CHEMISTRY

Paper 0620/12
Multiple Choice (Core)

Question Number	Key	Question Number	Key	Question Number	Key	Question Number	Key
1	D	11	B	21	B	31	B
2	C	12	C	22	B	32	A
3	B	13	A	23	D	33	B
4	C	14	A	24	C	34	A
5	A	15	C	25	A	35	A
6	D	16	B	26	C	36	C
7	D	17	C	27	A	37	D
8	A	18	B	28	D	38	D
9	B	19	A	29	C	39	D
10	D	20	D	30	A	40	C

General comments

Some candidates were not able to recall the meaning of essential terminology such as; soluble, filtrate, isotope and volatile and so struggled with some questions.

Candidates should be reminded that for some questions the options will include statements that are partially correct and that the full meaning of the statement should be considered.

Candidates found **Questions 15**, **17**, **27**, **33** and **38** to have the least challenge.

Questions 6, **13**, **25**, **31**, **36** and **40** were most demanding.

Comments on specific questions

Question 5

Candidates should take care to read the statements carefully. Option **D** was chosen by over a third of the candidates suggesting that they did not recognise the significance of the word ‘ion’ rather than ‘atom’.

Question 6

Only a third of the candidates overall gave the correct answer, with the candidates that performed less well overall appearing to be guessing. All options were chosen equally suggesting that the properties of ionic compounds were not well recalled.

Question 7

Almost half of the candidates who performed less well overall chose option **B**. Although the statement describes a correct property of graphite, it does not explain the use of graphite as a lubricant.

Question 9

Few candidates chose options **C or D** but well over a third of candidates chose option **A**. When asked to state the relative mass of a particle (including that of a proton), candidates are expected to give its value relative to the standard which is one twelfth of one atom of ^{12}C.

Question 10

Candidates who performed less well overall were more likely to choose options **B or C**, with option **C** being chosen by most candidates. Candidates should recall that if species are gaining and losing one or more oxygen atoms, a redox reaction is taking place. Many candidates did not recognise that combustion of a hydrocarbon to form carbon dioxide and water is an example of a redox reaction.

Question 13

This question was not well answered with option **C** being chosen by almost half of all candidates. Overall, this suggests that candidates are able to identify chemical changes where a new substance is produced but some candidates are confused by the direction of movement of thermal energy in the identification of an endothermic reaction.

Question 16

Although a small majority of candidates identified the correct answer, many suggested option **C**. In option **C**, the initial rates of reaction, shown by the gradient of the curve, appear to be identical. In experiment 2, the lower concentration of acid would give a lower initial rate and so a smaller gradient at the start of the reaction.

Question 20

This question discriminated well between candidates. Candidates who performed less well overall appeared to be guessing.

Question 21

Over a third of the candidates chose option **C**. Candidates should recall the presence of the hydrogen ion, as H^+, in all acidic solutions and the presence of hydroxide ions, as OH^-, in all alkaline solutions which react together in a neutralisation reaction.

Question 23

This question discriminated well between candidates. Determining the order and reason for stages in a salt preparation is a challenge for many candidates. Candidates who performed less well overall tended to choose option **A**, where they confused the terms soluble and insoluble or option **C** where they incorrectly assumed that the filtrate is the solid extracted from the mixture.

Question 25

Many candidates chose option **B**. This statement contains the correct information that halogens are diatomic but incorrect information that they are all gases at room temperature. Candidates should take care to read the whole statement.

Question 28

This question discriminated well between candidates. Almost half of the candidates who performed less well overall chose option **B**, confusing the alloy stainless steel with brass.

Question 31

This question was not well answered. The syllabus requires candidates to know how iron and aluminium are extracted. Most candidates assumed the question was about those metals and chose options **A** or **D**. The correct answer should be determined by their knowledge of the reactivity series and that more reactive metals are more difficult to extract from their ore.

Question 36

This question was not well answered. Both options **A** and **D** were commonly chosen by candidates suggesting that the colour changes of thymolphthalein and that of aqueous bromine were not well recalled.

Question 40

Only a few candidates chose option **D** showing that they recognised that there was no sulfate present. All the other options were commonly chosen suggesting that most candidates could identify either the anion or the cation, but few candidates could identify both from the information given.

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Paper 0620/22
Multiple Choice (Extended)

Question Number	Key	Question Number	Key	Question Number	Key	Question Number	Key
1	B	11	B	21	D	31	D
2	C	12	A	22	A	32	B
3	A	13	D	23	C	33	B
4	B	14	A	24	A	34	A
5	D	15	B	25	D	35	A
6	A	16	A	26	B	36	B
7	A	17	B	27	C	37	B
8	D	18	B	28	D	38	A
9	D	19	C	29	C	39	B
10	D	20	C	30	C	40	C

General comments

Candidates found this to be an accessible paper overall with many candidates performing well.

Candidates found **Questions 2**, **4**, **9**, **14**, **18**, **21**, **31**, **32** and **35** to have the least challenge.

Questions 10, **19** and **28** were most demanding.

Candidates should take care when reading longer statements where a partial truth may be given. An example would be **Question 30** where the replacement of an electrode is described but the wrong electrode is given. Other examples include questions where there are two or three columns, each with information, such as **Question 39** where both the monomer and linkage needed to be identified.

Comments on specific questions

Question 6

This question discriminated well between candidates. Candidates who performed less overall well were much more likely to choose option **B**. Candidates could use the boiling point information to identify methanal as a simple molecular compound. Using the information, a dot-and-cross sketch would help deduce the correct answer.

Question 10

This question was not well answered with over half of the candidates choosing option **B**. In each option the compound shown has an overall charge of zero. Option **B** is a compound containing three oxide ions with a total charge of –6. One Fe^{2+} and one Fe^{3+} ion would give +5. If combined, Fe_2O_3 would not be neutral. Fe_2O_3 must therefore contain two Fe^{3+} ions only and so it does not meet the description of magnetite.

Question 11

This question discriminated well between candidates. Although it was not considered a demanding question, the majority of candidates who performed less well overall chose options **A** and **D**.

Question 15

Questions involving a calculation are often considered more demanding. This question has an additional challenge because the equation was balanced using two moles of ethyne rather than one. The most common answer was option **A** where this was not recognised. Most candidates did recognise that the correct value is a negative number with few choosing options **C** or **D**.

Question 19

Option **D** was chosen by almost half of the candidates. The acidic nature of the solution and the observation with red litmus was well known but the colour change when aqueous iodide ions are oxidised to form aqueous iodine was not.

Question 24

This was quite a demanding question. It required candidates to determine the products of four reactions and to identify the reaction which produced an insoluble salt. Most of the candidates who performed well overall identified the correct reactants to give an insoluble salt. Other candidates appeared to be guessing, although there was a slight bias towards option **D**.

Question 27

Many candidates did not recall how the atoms in an alloy are related. Over a third of candidates gave an answer which suggested that an alloy is a compound rather than a mixture. Option **A** was the most commonly chosen incorrect answer.

Question 28

This question was not well answered. Half of all the candidates chose option **A.** Candidates should be reminded that metal atoms react by releasing electrons to become cations. In displacement reactions, the ion of the least reactive metal is reduced.

Question 30

Only half of the candidates identified the correct statement about the extraction of aluminium. Option **B** was the most commonly chosen incorrect answer. Candidates choosing this statement confused the cathode for the anode in the electrolysis.

Question 34

Many candidates chose option **D** which described the reflection of thermal energy from the Earth's surface. The statement is the opposite of the correct description where more rather than less thermal energy is reflected back to the Earth's surface. This reflection may also be described in terms of absorption followed by re-emission of the energy.

Question 37

Candidates who performed well overall had no trouble with this question whereas other candidates were more likely to choose options **C** or **D**, although the overall distribution suggests some were guessing.

Question 39

Questions on polymers and monomers are often quite challenging. Just over half of all candidates answered this correctly with the candidates who performed less well overall more likely to choose option **C**, which contains two incorrect statements. Candidates should practise identifying the linkages in both polyesters and polyamides to help identify the monomers used.

CHEMISTRY

Paper 0620/32
Paper 3 Theory (Core)

Key messages

- Questions where candidates had to match the name of a substance to a statement were answered well.
- Questions requiring simple answers to calculations were usually well answered, as were questions involving balancing equations. Candidates were able to easily calculate the relative molecular mass of a given compound as in **Question 2(e)(iii)**.
- Questions on more detailed aspects of the kinetic particle theory were generally answered well. There was a tendency for candidates to confuse 'arrangement', 'separation' and 'motion'.
- It is important that candidates read the question carefully to understand what exactly is being asked. Practice of reading and interpreting questions that involve data handling should also be prioritised.
- The answering of chemical test questions was not done well. Candidates' answers showed many large gaps in their knowledge. This is a part of the syllabus that needs to be practised and used in classroom tests more often. Many candidates struggled to 'Give a test for sodium ions' as in **Question 2(b)**.
- Organic questions were answered well, and some candidates could draw the correct structures of organic compounds. Some candidates could 'draw the displayed formula for ethanoic acid' as in **Question 2(e)(i)**.
- Candidates found some of the pollution-based questions as in **Question 2(d)** challenging. More work on this specific part of the syllabus should be done with candidates.

General comments

Many candidates tackled this question paper well, showing a good knowledge of core chemistry. Good answers were shown throughout the paper to several different questions. Most candidates found some of every question challenging. It was evident that many candidates are now using past paper practice as part of their revision programme, but more revision is needed on some aspects of this syllabus.

Misinterpretation of the rubric happened in some cases. The most common misinterpretation was in **Question 4(b)** which asked the candidates to 'State the meaning of the term unsaturated'. Many candidates answered this question using the concept of an 'unsaturated solution' instead of using the term 'unsaturated' when it was applied to alkenes. Another misinterpretation was in **Question 6(c)** where candidates were asked to 'Describe the motion and separation of the particles in solid sulfur'. Some candidates confused the terms and others thought that the 'separation' part of the question was to do with the separation of mixtures and answered with 'fractional distillation' or 'filtration'. Some candidates also talked about ways of changing the state of the solid sulfur and so did not achieve full credit. Candidates also struggled with the question 'State how the volume of ethene in the gas syringe changes when the temperature is decreased, and the pressure remains the same'. Some candidates answered this question with stating how the particles of ethene gas moved or how they escaped from the gas syringe in this process. They did not include in their answer how the volume would change if the temperature was decreased. The balancing of equations was good, demonstrating that candidates had practised these as part of their revision. Definitions from across the syllabus were well answered. Candidates had spent time learning them and had revisited them during their revision time.

Questions with the command word 'deduce' and 'predict' were answered well by many candidates and many were able to justify their response to the prediction. This showed much practice and revision of past paper questions. Data handling type questions were not always answered well. Candidates often made slight mistakes and were not precise enough when answering these types of questions.

The standard of English was very good. Some candidates need to be more explicit when writing about certain concepts and not use the vague words ‘it’ and ‘they’ to answer questions. Some better performing candidates wrote their answers as short phrases or bullet points. Candidates are less likely to write vague statements or contradict themselves if this is done.

Comments on specific questions

Question 1

Candidates found this first question the most accessible question on the paper. They especially did well on **(a)**, **(c)** and **(e)**.

(a) Most candidates could answer this question correctly. Zinc oxide was a common error.

(b) Most candidates could answer this question correctly. Common errors were stainless steel and zinc oxide.

(c) Many candidates identified methyl orange as the correct answer. However, thymolphthalein and litmus were often chosen.

(d) Many candidates incorrectly thought that glucose is a reactant in photosynthesis. Some candidates also gave wrongly carbon monoxide.

(e) This question was well answered. A small number of candidates thought that the correct answer was magnesium bromide.

(f) This question discriminated well between candidates. Candidates who performed less well overall did not achieve credit here. Calcium oxide and hydrogen were commonly seen incorrect answers.

Question 2

Candidates did very well on some of the parts of this question. However, they found the chemical test and pollution-based part questions challenging. Most candidates could calculate the relative molecular mass of the organic acid.

(a) (i) Most candidates answered this question correctly. A few candidates did not read the question carefully enough and so gave the ion with the highest concentration instead of, more specifically, the negative ion with the highest concentration.

(ii) Many candidates struggled with this part and could not name the compound correctly. Common incorrect answers included ammonia sulfate, nitric oxide and ammonium sulfide. More practice is needed on answering these types of questions.

(iii) Most candidates answered this question correctly. Some answers were out by a factor of 10 or 100.

(b) This question was very poorly answered with many candidates writing the wrong test, getting mixed up between tests or not writing a chemical test at all. A few candidates selected the correct test but then wrote incorrect observations. More practice and learning of the chemical tests are needed. Common wrong observations were a yellow precipitate instead of a yellow flame.

(c) Most candidates could describe a correct benefit but there were also some vague answers; for example, ‘to fertilise the soil’, ‘to kill insects’ and ‘to help the fields grow’ were answers which were not awarded credit.

(d) Candidates struggled with this pollution-based question and more practice is needed on these types of questions. In the first part, many candidates were not specific enough and gave very vague answers about sewage being harmful. Many candidates did not mention that the sewage caused disease. In the second part, many candidates described toxicity or gave a vague statement about the phosphates being a pollutant instead of, more specifically, that they reduce the amount of oxygen in the water.

(e) (i) This question was not well answered. Candidates struggled to draw the displayed formula of ethanoic acid and only better performing candidates correctly drew the structure. Some candidates were close to the correct answer but then did not show the covalent bond between the oxygen and hydrogen in the OH group of the carboxylic acid. Some candidates gave a correct displayed formula for propanoic acid instead and others drew alcohols.

(ii) Many candidates identified sodium ethanoate and spelled the chemical name correctly, although there were a few close spellings such as 'ethanote'. Most candidates were able to identify water as the other product. Hydrogen was a common error.

(iii) Most candidates were able to calculate the relative molecular mass of the organic acid correctly.

Question 3

The changes in the metallic character of the elements across a period and the trends in the properties of the elements going down Group I were not well understood. Many candidates found this question the most challenging question on this paper.

(a) (i) Only a few candidates knew what this question was asking, and few correct answers were seen. Many candidates described melting point, boiling point, density, outer electrons and reactivity and some referenced trends down a group as well.

(ii) Most candidates stated that reactivity increases down the group. Some candidates made a statement which was not a trend; for example, that 'Group I has a high melting point or a high density'. Some candidates just named two Group I elements or gave an atomic number or the number of electron shells.

(b) (i) Full credit was rarely awarded. The most common error was to give '2Br' instead of 'Br_2'. A few candidates gave the wrong halogen.

(ii) This question was not well answered. Many candidates referenced the reactivity of iodine against sodium, sodium bromide and bromide. Other candidates stated that they were both aqueous or referenced their position in Group VII.

(iii) Most candidates could draw the pair of electrons between the two iodine atoms. Many candidates could not complete this dot-and-cross diagram with the correct number of non-bonding electrons on each iodine atom. Some candidates gave two non-bonding electrons on each iodine atom while other candidates gave four or seven.

(c) This question discriminated well between candidates. Many candidates could correctly name the product formed at each electrode. Some candidates confused 'bromide' with the correct 'bromine'. A few candidates misread the question and thought that the electrolysis was in aqueous solution and so used hydrogen as one of their answers.

(d) (i) This question was not well answered by many candidates with a large number of candidates giving no answer at all. Arrows were seen to the part of the cathode that was outside the electrolyte, to the electrolyte itself, to the wrong electrode and to the power supply.

(ii) Most candidates performed well here, and many correct answers were seen.

Question 4

The questions on organic chemistry and chemical energetics were mostly well answered by candidates who went on to perform very well overall. This question discriminated very well between candidates. Parts **(a)(i)**, **(a)(iii)**, **(c)(i)** and **(e)(i)** were very well answered. Candidates often found parts **(a)(ii)** and **(f)(ii)** more challenging.

(a) (i) This question was generally well answered by most candidates. A few candidates confused the general formula of an alkene with that of an alkane or gave a '+' sign in the answer. For example, these candidates gave wrongly 'C_nH_{2+n}'.

(ii) This question was often not well answered. Most candidates just described what cracking is rather than why it is done.

(iii) Most candidates could describe one condition for cracking. High temperature was the most popular correct answer. Some candidates wrote incorrectly 'temperature' or 'high pressure'.

(b) Candidates needed to be more specific in their answering of this question. Many candidates gave 'double bond' in their answer but then omitted to mention that it was between carbon atoms and did not gain credit. Some candidates misinterpreted this question and thought that the question was asking about the meaning of the term 'unsaturated solution'.

(c) (i) Most candidates answered this question correctly. There were a few candidates who left out the minus sign in their answer for the temperature.

(ii) This question was not well answered. Many candidates thought that the correct state was 'solid'. Many candidates, who did get the correct state, were then not able to compare the stated temperature to the melting point and boiling point given in the question.

(d) This was another question where candidates misinterpreted the rubric. Many candidates described pressure, reaction rate or particles in their answers instead of how the volume of ethene changes.

(e) (i) Most candidates answered this question correctly. However, some candidates did not mention heat or thermal energy in their answers.

(ii) This question was generally well answered by most candidates. Errors included not comparing the energy of the reactants to the energy of the products and just stating that 'the reactant is greater than the product' or that 'more product is produced' or 'more energy is released at the end of the reaction'.

(f) (i) Few candidates gained full credit. Many errors in the formula of ethanol were seen; many candidates thought that ethanol contained two oxygen atoms or five hydrogen atoms.

(ii) Few candidates answered this question correctly. The most common wrong answer was 'alkali'.

Question 5

Candidates were able to deduce the number of electrons and neutrons in the samarium atom and many could describe the effect of changes in reaction conditions on the reaction rate. Some candidates struggled with drawing the apparatus for the experiment in **(c)(i)** and with defining the term 'hydrated' as in **(f)(i)**.

(a) Most candidates could deduce the number of electrons and neutrons in the samarium atom shown.

(b) Most candidates could identify the correct property of samarium.

(c) (i) Most candidates did attempt to draw a viable gas syringe. However, very few candidates labelled their diagram. Not many candidates drew a completely workable apparatus. There were air gaps seen in many drawings, so the apparatus was not closed. The most common error was not drawing a stopper with a tube going through it at the top of the conical flask.

(ii) Most candidates answered this question correctly. The most common error was to give an answer that was not comparative such as 'the reaction is fast'. Some candidates also confused the rate with the time of reaction and stated that 'less time would be taken'.

(iii) Most candidates answered this question correctly.

(d) Most candidates could order the four metals correctly. This was the question on this question paper with the highest number of completely correct answers.

(e) Most candidates were able to balance the product. However, many candidates could not successfully complete the balancing of the whole equation and could not balance the reactant successfully.

(f) (i) This was the question on this question paper that had the lowest number of correct answers. Most candidates recognised that water was involved but could not describe correctly how. A very small number of candidates gave correct syllabus definitions.

(ii) This question was not well answered, with very few candidates gaining full credit. Some candidates correctly stated that ionic compounds have high melting and boiling points. However, many candidates just stated 'conducts electricity' without also stating the conditions of when molten or in aqueous solution. Other incorrect answers were also seen such as 'hard', 'metallic', 'shiny' and 'ductile'.

Question 6

Candidates found this question the most challenging question on this paper. Many candidates struggled with parts **(a)**, **(b)**, **(e)(ii)** and **(e)(iv)**. They especially found answering the questions asking about sulfur dioxide acting as a pollutant challenging. However, the sign for a reversible reaction was very well known by most candidates.

(a) Candidates performed less well on this question, and many could not correctly state the meaning of the term element. Many candidates described molecules, compounds or types of bonding. Some candidates described an element as 'made of one atom'.

(b) Very few candidates knew that the first gap referred to sulfur isotopes. Common errors were ^{32}S or 'protons'. More candidates knew the second gap was ^{12}C.

(c) Many candidates performed well on this question, especially on the first part. Some candidates confused motion with separation, and others thought that the separation part of the question was to do with the separation of mixtures and answered in terms of 'fractional distillation' or 'filtration'. Some candidates also gave ways of changing the state of solid sulfur, such as melting and boiling and so did not achieve credit.

(d) (i) Many candidates could describe one general physical property, with the most popular correct answer being 'liquid takes the shape of its container'. However, some candidates struggled to think of a second difference. Some candidates confused bulk with particle properties and mentioned wrongly about particles. Many candidates described liquids as having a variable volume.

(ii) Most candidates could correctly calculate the mass of the product. There were several common wrong answers given, such as 9.1 which was calculated using $\left(\frac{19.2}{13.5}\right) \times 6.4$.

(e) (i) Most candidates answered this question correctly. Incorrect answers ranged from 3% to 100%.

(ii) Very few candidates could state one source of the pollutant sulfur dioxide in the air other than from burning sulfur. Most common incorrect answers were 'car engines', 'factories' and 'burning of fuels'.

(iii) Most candidates answered this question correctly.

(iv) This question was one of the least well answered on this question paper. Very few candidates could recall one method of reducing the emissions of sulfur dioxide. The most common incorrect answers suggested burning less sulfur or fossil fuels.

(v) The formula of the ion that is present in all aqueous acids was not well recalled in this question. Most answers were not ions; for example, H_2O was given as well as O_2. Equations were also given here. Some equations made sulfurous acid, and a few candidates suggested wrongly OH^- or SO_4^{2-}.

(vi) Most candidates could correctly write the sign for a reversible reaction.

Question 7

Most candidates were able to deduce the electronic configuration of magnesium and complete the word equation for the reaction of magnesium oxide with hydrochloric acid. However, some candidates struggled to explain how the given equation shows that magnesium oxide is reduced and to choose from the list one other compound that is insoluble in water.

(a) Most candidates could deduce the electronic configuration of magnesium.

(b) This question was not well answered. Few candidates could explain correctly how the given equation shows that magnesium oxide is reduced. 'Magnesium has lost oxygen' and 'reduction is loss of oxygen' were the most common incorrect answers.

(c) Most candidates identified the diagram **B** which represented the structure of an alloy. The most common incorrect answer was **A**.

(d)(i) Most candidates correctly stated magnesium chloride. However, fewer candidates could name water. The most common incorrect answer was hydrogen.

(ii) Many candidates were unable to recall the solubility rules and so performed poorly here. Magnesium sulfate was the most common incorrect answer.

(e) Candidates struggled with deducing the correct period. Many candidates identified the element or group number but not the period. Period 3 was the most common incorrect answer.

CHEMISTRY

Paper 0620/42
Paper 4 Theory (Extended)

Key messages

- Candidates need to be careful in the use of subscripts in formulae and upper/lower case in symbols.
- Candidates need to read the question carefully, e.g. **Question 3(d)(i)** in which candidates were asked to use the information in the table (i.e. pH values) to determine the substance with the highest concentration of H^+(aq) ions.
- Calculations were generally done well but some candidates did not secure partial credit through lack of working.

General comments

The overall standard was very high, but it was noticeable that some candidates were not familiar with the newer content of the new syllabus which was first examined in March 2023.

Centres should avoid going beyond the scope of the syllabus, and A Level electronic structures, such as $1s^2$, $2s^2$, $2p^6$, are not necessary.

When candidates are asked for a name, a name should be given, not a formula and vice versa.

Comments on specific questions

Question 1

(a) (i) Most candidates named coke as the substance which provides carbon for the reaction shown by **equation 1**, although coal was a frequently seen incorrect answer.

(ii) Most candidates knew that carbon is combusted to produce heat or to provide carbon dioxide (for further reaction with carbon/coke).

(b) (i) Although most candidates calculated the percentage correctly, others fell short by assuming the total mass of iron within Fe_2O_3 was 56 (instead of 112) leading to an answer of 35% (rather than the correct value of 70%). Another common error was to use the atomic number of Fe rather than the relative atomic mass.

(ii) Hematite or close homonyms were frequently seen. Bauxite was a regular error.

(iii) Most candidates were able to correctly state that carbon monoxide is formed when coke (carbon) reacts with carbon dioxide. Some weaker responses assumed it formed through thermal decomposition of limestone.

(iv) The expected symbol equation, $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$, was often seen. Weaker responses were not balanced or used Fe_2 as part of the balancing.

(v) Most candidates could correctly name the process as reduction, although 'displacement' was a common error.

(c) Most candidates recognised the reaction in **equation 2** as a thermal decomposition.

(d) (i) Candidates who performed less well often gave non-specific responses based upon neutralisation. Other candidates were able to correctly state that CaO, being a metal oxide, is basic and, conversely, SiO_2 is an acidic oxide.

(ii) The chemical name of SiO_2, silicon(IV) oxide, was usually known, but the common name of CaSiO3, slag, was less well known.

(e) (i) Better performing candidates knew that aluminium could not be extracted from its ore using a blast furnace due to it being more reactive than carbon

(ii) The expected answer of 'electrolysis' was often seen, although it was clear that many candidates had been taught that aluminium was extracted by the Hall–Héroult process.

(f) (i) Most candidates knew the electronic configuration of the aluminium ion was 2,8. However, some candidates gave 2,8,3 which is the electronic configuration of the aluminium atom, presumably as a result of misreading the question.

(ii) Better performing candidates gave totally correct answers. Weaker responses sometimes added on 3 electrons.

Question 2

(a) Fluorine was almost universally known as the halogen with the lowest density.

(b) Many candidates knew bromine was a red-brown liquid at r.t.p., although some thought it to be orange, presumably because of confusion with bromine water.

(c) Better performing candidates used the Periodic Table on the Question Paper and most correctly gave Ts as the symbol of the halogen with the highest atomic number (the name was also accepted). Realising that as Ts was in Period 7, it therefore had 7 occupied electron shells was less well known.

(d) (i) This recall question proved to be the most difficult on the paper. Section **2.5.1** of the syllabus reads: *State that a covalent bond is formed when a pair of electrons is shared between two atoms leading to noble gas electronic configurations.*

The expected answer was 'a pair of electrons shared between two atoms'. The key points being that **two** electrons were shared and **two** atoms were involved. Many candidates wrote 'when two or more atoms …' or 'when two or more electrons …'. Many weaker responses wrote about electrons being shared between two non-metals without referring to atoms.

A covalent bond has two electrons only and involves two atoms only.

(ii)(iii) The stem of **Question 2** reminded candidates that halogens form halide ions and it is important that candidates distinguish between halogens and halides. Iod**ine**, instead of iod**ide**, was a common error in both question parts. In **(d)(iii)**, candidates who simply stated 'bromine is more reactive' gained no credit as it was not clear what bromine was more reactive than?

(e) Most candidates knew that the halide used to detect water is cobalt(II) chloride, but many omitted the key point that it should be the *anhydrous* form of the compound.

(f) The dot-and-cross diagram was completed successfully by most candidates. Common errors included omitting the third shell of Ca or having 8 'dot' electrons in the third shell of C*l*. Weaker responses gave correct charges only.

(g) (i) The rules of solubility of salts, as given in section **7.3.2** of the syllabus, were not well known and the expected answer of 'lead nitrate' was seldom seen. The most common error seen was 'lead bromide'.

(ii) Candidates who performed less well struggled with the ionic equation for precipitate formation. Such equations will always have two reactant *ions* and one product compound. (In this question, the formula of the product compound, $PbCl_2$ was given). The sequence of state symbols will always be (aq) + (aq) → (s).

Errors were to only have one Cl^-(aq) ion as a reactant ion or to attempt to write the complete symbol equation, usually unsuccessfully.

Candidates should be advised to identify the solid product and 'split' this up into its constituent ions. These will be the reactants.

(iii) Lack of knowledge of the rules of solubility made this question challenging for many candidates, and very few could name silver chloride as an insoluble chloride.

Question 3

(a) Most candidates could define the term base as a proton acceptor.

(b) The term alkali was less well known. Section **7.1.3** of the syllabus reads: *State … that alkalis are soluble bases.* This simple response was not seen often.

(c) Many candidates performed well on this question. Most candidates knew thymolphthalein indicator in the presence of NaOH would be blue, but only few candidates stated it would be colourless in the presence of CH_3COOH.

(d) (i) Most candidates identified HNO_3 as the substance from Table 3.1 with the highest concentration of H^+(aq) ions, and many went on to use the information, which was what the question required, and explained this was because HNO_3 had the lowest pH.

Correct statements, such as 'HNO_3 is the strongest acid', did not receive credit as this response did not use the information given in Table 3.1.

(ii) Most candidates identified universal indicator as the indicator which can be used to identify the substance with the highest concentration of H^+(aq) ions. Litmus did not gain credit as it would not distinguish between the two acids, CH_3COOH and HNO_3.

(e) Better performing candidates showed the formation of the H^+ ion and the CH_3COO^- ion. Fewer candidates knew that as CH_3COOH is a weak acid, it only partially dissociates so an equilibrium arrow should be used, as described in section **7.1.12** of the syllabus.

(f) It was clear that although some candidates knew the answer, many candidates were unfamiliar with section **7.1.8** of the syllabus.

(g) This question was done very well by the majority of the candidates and full credit was often seen. Weaker responses calculated the number of moles of $Ca(OH)_2$ used and the M_r of HNO_3 only.

Candidates should be advised not to use fractions as answers.

Question 4

(a) (i) This question proved difficult with few candidates recognising HCOOH as a structural formula.

(ii) The empirical formula of HCOOH was well known.

(b) The name of the ester was known by most candidates. The most common error was the misspelling of 'methanoate' as 'methanote'. Most candidates were able to draw the displayed formula of ethyl methanoate.

(c) (i) The term 'closed system' was not strongly explained by many candidates, although most stated nothing could enter the reaction vessel, or nothing could leave it. Better performing candidates gave both scenarios. Many incorrect responses stated that external factors, such as temperature or pressure had no effect.

(ii) Many candidates could state from section **6.3.3** of the syllabus, at equilibrium:
(a) the rate of the forward reaction is equal to the rate of the reverse reaction.
(b) the concentrations of reactants and products are no longer changing ('constant' being equivalent to 'no longer changing').
The main error seen in the first statement was 'forward reaction is equal to reverse reaction' without mention of rates. The main error seen in the second statement was the concentrations of reactants and products are the same or are equal.

(iii) Most candidates coped well with predicting the effect of changing the conditions and many gained full credit. A significant number of candidates did not read the question carefully and a common error was to describe the change in equilibrium position without stating what this meant for the concentration of **X**, which was what the question asked for.

Question 5

(a) Better performing candidates were able to relate the higher rate of diffusion of but-1-ene to its lower M_r. Weaker responses simply referred to but-1-ene being 'lighter' or 'less dense' or having a 'lower A_r'. Several candidates gave incorrect reasons such as 'but-1-ene has 2 fewer H atoms' or 'but-1-ene has a double bond'.

(b) Candidates who performed less well found this challenging. Some candidates stated incorrectly only 'carbon dioxide', others wrote 'carbon dioxide + hydrogen'.

(c) (i) 'Photochemical' was well known.

(ii) Many candidates were able to refer to section **11.4.4** of the syllabus and correctly described ultraviolet light as providing the activation energy for the reaction.

Many other responses were too vague, such as 'to provide energy' or just 'activation energy'. Incorrect responses included 'catalyst' or 'to lower E_a'.

(iii) 'Substitution' was well known, although many candidates stated the incorrect term 'displacement' as the type of reaction.

(iv) Most candidates realised that only two monosubstituted isomers were formed. Common errors included '10', based on the fact there were 10 H atoms, or '4', based on the fact there were 4 C atoms.

(d) (i) The majority of candidates correctly opted to identify the **type** of catalyst as 'acid', which reflects section **11.6.1** of the syllabus.

(ii) Displayed formulae were often seen to be missing the O–H bond. Where candidates opted not to draw an O–H bond, several drew bonds from the C atom to the OH group in an ambiguous way which meant it was hard to tell if the bond went from the C atom to the H atom or to the O atom of the OH group.

Candidates were generally not familiar with the IUPAC system of naming unbranched alcohols as given in section **11.2.3 (part c)** of the syllabus.
Name and draw the structural and displayed formulae of unbranched:
(c) alcohols, including propan-1-ol, propan-2-ol, butan-1-ol and butan-2-ol.

Quite often, 'butan-1-ol' appeared as 'butanol' and where numbering was applied, it was often incorrect and names such as 'but-2-ol' were frequently seen.

(e) (i) Most candidates knew the type of polymerisation was addition.

(ii) Many candidates found this question challenging. The most common incorrect response was a 12-carbon saturated hydrocarbon, with or without continuation bonds. Also seen frequently were three sets of four-carbon saturated hydrocarbons, often in brackets with continuation bonds or without brackets and joined by divalent hydrogen atoms. Most candidates who gave the correct structures did not draw in the C–H bonds in the ethyl group.

CHEMISTRY

Paper 0620/52
Paper 5 Practical Test

Key messages

The Confidential Instructions state that the supervisor must do the experiments in **Question 1** and **Question 2** and record the results on a copy of the question paper. These results must then be included with the scripts from the centre when they are returned. Where the practical exam has taken place in more than one practical session or laboratory, it should be clear which set of supervisor's results are for which session or laboratory and also which candidates were in which session or laboratory.

It is essential that centres make up solutions and provide apparatus in accordance with the details contained in the Confidential Instructions. If there is difficulty in obtaining some substances, then the centre should contact Cambridge Assessment for advice. Substances used should be of good quality. It is evident from results recoded that, on occasion, some substances used are contaminated or partially decomposed.

Readings recorded from a given item of apparatus should all be recorded to the same resolution (the same number of decimal places).

When a question asks candidates to identify a substance, the name or formula is acceptable. However, incorrect names or formulae will not be accepted (for example, 'iodine' is not an acceptable alternative for 'iodide'). General terms such as 'salt', 'acid', 'impurity' or 'residue' will **not** gain credit if the identity has been asked for.

In qualitative analysis, not all the tests described will necessarily give a positive result. A negative test result is useful since it tells us that a certain ion is not in the compound being tested.

In the qualitative analysis question (**Question 2**), where a question states 'Test any gas given off' then candidates are expected to test the gas and record the details for the gas test that gave a positive result. Candidates are expected to use the term 'precipitate' when describing the formation of a solid from the reaction between two solutions; if when two solutions are mixed the product becomes cloudy and opaque then a precipitate has been formed.

General comments

The vast majority of candidates successfully attempted all of the questions. The paper was generally well answered, with very few unanswered questions.

In answering the planning question (**Question 3**), there is no need for candidates to spend time writing a list of variables or a list of apparatus at the start, nor the aims of the experiment. Where there is credit available for the use of suitable apparatus, then that will only be awarded if it is stated what the apparatus is used for. Credit will not be awarded just for a name in a list of other apparatus.

Comments on specific questions

Question 1

(a) The vast majority of candidates were able complete correctly Table 1.1. All burette readings given to 1 decimal place or all readings to the nearest 0.05 are accepted, but not a mixture of the two. The majority of candidates gained a titre in Experiment 1 that was comparable to the supervisor's result and a titre in Experiment 2 that was approximately half of the titre in Experiment 1.

(b) (i) Most candidates correctly stated that acid **A** was the more concentrated because it needed a smaller volume to neutralise the fixed volume of aqueous sodium carbonate. The most common error was to state acid **B** was the more concentrated because a larger volume was used.

(ii) Most candidate gained the credit available. It was evident that some candidates compared Experiment 2 to Experiment 3, whereas the comparison should have been between Experiments 1 and 3, the only difference between these two experiments being the acid used. Some candidates incorrectly divided the titre from Experiment 1 by the titre from Experiment 3 and so arrived at an answer of less than 1; if acid **A** is more concentrated than the number of times more concentrated must be a number greater than 1. Candidates were expected to give an answer to the nearest 0.5 or better. There was some evidence of incorrect rounding. If answers are rounded, then the rounding must be correct. A small minority of candidates rounded answers twice, and so, for example, having got a factor of 1.45, rounded it to 1.5 (which would have been accepted) but then rounded it again to 2 (which would not have been accepted).

(c) (i) Most candidates correctly stated that Experiment 1 used a greater volume of hydrochloric acid than Experiment 2, and then correctly stated the difference in terms of a factor or a volume.

(ii) The best answers calculated the expected titre by either using the answer to **(c)(i)** or using the titres in Table 1.1. Candidates should be aware that physical quantities require units, in this case cm^3.

(d) (i) This question required candidates to identify a substance, so the answer should have been a chemical name of formula; vague answers such as 'impurities' did not gain credit. As the burette had only been used to hold dilute hydrochloric acid **A**, that was the only substance that water could have removed from the burette. Most candidates stated this; although a significant number thought bacteria, indicator or sodium carbonate were in the burette.

(ii) This question asked candidates to describe **how** the result of the titration would change. Some candidates just stated the results would change; this did not gain credit. Water left in the burette would decrease the concentration of the acid, and so a greater volume would need to be added from the burette to reach the endpoint.

(iii) This proved to be a very demanding question. The strongest responses stated correctly that rinsing with aqueous sodium carbonate would leave a residue of aqueous sodium carbonate in the flask which would result in a total volume of greater than 25 cm^3. A common error was to say that as the same solution of sodium carbonate is used in every experiment, the flask does not need washing. Often it was not clear whether candidates were explaining why it was acceptable to leave water in the flask after rinsing or why aqueous sodium carbonate was not suitable.

(e) Most candidates correctly stated that the white tile made the colour change more visible or easier to see. The idea of improvement (more visible or easier) is important since the colour change can be seen without the white tile, it is just harder to see. A small minority of candidates had clearly not understood the experiment and wrote about disappearing crosses on the tile.

(f) Only the strongest responses gained full credit. A very common misconception was that titrations are linked to the rate of the reaction. This resulted in answers such as 'the reaction would take less time so less hydrochloric acid is required'. While the increase in temperature would increase the rate of the reaction between the hydrogen ions from the acid and the carbonate ions from the sodium carbonate, the reaction is already almost instantaneous (as are all reactions used in titrations), hence any increase in the rate is irrelevant. There would be no change to the titre recorded as heating the aqueous sodium carbonate will not change the number of moles of sodium carbonate in the flask.

Question 2

It was evident that in some centres the ammonium iodide provided was partially decomposed. It should be a white solid which gives a colourless solution when dissolved, rather than a brown solution. Observations made in some centres suggested the ammonium iodide provided contained traces of iodine as the solid was coloured and the aqueous solution obtained was yellow.

(a) The fact that the mark allocation was [3] for this question, should have alerted candidates that three distinct observations were required. Some candidates gave full and detailed observations. The universal indicator paper should have turned blue due to the decomposition of the salt to produce ammonia gas. Other possible observations included a colour change of the solid from white to pink or brown, the formation of a sublimate near the mouth of the tube and smoke (which should have been white but may have been coloured if the solid was heated strongly as opposed to gently as highlighted in the instructions).

(b) The majority of candidates correctly stated that there was no change to be observed.

(c) The majority of candidates stated correctly that a precipitate formed. As the compound was an iodide, the precipitate should have been yellow.

(d)(i) The majority of candidates stated correctly that there was no change on addition of aqueous sodium hydroxide.

(ii) As the question stated: ‘test any gas given off’, candidates were expected to describe and give the positive result for the gas produced in this reaction; ammonia gas.

(e) The expected identity of solid **C** was ammonium iodide. An error carried forward from the precipitate colour in **(c)** was allowed.

(f) The expected flame test colour was yellow. Orange was allowed as an alternative flame test colour for sodium. Where centres submitted completed supervisor’s results, we could allow for other colours seen as a result of contaminated samples; we cannot do this if the supervisor does not fully complete their copy of the paper.

(g) As the question stated: ‘test any gas given off’, candidates were expected to report a positive result when the gas was bubbled through limewater. Effervescence in the reaction tube should also have been evident.

(h) The majority of candidates noted the formation of a green precipitate. Some candidates stated that the precipitate then dissolved; as solid **D** contained iron(II) ions this could not have happened; the precipitate should have remained even in excess aqueous sodium hydroxide.

(i) While many candidates gained full credit, common errors were the identification of calcium ions and chromium(III) ions in solid **D**. Candidates who chose to give the formulae of the ions rather than the names sometimes did not gain one or more of the marks by writing incorrect formulae. The most common error was with the formula for the carbonate ion.

Question 3

This planning task was based on the rate of reaction in which a gas is formed. As it deals with rate of reaction, there is a quantitative aspect to it and quantities used must be controlled. The two reagents were a solid (zinc) and an aqueous solution (dilute sulfuric acid). Candidates were expected to use **volumes** for solutions and **masses** for solids.

Most candidates gave good answers, but full credit was rare. This was normally due to not considering both aspects of a catalyst.

- Catalysts speed up reactions and so the plan needed to have a workable method of determining if the catalyst increased the rate of the reaction.
- Catalysts remain unchanged at the end of the reaction and so the plan needed to have a method of checking the copper had not been used up in the reaction, usually by weighing it before and after.

The ideal plan would have included:

- combining a known volume of sulfuric acid and a known mass of zinc together in a suitable container such as a conical flask
- a description of how to determine the rate of the reaction
- repeating the experiment with the addition of copper
- checking that the copper had not been used up (most often this was done by weighing the copper after the reaction)
- a conclusion based on the rate of the reactions and the fact that copper is not used up.

There were several ways to determine the rate of the reaction, the simplest of these was to time the reaction until there is no more effervescence. Just stating ‘time the reaction until it has finished’ is insufficient as it does not say how we know that the reaction has finished. Several candidates timed until the reaction started (which will be as soon as the reagents are combined).

It should be noted that there is no need for candidates to write a list of aims and lists of apparatus at the start of their answers. The aim of the plan is stated in the question and credit will not be given for listing items of apparatus. Where credit is available for the selection of an appropriate item of apparatus, then it must be clear in the plan for what the item of apparatus will be used.

As an additional point, some candidates stated that catalysts do not take part in the reaction. While this did not prevent any of the marks being awarded, it is not correct chemistry as if the catalyst took no part in the reaction, then it could not possibly change the rate of the reaction. The syllabus states that catalysts are unchanged at the end of the reaction; the syllabus does not state that catalysts take no part in the reaction.

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Paper 0620/62
Paper 6 Alternative to Practical

Key messages

Readings recorded from a given item of apparatus should all be recorded to the same resolution (the same number of decimal places).

When a question asks candidates to identify a substance, the name or formula is acceptable. However, incorrect names or formulae will not be accepted (for example, 'iodine' is not an acceptable alternative for 'iodide'). General terms such as 'salt', 'acid', 'impurity' or 'residue' will **not** gain credit if the identity has been asked for.

In qualitative analysis, not all the tests described will necessarily give a positive result. A negative test result is useful since it indicates that a certain ion is not in the compound being tested.

In the qualitative question, **Question 3**, when the question states that the gas given off is tested, then candidates are expected to state both the correct test for that gas and the positive result of that test.

General comments

The vast majority of candidates successfully attempted all of the questions. The paper was generally well answered, with very few unanswered questions.

In answering the planning question (**Question 4**), there is no need for candidates to spend time writing a list of variables or a list of apparatus at the start, nor the aims of the experiment. Where there is credit available for the use of suitable apparatus, then that will only be awarded if it is stated what the apparatus is used for. Credit will not be awarded just for a name in a list of other apparatus.

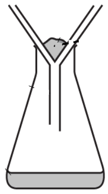
Comments on specific questions

Question 1

(a) Fig. 1.1 showed the item of apparatus labelled **A** being used to stir the mixture. The answer 'stirrer' was a common incorrect answer. This was not credited as it added no more information than candidates were provided in the diagram. The expected answer was glass rod or stirring rod.

(b) The vast majority of candidates correctly stated that the stirring was to mix the reactants; the effect of this is to ensure an even distribution of the reactants so that all the sodium carbonate reacted. The most common error was for candidates to state that stirring ensured that everything dissolved. As the reaction involved two aqueous solutions, everything was already dissolved and so this answer gained no credit.

(c) Some excellent fully correct diagrams of the apparatus used for filtration were seen. The most common errors were to omit the vessel to collect the filtrate or to not add the filter paper inside the funnel. Filter papers should have been shown inside the funnel as shown in the diagram rather than as a flat sheet at the top or bottom of the funnel.



It is expected that candidates will draw a diagram as a 2-dimensional representation of a cross section of the apparatus rather than an attempted 3-dimensional representation which would result in the filter paper being hidden inside the funnel.

(d) (i) Many candidates deduced that as the aqueous calcium chloride was in excess and that one of the products was aqueous sodium chloride, the impurity had to be sodium chloride or calcium chloride. Many incorrect answers were seen, some of which were inexplicable as they were not used or made in the reaction. For example, 'ethanol' was a common incorrect answer, despite no ethanol having been used or made.

(ii) As the impurity is soluble in water, the expected answer was to wash the residue with distilled water. While the majority of candidates described this, common errors included distillation, sometimes with the explanation that the sodium chloride would evaporate, or just heating, which would remove water, but not the impurity.

(e) If the calcium chloride is in excess, then the filtrate will contain calcium chloride as well as the sodium chloride made in the reaction. It will not contain sodium carbonate as all of the carbonate ions will have reacted and combined with calcium ions to form the precipitate of calcium carbonate. Hence, to show that calcium chloride was in excess, candidates needed to either give a positive test and result for calcium ions or give the test for carbonate ions and a negative result. The most common error was to test for chloride ions which were certain to be in the filtrate.

Question 2

(a) The vast majority of candidates were able to read correctly the burette diagrams and calculate the volumes of dilute hydrochloric acid. The most common error was the inconsistent use of decimal places in the recorded values. Since all readings are taken from the same apparatus, all readings should be given to the same resolution. In the case of burettes, all readings given to 1 decimal place (to the nearest 0.1 cm^3) or all readings to the nearest 0.05 cm^3 were accepted but not a mixture of the two.

(b) (i) Most candidates correctly stated that acid **A** was the more concentrated because it needed a smaller volume to neutralise the fixed volume of aqueous sodium carbonate. The most common error was to state acid **B** was the more concentrated because a larger volume was used.

(ii) Most candidates gained the credit available. It was evident that some candidates compared Experiment 2 to Experiment 3, and so concluded acid **A** was 3 times more concentrated. The comparison should have been between Experiments 1 and 3; the only difference between these two experiments being the acid used. Some candidates incorrectly divided the titre from Experiment 1 by the titre from Experiment 3 and so arrived at an answer of less than 1. If acid **A** is more concentrated than the number of times more concentrated must be a number greater than 1.

(c) (i) Most candidates correctly stated that Experiment 1 used a greater volume for hydrochloric acid than Experiment 2, and then correctly stated the difference in terms of a factor or a volume, in this case double or 12.7 cm^3 more.

(ii) The strongest responses stated that because the titre in Experiment 2 was half of the titre in Experiment 1 then the new titre would be half of the titre in Experiment 3. Candidates should be aware that physical quantities require units, in this case cm^3.

(d) (i) This question required candidates to identify a substance, so the answer should have been a chemical name or formula; vague answers such as 'impurities' did not gain credit. As the burette had only been used to hold dilute hydrochloric acid **A**, that was the only substance that water could have removed from the burette. Most candidates stated this; although a significant number thought bacteria, indicator or sodium carbonate were in the burette.

(ii) This question asked candidates to describe **how** the result of the titration would change. Some candidates just stated the results would change; this did not gain credit. Water left in the burette would decrease the concentration of the acid, and so a greater volume would need to be added from the burette to reach the endpoint.

(iii) This proved to be a very demanding question. The strongest responses stated correctly that rinsing with aqueous sodium carbonate would leave a residue of aqueous sodium carbonate in the flask which would result in a total volume of greater than 25 cm^3. A common error was to say that as the same solution of sodium carbonate is used in every experiment, the flask does not need washing. Often it was not clear whether candidates were explaining why it was acceptable to leave water in the flask after rinsing or why aqueous sodium carbonate was not suitable.

(e) Most candidates correctly stated that the white tile makes the colour change more visible or easier to see. The idea of improvement (more visible or easier) is important since the colour change can be seen without the white tile, it is just harder to see. A small minority of candidates had clearly not understood the experiment and wrote about disappearing crosses on the tile.

(f) Only better performing candidates gained both full credit. A very common misconception was that titrations are linked to the rate of the reaction. This resulted in answers such as 'the reaction would take less time so less hydrochloric acid is required'. While the increase in temperature would increase the rate of the reaction between the hydrogen ions from the acid and the carbonate ions from the sodium carbonate, the reaction is already almost instantaneous (as are all reactions used in titrations), hence any increase in the rate is irrelevant. There would be no change to the titre recorded as heating the aqueous sodium carbonate will not change the number of moles of sodium carbonate in the flask.

Question 3

(a) This question described a sulfate test. Most candidates correctly stated that there would be no change or no reaction. This is a negative test. As solution **C** is not a sulfate it will not give a positive result in this sulfate test. The most common incorrect answer was a positive result for the sulfate test.

(b) The vast majority of candidates correctly stated that a yellow precipitate would form.

(c) (i) Many candidates stated that ammonia would be formed. While this is correct (ammonia is given off slowly but much more quickly on warming), it is not an observation as you cannot see the ammonia and no bubbles are produced at room temperature. The expected answer is that there would be no visible change or that the solution would remain colourless.

(ii) The question stated 'and tests any gas given off', and so candidates were expected to describe and give the positive result for the test for ammonia gas, the gas produced in this reaction.

(d) The test for water vapour using anhydrous cobalt(II) chloride paper was well known. The most common error was to state that the test paper became blue (that being the correct colour for anhydrous copper(II) sulfate being used as the test reagent).

(e) This question proved very demanding. Test 4 in Table 3.1 is the test for nitrate ions, as a negative result was obtained, this shows that nitrate ions were not present. A common error was to state that iron(II) or chromium(III) ions were not present – despite the formation of a green precipitate on addition of aqueous sodium hydroxide.

(f) This was almost always correct.

(g) Many candidates could identify two ions and some could identify all three. Test 1 shows the presence of sodium ions, test 3 the presence of either iron(II) or chromium(III) ions and test 5 the presence of carbonate ions. Either the names or the formulae of ions are acceptable, although if names are given, the oxidation state of the iron must be shown and if formulae are used, they must be completely correct.

Question 4

This planning task was based on the rate of reaction in which a gas is formed. As it deals with rate of reaction, there is a quantitative aspect to it and quantities used must be controlled. The two reagents were a solid (zinc) and an aqueous solution (dilute sulfuric acid). Candidates were expected to use **volumes** for solutions and **masses** for solids.

Most candidates gave good answers, but full credit was rare. This was normally due to not considering both aspects of a catalyst.

- Catalysts speed up reactions and so the plan needed to have a workable method of determining if the catalyst increased the rate of the reaction.
- Catalysts remain unchanged at the end of the reaction and so the plan needed to have a method of checking the copper had not been used up in the reaction, usually by weighing it before and after.

The ideal plan would have included:

- combining a known volume of sulfuric acid and a known mass of zinc together in a suitable container such as a conical flask
- a description of how to determine the rate of the reaction
- repeating the experiment with the addition of copper
- checking that the copper had not been used up (most often this was done by weighing the copper after the reaction)
- a conclusion based on the rate of the reactions and the fact that copper is not used up.

There were several ways to determine the rate of the reaction, the simplest of these was to time the reaction until there is no more effervescence. Just stating ‘time the reaction until it has finished’ is insufficient as it does not say how we know that the reaction has finished. Several candidates timed until the reaction started (which will be as soon as the reagents are combined).

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As an additional point, some candidates stated that catalysts do not take part in the reaction. While this did not prevent any of the marks being awarded, it is not correct chemistry as if the catalyst took no part in the reaction, then it could not possibly change the rate of the reaction. The syllabus states that catalysts are unchanged at the end of the reaction; the syllabus does not state that catalysts take no part in the reaction.