Qualification Accredited

Oxford Cambridge and RSA

GCSE (9-1)

Examiners' report

TWENTY FIRST CENTURY SCIENCE CHEMISTRY B

J258

For first teaching in 2016

J258/04 Summer 2022 series

Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. A selection of candidate answers are also provided. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from OCR.

Advance Information for Summer 2022 assessments

To support student revision, advance information was published about the focus of exams for Summer 2022 assessments. Advance information was available for most GCSE, AS and A Level subjects, Core Maths, FSMQ, and Cambridge Nationals Information Technologies. You can find more information on our website.

Paper 4 series overview

J258 04 is the Higher Tier paper of two papers for GCSE examination for Chemistry B. This paper is designed to test the depth of candidates' knowledge. As such, candidates are expected to show that they can develop ideas within a question, often over a narrow range of linked specification statements from a single topic. Some questions further test their ability to further make links or to contrast learning from different specification areas.

The question style is short answer, often using stems of information for candidates to process and use in their answers. There are also two longer Level of Response questions, where candidates need to organise their ideas to make reasoned arguments to present their views based on provided information. The Science for the Twenty First Century suite of specifications include integral Ideas about Science, which are also assessed through the contextualised and issue-based question style, where candidates are expected to process unfamiliar information, make informed decisions and solve problems.

The specification also includes questions which test both practical skills and mathematics in line with national requirements for the mathematical content of GCSE question papers. Practical skills were identified by examiners as being a significant discriminator between candidates. Some candidates did not show knowledge of practical procedures and techniques. Candidates generally approached the mathematical questions appropriately and laid out their working. It is important that they take time to consider the information given, including any instruction to quote values to a particular number of decimal places or significant figures or to quote final values in a particular unit.

Candidates who did well on this paper generally did the following:	Candidates who did less well on this paper generally did the following:
• read and assimilated information given in question stems and applied this when answering the questions (less successful responses often copy out information without explaining how it applies to the question). • answered longer 2 and 3 mark questions by considering the number of clear points necessary and ensuring that their marks matched the mark allocations. • answered succinctly and clearly. • came to the examination prepared for the mathematical demands listed in the specification and considered instructions to give answers to a particular number of decimal places or significant figures when asked to do so. • considered the information in the Level of Response questions before starting to write to make sure that they used all available information. • considered the instructions carefully for the Level of Response questions and made sure to answer all aspects of the question. • knew practical techniques and procedures mentioned in the specification.	• repeated information in the question stems or in tables without applying it to answer the problem or question asked. • gave partial answers to longer questions so that the available number of marks were not all addressed. • gave unstructured, lengthy and rambling answers, some of which went beyond the available space onto extra sheets, which did not make points clearly or contradicted correct statements due to confused statements or extra, incorrect statements. • did not always read the question carefully so that the answer given did not always match the instructions in the question. In the Level of Response questions some candidates only answered one aspect of the question, limiting them to the lower mark ranges. • showed limitations in their knowledge of practical techniques and procedures.

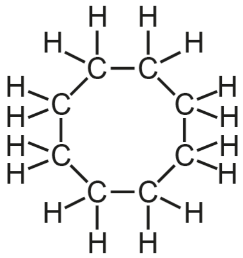
Question 1 (a) (i)

1 **Fig. 1.1** shows the uses, properties and structure of some substances which contain carbon atoms.

Cyclo-octane

Added to petrol

Very flammable

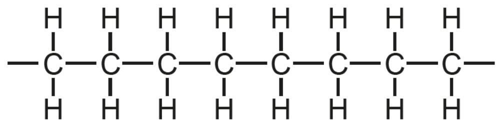


Carbon atoms bonded to other carbon atoms in rings and to hydrogen atoms

Polyethene

Used to make carrier bags

Flexible, softens at 1200 °C, stretches and breaks easily

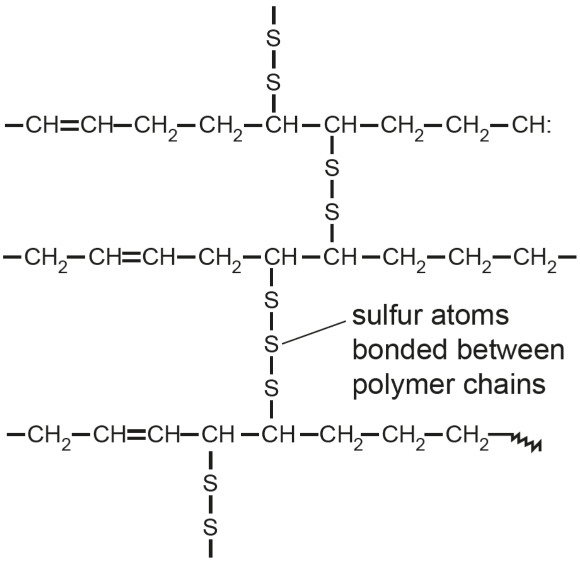


Carbon atoms bonded to other carbon atoms in long chains and to hydrogen atoms

Synthetic rubber

Used to make car tyres

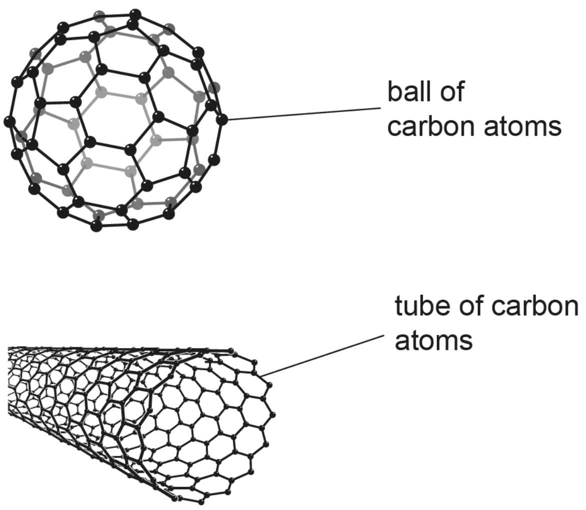
Stronger and harder than most polymers and has a higher melting point



Carbon atoms bonded to other carbon atoms in long chains with sulfur atoms bonded between the polymer chains

Nanoparticles

Used to carry medicine molecules into the body



Carbon atoms bonded to other carbon atoms to form balls and tubes

Fig. 1.1

(a) Petrol contains cyclo-octane.

(i) Which symbol should be used to warn people of the main hazard when handling cyclo-octane?

Tick (✓) **one** box.


☐


☐


☐


☐

[1]

Almost every candidate knew the hazard sign for cyclo-octane is 'flammable'.

Question 1 (a) (ii)

(ii) Write down **two** safety precautions people should take when filling their cars with petrol.

1 ....

....

2 ....

.... **[2]**

Most candidates identified a safety precaution linked to the flammability of petrol, such as avoiding naked flames or the use of electronic devices while filling cars. Some stated it was important to avoid petrol coming into contact with hands. However, some candidates gave very vague responses such as taking extra care while filling, without identifying clearly how to avoid risk. Some discussed precautions that are not directly relevant to 'when filling cars' such as washing hands afterwards.

Question 1 (b)

(b) Carbon makes a much bigger range of different types of molecules than any other element.

Give **one** reason why carbon atoms can form so many different types of molecules.

Use **Fig. 1.1** to help you to answer.

....

.... **[1]**

The idea that carbon forms 4 bonds was not well expressed. Some candidates said carbon formed 'up to' 4 bonds, which is incorrect. Candidates often made vague comments, such as 'carbon makes many bonds' or 'carbon bonds with lots of elements'.

Question 1 (c)

(c) Explain why polyethene and synthetic rubber have different properties.

Use ideas about structure from **Fig. 1.1** to help you to answer.

....

....

....

.... **[2]**

Most candidates described differences between polyethene and synthetic rubber from Fig. 1.1, but these features did not always relate to the stated properties in the boxes. Common insufficient answers were that rubber 'contains a double bond' or 'contains sulfur atoms'. Best answers referred to sulfur atoms forming bonds between chains and linked this to a difference in the properties such as their different melting points.

Question 1 (d) (i)

(d) (i) How are nanoparticles different to the other substances in **Fig. 1.1**?

....

.... **[1]**

There were two acceptable lines of answer here. Candidates could either recall information about nanoparticles, such as their extremely small size, or process data from the question by stating that in this case the nanoparticles contained only carbon atoms. Most candidates gained a mark for one of the routes. Nanoparticles are 'small' alone was not given a mark. All molecules are small.

Question 1 (d) (ii)

(ii) Explain why the structure of carbon nanoparticles helps them to carry medicine molecules into the body.

....

.... **[2]**

The question asks the 'explain why the structure….'. Many answers did not refer to structure. Many also repeated the question, making statements such as carbon nanoparticles can carry medicines. Some also repeated that 'nanoparticles are small and so can enter the body' this was not given a mark. Best answers discussed the hollow shape allowing medicines to be placed within the structure or related the extreme small size to the ability to travel in blood vessels or across membranes.

Question 2 (a) (i)

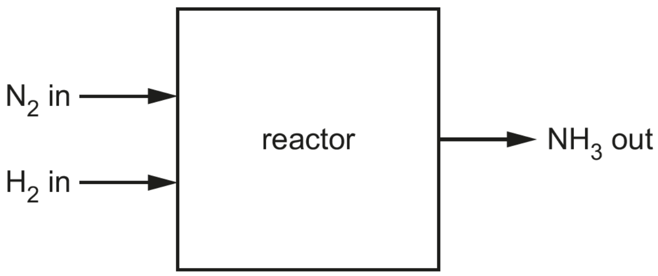
2 Ammonia is used to make fertilisers. It is produced in a large-scale process.

The equation shows the reaction that happens in the process:

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

ammonia

The process happens in a reactor.



(a) The percentage yield of ammonia is usually between 10% and 20%.

(i) Use the equation to explain why it is not possible to get 100% yield of ammonia.

....

.... **[1]**

Some candidates did not use the equation to answer. Instead they said that 'nitrogen and hydrogen escape from the reactor' or similar. Best answers referred to reversible reactions or equilibria.

Question 2 (a) (ii)

(ii) The gas that leaves the reactor contains ammonia mixed with two other gases.

Use the equation to help you to give the names of the other **two** gases.

.... **and** .... **[1]**

This question was almost always answered correctly, although carbon dioxide or oxygen were occasionally seen.

Question 2 (b)

(b) An ammonia factory tests a new reactor.

The table shows the theoretical yield and actual yield for a process in the new reactor.

Theoretical yield (tonnes)	150
Actual yield (tonnes)	19.5

Calculate the percentage yield for the process in the new reactor.

Use the equation: $\text{percentage yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100\%$

percentage yield = ... % **[2]**

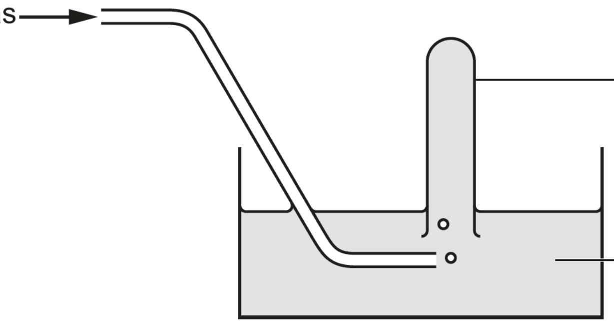
This calculation was very well answered, with almost all candidates correctly calculating the yield.

Question 2 (c) (i)

(c) Ammonia is very soluble in water.

Kofi does an experiment to make some ammonia.

He tries to collect it using the apparatus shown.



(i) Bubbles of ammonia gas enter the water but no gas collects in the test-tube.

What happens to the ammonia gas when it enters the water?

....

.... **[1]**

Many candidates commented correctly on the solubility of ammonia leading to the gas dissolving in the water. Some incorrectly said it 'reacts' with water. This was ignored. Some gave vague answers about ammonia 'escaping' or 'dissipating' in the water without explaining what happens.

Question 2 (c) (ii)

(ii) Which apparatus should Kofi use to collect ammonia?

Tick (✓) **one** box.

burette	☐
gas syringe	☐
measuring cylinder	☐
volumetric flask	☐

[1]

Almost all candidates knew that a gas syringe can be used to collect a soluble gas.

Question 2 (d) (i)

(d) Ammonia is an alkaline gas.

The pH of ammonia solution can be measured using a pH meter.

(i) Predict the pH of ammonia.

pH .... **[1]**

Most candidates quoted numbers above 7. Some gave incorrect values below 7. Some made the error of saying '7-14' which is incorrect, as 7 is neutral.

Question 2 (d) (ii)

(ii) Describe another method you could use to measure the pH of ammonia solution.

....

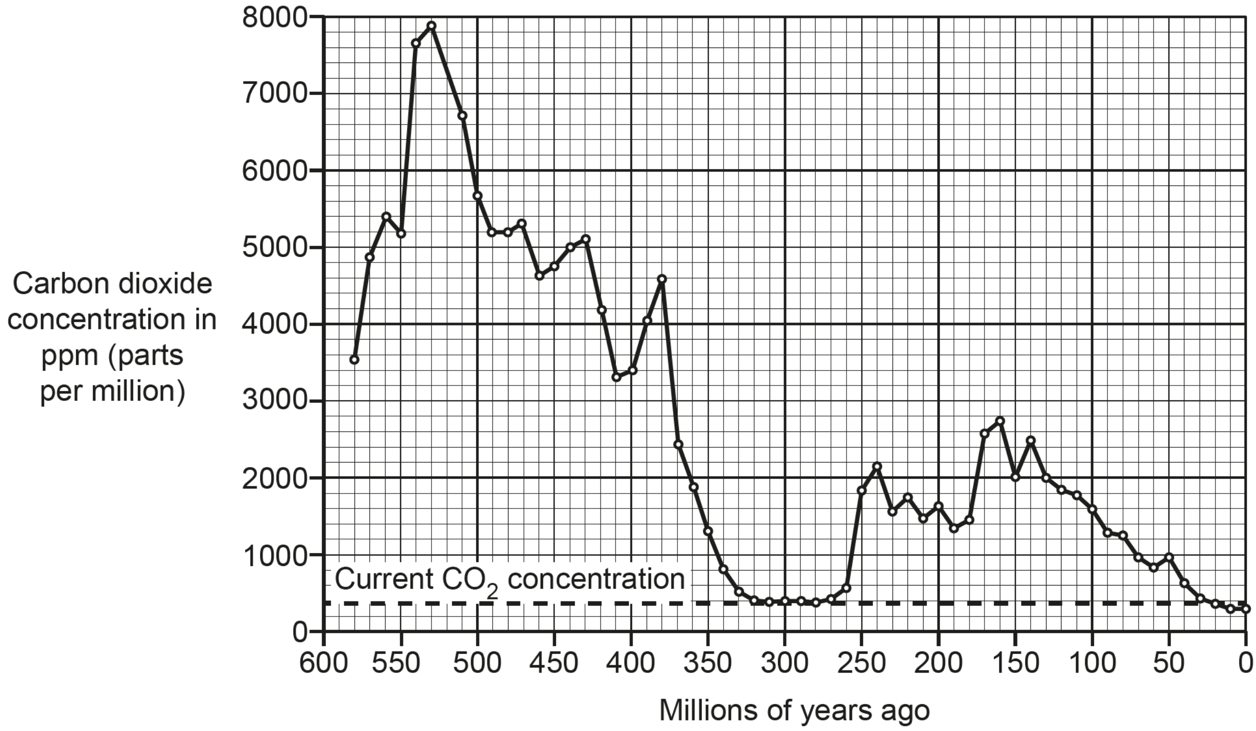
....

.... **[2]**

Many candidates correctly suggested using universal indicator, but a common error was to name an acid-base indicator such as litmus. The second mark was not always given. Many stated actual colours such as 'if it is purple, it's an alkali' rather than explaining how pH is measured by comparison of the colour with a pH colour chart.

Question 3 (a) (i) and (ii)

3 The graph shows the change in carbon dioxide concentration in the Earth's atmosphere over the last 575 million years.



(a) (i) How many millions of years ago was the concentration of carbon dioxide at its highest point?

.... million years ago **[1]**

(ii) What was the concentration of carbon dioxide at its highest point?

.... ppm (parts per million) **[1]**

Candidates generally read the graph accurately and gained both marks for reading values from each axis.

Question 3 (b)

(b) Ben looks at the graph and says, 'Carbon dioxide concentration was always much higher in the past than it is today.'

Does the graph support this statement?

Tick (✓) **one** box.

Yes ☐

No ☐

Use values from the graph to explain your answer.

....

....

.... **[2]**

This question differentiated well as there was a range of responses. Some candidates said 'yes, because carbon dioxide used to be much higher'. Although this statement is true, it does not agree with Ben's statement, as it was not always much higher. Secondly, during the period about 300 million years ago, the carbon dioxide was at a similar level to today. Many candidates discussed this correctly. Some mis-read the graph saying that the previous low was 300 years ago, omitting the 'million'.

Question 3 (c)

(c) Scientists say that the concentration of carbon dioxide is now 0.04 %.

In the year 2000 the concentration of carbon dioxide was 370 ppm (parts per million).

Do a calculation to find out the difference between these two values.

Give your answer in ppm.

Use this formula:

$$\text{concentration in ppm} = \text{concentration in \%} \times 10^4$$

difference between values .... ppm **[2]**

Most candidates attempted to multiply or divide by 10^4. The question asked for values to be given in ppm. Some candidates instead converted the 370ppm into a percentage. However, overall candidates handled this superscripted value well.

Question 3 (d)

(d) Some scientists fear that increased carbon dioxide in the air may lead to global food shortages.

Explain why this could happen.

....

.... **[1]**

In common with most questions about environmental issues, answers were often vague or repeated the question. Answers such as 'climate change affects food production' or 'global warming means food is scarce' were not given marks. Best answers linked a change in climate (or an outcome of this, such as droughts) to crop failure or unsuitable conditions to farm animals.

Question 4 (a) (i)

4 The table shows information about some alkanes.

Alkane	Molecular formula	Relative formula mass	Melting point (°C)	State at room temperature (at 20 °C)
methane	CH_4	16	–182	gas
propane	C_3H_8	44	–190	gas
octane	C_8H_{18}	114	–57	liquid
pentacontane	$C_{50}H_{102}$	702	93	solid

(a) The empirical formula of octane is C_4H_9.

(i) What is the **empirical** formula of pentacontane?

.... **[1]**

This question was very well answered. Almost all gave the correct formula.

Question 4 (a) (ii)

(ii) The empirical formulae of methane and propane are the same as their molecular formulae.

Explain why.

....

.... **[1]**

Most candidates knew the meaning of an empirical formula and expressed how it could not be divided or simplified.

Question 4 (b)

(b) Predict the **boiling** point of octane.

Explain your reasoning.

Boiling point .... °C

Reason ....

.... **[2]**

Most candidates gave a boiling point within the acceptable range. Fewer were able to explain why this was correct and many stated vaguely it 'needed to be above room temperature' without explaining why.

Question 4 (c)*

(c)* A text book has this description of a homologous series.

> A homologous series contains compounds with similar structures, the same general formula and similar chemical properties. The compounds show a trend in physical properties down the series.

Use your own knowledge and the information in the table to explain how the alkanes match this description of a homologous series.

....

....

....

....

....

.... **[6]**

This Level of Response was set to differentiate mainly at standard demand. The information refers to the main points of structure, general formula, chemical properties and physical properties. For 6 marks it was essential that the answer addressed all of these points. The most common reason for fewer marks were given was that candidates did not address all aspects of the question. The most common omission was to omit to discuss the chemical properties of alkanes. Most candidates gave the correct general formula and used the information in the table to state that boiling points increase down the group. Fewer discussed either the structure or chemical properties of alkanes. Common incorrect or insufficient points raised included:

alkanes have single bonds between carbon and hydrogen atoms (a true statement, but not enough to explain that alkanes are saturated).

alkanes contain carbon and hydrogen (true, but also true for all organic compounds, they needed to say that they are hydrocarbons or contain carbon and hydrogen only).

common errors included confusion with alkenes, for example by mentioning double bonds.

Exemplar 1

- Alkanes have the general formula ~~Cn~~ CnH2n+2.
- Alkanes have a double carbon bond that gives them stronger covalent bonds and therefore a generally high melting and boiling point.
- Down the group their melting point gets higher as they ~~have~~ are longer chains so need more heat to overcome the stronger intermolecular forces.

Relative formula mass also increases down the group as there are more elements so more masses to add.
Alkanes can open up their double carbon bonds

This response was given Level 2, 3 marks. Note that the general formula is correct and there is a comment on the trend in boiling points. There is an attempt to talk about structure but this is incorrect, the candidate states that alkanes have double carbon bonds. The comment about stronger intermolecular forces is correct. In terms of the information that the candidate has been asked to discuss there is no reference to chemical properties and the response includes clear errors. However, the correct information gives a Level 2, but the omissions and errors mean that only 3 marks are given.

Question 5 (a)

5 Some metals are extracted from their ores by heating with carbon.

Other metals are extracted from their ores by electrolysis.

Fig. 5.1 shows the order of reactivity of some metals, compared to carbon.

most reactive	sodium	extracted by electrolysis
↓	calcium	
	magnesium	
	[carbon]	
	zinc	extracted by heating with carbon
least reactive	copper	

Fig. 5.1

(a) Explain why calcium and copper must be extracted by different methods.

....

.... **[2]**

Most candidates gave a fully correct answer, but some compared the reactivity of calcium and copper to each other rather than comparing each separately to carbon.

Question 5 (b)

(b) What are the most common methods of extraction for iron, potassium, aluminium and lead from their ores?

Use ideas about the order of reactivity of the metals to help you to answer.

Put a tick (✓) in **one** box in each row.

Metal	Extracted by heating with carbon	Extracted by electrolysis
iron		
potassium		
aluminium		
lead		

[2]

This question proved challenging. Candidates needed to correctly recall the order of reactivity and then use the information provided to process this to predict an extraction method. Most gained a single mark.

Assessment for learning

The reactivity series is an important 'recall' area of the specification. Most questions relating to the reactivity series ask candidates to both recall and then process information about the relative reactivity of metals. This is a 'good' question to use to practise these skills.

Question 5 (c) (i)

(c) Some copper ores contain copper sulfide.

Copper is extracted from copper sulfide in a two-stage process.

Stage 1: Copper sulfide reacts with oxygen:

$Cu_2S(s) + 2O_2(g) \rightarrow 2CuO(s) + SO_2(g)$

Stage 2: Copper oxide reacts with carbon:

$2CuO(s) + C(s) \rightarrow 2Cu(s) + CO_2(g)$

(i) Look at the equation for **Stage 1**.

Predict whether the mass of the solid increases, decreases or stays the same during **Stage 1**.

Use the Periodic Table and calculations of relative formula masses to help you.

Prediction .... **[3]**

This question was answered well, but there were common and significant errors by some candidates. The question asks about the mass of the solids. A relatively common error was for candidates to add up all of the masses on each side of the equation, hence proving that the law of conservation of mass is valid, rather than that the mass of the solids stays (almost) constant.

Question 5 (c) (ii)

(ii) During **Stage 2**, the total mass of the solids decreases.

Explain why **Stage 2** obeys the law of conservation of mass even though the total mass of the solids decreases.

....

....

.... **[2]**

Candidates typically gained at least 1 mark, either for saying that gas is lost (so mass appears to fall) or that the overall mass stays the same.

Assessment for learning

Candidates need to look at the total number of marks for a question to make sure that they write enough separate points to address all aspects of the question. One suggestion for developing this skill is to ask them to write a mark scheme for a question and revise it as a group.

Question 5 (c) (iii)

(iii) The reaction of copper in **Stage 2** can be represented by a half equation:

$Cu^{2+} + 2e^{-} \rightarrow Cu$

Is copper oxidised or reduced in this half equation?

Explain your answer.

Oxidised or reduced? ....

Explanation ....

.... **[1]**

Many thought that copper was oxidised, although they went on to state it gained electrons.

Question 6 (a)

6 **Fig. 6.1** shows the particle model for solids, liquids and gases.

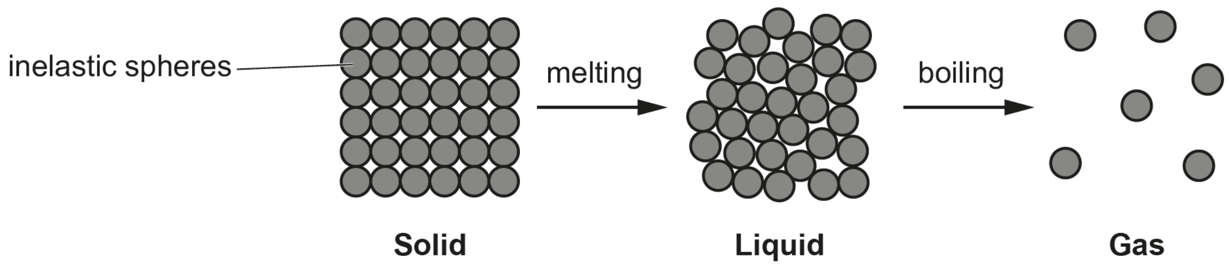


Fig. 6.1

(a) Neon is a gas in Group 18 (0) of the Periodic Table.

Use the particle model in **Fig. 6.1** to describe what happens to the arrangement and movement of the atoms when neon changes from a liquid to a gas.

....

....

.... **[2]**

The question asks candidates to discuss how both the arrangement and movement of atoms changes when neon becomes a gas. In order to answer this question, the two relevant diagrams to look at are those for the liquid and for the gas. Many candidates said that particles become 'more random'. This is not true, particles in a liquid are also random. This implies that they were also taking into account the solid. Best answers discussed that particles are further separated and move much more quickly.

Question 6 (b)

(b) Sodium atoms form sodium ions with a single positive charge.

Neon atoms do not form ions.

Use ideas about electrons to explain these statements.

....

....

....

.... **[3]**

Almost all candidates knew that neon has a full outer shell of electrons. The fact that sodium atoms have one electron in their outer shell which is lost to form an ion with a single positive charge was less clearly stated. Some said that 'sodium loses electrons' without stating how many or why.

Question 6 (c)*

(c)* Sodium chloride contains sodium ions, Na^+, and chloride ions, Cl^-.

Fig. 6.2 shows the ionic model for solid and liquid sodium chloride.

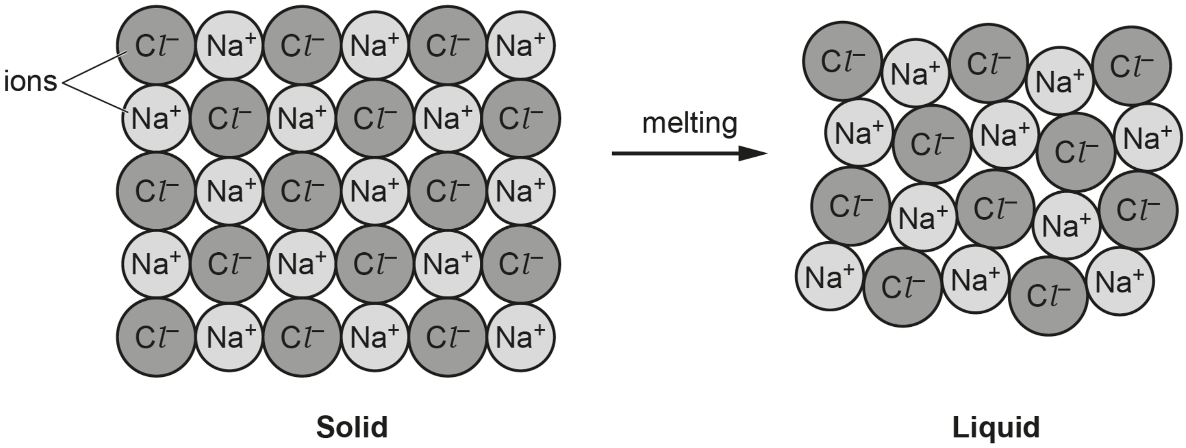


Fig. 6.2

The melting points of neon and sodium chloride are shown in the table.

	Melting point (°C)
neon	–249
sodium chloride	801

Describe the similarities and differences in how melting is represented by the models in **Fig. 6.1 and Fig. 6.2** and explain why both models are needed to explain the differences in the melting points shown in the table.

....

....

....

....

....

.... **[6]**

This Level of Response question was designed to differentiate between the higher grades. Candidates were asked to do several things: to discuss both similarities and differences between the models in Figs. 6.1 and 6.2 and to explain why both models are needed to explain the difference in melting points of the two substances. As with other Level of Response questions, the commonest reason for lower marks was that candidates did not typically address all aspects of the question. Some did not clearly compare and contrast the two models. Some did not explain the differences in melting points.

Exemplar 2

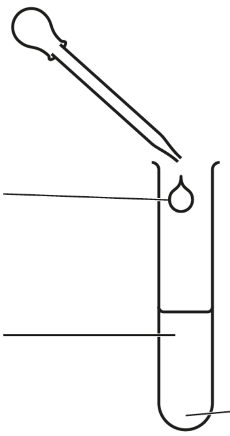
In figure 6.1, the model shows each atom as an inelastic sphere, each having the same size. When shown to melt, the atoms become distorted in structure, with no set arrangement, and no regular pattern. In figure 6.2 the model shows the two types of ions to be different sizes. When melted into a liquid, they maintain some level of structure but the arrangement is slightly different. Both models show that the atoms are no longer in a fixed arrangement when melted, and they show the atoms still touch one another. However, the model in figure 6.1 shows the messy arrangement of particles in a liquid as they move around touching any other neon atoms. As for figure 6.2, each cation and anion doesn't touch another ion with the same charge, even as a liquid. Both models are required in order to show how materials with lower melting points have weaker electrostatic forces of attraction and so can move freely in liquids, still touching each other. But, compounds with high melting points are often strongly bonded together, eg as ions, and therefore are represented differently **[6]**

This response was given Level 3, 5 marks. This is a very 'good' response which addresses all points of the question. The response discusses both the similarities and differences between the models (in the first half) and then discusses why each diagram shows a substance with different melting points due to the differences in the nature and strength of the attractions between the atoms or ions. A 5 was given rather than a 6 because the candidate does not make it clear, towards the end, whether the points raised relate to neon or sodium chloride and does not clearly relate the models to the table of melting points. Nevertheless, a very successful response.

Question 7 (a)

7 Jane does an experiment.

She puts 10 cm^3 of copper sulfate solution in a boiling tube. She adds 5 cm^3 of sodium hydroxide solution. A precipitate of copper hydroxide forms.



(a) Complete the **word** and **symbol** equations for the reaction in the boiling tube by filling in the name of the missing product and the state symbols for each substance.

copper sulfate + sodium hydroxide → copper hydroxide + ...

....

$CuSO_4(\ldots\ldots.) + 2NaOH(\ldots\ldots.) \rightarrow Cu(OH)_2(\ldots\ldots.) + Na_2SO_4(\ldots\ldots.)$

[3]

Most candidates correctly gave 'sodium sulfate' as the other product. The state symbols were not usually correctly completed.

Key point call out

'Hints' are often given in the question when state symbols are asked for. In this case the candidates are told that copper sulfate and sodium hydroxide are both solutions and that copper hydroxide is a precipitate. This should make it straightforward to enter the state symbols for these compounds.

Question 7 (b) (i)

(b) The final mixture contains a precipitate of copper hydroxide mixed with a solution of other dissolved substances.

Jane wants to separate pure copper hydroxide from this mixture. She wants to make sure that she removes any traces of other dissolved substances from the precipitate.

(i) Describe how she can separate pure copper hydroxide from the final mixture.

....

....

....

.... **[2]**

This practical question was not well answered. Many candidates suggested unsuitable separation techniques, most often evaporation or crystallisation but also distillation or even fractional distillation. Separating a solid from a solution by filtration should be a straightforward and well known technique. The idea of washing the precipitate to removed dissolved substances was almost never seen across all candidate responses.

Exemplar 3

She can use the process of ~~dr~~ crystallisation to ~~ne~~ separate pure copper hydroxide from the mixture. The mixture should be heated, and the copper hydroxide should turn into crystals, which can then be dried out.

This response was given 0 marks. This was a very common response. Candidates often suggested separating a precipitate from a solution by evaporation or crystallisation.

Question 7 (b) (ii)

(ii) Jane leaves the copper hydroxide to dry in a warm oven. After 30 minutes she weighs the copper hydroxide on a balance.

Jane is not sure if the copper hydroxide is completely dry.

Suggest how Jane can use the oven and the balance to show that the copper hydroxide is completely dry.

....

....

.... **[2]**

Most answers showed some understanding of what to do but often did not explain ideas well. Some candidates incorrectly stated that a comparison to the theoretical yield should be made. Some said 'keep going until it weighs the same' without explaining how the oven and the balance would be used to do this. Best answers said to return the sample to the oven, reweigh, and to continue this process until constant mass.

Question 7 (c) (i)

(c) Jane does more experiments.

She adds a different volume of sodium hydroxide solution to 20 cm^3 of copper sulfate solution each time.

She records the mass of dry copper hydroxide that forms in each experiment.

The table shows her results.

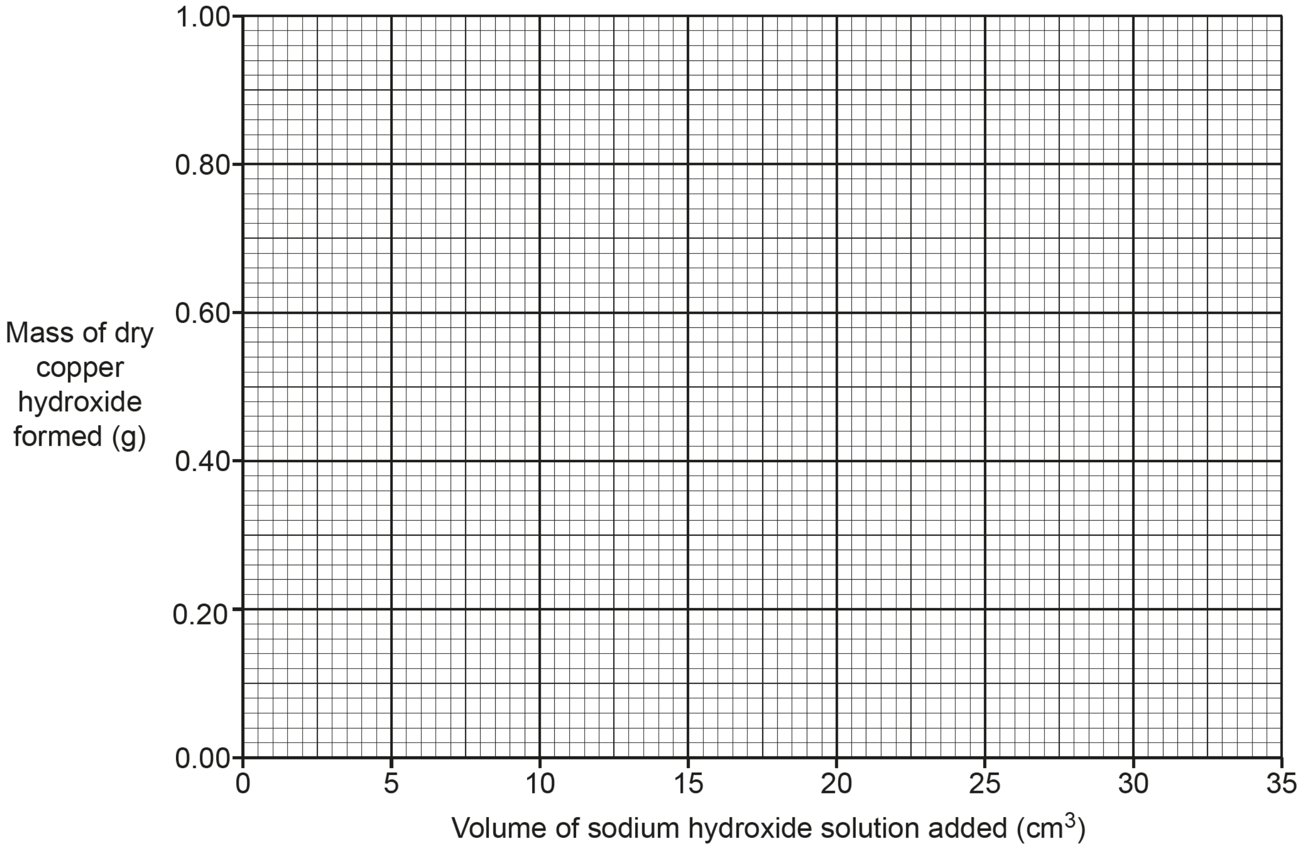
Volume of copper sulfate solution (cm^3)	Volume of sodium hydroxide solution added (cm^3)	Mass of dry copper hydroxide formed (g)
20	5	0.25
20	10	0.49
20	15	0.75
20	20	0.98
20	25	0.98
20	30	0.98

(i) Plot Jane's results on the graph.

Draw lines of best fit to show the pattern in the results. **[3]**

The plotting of results was usually done correctly. The line of best fit, however, was often incorrect. Many omitted the 'constant' part at the top. Many incorrectly curved the line rather than using two straight lines to show the pattern. This implies confusion with a rate curve. Answers with a small curve at the top were accepted but the relationship should be linear.

Question 7 (c) (ii)



(ii) Suggest why the mass of the dry precipitate does not continue to increase when more than 20 cm^3 of sodium hydroxide solution is added.

....

.... **[1]**

Some recognised that copper sulfate was the limiting factor, but many incorrectly stated that 'the copper is all used up'.

Question 7 (c) (iii)

(iii) Jane and Alex look at the table and the equation for the reaction:

$CuSO_4 + 2NaOH \rightarrow Cu(OH)_2 + Na_2SO_4$

They disagree about the results.

Jane says, 'I think the concentration of copper sulfate solution is the same as the concentration of sodium hydroxide solution.'

Alex says, 'I think the sodium hydroxide solution is double the concentration of the copper sulfate solution.'

Who is right?

Jane ☐

Alex ☐

Use information from the table and the equation to explain your choice.

....

....

....

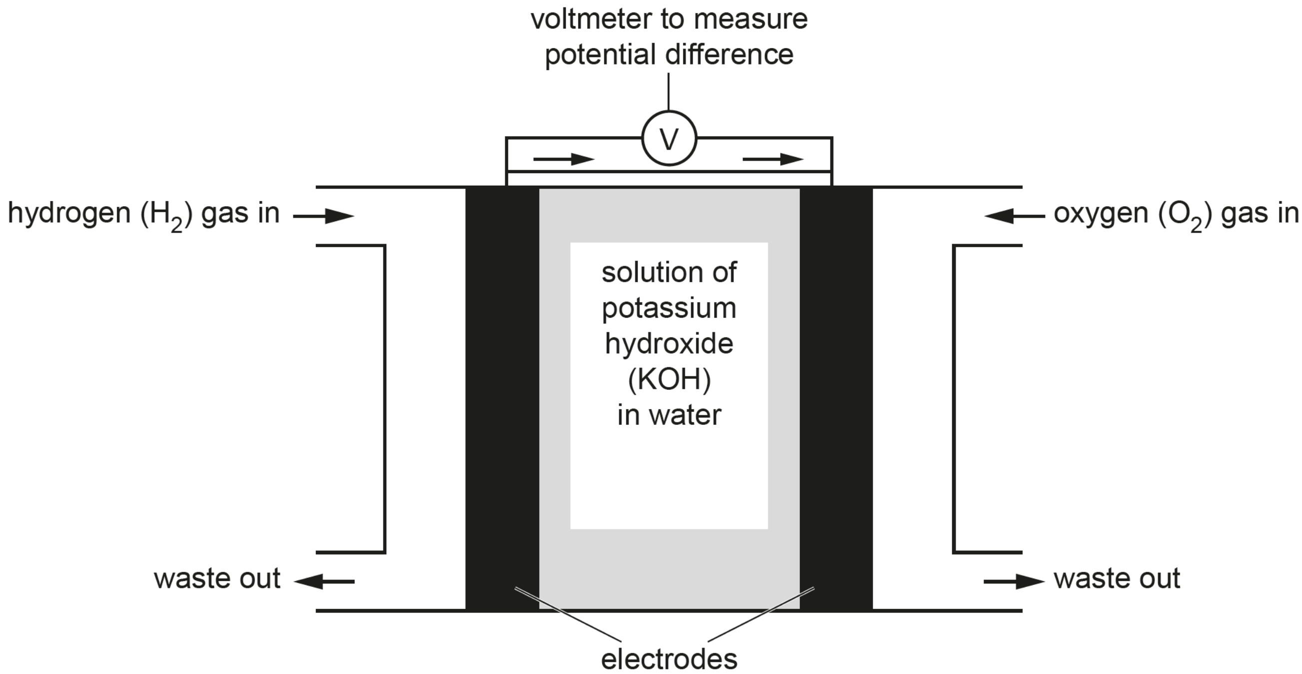
.... **[2]**

In common with other questions, some candidates appeared to show some understanding but did not express themselves well enough to earn marks. The question specifically asks candidates to refer to both the table and the equation. Best responses commented that the maximum mass of precipitate is formed when $20cm^3$ of each solution is used. Some candidates went on to say that the equation shows a 2:1 mole ratio of $NaOH:CuSO_4$ which means that the concentration of sodium hydroxide must be double. Vague answers such as 'you need twice as much' without clearly referencing either the table or the equation did not earn any marks.

Question 8 (a)

8 Beth works for a company that makes hydrogen fuel cells.

She measures the potential difference of the cell shown.



(a) Before she sets up the cell, Beth tests each gas to check its identity.

Describe the tests and the results for hydrogen and oxygen gas.

hydrogen test ....

result ....

oxygen test ....

result ....

[2]

In common with other practical questions on the paper, this was not well answered. Many stated that 'the pop test' should be used for hydrogen without stating that a lighted splint is needed. Others said an extinguished or 'blown out' splint should be used for oxygen.

Assessment for Learning

There is some evidence that questions testing practical skills are not well answered. It is suggested that revision of knowledge of practical tests and techniques are a revision priority for candidates.

Question 8 (b) (i)

(b) These half equations show the reactions that happen at each electrode in the fuel cell:

at the hydrogen electrode: $2H_2 + 4OH^- \rightarrow 4H_2O + 4e^-$

at the oxygen electrode: $O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$

(i) Beth wants to make sure that she gets the highest possible potential difference from the fuel cell.

She makes sure that she uses double the volume of hydrogen compared to oxygen.

Use the half equations to explain why she needs to do this.

....

.... **[1]**

To answer this question, candidates needed to recognise that there is a 2:1 mole ratio across two equations. Most gave answers which did not express this idea clearly enough. 'To produce 4 electrons for oxygen' was a common answer which was insufficient to earn a mark.

Question 8 (b) (ii)

(ii) Use the half equations to write an overall equation for the reaction that happens in the fuel cell.

.... **[2]**

This was a very challenging question for candidates. Some gave partially correct equations with some or all spectator species left on both sides. Some had attempted to cancel down but done so incorrectly so that the equation no longer balanced.

Question 8 (b) (iii)

(iii) A fuel cell filled with potassium hydroxide solution works better than a fuel cell filled with pure water.

One reason it works better is because potassium hydroxide solution is a better electrical conductor than pure water.

Explain why potassium hydroxide solution is a better electrical conductor than pure water.

....

.... **[1]**

Some stated correctly that a solution containing ions conducts electricity better than one which only contains pure water. However, a very, very common error was to state that potassium hydroxide provides electrons for conduction.

Question 8 (b) (iv)

(iv) Use the equations to suggest one other reason why using potassium hydroxide solution helps the fuel cell to work better.

....

.... **[1]**

The candidates were instructed to 'use the equations'. These show that hydroxide ions are involved in the fuel cell reactions. Best answers referred to the fact that potassium hydroxide provides hydroxide ions. However, most answers missed this and did not appear to have referred to the equations.

Question 8 (c)

(c) Beth uses a fixed amount of hydrogen and oxygen gas. After a time the potential difference of the cell decreases.

Explain why this happens.

....

.... **[1]**

The idea that the potential difference falls with the reactants are used up was generally understood.

Question 8 (d) (i)

(d) Beth's company want to use the cell to provide power for a submarine.

Submarines travel deep under the surface of the sea.

Most submarines have engines that burn diesel fuel.

Beth thinks that submarines that burn diesel fuel produce waste that is much more harmful to the sea than submarines that use hydrogen fuel cells.

(i) Explain why she is correct.

....

....

.... **[2]**

Almost all candidates identified a correct pollutant, such as carbon monoxide or nitrogen oxides, produced by diesel engines. However, very few stated why hydrogen fuel cells are less polluting. Some gave a partial answer such as 'hydrogen fuel cells produce water'. This was not given a mark, as diesel also produces water. When discussing the advantages of output of waste from hydrogen it is necessary to state that it produces only water as a waste product.

Question 8 (d) (ii)

(ii) Give one **disadvantage** of using a hydrogen fuel cell rather than diesel for a submarine.

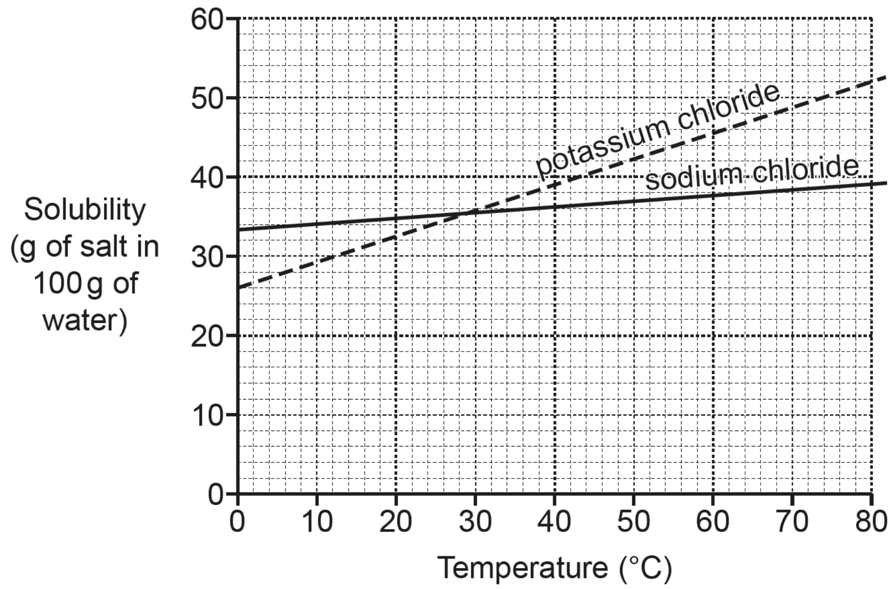
....

.... **[1]**

Most candidates could give at least one disadvantage of hydrogen, usually related to difficulties in storage of the flammable gas.

Question 9 (a) (i)

9 The graph shows the solubility of some Group 1 salts in water.



(a) (i) Use data from the graph to calculate the solubility of sodium chloride at 50 °C.

Use the information:
100 g of water = 100 cm^3 of water.

Give your answer in g / dm^3.

Solubility of sodium chloride at 50 °C .... g / dm^3 **[2]**

Most correctly read the graph to give 37g solubility in 100g of water. However, most candidates did not convert this correctly into the units asked for in the question.

Question 9 (a) (ii)

(ii) Calculate the concentration of sodium chloride at 50 °C in mol / dm^3.

Use the equations: number of moles = $\frac{\text{mass of substance (g)}}{\text{relative formula mass (g)}}$

and concentration (mol / dm^3) = $\frac{\text{number of moles of solute}}{\text{volume (dm}^3\text{)}}$

Use your answer to **(a)(i)**.

Give your answer to **3** significant figures.

Concentration of sodium chloride at 50 °C .... mol / dm^3 **[3]**

Most calculated the correct RFM of sodium chloride, but fewer were able to continue the calculation by correct substitution into the two equations. Most obeyed the instruction to record their final answer to 3 significant figures.

Question 9 (b) (i)

(b) Kai looks at the graph and writes down a mathematical relationship.

(i) Kai writes:

solubility of potassium chloride α temperature

Use the graph to explain in words why this relationship is **incorrect**.

....

....

.... **[2]**

Almost all candidates recognised the proportional symbol and knew what the relationship meant. Many stated it was incorrect because the graph does not go through the origin.

Question 9 (b) (ii)

(ii) Use data from the graph to do a calculation to predict the solubility of potassium chloride at 100 °C.

Solubility .... g in 100 g of water **[3]**

This question gave a clear instruction to 'do a calculation'. The most common error here was to ignore that instruction but instead to extend the graph and estimate a value by that method. It is important that candidates follow instructions to access the marks. Best answers either calculated a gradient or an interval between readings and used this value to give a final estimate of solubility within the acceptable range.

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