therefore there was heat loss to the surroundings.

Student 4 Heat from the surrounding may not have been ignored.

Answer	Additional Guidance
An answer that makes reference to the following point: • heat loss (to the surroundings)	Ignore references to non-standard conditions

Improving delivery in AO3

Experimental skills

The specification lists 16 ‘Core Practicals’

These core practicals are selected because they provide opportunities to develop skills

They have **NOT** been chosen because they provide ‘perfect’ examples of experimentation or can be used to demonstrate a textbook ‘fact’

Experimental skills

The 16 core practicals should be used to allow students to develop their practical techniques and skills and also to use their mathematical skills

It is expected that the course will include other practicals that also allow these techniques and skills to be introduced and practised but it is essential that the core practicals are given priority and emphasis

Experimental skills

As mentioned earlier, experimental skills will be tested in Units 3 and 6

Unit 3 covers the skills and techniques developed during practical work in Units 1 and 2

Unit 6 covers the skills and techniques developed during practical work in Units 4 and 5, as well as the tests for anions and cations, gases and organic functional groups from Units 1 and 2

Practical assessment areas

There are four broad areas of practical assessment:

- planning experimental work
- implementation of experimental work
- analysis of observations and data
- evaluation of methods

Planning experimental work

Students are expected to be able to plan experiments and investigations that will produce valid data

The basic ideas behind a valid plan are:

- identification of independent, dependent and control variables
- use of repeat readings
- consideration of the hazards involved and how to minimise them

IAL planning requires more detail, explanation and precision than International GCSE/GCSE

Implementing experimental work

Students are expected to be able to:

- Present their results appropriately, e.g. tables, including units
- Drawing diagrams of apparatus, e.g. filtration under reduced pressure, distillation, etc.
- Select and assemble apparatus and equipment that could be used
- Comment on numbers of repeats, appropriateness of ranges, etc.

Analysis of observations and data

Students are expected to be able to:

- make deductions from observations obtain in both inorganic and organic analysis
- process data, for example by doing calculations or plotting appropriate graphs
- explain, discuss and evaluate data

Evaluation of methods

Students are expected to be able to:

- recognise procedural errors in methods
- suggest improvements that will lead to more accurate and/or precise measurements
- justify the improvements suggested
- calculate uncertainties in measurements, e.g. in using a burette, a pipette, a digital balance, etc.

Developing Experimental Skills

Independent thinking and evaluation

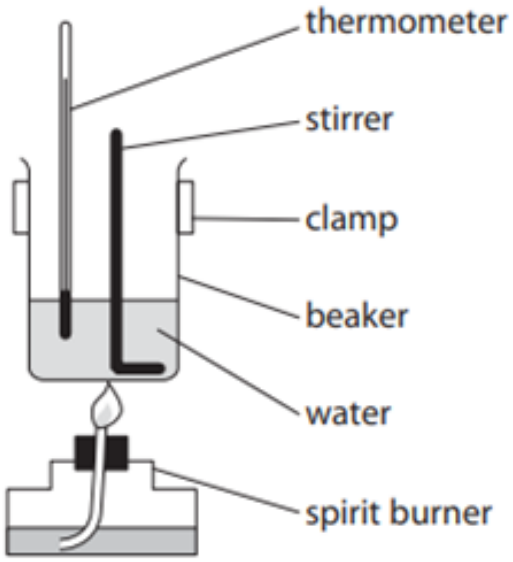
- Challenge students to think critically about a practical procedure from the start of the A level course

- Students need to realise that what has served them well at International GCSE/GCSE needs to be developed to achieve the same success later

Coping with questions on experimental skills

This is a question taken from Unit 3 October 2019

(d) The apparatus shown was used to find the enthalpy change of combustion of one of the liquids **C**, **D** or **E**.



(i) List all the measurements you would make in carrying out this experiment. (3)

(ii) Give **two** ways, other than changing the measuring instruments or repeating the experiment, in which the accuracy of the results using this apparatus could be improved. (2)

Coping with questions on experimental skills

Here is the mark scheme for (d)(ii)

Question Number	Answer	Additional guidance	Mark
2(d)(ii)	An answer that makes reference to two of the following points: • putting a lid on the beaker (1) • putting a lid on the burner (before and after combustion) (1) • adding a draught shield around the apparatus / insulating the beaker (1) • using copper instead of a glass beaker (1)	Allow top or bung for lid Allow reweigh burner as soon as possible to prevent loss of liquid Do not award insulating the beaker with flammable material Do not award polystyrene cup Ignore any reference to changing apparatus or adding oxygen Ignore stirring the water Ignore changing the volumes of water Ignore burning more (or less) fuel Ignore not allowing the thermometer to touch the beaker Ignore distance of burner from the beaker Do not award drawing a temperature time graph Do not award a closed environment	(2)

Coping with questions on experimental skills

Here is the Examiner's report on (d)(ii)

- Responses on ways to improve the accuracy of the experiment in (d)(ii) were varied
- Most candidates recognised the need to prevent heat loss, but often careless language prevented marks being scored
- A common mistake was the use of a polystyrene cup
- Many candidates also suggested modifications such as using a greater volume of water, stirring the water or adjusting the distance between the burner and the beaker, all of which did not score

ACTIVITY 5

Definition of Terms

Match the following terms to their definition

	Term
1	Precision
2	Random error
3	True value
4	Accurate
5	Valid
6	Systematic error
7	Independent variable
8	Dependent Variable
9	Controlled Variable
10	Uncertainty

	Definition
A	A value that is close to the true value
B	Factors that would affect the experiment and so need to be maintained constant
C	Variable that is measured as a result of changing another
D	The variable that is under investigation and is changed by the experimenter
E	A measure of the closeness of repeated measurements.
F	An error that arises due to inconsistency in the experiment. Often causes anomalies.
G	An error that is repeated when each measurement is taken, for example if a balance always reads 0.1 g above the true value.
H	An investigation where all variables have been controlled and the results are reliable.
I	A measure of the range of values within which the true value lies.
J	The value that would be obtained under ideal conditions.

Definition of Terms

Term	Definition
Accurate	A value that is close to the true value
Controlled Variable	Factors that would affect the experiment and so need to be maintained constant
Dependent Variable	Variable that is measured as a result of changing another
Independent variable	The variable that is under investigation and is changed by the experimenter
Precision	A measure of the closeness of repeated measurements.
Random error	An error that arises due to inconsistency in the experiment. Often causes anomalies.
Systematic error	An error that is repeated when each measurement is taken, for example if a balance always reads 0.1 g above the true value.
Valid	An investigation where all variables have been controlled and the results are reliable.
Uncertainty	A measure of the range of values within which the true value lies.
True value	The value that would be obtained under ideal conditions.

1 E 2 F 3 J 4 A 5 H 6 G 7 D 8 C 9 B 10 I

Exam Technique

The Exam Paper

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*
- Show all the steps in any calculations and state the units.
- Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Information

- The total mark for this paper is 110.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Write your answers neatly and in good English.
- Try to answer every question.
- Check your answers if you have time at the end.

Exam Technique

Preparation

- Effective exam techniques need to be practised by students using past papers or part-papers; perhaps ‘home-made’ papers using Exam Wizard tailored to suit the exercise or focused on the particular technique being practised
- Give students such a paper to practice how to access it
- Give students mark schemes so they can learn what is expected
- Having a ‘go to’ strategy, a starting point, builds confidence and reduces the stress of ‘what do I do first’

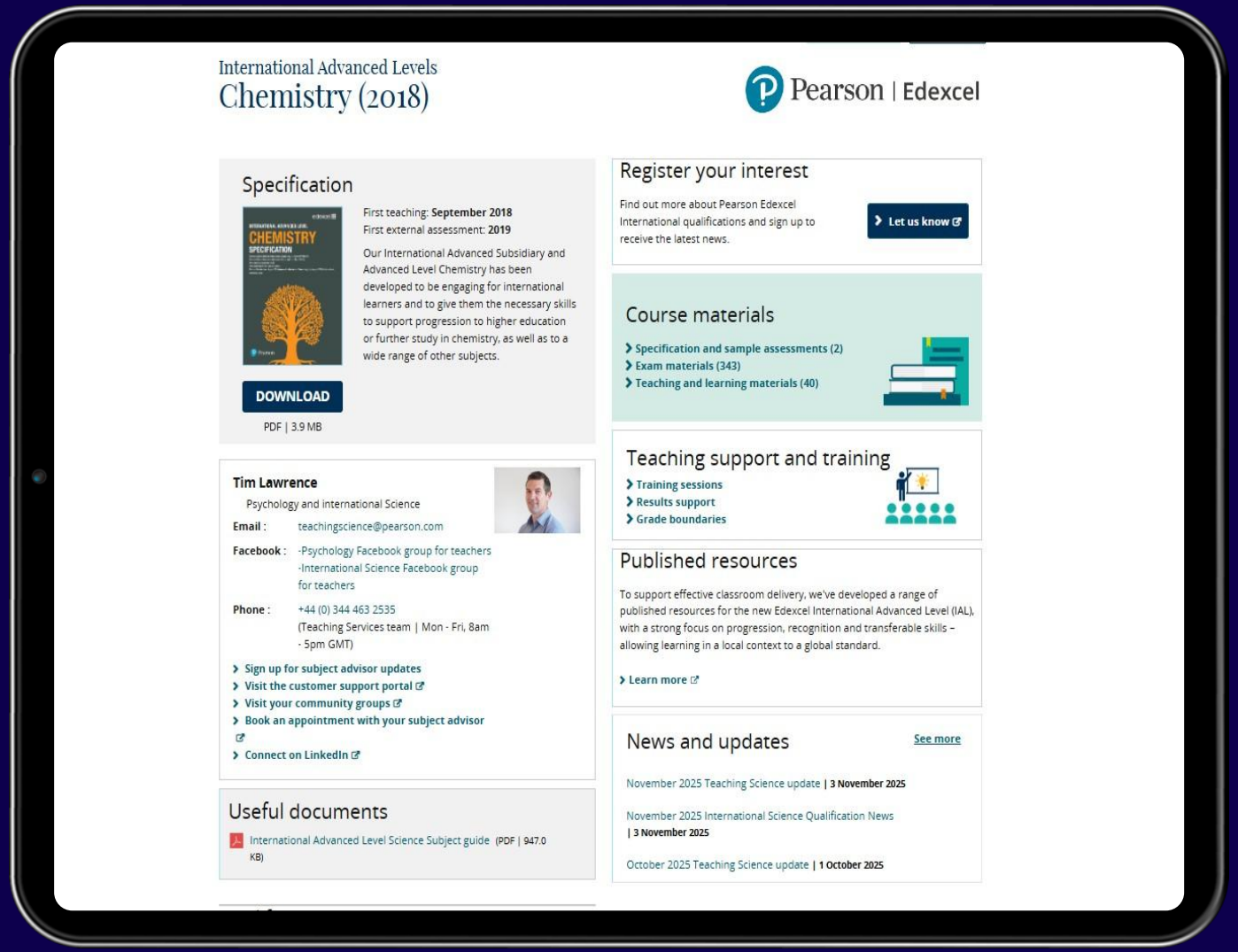
Exam strategy – one way to tackle a paper

- Look through the whole paper first, underlining (or, better, highlighting) the command words in each question
- Decide which question to do first – start with the question(s) you feel most confident with, which is not necessarily question 1
- Read question carefully – **do not repeat stem in your answer**
- Do not give up on a whole question if you find one section of the question difficult – move on to the next part
- The same strategy holds for whole questions you find difficult – move on
- Come back to missed questions and parts of questions when you have picked off all the 'low-hanging fruit'

Walking-talking mocks

- Students sit in the same exam room where they will do their exam, preferably in the same seats (it can be done in the classroom, but not always as effective in building confidence in exam conditions)
- Students are given an exam paper which is as close to being like the real thing as possible (i.e. exam writing booklet if relevant)
- Students are literally walked through every question on the paper – the person leading the session talks them through the smallest steps, such as underlining key words, how to plan, things to remember, etc.
- You might focus on a particular area – such as mathematical questions, or questions based on devising a practical investigation
- Students then write their responses in timed conditions

Support for you at every Stage



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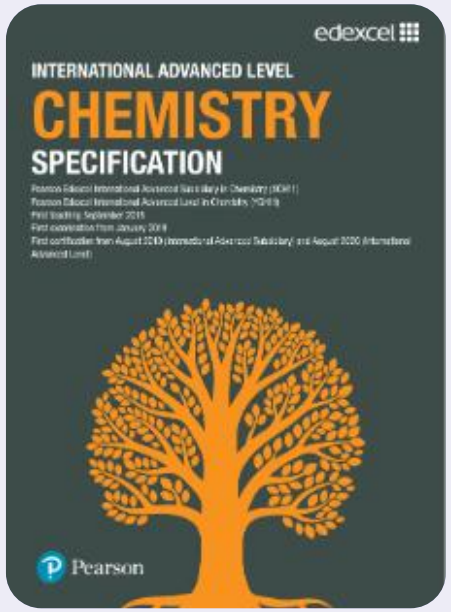
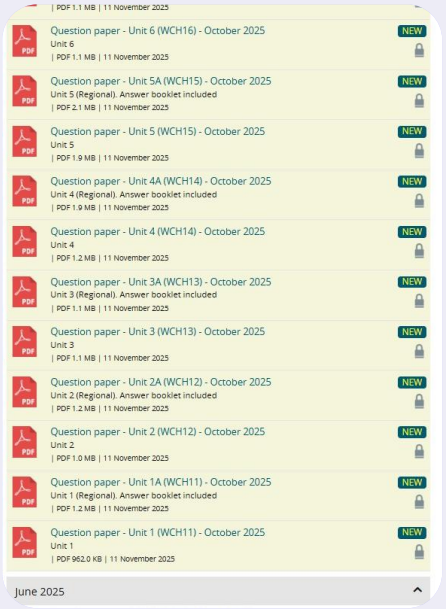
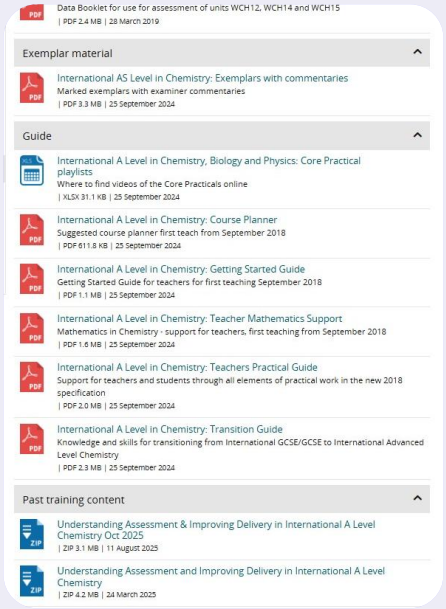


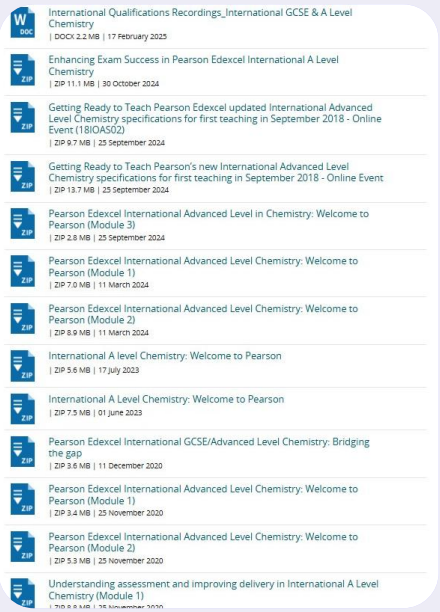
Specification



Past Papers



Teaching and Learning Materials



Past Training Content

Results Plus

- Provides detailed analysis of your students' performance.
- Identify potential topics, skills and types of question where students may need to develop their learning further.
- See actual scores for each exam question for a student, class or group.
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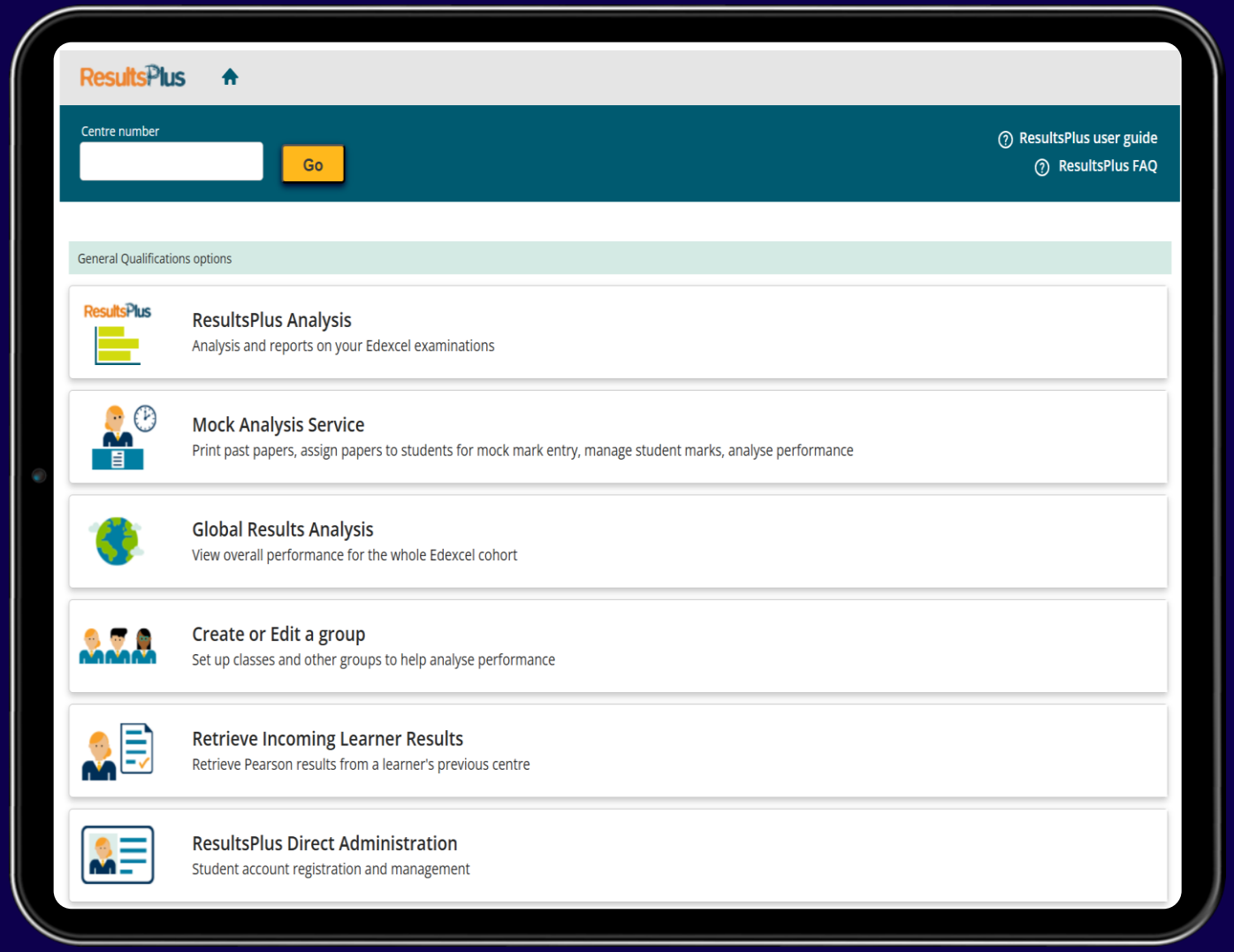
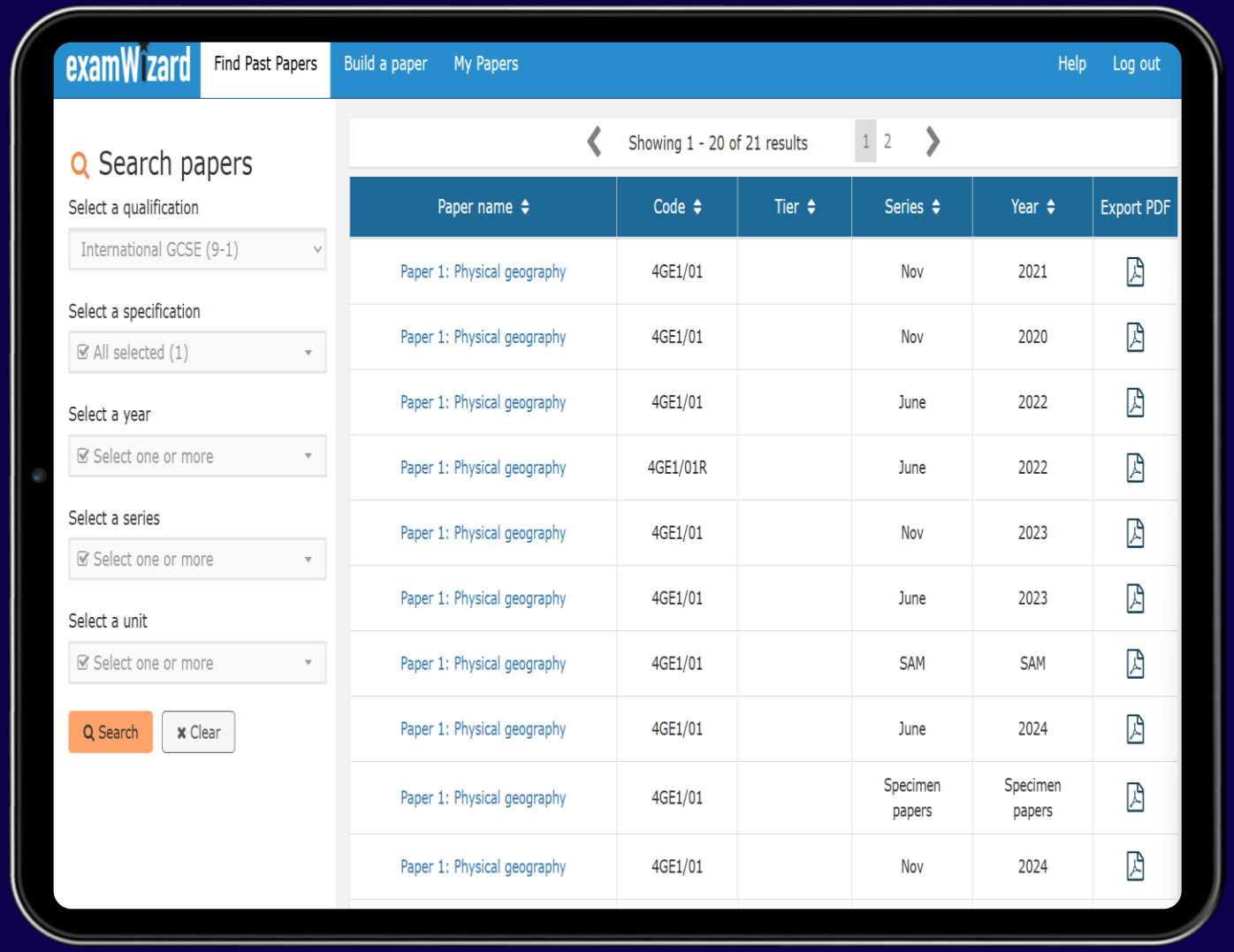


Exam Wizard

- Saves time by creating your own mock paper exams, topic tests, homework or revision activities.
- Uses our Pearson back catalogue of exam questions to practice and develop these skills with your students.
- Gain access to past papers and test questions to create tailored learners plans, which target individuals' weaknesses.
- Works in conjunction with ResultsPlus to help create exam practice resources for whole cohorts or individual students.



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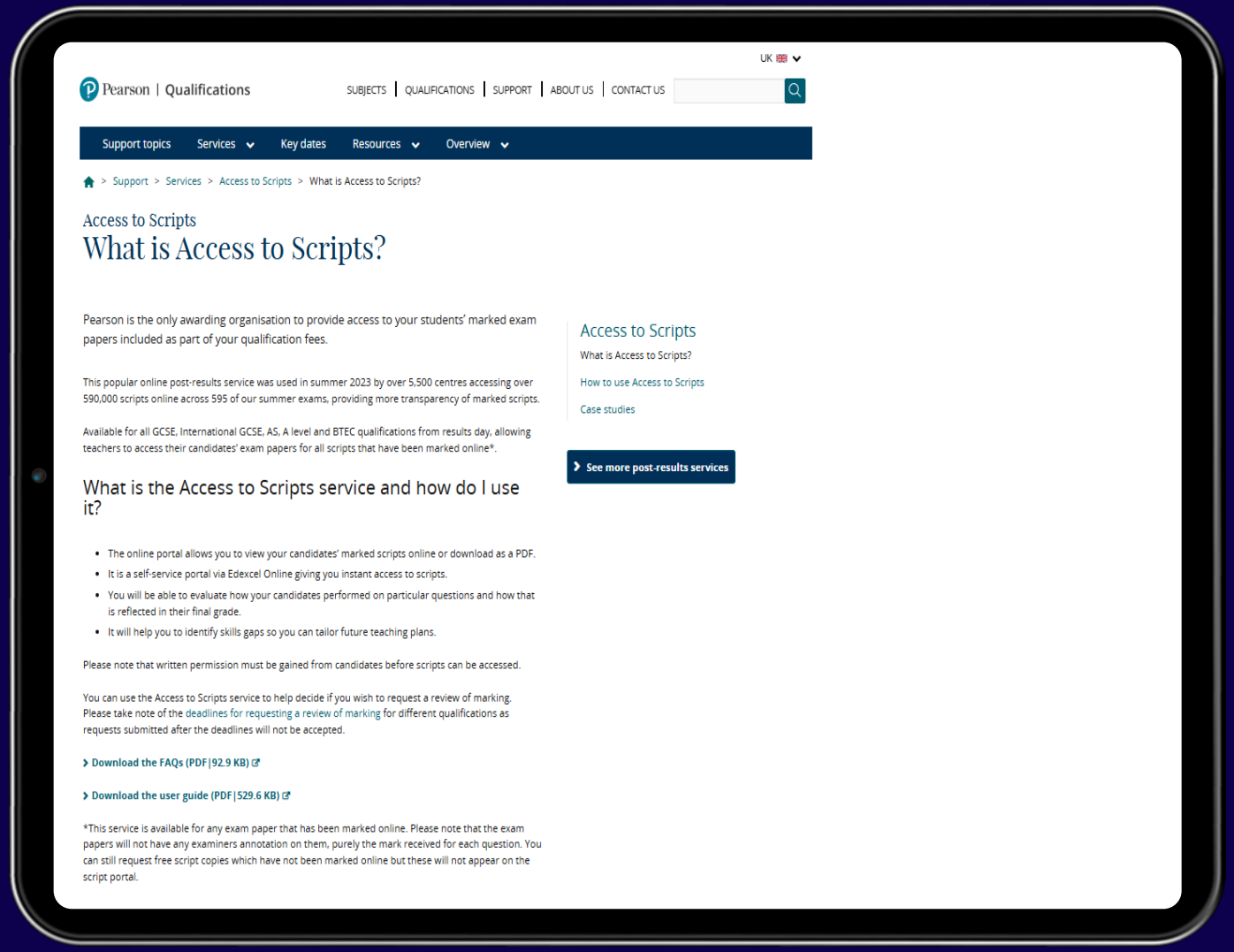

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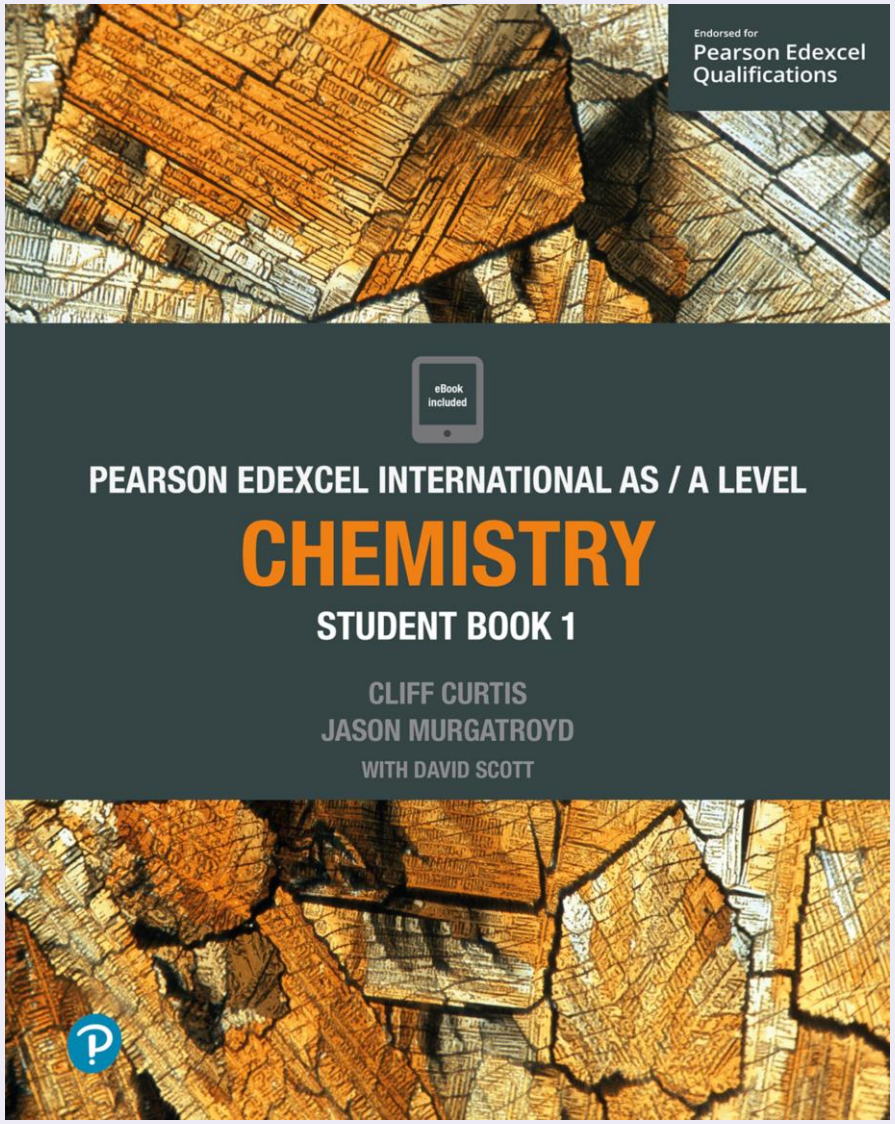
Developed for the latest International A Level Science specifications, these resources are specifically designed for international students, with a strong focus on progression, recognition and transferable skills, allowing learning in a local context to a global standard.



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- Student book answers and Exam Practice questions
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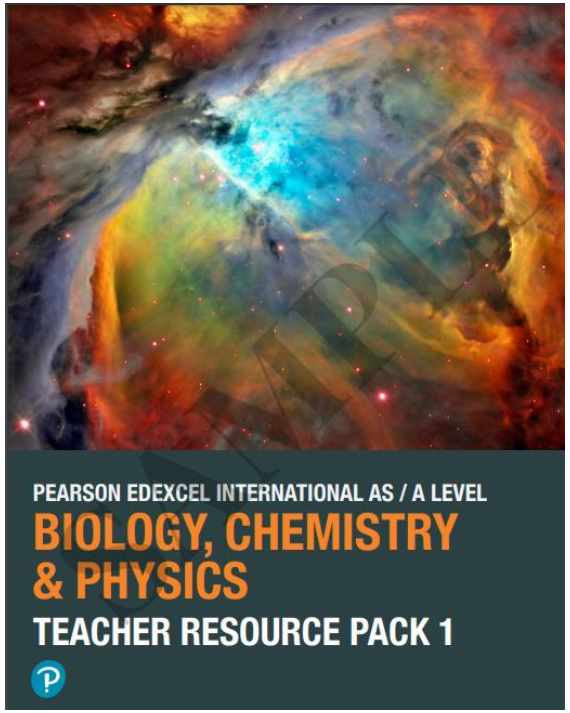
- Guide to Thinking Bigger



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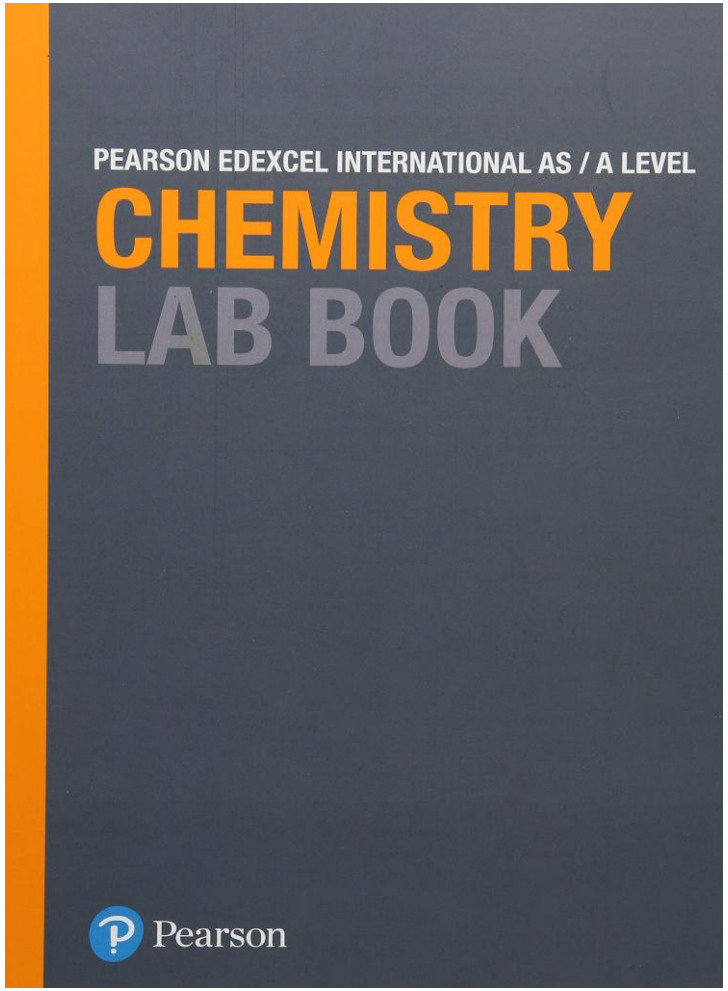
Pearson have also published a Lab Book that covers all of the Core Practicals.

These Science resources have been written to support the Pearson Edexcel International Advanced Levels (IAL), which are globally recognised qualifications which open doors to top local and international universities worldwide. International A Levels have a modular structure, yet remain comparable to A levels, as confirmed by NARIC (The national agency responsible for providing information and expert opinion on qualifications and skills worldwide).



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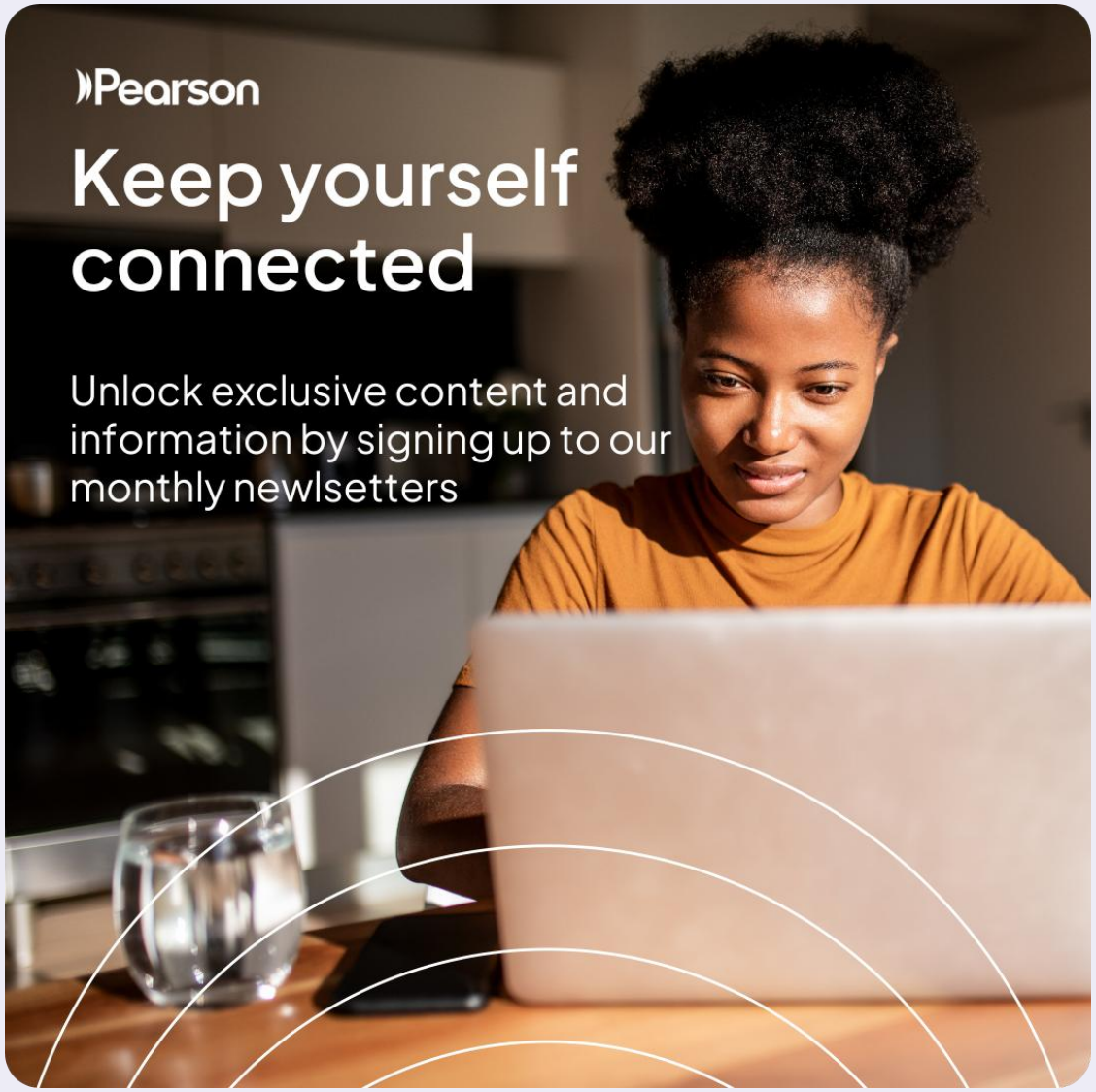

Questions

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Thank you