CHEMISTRY

Paper 0620/11
Multiple Choice

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

Candidates performed quite well on this paper. **Questions 1**, **8**, **13**, **15**, **22**, **23**, **25**, **26** and **30** proved to be particularly straightforward with a large majority selecting the correct answer.

Questions 17, **24** and **34** proved to be the most difficult with less than half the candidates selecting the correct answer.

The following responses were popular wrong answers to the questions listed:

<u>Comments on Specific Questions</u>

Question 17

Response **C**. This area represents the time just before neutralisation where no excess acid would be present. Candidates clearly chose the alternative where the alkali had been neutralised without thinking about the acid content.

Question 34

Response **A**. Candidates recognised the presence of alkene and carboxylic acid groups but wrongly thought that the presence of the –OH group indicated alcohol, even when it was part of the carboxylic acid.

Question 39

Response **A**. Some candidates opted for this response because of the presence of carbon monoxide. It appears that they either did not read further or did not realise that hydrogen is never produced in a combustion reaction.

CHEMISTRY

Paper 0620/12
Multiple Choice

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

Candidates performed quite well on this paper. **Questions 1**, **2**, **7**, **8**, **9**, **10**, **11**, **22**, **23**, **27**, **30**, **38** and **39** proved to be particularly straightforward with a large majority selecting the correct answer.

Questions 3, 18 and **25** proved to be the most difficult with less than half the candidates selecting the correct answer.

The following responses were popular wrong answers to the questions listed:

<u>Comments on Specific Questions</u>

Question 3

Response **B**. Candidates clearly did not realise that a measuring cylinder would be needed to dilute the acid.

Question 4

Response **A**. Candidates opted for what they thought was an obvious response without reading the other alternatives.

Question 6

Response **B**. Candidates selected the first substance which had the correct electrical properties without considering the melting point.

Question 16

Response **D**. Candidates wrongly assumed that the solution after filtration would be alkaline without taking account of the fact that copper(II) oxide is insoluble.

CHEMISTRY

Paper 0620/13

Multiple Choice

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

Candidates performed quite well on this paper. **Questions 1, 9, 11, 23, 24, 26**, proved to be particularly straightforward with a large majority selecting the correct answer.

Questions 3, 6, 7, 17, 18, 21, 25, 32, 33, 35 and **40** proved to be the most difficult with less than half the candidates selecting the correct answer.

The following responses were popular wrong answers to the questions listed:

<u>Comments on Specific Questions</u>

Question 2

Response **B**. Candidates clearly did not realise that a measuring cylinder would be needed to dilute the acid.

Question 5

Response **A**. Candidates opted for what they thought was an obvious response without reading the other alternatives.

Question 6

Response **D**. Candidates selected a response where one number was double the other, without fully understanding the question.

Question 7

Response **C**. Candidates must have selected the first alternative where the solid did not conduct without fully reading the rest of the response.

Question 10

Response **D**. Candidates knew that graphite was the correct form of carbon but chose the wrong electrode.

Question 18

Response **C**. Candidates chose the area just before complete neutralisation when there would be no excess acid.

Question 20

Response **A**. Candidates knew that the element must be in group 0 but missed the 'denser than air' point. Candidates should know that helium is less dense than air.

Question 25

The answer to this question was clearly not understood very well, and those candidates who did not know the answer seemed to simply guess. The responses were quite evenly spread through the possible responses.

Question 30

Response **D**. Candidates clearly knew that both carbon monoxide and carbon dioxide were formed, and then guessed wrongly.

Question 33

Response **A**. Candidates presumed that an –OH group which is part of a carboxylic acid group still counted as an alcohol.

Question 35

Response **A**. Candidates did not know that fuel oil was used in central heating and did not read the rest of the question.

Question 40

Response **A**. This response was more popular than the correct response. Candidates selected it because of the carbon monoxide, not realising that hydrogen is never formed during combustion of a fuel.

CHEMISTRY

Paper 0620/21
Core Theory

Key Messages

- Questions involving equation writing were generally done well. Word equations should include + signs and an arrow sign going from reactants to products rather than the words 'and' and 'makes'. A distinction should be made between word equations and balanced chemical equations.
- Questions on general chemical properties were generally done well by most candidates. Other candidates need more practice in answering questions relating to organic structures and petroleum fractionation.
- It is important that candidates read the question carefully in order to understand exactly what is being asked.
- It is important to understand the meaning of the keywords 'explain' and 'describe' and to understand the difference between observations and inferences drawn from observations.
- Interpretation of data from graphical information and the drawing of graphs were both generally done well.

General comments

Many candidates tackled this paper well, showing a good knowledge of core chemistry. Good answers were seen to many parts of every question. Nearly all candidates were entered at the appropriate level and few candidates scored less than one quarter of the available credit. Many candidates misinterpreted what was being asked by some questions. For example, in **Question 2(b)** some candidates wrote the formula for sulfur dioxide rather than calculate its molecular mass, whilst in **Question 6(b)** many candidates described the products of the reaction rather than their observations. Many candidates ignored the instruction to tick two boxes in **Question 7(a)(i)** and only ticked one box. Compared with previous sessions, very few candidates left blank spaces. The extraction of information from graphs was generally good, as was graph plotting. Some candidates seemed not to plot all the points; the origin is just as valuable as any other point and should be plotted if given in the table of data. Equations were well constructed by many candidates. Others had difficulty in writing word equations correctly. For example in **Questions 6(a)(i)** and **7(a)(i)** some omitted the + and → signs. Some candidates also wrote symbol equations where word equations were asked for. The balancing of equations by placing numbers in the appropriate spaces was generally well done. A considerable minority of candidates did not realise that hydrogen is diatomic. In some equations, e.g. in **Questions 3(d)(ii)** and **7(a)(iii)**, candidates did not realise that the question was about counting atoms, and that there should be an equal number of each type on each side of the equation. The nature of the liquid state was not well known in **Question 1(d)**. Many candidates believed that the particles in a liquid are 'not touching' or a 'little way apart from each other'. Others thought that the particles in a liquid were a considerable way apart. This is a commonly held misconception. Definitions were not always as precise as they might be. For example, the candidate answers to the definition of an element in **Question 2(a)(ii)** often omitted to state that the atoms were the same, or incorporated words such as 'molecules' or 'mixtures'. The idea of an homologous series was slightly better understood. The main problem here was in the omission of the important words 'the same' when writing about general formulae. Many candidates need more practice at questions involving appropriate separation techniques. For example in **Question 5(d)** the candidates should be encouraged to first consider the state of each of the components to be separated and then ask themselves what the most appropriate technique would be. In **Question 6(b)** many candidates did not respond adequately to the keyword observations and included statements about the products. In **Question 7(b)** many candidates misread the question and did not explain adequately the effect of acid rain on buildings. These last two examples show why it is important that candidates know the difference between the keywords 'explain' and 'describe' and to understand the difference between observations and inferences drawn from observations. In organic chemistry, many candidates could write the correct displayed formulae of methane but fewer could write the more complex formula of ethanol, whilst others had a limited knowledge of petroleum fractionation and hydration of ethene. The standard of English was reasonably good. Some candidates need to analyse the questions more thoroughly since a considerable number of errors were made by not doing so. Some candidates wrote their answers in the form of short phrases or bullet points. This was especially useful in questions involving free response such as **Question 6(b)**. Candidates are less likely to contradict themselves if this is done.

Comments on specific questions

Question 1

This was the best answered question on the paper, most candidates obtaining the majority of credit available. Most candidates had a good grasp of naming apparatus and reading graphs. Some gave rather poor descriptions of the liquid state, especially when describing the proximity of particles. The chemical test for water was not particularly well known. Those who realised that copper sulfate or cobalt chloride could be used, did not always capitalise on their knowledge because they omitted the word ‘anhydrous’ or failed to refer to the correct colour change.

(a) Nearly all candidates correctly identified the pieces of apparatus. A few mistakenly wrote thermometer for B and beaker for A. The main error was to name the beaker as a flask, usually a conical flask.

(b) (i) This was fairly well answered. Most candidates referred to the water having to be at the same temperature throughout, to even out the temperature of the water or to make sure that there were no ‘hot spots’. The main errors were to write about reactions occurring between the acid and the water or to suggest that it controlled the rate of dissolving of the acid in the water.

(ii) Only about a quarter of the candidates gave a correct chemical test for water in sufficient detail to gain full credit. A common error was to describe a physical test for water rather than a chemical test. The use of litmus or other indicators was another incorrect answer often seen. Many candidates omitted to give the original colour of the copper sulfate or cobalt chloride or failed to mention that it was anhydrous. A considerable minority put the colours the wrong way round, especially if they used cobalt chloride, i.e. pink to blue.

(c) (i) Most candidates were able to read the graph correctly. The main error was inaccurate reading, e.g. 44 °C and 46 °C were common incorrect answers.

(ii) The majority of candidates answered this correctly. The commonest errors were 52 °C (the difference between the initial temperature and the actual melting point), 20 °C (the initial temperature) and 98 °C (the last recorded temperature on the graph).

(d) Many candidates gave good answers about the arrangement and motion of the particles. Some answers were contradictory, for example ‘sliding next to each other but far apart’. Credit was given less often for arrangement than for motion, mainly because many candidates believed that the particles in a liquid are ‘not touching’ or a ‘little way apart from each other’. This is a commonly held misconception. Those candidates who gave the answer which better fitted the question, ‘the particles are randomly arranged’, were more likely to be awarded credit. Common errors relating to the motion of the particles included ‘moving fast’ and ‘moving everywhere’.

(e) (i) Most candidates answered this correctly. No one distractor seemed any more common than another.

(ii) The most popular answers related to drinking water or medicines, or the relevant places or processes where purity is important. A significant minority did not obtain credit here because they wrote ‘water’ without any qualification, or listed a number of answers, some correct and others incorrect. A number of candidates did not read the question carefully enough and chose to write answers which were not directly related to the everyday life of individuals, e.g. industrial processes.

Question 2

This question was generally well done, with many candidates getting over half the available credit. Most candidates could distinguish an element from diagrammatic structures. Fewer could give a convincing definition. Although many could calculate relative molecular mass correctly, fewer could write a correct formula from a diagram showing ionic structure.

(a) (i) Most candidates could identify the distinguish the element present from the diagrammatic structures. The commonest incorrect answer was the ionic structure, **D**.

(ii) Despite the fact that many candidates could identify an element in part **(a)(i)**, fewer were able to write a convincing definition of the term. There was some confusion of the words atom, molecule, compound and element which led to some circular arguments about the term *element*. For example 'an element is made up of atoms of that element', or 'atoms of molecules of the element'. In general, the presence of the term 'molecule' was an indicator that credit might not be scored. Some candidates did not gain credit because they included the term 'mixture' in their answer. For example, 'elements are mixtures of atoms of the same type'. It is clear that many candidates had made some attempt at learning a standard definition of an element, but the definition was often not quite rigorous enough, for example 'single atoms on their own'.

(b) About half the candidates calculated the relative molecular mass of sulfur dioxide correctly. Common errors involved using atomic rather than mass numbers or forgetting to multiply the oxygen by two. Some confused the question with molecular formula, rather than molecular mass.

(c) Few candidates gave the correct formula for sodium sulfide from the diagram of its structure. The commonest answer was NaS. NaS_2 was frequently seen, as was $NaSO_4$, despite the fact that there was no oxygen in the structure. Many candidates did not find the simplest ratio of ions. In this type of question, candidates should be advised to count up each ion (or atom), and then find the simplest ratio. Charges should not be shown, since this always leads to complications.

(d) The majority of candidates were able to identify the compound which conducts electricity when molten. Few were able to give a convincing explanation in terms of movement of ions as to why it conducts. Many suggested that it was a metal or that the electrons were moving.

(e) Many candidates correctly interpreted the equation as being an example of oxidation. The commonest incorrect choice was decomposition.

Question 3

This question was reasonably well done by some candidates. The symbol equation was generally balanced well but many gave a symbol equation instead of a word equation as requested. The uses of compounds such as calcium carbonate and calcium oxide were not always well known. Simple organic structures also need revision by many candidates.

(a) The majority of candidates answered this correctly, although a few thought that acidic solutions had a pH of 9. Few chose pH 7 or pH 13.

(b) At least half the candidates scored most or all of the credit available. Common errors were to suggest that litmus turned blue, failing to specify red litmus, or making no reference to dipping the litmus paper or adding litmus to the solution which was the most common reason for not gaining full credit. A large minority of candidates described using Universal Indicator and pH scales.

(c) (i) Many candidates scored some credit here, but few scored full credit. Many attempted to write a symbol equation rather than a word equation. Very few of the symbol equations given were correct. Common errors included giving hydrogen rather than water as a product, calcium chlorine rather than chloride, or omitting a product, usually carbon dioxide. Many suggested hydrogen carbonate instead of water + carbon dioxide. This was allowed (in place of carbon dioxide and water) for a minimal credit.

(ii) This was fairly well answered, although some confused calcium carbonate with a carbonate derivative such as calcium oxide or calcium hydroxide and suggested that it was used in cement or in limewater. Many stated that it was used in building, which was an acceptable, if simplistic, answer. Few related its use to iron extraction.

(iii) Only a minority of candidates could give the name of a suitable compound used to treat acidic soils. Common incorrect answers given were fertilisers, potassium, phosphorus or sulfur. Many candidates gave calcium carbonate, even though the question asked for a compound other than calcium carbonate.

(d) Many candidates scored full credit for this question. A few gave an element other than hydrogen, but a considerable minority either wrote hydrogen as H or did not balance the equation correctly.

(e) (i) Few candidates scored full credit. Many were able to give either the correct structure of ethanol or the correct molecular formula of ethanoic acid. The structure of ethanol often showed the OH bond incorrectly, e.g. C=O or O=H, or a hydrogen atom between the carbon and the oxygen in the OH group. A number of candidates did not put the correct number of hydrogen atoms, or wrote the formula for ethanal rather than ethanol. The molecular formula was often shown in a variety of ways other than $C_2H_4O_2$, with seemingly random arrangements of atoms, even when the number of each type of atom was correct, e.g. $C_2H_2OOH_2$. Some candidates drew the structure of ethanol and wrote the molecular formula in the incorrect boxes.

(ii) Few candidates were able to answer this correctly. The commonest error was to suggest C_2H_5 and OH. Many candidates gave formulae which did not balance with the right hand side, and many seemed not to realise that steam is water in its gaseous state.

Question 4

This question was reasonably well answered by many candidates. The definition of 'hydrocarbon' was not well known, nor was the concept of 'homologous series'. The equation for the combustion of methane was generally well completed and the structure of methane was well known.

(a) This was well done, with many candidates scoring full, or nearly full credit. The commonest errors were in the uses of the naphtha and lubricating fraction. It was common for candidates to suggest that the naphtha fraction is used for surfacing roads and that the lubricating fraction is used for making chemicals.

(b) Many candidates had a vague idea of the definition of a hydrocarbon but wrote statements which were far too vague or incorrect to allow credit to be given. As in **Question 2(a)(ii)**, there was confusion about the terms atom, molecules and mixtures. This led to statements such as 'mixtures of hydrogen and carbon' or 'atoms of hydrogen and carbon'. Many suggested that hydrogen and carbon were present but did not mention the essential word 'only'. Some even went further and suggested that oxygen might be present.

(c) (i) Most candidates knew the structure of methane. Some drew a diagram to show the electronic structure. Although this was not asked for, if it was given correctly, credit was awarded. Writing electronic structures when a bond structure is required is not to be advised since candidates are more likely to make an error if they do this.

(ii) About half the candidates were able to write a correctly balanced equation. The commonest error was in incorrect balancing. Most realised that the correct product was CO_2. Incorrect products included hydrogen, carbon and carbon monoxide. Some candidates wrote carbon or carbon dioxide in words rather than as a symbol.

(iii) Few candidates could define the term *homologous series* or give examples of their characteristic properties. There was often confusion between functional groups and groups in the Periodic Table. Many suggested similar 'properties' without stating whether they were chemical or physical properties. Others suggested that the physical properties were the same, or that the molecular formulae were the same. Many candidates were not specific enough in their writing, for example the statement that 'they have a general formula' or 'they have a functional group' does not imply that the general formula or functional group is the same for each member of the series.

(iv) Many candidates were able to name ethane as the second member of the alkane homologous series. Common errors were 'alkene', 'methane' and propane'.

Question 5

Parts of this question were well done by the majority of candidates. Many were able to plot graphs and use suitable words relating to rates of reaction. In part **(d)** some candidates understood how to separate a solid from a solution and obtain a crystalline sample of a salt from a solution. Others did not realise the importance of considering the state of each of the components to be separated before selecting an appropriate separation technique. The ideas involved in separating various types of mixtures needs further revision for many candidates.

(a) Many realised that the string needed to be lowered or the zinc tipped into the hydrochloric acid to start the reaction. Common errors included 'heating the flask' or 'starting the stopclock'.

(b) (i) Most candidates scored the majority of available credit here. Graph plotting was generally good, although a large minority of candidates omitted the 0-0 point, and some omitted the point at 7 minutes. The drawing of the line of best fit between the points was reasonably well done. Common errors were joining the points using straight lines (using a ruler in many cases), making separate curves between each point so the graph appeared like the edge of a scallop shell, significant deviation for the plotted points or drawing the line as a curve between 5 and 7 minutes, when it should have been a straight line.

(ii) Most candidates realised that the reaction had stopped when there was no longer any evolution of gas. Few candidates were able to score full credit as most suggested that the zinc had run out, despite the information in the stem of the question informing them that the zinc was in excess.

(c) Many candidates scored most or all of the available credit. A minority seemed to put the words in randomly or wrote a word or phrase that was not given in the list. In these cases, the chosen words or phrases did not make grammatical sense and a quick re-read could have prompted the candidate to reconsider their answer. The commonest errors were inverting increase and decrease or suggesting volume rather than concentration.

(d) This was the lowest scoring question on the paper. Many candidates did not realise they had to separate the zinc from the zinc chloride solution, despite it being made clear in the stem of the question that a mixture of these two was present. In questions involving separation techniques, candidates should always be encouraged to first consider the state of each of the components to be separated. Many lost credit because they did not mention filtration in the correct context. Many wrote about filtration in order to separate the crystal from the solution. Others suggested distillation or titration techniques or heating the zinc, rather than the zinc chloride solution. Many candidates chose to heat or evaporate the water completely rather than heating to the point of crystallisation and then leaving to crystallise. Those who did understand that the first step should be filtration often gained full credit.

Question 6

Parts of this question were well answered. Many candidates were able to construct both word equations and symbol equations. Others seemed confused by the difference between these two types of equation and did not put + or arrow signs in the word equation or wrote a symbol equation when a word equation was required. In part **(b)** The properties of the alkali metals were not always well known and many did not appear to understand that the term 'observation' means what one sees, feels or hears. The electrolysis question, **(c)**, was fairly well understood by many candidates. Others need more revision on the products of electrolysis. Candidates should also be advised not to list more answers than necessary. Long lists of properties were seen in response to the question on physical properties of the Group 1 elements in **(d)**. Many of these were irrelevant. If answers are contradictory it may lead to loss of credit, even though a correct answer is present.

(a) (i) The majority of candidates were able to write a correct word equation for the reaction of lithium with water. Some tried to write equations without + signs or the arrow between the reactants and products. The commonest error was to suggest that lithium oxide was formed rather than lithium hydroxide. A number of candidates included unnecessary numbers in their answers, e.g. 2lithium, hydrogen_2.

(ii) About half of the candidates gained credit for replacing lithium in the given equation with sodium. The commonest errors were writing a word equation rather than a symbol equation, using S as the symbol for sodium rather than Na, or writing an unbalanced equation. Many candidates apparently did not realise that the question was about elements in Group 1 of the Periodic Table having the same chemical properties and therefore the equations for a given reaction would have the same stoichiometry.

(b) Many candidates scored some credit here, but few scored full credit. Common errors were reversing the order of reactivity, only comparing the reactivity of two of the three metals or implying that sodium and lithium had similar reactivity, giving sodium as the most reactive, describing how the experiment would be carried out or naming the products of the reaction rather than the observations, describing only one observation and stating it for all three metals, e.g. bubbles, or making an assumption that an indicator was added to the water (the water was reported in some cases as going purple without mentioning the addition of an indicator). In comparing reactivity, many candidates disadvantaged themselves by writing synonymous words for the reactions of the metals, e.g. 'lithium bubbles rapidly, sodium bubbles vigorously and potassium has a strong reaction'. Candidates should be encouraged to use simple words or phases such as 'a few bubbles', 'more bubbles than…', 'even more bubbles than…' when making such comparisons.

(c) (i) Over half the candidates correctly identified the anode and the electrolyte. The letter for the electrolyte was more often incorrectly given than the letter for the anode, suggesting that candidates were less familiar with this term. A minority of candidates appeared to guess and write any letter, e.g. **C** for anode **D** for electrolyte.

(ii) Many answered this correctly. Others made careless errors such as naming the electrodes as anode and cathode rather than giving the name of the product at each electrode. The main errors were writing chloride instead of chlorine or suggesting either hydrogen or oxygen was a product: This suggests that these candidates were thinking that they had an aqueous solution of sodium chloride rather than molten sodium chloride. Many gained some credit for giving two correct products at the incorrect electrodes.

(iii) Most candidates realised that graphite was the most suitable substance to use for the anode. The commonest incorrect answer was sodium. Iodine was also incorrectly suggested by a considerable minority of the candidates.

(d) Most candidates scored some credit for this question, with about half scoring full credit. Many gave long lists of possible properties. Many of these were suggestions were regarded as neutral by the Examiners. Candidates should bear in mind when writing answers, that by writing long lists when only two examples are required, they are in danger of negating a correct answer. A considerable minority of candidates stated 'low density' which was not allowed because the question quite clearly indicates 'state two other physical properties'. Many stated chemical properties rather than physical properties.

Question 7

Many parts of this question were well answered. Equation writing was generally good and many understood which species were oxidised and which were reduced in a given equation. As in previous sessions, environmental chemistry was not well known. In part **(b)** few candidates scored full credit for explaining the effect of acid rain on buildings made from limestone. Many concentrated on the formation of acid rain rather than explaining the reaction. Candidates should be advised to look out for keywords in the question, such as 'explain' or 'describe', and be able to understand the difference between them.

(a) (i) Most candidates obtained at least some credit for the word equation. The commonest answer was sulfur oxide rather than sulfur dioxide. Some confused sulfur with sodium. A few candidates tried to write equations without + signs or the arrow between the reactants and product, or included unnecessary numbers in their answers, e.g. 2sulfur dioxide, oxygen$_2$. A number included oxygen as a product. This may have been because the candidate was looking at equation **B** rather than equation **A**.

(ii) Many candidates scored full credit. The commonest errors were ticking only one box or ticking the second and fourth boxes (oxidation and reduction the wrong way round).

(iii) A majority of the candidates gave the correct answer. The commonest errors were to suggest H_2 or OH. These candidates presumably did not realise that the question was about counting atoms so that there are an equal number of each type on each side of the equation.

(b) Few candidates gave convincing answers to this question. Many referred to buildings collapsing, melting, being destroyed, trapping people inside, burning and in more than one case causing electrical shock waves. The word ‘corrosion’ was often incorrectly used instead of ‘erosion’. In many answers, the candidates gave a good description of how acid rain forms without referring to the effects on the buildings.

(c) Fewer than half the candidates were able to give a appropriate effect of acid rain other than on buildings. Some simply reiterated acidification of limestone as described in part **(b)**. A considerable number gave one word answers such as ‘plants’ or ‘animals’ without further qualification.

CHEMISTRY

Paper 0620/22

Core Theory

Key Messages

- Questions requiring simple answers to inorganic chemistry were generally well done as were questions involving equations and calculations of formula mass.

- Answers to questions on aspects of practical procedures, e.g. finding the pH of a solution and devising a rate of reaction experiment, need to contain more focused explanations and attention to detail.

- Some candidates need more practice on answering questions requiring extended answers, e.g. **Question 7(a)**. When answering such questions, it is advisable to check the amount of available credit, as this is a good indicator of how many points are required in the answer. This should also be applied to any other question.

- It is very important that candidates read the question carefully in order to understand what exactly is being asked.

- Many candidates need more practice at answering questions on organic chemistry, especially fractional distillation and testing for alkenes. More specific revision of the uses of the elements and compounds mentioned in the syllabus would also be an advantage to many candidates.

General Comments

Many candidates tackled this paper well, showing a very good knowledge of core chemistry. Good answers were given to a number of different questions throughout the paper, however, most candidates found parts of every question challenging. Nearly all candidates were entered at the appropriate level.

The standard of English was good. Some 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. Candidates are beginning to become more familiar with the tests for particular gases. There has been an improvement in the writing of word equations, although the correct spelling of chemical compounds still needs to be practised. Very often chemical names will already have been mentioned in the question, so candidates should be encouraged to check this if in any doubt about the spelling.

Candidates still have a limited knowledge of organic chemistry. Many did not know that hydrocarbons with double bonds decolourise bromine water. Many candidates showed a good knowledge of inorganic chemistry and could write simple molecular formulae and balance symbol equations correctly.

Comments on specific questions

Question 1

Most candidates scored reasonably well on this question although **(b)(ii)** was found to be quite challenging with very few candidates answering correctly.

(a) Most candidates gained full credit in this part. The most common mistake was confusing oxygen and hydrogen. Very few candidates either failed to answer this question or gained minimal credit.

(b) (i) This question was answered very well by the majority of candidates. Even though the names of the reactants were given in the stem of the question, some candidates still either gave different chemicals or spelt them incorrectly. Other less frequent mistakes were giving 'hydrochloride', omitting the word 'acid' from hydrochloric acid, and giving 'manganese chlorine' and 'chloride' as the products. Candidates should be reminded that when writing a word equation the '+' sign and the arrow should still be used, not 'plus' and 'gives'. Some candidates gave magnesium instead of manganese and therefore lost most of the available credit.

(ii) Candidates found this question one of the most challenging on the paper, and many gave the answer **B**. This was presumably down to either misinterpretation or simply not reading the information which clearly stated that chlorine is denser than air and soluble in water.

(c) (i) Most candidates knew that the correct formula for oxygen gas is O_2 and were able to balance the equation correctly. A few gave 2O instead but still managed to balance the equation successfully.

(ii) Even though the candidates had reasonable knowledge of the uses of hydrogen and water, many were not specific enough here and therefore could not be awarded credit. A few candidates stated that 'hydrogen could be used to make water', and 'water is used to keep hydrated', neither of which were creditworthy responses. Better answers were 'hydrogen is used to make ammonia, margarine or as a fuel' and 'water is used as a coolant, for drinking or washing'.

Question 2

In this question, parts **(b)** and **(d)** were generally done well. Many had problems describing the experimental technique in part **(c)**.

(a) About half the candidates circled the correct answer. Each of the incorrect answers was chosen with about the same frequency.

(b) Most candidates gave a value above 7, with none giving higher than 15. In a few cases candidates incorrectly gave values below 7, and some mentioned chemical names.

(c) A few candidates were awarded full credit for this question. Some described dipping or physically putting the indicator into the solution. Many candidates did not state where they would put the indicator, e.g. into the beaker, or into the solution, so were not awarded credit. Many candidates did not specify Universal Indicator **paper** or **solution**, or suggested litmus paper which was incorrect. Some talked about a specific indicator such as methyl orange, and even Benedict's solution was incorrectly mentioned. Very few mentioned comparing the colour with a pH colour chart and simply said 'red is acidic and blue is alkaline' with no mention of the pH scale. Those who did talked about identifying the 'colour change' of the indicator and not the specific colour. Few mentioned the use of a pH meter or that they would just read the pH from the meter.

(d) (i) Most candidates stated that the plants might die or that they would not grow. Only a few gave answers that did not relate to the growing of plants and just suggested that there would be a problem with the soil, e.g. the soil would not be good enough.

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This proved to be one of the most difficult questions on the paper. Only a few candidates exhibited a good knowledge of the colours of the halogens or of the precipitates formed, and hence not many were awarded full credit in parts **(a)** and **(c)**.

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(ii) Most candidates could recognise the ionic salt, and there were few incorrect answers here.

(iii) Most candidates correctly recognised the carboxylic acid functional group from the substances given, and again there were very few wrong answers.

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(ii) Candidates found this question to be straightforward and showed their knowledge very well here. There were some excellent definitions. Only a minority of candidates lost credit.

(iii) Not many candidates realised that the correct answer here was that the amount of oxygen was reduced or that there was less oxygen. Many misinterpreted the question as stating that all the holes had been blocked, instead of 'some of the air holes'. This led to statements such as that there would be 'no oxygen present', which could not be credited. A few candidates stated that carbon monoxide was formed by carbon dioxide losing oxygen. Not many candidates used the term 'incomplete combustion', for which they would have received credit.

(iv) Over half of the candidates gained full credit for this question, with 'poisonous' and 'toxic' being the most popular correct answers. Higher level answers using the combining of carbon monoxide with haemoglobin were also good, but some candidates' answers were too vague to gain credit, with carbon monoxide combining with the red blood cells being a popular vague answer. A few candidates thought that it was the carbon that was poisonous.

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Many candidates gave good answers to parts **(a)**, **(b)(i)** and **(c)(i)**. Most gave very vague answers to the experimental question **(b)(ii)**. Some included the words 'element' or 'atom' in their definition of a compound along with 'bonded' or 'joined together' to gain full credit. Many candidates wrote about mixtures for which credit was not awarded.

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(b) (i) Most candidates wrote this word equation correctly and scored full credit. However, a few did not give sulfuric acid as one of the reactants, even though it was stated and spelled correctly in the question. Candidates must take care when reading the question. Other incorrect answers seen were 'iron sulfide' and 'iron sulfuric', instead of iron sulfate. A few candidates incorrectly gave ferric instead of iron.

(ii) Many candidates did not score well on this question. There were many vague answers such as 'time how long it takes for the reaction to stop' or 'for the iron to disappear' with no mention of a gas being given off. There were a couple of drawings of electrolysis experimental equipment, and a few candidates wrote about timing how long it took for a cross or shape on a piece of paper to disappear. Candidates who realised that a gas was given off and mentioned bubbles earned some credit. Some drew a collection apparatus but then did not show a closed system. When candidates did draw a syringe, some did not write about measuring the volume of the gas and just stated to 'collect the gas'. A few candidates did draw the correct apparatus, but most of these did not state to 'measure time after certain time intervals' but just said 'measure the time'. A few candidates wrote about a weight loss experiment, but again these were very vague.

(c) (i) Nearly all candidates realised that this was an exothermic reaction. Incorrect answers tended not to state that it was endothermic, but gave a totally unrelated answer. This does at least show that candidates are not getting confused between the terms *exothermic* and *endothermic*.

(ii) Very few candidates answered this question correctly. The most common incorrect answers omitted 'element' or 'atom' and used the words 'particles' and 'substances'. Candidates did not, on the whole, use the words 'bonded' or 'joined'. Some were not credited because they used the word 'react'. Many candidates gave 'mixed' or 'mixture' in their answers which also lost credit.

(iii) Many candidates did not gain any credit for this answer. Even the highest scoring candidates did not gain credit here and the correct formula of FeS was seen very infrequently. Other formulae such as Fe_2S, 2FeS and $FeSO_4$ were also seen. Some candidates wrote $Fe_{10}S_{10}$ and did not cancel down any further. The most frequent incorrect answer was Fe(II)S.

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This question was one of the least well answered on the paper. Few candidates exhibited a good knowledge of the fractional distillation of crude, only a minority remembering the name of the unknown fraction. The uses of the two fractions were also not well known and even though most candidates seemed to know what relative molecular mass is, they struggled to remember what class of hydrocarbons decolourised aqueous bromine.

(a) Candidates found this question one of the hardest on the paper with many candidates not being able to respond at all. Many put a cross at the top of the column, some tried to put a cross between layers in the column and some even put the cross outside the column. Only a very few correctly put a cross in the bottom compartment, of those who did, some put it half outside.

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(c) Some candidates gave answers which were too vague, and instead of saying 'a fuel for ....' they just wrote 'aeroplanes' and 'cooking' for kerosene and for diesel 'cars or trucks'. Some got confused between the two fractions and others suggested uses which would be suitable for other fractions, e.g. wax and candles.

(d) Not many candidates scored full credit for this part, although many only lost a small amount of credit. It was the third answer that usually cost the attainment of full credit, with many candidates writing 'higher' instead of 'lower'. Most realised that the correct answers were 'mixture' and 'heated' for the first two responses, showing some knowledge of the organic section of the syllabus. However, the fourth space produced a variety of answers, e.g. 'vaporises' instead of 'condenses'. In the last space, many candidates put 'melting' instead of 'boiling'.

(e) (i) In this question many candidates were awarded full credit for part **(i)** showing that they could work out the molecular formula of an organic compound and then work out which two had the same relative molecular mass.

(ii) Only a small number of candidates were awarded credit for this part and many incorrectly wrote down the two alkanes, **A** and **C**. This showed either a lack of knowledge of the chemical test for an alkene or a misinterpretation of the question with candidates either thinking that the question stated 'will not decolourise bromine', or that having chosen **B** and **D** already for part **(i)**, they could not use them again in part **(ii)**.

Question 7

The extended writing part **(a)** was answered very well in quite a few cases and most candidates scored at least some credit. Some candidates did not perform as well in parts **(b)(i)** and **(ii)**.

(a) The answers in this part were mainly good and candidates showed a very good knowledge of the kinetic particle theory. Many candidates talked about the particles dissolving and diffusing for which they were awarded credit. Some wrote about the movement of the particles and that they spread themselves out. A few also wrote about the random movement and collisions of the particles but these tended to be the most able ones who went on to achieve full credit. Common misconceptions were that the salt particles rose up because they were less dense and that the salt and water particles reacted with each other.

(b) (i) About half the candidates achieved full credit here. These were mainly the ones who had worked out the electronic configurations in the space below the question. The sharing of electrons was a common misconception.

(ii) Very few candidates gained full credit for this comparison question. However, many did realise that this was a comparison question and put down an answer for both solid and molten sodium chloride. Many did not use the word 'ion' so did not gain credit. Some candidates did use the term ions but did not make a comparison and just wrote that in molten sodium chloride the ions could move but did not refer to the solid. The most commonly used words were electrons and particles which gained no credit.

(iii) A common misconception in this question was that the solution was not aqueous and many candidates gave chlorine at the positive electrode and sodium at the negative, for which only partial credit could be awarded. Only those who realised that it was an aqueous solution gave hydrogen as the correct answer at the negative electrode. Common errors were writing chloride and Cl^- instead chlorine.

(iv) Nearly all candidates gave the correct answer here. A few thought that the negative electrode was called the anode or cation.

(v) About half the candidates realised that graphite was a suitable material for an electrode because it conducts electricity, but some answers were too vague and just said that it conducts. Some candidates wrote that graphite was not very reactive rather than inert. Other answers which gained no credit were that graphite was strong and that it was made of carbon.

CHEMISTRY

Paper 0620/23

Core Theory

Key Messages

- Questions requiring simple answers to inorganic chemistry were generally well done as were questions involving equations and calculations of formula mass.
- Answers to questions on aspects of practical procedures, e.g. finding the pH of a solution and devising a rate of reaction experiment, need to contain more focused explanations and attention to detail.
- Some candidates need more practice on answering questions requiring extended answers, e.g. **Question 7(a)**. When answering such questions, it is advisable to check the amount of available credit, as this is a good indicator of how many points are required in the answer. This should also be applied to any other question.
- It is very important that candidates read the question carefully in order to understand what exactly is being asked.
- Many candidates need more practice at answering questions on organic chemistry, especially fractional distillation and testing for alkenes. More specific revision of the uses of the elements and compounds mentioned in the syllabus would also be an advantage to many candidates.

General Comments

Many candidates tackled this paper well, showing a very good knowledge of core chemistry. Good answers were given to a number of different questions throughout the paper, however, most candidates found parts of every question challenging. Nearly all candidates were entered at the appropriate level.

The standard of English was good. Some 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. Candidates are beginning to become more familiar with the tests for particular gases. There has been an improvement in the writing of word equations, although the correct spelling of chemical compounds still needs to be practised. Very often chemical names will already have been mentioned in the question, so candidates should be encouraged to check this if in any doubt about the spelling.

Candidates still have a limited knowledge of organic chemistry. Many did not know that hydrocarbons with double bonds decolourise bromine water. Many candidates showed a good knowledge of inorganic chemistry and could write simple molecular formulae and balance symbol equations correctly.

Comments on specific questions

Question 1

Most candidates scored reasonably well on this question although **(b)(ii)** was found to be quite challenging with very few candidates answering correctly.

(a) Most candidates gained full credit in this part. The most common mistake was confusing oxygen and hydrogen. Very few candidates either failed to answer this question or gained minimal credit.

(b) (i) This question was answered very well by the majority of candidates. Even though the names of the reactants were given in the stem of the question, some candidates still either gave different chemicals or spelt them incorrectly. Other less frequent mistakes were giving 'hydrochloride', omitting the word 'acid' from hydrochloric acid, and giving 'manganese chlorine' and 'chloride' as the products. Candidates should be reminded that when writing a word equation the '+' sign and the arrow should still be used, not 'plus' and 'gives'. Some candidates gave magnesium instead of manganese and therefore lost most of the available credit.

(ii) Candidates found this question one of the most challenging on the paper, and many gave the answer **B**. This was presumably down to either misinterpretation or simply not reading the information which clearly stated that chlorine is denser than air and soluble in water.

(c) (i) Most candidates knew that the correct formula for oxygen gas is O_2 and were able to balance the equation correctly. A few gave 2O instead but still managed to balance the equation successfully.

(ii) Even though the candidates had reasonable knowledge of the uses of hydrogen and water, many were not specific enough here and therefore could not be awarded credit. A few candidates stated that 'hydrogen could be used to make water', and 'water is used to keep hydrated', neither of which were creditworthy responses. Better answers were 'hydrogen is used to make ammonia, margarine or as a fuel' and 'water is used as a coolant, for drinking or washing'.

Question 2

In this question, parts **(b)** and **(d)** were generally done well. Many had problems describing the experimental technique in part **(c)**.

(a) About half the candidates circled the correct answer. Each of the incorrect answers was chosen with about the same frequency.

(b) Most candidates gave a value above 7, with none giving higher than 15. In a few cases candidates incorrectly gave values below 7, and some mentioned chemical names.

(c) A few candidates were awarded full credit for this question. Some described dipping or physically putting the indicator into the solution. Many candidates did not state where they would put the indicator, e.g. into the beaker, or into the solution, so were not awarded credit. Many candidates did not specify Universal Indicator **paper** or **solution**, or suggested litmus paper which was incorrect. Some talked about a specific indicator such as methyl orange, and even Benedict's solution was incorrectly mentioned. Very few mentioned comparing the colour with a pH colour chart and simply said 'red is acidic and blue is alkaline' with no mention of the pH scale. Those who did talked about identifying the 'colour change' of the indicator and not the specific colour. Few mentioned the use of a pH meter or that they would just read the pH from the meter.

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Question 3

This proved to be one of the most difficult questions on the paper. Only a few candidates exhibited a good knowledge of the colours of the halogens or of the precipitates formed, and hence not many were awarded full credit in parts **(a)** and **(c)**.

(a) (i) Many candidates knew that bromine is brown, but fewer that chlorine is green. The commonest error was to give two colours for an answer, one of which was incorrect, e.g. orange-green for chlorine and yellow-brown for bromine. Some candidates wrote colourless for both.

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CHEMISTRY

Paper 0620/31

Extended Theory

Key Messages

There are three elements to preparing for this examination. They are:

1 Learn the Chemistry as specified in the current syllabus. This is best achieved by a steady acquisition throughout the course. Learning should be an active process; just reading notes or a text book is an inefficient method of acquiring knowledge. There should be an element of self-assessment or testing. Without a secure base of relevant material, a creditable examination grade will not be achieved.

2 The acquisition of the required skills is the next step. These would include the various types of calculation specified in the syllabus, writing formulae and equations. These skills need to be practised.

3 The final element of this preparative phase is examination technique. It is a lack of competence in this attribute which is a major cause of disappointing grades. Proficiency in this technique can only be acquired through practice on past papers, using published mark schemes and seeking guidance from your teacher.

Even if these three elements are securely in place, there is still one crucial skill and that is the ability to communicate. This deserves a lot more attention during the actual examination and currently it is a major reason why credit cannot be awarded. The problems range from poor quality handwriting and diagrams, ambiguities and not directing the response to the requirements of the question. Most of these shortcomings could be rectified by more care and attention.

General Comments

There has been a real improvement in the proportion of candidates who reference responses written in places other than the allocated space. It is preferable that candidates give a precise location, e.g. at the bottom of page 10 or after **Question 7**.

Centres should advise candidates about the consequences of poor or illegible handwriting. Examiners will make every reasonable effort to determine the meaning, but if it cannot be read then it cannot be marked. Similarly ambiguities, if indeterminate, will not be resolved in favour of the candidate. Unfortunately this problem has not improved since the previous session.

The proportion of questions which were not attempted appears to have reduced since last session.

Many candidates prefer to draw diagrams in pencil. If they use a hard pencil the scanned image tends to be indistinct. Centres should advise their candidates to use a soft pencil, B or 2B.

Comments on Specific Questions

Question 1

(a) (i) Most of the candidates correctly gave evaporation and condensation.

(ii) The change of state which is exothermic is condensation. The reasons offered included:

- energy is given out
- evaporation requires energy so condensation must produce energy
- in a liquid the molecules come closer and intermolecular bonds form. Bond forming is exothermic.

The last two reasons show a clear understanding of thermicity.

(b) Many answers included unnecessary detail - aeration, flocculation, progressive filtration, etc., all of which are correct but not required for credit. Candidates should be advised that the credit allocation gives some indication of the amount of detail required. A common error was to state that fluorine was added for better dental health.

(c) (i) The formation of acid rain could be explained either by the sulfur route or the nitrogen route. The majority of candidates knew the chemistry for either or both of these routes. The main reason for not awarding credit was that the explanation did not include sufficient detail.

Many candidates failed to achieve all the available credit as one of the points was omitted, usually the name of the acid formed, or the reaction of oxides of nitrogen in the atmosphere to form nitrous acid or nitric acid.

A common misconception was the belief that carbon dioxide played a significant part in acid rain. The pH of aqueous carbon dioxide is approximately 6.5.

(ii) There has been a real improvement since this topic was last examined. Calcium carbonate is insoluble in water so even if an excess of this base is added, the pH of the water does not exceed 7. In contrast, calcium oxide reacts with water to form an alkali and the resulting pH of the water is above 7.

Typical errors were:

- calcium carbonate is the stronger base;
- the reaction between calcium carbonate and acid rain forms carbon dioxide which is beneficial to plants due to its role in photosynthesis.

Question 2

(a) This question was very well answered, with almost all candidates achieving at least half of the available credit.

(b) (i) The ionic equation proved to be difficult. The main issues were the valency of silver, spectator ions and state symbols.

(ii) Far more correct responses were given to this part.

Question 3

(a) (i) The melting points decrease down the Group. However, almost half of the candidates gave “increase” as the answer.

(ii) Lithium, which is the lightest metal in the Periodic Table, was suggested by a minority.

(iii) Many candidates gave the correct equation. The typical errors were $Rb(OH)_2$ or the oxide rather than the hydroxide, and balancing the equation, particularly the hydrogen atoms.

(b) (i) Most gave the correct formula, Li^+.

(ii) Deducing the formula of the nitride ion proved more problematical. Candidates did not appreciate that "ide" indicates a binary compound with a non-metal, in this case nitrogen. Nitrate was quite a common response, as were oddities such as NO^+, etc.

(iii) In the lattice of an ionic compound, the ions are arranged in a regular pattern, or positive and negative ions alternate. Some candidates described a metallic lattice or discussed atoms instead of ions.

(iv) The correct ratio, $3Li^+ : 1N^{3-}$, can be justified by balancing the charge in a compound, valencies of the elements, oxidation state of the elements and electron transfer between the atoms of the elements. Even if the formulae of the ions were incorrect in parts **(b)(i)** and **(b)(ii)**, credit could be awarded as an error carried forward.

Many of the candidates stated that the lithium ion needs to lose an electron and the nitride needs to gain three electrons.

Question 4

(a) This was a simple arithmetic calculation, with the total, Z = 23.

(b) The properties given had to be typical physical properties of Transition Elements, not of metals in general. There were several possible properties that were acceptable. Examples of properties that were not accepted as they are properties of metals in general were: sonorous, lustre, good conductors of electricity or heat, etc. Other unacceptable suggestions were chemical properties such as that they form coloured compounds, have more than one oxidation state, or have catalytic properties.

(c) Most correctly commented that an increase in temperature would decrease the yield of sulfur trioxide but failed to add that a catalyst would not affect the yield.

(d) (i) The candidates were only required to indicate one chemical as the oxidant. This is a single reactant, in this case V^{3+}. The ionic charge is essential.

(ii) The candidates could indicate the two chemicals either by an arrow or by writing V^{3+} to V^{4+}. The reason given should have been that there is an increase in oxidation state or number, or that V^{3+} has lost an electron which is oxidation.

Question 5

(a) Many candidates scored credit in this question.

(b) (i) A very frequently seen error was to omit "oxide" from copper oxide.

(ii) A higher proportion of candidates gave the correct equation than in previous years.

(c) The oxides of calcium and sodium are not reduced by carbon.

(d) Both in this part and part **(c)** it appeared that many candidates were guessing rather than using the reactivity series to predict the answer.

Question 6

(a) The volume ratio is the same as the mole ratio in the balanced equation. Many candidates were aware of this link and gave the correct answers.

(b) (i) Any one of the following was accepted as the type of reaction between butane and chlorine: chlorination; substitution; photochemical; exothermic; halogenation; free radical. Generally one of the above was suggested, although typical errors included displacement and endothermic.

(ii) The explanation of the term isomerism had to include the same molecular formula, but different structural formula or structures. In this instance there was no requirement for the phrase *different compounds* but candidates would be well-advised to include this in the future. They should also be aware that the terms 'chemical formula' and 'general formula' are not the same as 'molecular formula'.

(iii) There were many accurate diagrams of two isomeric chlorobutanes. Common mistakes were to offer dichlorobutanes and rotations of the same molecule.

(c) (i) Acceptable oxidants were potassium manganate(VII), potassium dichromate(VI) and copper(II) oxide. The oxidation states, if given, had to be correct.

(ii) The acid is butanoic acid.

(iii) The name of the ester is butyl ethanoate NOT ethyl butanoate. In the past, questions of this type proved particularly challenging, but this session seems to mark a significant improvement, particularly with the structural formula of the ester, and a pleasing proportion of candidates were able to draw the structure of the ester linkage.

Question 7

(a) The advantages of disposing of plastic waste by burning is that it obviates most of the difficulties caused by plastic waste in the environment – visual pollution, danger to wildlife etc. The energy released can be used to generate electricity or for area heating. An additional advantage is that it reduces the need for landfill sites and the land released can be used for other purposes.

The disadvantages of burning plastic include the formation of toxic gases and of greenhouse gases.

The recycling of plastics does not produce the same plastic of the same quality. Recycling conserves resources but does not mean that fewer plastics need to be made.

Recycling of plastics often equates to reusing in lower quality products. The sorting of plastics prior to recycling is slow and expensive.

Almost all of the candidates were able to make acceptable comments in this question.

(b) (i) There were some very good answers to this question on addition and condensation polymerisation. A further improvement in the quality of the responses could be realised by including a comment that in addition there is only one product – the polymer.

(ii) The skill of drawing the structural formula of polyesters and polyamides has improved. When questions of this type were first introduced they proved a real challenge for the majority of the candidates. On this paper a higher proportion either answered the question correctly and clearly or made a meaningful attempt at drawing these structural formulae.

Question 8

(a) (i) The most popular correct explanation was that a cell produces electrical energy from chemical energy. Other explanations involved producing electricity by the difference in reactivity of metals and by redox reactions. Both were equally acceptable.

(ii) This proved to be the most difficult question on the paper. The syllabus advises that cells should be linked to redox. For those who heeded this advice, this question presented no problems. The electrode at which oxidation takes place is electrode B, because there is electron loss, (see electron flow on diagram). The electrode becomes thinner because iron goes into solution as ions.

Trying to link this cell to electrolysis and use terms such as anode and cathode is fraught with difficulties.

(iii) All that is needed to measure the rate of rusting is either the loss of mass of electrode B or the mass of rust formed and the time. Some candidates used the terms amount, size and volume of the electrode, none of which were acceptable.

(iv) The most common response was that sodium chloride acts as a catalyst. The correct explanation for the increased rate of rusting is that the water containing dissolved sodium chloride is a better conductor.

(b) The formula $Fe_2O_3.(H_2O)_2$ was not accepted, as this is not the standard way of showing hydration in a solid.

The main source of errors in this calculation was incorrectly calculated number of moles, closely followed by an inability to arrive at the correct whole number ratio.

0.926 : 1.389 : 0.926 was thought to be 1 : 2 : 1. Those who followed the correct procedure and divided by the lowest number came to 1 : 1.5 : 1. Not all candidates doubled it to achieve the simplest whole number ratio.

CHEMISTRY

Paper 0620/32
Extended Theory

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- It has been commented on in previous reports that if a comparison between two things is asked for in a question, **both** things must be referred to if maximum credit is to be achieved. This applied particularly to **Questions 1(a)** and **2(c)**.

- The small number of candidates who suggest using sodium, potassium and fluorine for use in chemical experiments should be aware that these are dangerous substances and would not be allowed in schools for routine class experiments.

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(a) This is a question about electron configuration of atoms. Quite a number of excellent answers showed awareness of the differences between neon atoms and fluorine atoms. Neon atoms have a full outer shell of electrons, but fluorine atoms do not. Thus fluorine atoms need to share a pair of electrons/form a covalent bond to achieve a full outer shell. The boiling points in the table were a distraction for many candidates in this response. Stability alone would not achieve credit without some explanation related to electron configuration or bonding. Candidates commonly mentioned that neon was a noble gas in group 0 and that fluorine was a halogen in group 7, but none of these points addressed the requirements of the question.

(b) The only correct answer to this question is the atomic number (of the element) or the number of protons (in one atom of the element). Many mentioned electrons and even electron shells.

(c) The question expected a comment about ‘the bond between the atoms being very strong’. A few candidates stated that the bond between the atoms does not break. It is only the weak forces of attraction between nitrogen molecules that break when liquid nitrogen boils. The intention of this question was to discover whether candidates realised that weak intermolecular forces break when a simple molecular substance boils, but strong covalent bonds between nitrogen atoms within nitrogen molecules do not break when liquid nitrogen boils.

(d) Examiners had to be able to count the dots and crosses in order to mark this question. Thus candidates should be reminded of the necessity to draw <u>large</u> diagrams. Many candidates drew a nitrogen atom rather than a nitrogen molecule. There was no penalty for drawing inner shells and nuclei in addition to outer shells, but the question does ask for outer shells only. There were quite a number of candidates who used 14 instead of 7 as the atomic number of nitrogen.

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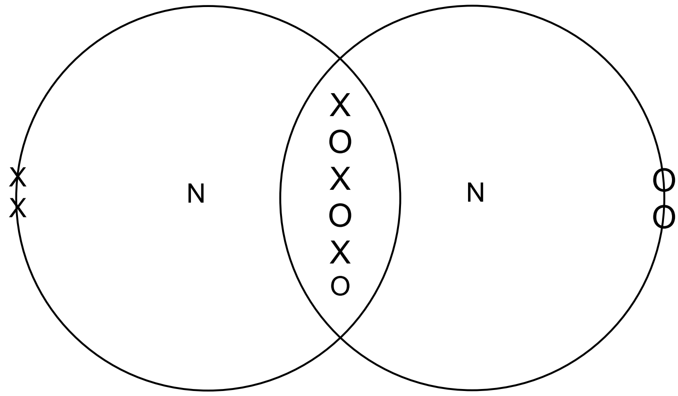

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(a) Graphite is a giant molecule, and therefore it is not appropriate to write about ***intermolecular*** forces between layers. There are weak forces of attraction between layers which is why the layers can slide over each other. Many candidates referred either to weak forces between layers or that the layers could slide, but only a minority of candidates made both points.

(b) The correct answer to this question should have focused on the fact that **all** the bonds in diamond are strong covalent bonds, (there are no weak bonds), which is why diamond is resistant to change when forces are applied.

(c) Graphite is a good conductor of electricity because it contains electrons that can move. Diamond does not contain electrons that can move, because all the outer shell electrons in diamond are used in covalent bonding. A common misconception was that diamond has no space in the lattice for electrons to move, rather than to say that diamond did not possess moving electrons.

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(a) Plastics are flexible and can be moulded into a suitable shape to surround the cable underneath. They are unreactive and therefore offer suitable protection for the conducting metal in the cable. Many candidates repeated information about plastics being good insulators, even though this was given in the question.

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(c) Candidates generally answered this question well. Aluminium is used extensively in the manufacture of aeroplanes because it is a low density metal which is strong. It has a protective layer of aluminium oxide which prevents the metal underneath from corroding.

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(e) The question asks about (metallic) bonding in metals rather than (ionic) bonding in compounds containing metals. Attraction, or forces of attraction (as opposed to forces alone), between positive ions and electrons was required for full credit to be awarded. The question asks for a description of the bonding as opposed to a description of the structure. This is why mentioning attraction is so necessary. It was common to see reference to atoms or protons rather than positive ions.

Question 4

(a) (i) Most candidates correctly named at least one of the products formed at the anode.

(ii) Cryolite is used to lower the operating temperature at which this electrolysis occurs. This saves energy costs. Cryolite acts as a solvent because aluminium oxide (alumina) dissolves in cryolite. Cryolite also improves the conductivity of the electrolyte. It is a common misconception that cryolite is a catalyst. Many candidates referred to *aluminium* instead of aluminium oxide or alumina.

(iii) Iron(III) oxide does not react or dissolve in aqueous sodium hydroxide and therefore has to be separated from the rest of the mixture by filtration or an alternative suitable method, otherwise complete separation is not achieved. The majority of candidates did not include this and therefore were not awarded full credit.

(b) (i) Many candidates achieved full credit in this question. Half equations were almost always correct. Non-electrolytic methods were inappropriate. Sodium chloride does not react with water, but merely dissolves in it to form an aqueous solution of sodium chloride, the starting material for the electrolysis.

(ii) Candidates who knew that the two chemicals were hydrogen and chlorine were usually also able to give a use for each one.

Question 5

(a) (i) The repeat unit of starch can be represented as

-O-☐-

Any number of repeat units could have been drawn. It is important to draw extension bonds on both ends of the polymer to achieve full credit, but these were not always seen. It is unnecessary to use brackets with or without an n outside the brackets, but there was no penalty for this.

(ii) Catalysts in industrial and laboratory processes are generally specific for only one reaction. Therefore iron, nickel and vanadium(V) oxide would not catalyse the hydrolysis of starch, which is catalysed by aqueous solutions of acids. Yeast is not a catalyst. UV light only catalyses photochemical reactions.

(iii) There was a wide variety of answers to this question. Many candidates knew that carbohydrates are made from carbon, hydrogen and oxygen. 'Elements' refers to chemical elements, but some candidates gave answers that were not elements.

(b) (i) A wide variety of answers to this question were seen. Starch and yeast were often given as products. Water was often seen instead of carbon dioxide as a product in addition to ethanol. A number of candidates gave alcohol instead of ethanol.

(ii) Yeast is a source of enzymes which act as a catalyst in fermentation. Some candidates interpreted this question as asking why more yeast is added. Because yeast is a living organism it reproduces as respiration proceeds.

(iii) Enzyme catalysed reactions, such as fermentation, are sensitive to extremes of temperature. This is because enzymes are denatured at temperatures above their optimum, which leads to a decrease in reaction rate. Le Chatelier's principle cannot be applied to enzyme catalysed reactions. Yeast cannot be denatured, nor can enzymes, (which are not living), be killed. The consequences of enzyme denaturation/yeast death were required for full credit to be awarded.

(c) (i) The word 'suggest' in this part, and also in **(c)(ii)**, indicates that it was not expected that candidates were familiar with the complex chemical changes occurring in this process, but that they were expected to make a reasonable suggestion based on their knowledge of similar processes and issues.

If oxygen was present it is likely that an aerobic process would occur, rather than an anaerobic process. This means that the product would be something other than methane, or that methane could be produced and oxidised further by reaction with oxygen.

(ii) Phrases such as 'no pollution', 'environmentally friendly', 'eco-friendly', or 'saves money' could not gain any credit without further explanation. Any process in which fuels are produced from plant materials result in the absorption of carbon dioxide when the plant grows. This compensates to some extent for the release of carbon dioxide into the atmosphere when the fuel burns, thus limiting the net production of a greenhouse gas. This is often expressed as carbon neutrality. Plants are renewable resources whereas fossil fuels are non-renewable. The other advantage of this process is that the waste is recycled rather than allowed to cause disposal problems.

Question 6

(a) (i) Most candidates were able to put the four experiments in order of reaction speed.

(ii) Many candidates achieved only minimal credit for stating the reason for their choice in **(a)(i)** was that as time increased rate of reaction decreased. Very little credit was achieved by merely restating the information in the question with very little explanation. The question was asking for an explanation of why the reactions with the four acidic solutions proceeded at different rates.

Some candidates calculated that if the concentration of propanoic acid doubled, the time taken would be 115 seconds, and did similar calculations for the other acids. This does not address the question.

Strength of acids relates to the degree that an acid dissociates or splits up into ions. Both hydrochloric and sulfuric acids are strong, whereas propanoic acid is weak. Concentration refers to the number of moles of acid in 1 dm^3 of solution. B and D are of equal concentration, although D is stronger than B which is why D reacts faster than B. Sulfuric acid is diprotic, whereas the other two acids are monoprotic. Thus sulfuric acid produces a greater concentration of H^+ ions than hydrochloric acid of the same concentration, which is why A reacts faster than C.

(b) Some candidates ignored the statement in the question that the concentration of the acid and the mass of magnesium were kept the same, and suggested changing the concentration. Changing the pressure in a reaction between a solid and an aqueous solution will have no effect on the rate of reaction. Increasing the pressure will affect the rate of reactions between gases, because at higher pressure gaseous molecules are closer together and will collide more often.

Question 7

(a) (i) The empirical formula represents the smallest whole number ratio of atoms of each element in a compound. The empirical formula is CH_2 in all alkenes. C_nH_{2n} was by far the most common answer.

(ii) Compounds in the same homologous series or with the same functional group or with the same general formula do not necessarily have the same empirical formula. Alkenes have the empirical formula CH_2 because the formulae of all alkenes cancel down to a smallest whole number ratio of 1C : 2H. Members of **all** homologous series (not just alkenes) differ from the preceding member by a $–CH_2–$ group of atoms.

(b) (i) Amongst the many correct answers it was fairly common to see ethanoic acid and methanoic acid, instead of propanoic acid and ethanoic acid respectively. Organic compounds are named according to the total number of carbon atoms in each molecule, and this includes the carbon atom in the functional group in the case of carboxylic acids.

(ii) Any symmetrical alkene was accepted as a correct answer. Ethene was seen fairly regularly, as well as the non-existent methene.

(c) (i)(ii) Many products of both reactions were seen to have double bonds, which is not the case in addition reactions.

In **(c)(i)** $CH_3CH_2CH_2Br_2$ was occasionally seen. In an addition reaction the two added atoms are not added to the same carbon atom.

(d) Most candidates drew polyethene (polythene), with a chain containing three carbon atoms, i.e. —CH_2-CH_2-CH_2— (or more usually a fully displayed version), as opposed to poly (propene).

Any number of correct repeat units could have been drawn. It is important to draw extension bonds on both ends of the polymer to achieve full credit. It was unnecessary to use brackets with or without an n outside the brackets, but there was no penalty for doing so.

(e) Although the number of 'moles of O_2' (molecules) was requested, the number of moles of O (atoms) i.e. 2.4/16 = 0.15 was often seen. This error could have been rectified in subsequent steps to score full credit. Some candidates approximated the number of moles of O_2 from 0.075 to 0.08 and were unable to recover from this severe over approximation to achieve any credit.

The easiest way to deduce the formula of the alkene is to calculate the number of moles of CO_2 which is 2.2/44 = 0.05. The mole ratio between the alkene and carbon dioxide is 0.01 : 0.05 which in whole numbers is 1 : 5. Therefore it must follow that 1 molecule of the alkene must contain 5 carbon atoms and because alkenes have the general formula C_nH_{2n} the molecular formula of the alkene is C_5H_{10}.

Question 8

Candidates found **(c)** and **(d)** amongst the most difficult parts of the whole paper.

(a) Acids are defined as **proton donors**. This was the only acceptable answer.

(b) Candidates were expected to give a <u>very</u> brief description of an experiment, such as measure pH/add Universal Indicator, and an observation, such as ethylamine has a lower pH, rather than giving a great deal of underlying theory.

Universal Indicator produces different colours when added to strong and weak bases rather than different shades of the same colour. Litmus cannot be used to distinguish between strong and weak bases, because it changes to the same colour (blue) in both. Weak bases and strong bases do not require different volumes of acid to neutralise them, assuming that equal numbers of moles of the base are present. The reaction between aqueous solutions of ethylamine or sodium hydroxide and acids does not proceed with any visible differences, and therefore it is not possible to compare the rates of reaction.

(c) Ammon**ium** salts, such as ammon**ium** chloride, react when heated with strong bases such as sodium hydroxide to produce ammonia; therefore ethylammon**ium** salts such as ethylammon**ium** chloride would be expected to react similarly when heated with strong bases such as sodium hydroxide to produce ethylamine. Those who were aware that a strong base was required, usually omitted to mention that heat was also necessary.

(d) Some candidates recognised the fact that an aqueous solution of ethylamine behaved in a similar manner to aqueous solutions of ammonia and sodium hydroxide when added to an aqueous solution of an iron(III) salt. Candidates were aware that the precipitate indicated a positive test for iron(III) ions in aqueous solution. Although hydroxide ions are commonly used to carry out a test for iron(III) ions in aqueous solution, the converse is also true, which means that aqueous solutions containing iron(III) ions can be used to show the presence of hydroxide ions in aqueous solution.

The question asked for and explanation of the chemistry and a correct response required the knowledge that the hydroxide ions formed reacted with the iron(III) ions to produce a brown precipitate of iron(III) hydroxide.

Candidates commonly identified the brown precipitate as either iron or rust.

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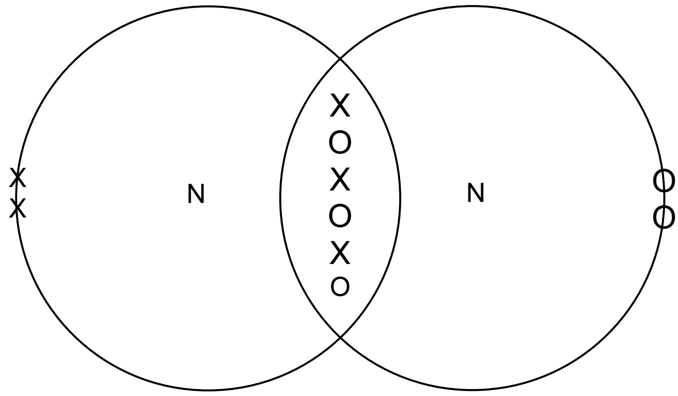

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(c) (i) The word 'suggest' in this part, and also in **(c)(ii)**, indicates that it was not expected that candidates were familiar with the complex chemical changes occurring in this process, but that they were expected to make a reasonable suggestion based on their knowledge of similar processes and issues.

If oxygen was present it is likely that an aerobic process would occur, rather than an anaerobic process. This means that the product would be something other than methane, or that methane could be produced and oxidised further by reaction with oxygen.

(ii) Phrases such as 'no pollution', 'environmentally friendly', 'eco-friendly', or 'saves money' could not gain any credit without further explanation. Any process in which fuels are produced from plant materials result in the absorption of carbon dioxide when the plant grows. This compensates to some extent for the release of carbon dioxide into the atmosphere when the fuel burns, thus limiting the net production of a greenhouse gas. This is often expressed as carbon neutrality. Plants are renewable resources whereas fossil fuels are non-renewable. The other advantage of this process is that the waste is recycled rather than allowed to cause disposal problems.

Question 6

(a) (i) Most candidates were able to put the four experiments in order of reaction speed.

(ii) Many candidates achieved only minimal credit for stating the reason for their choice in **(a)(i)** was that as time increased rate of reaction decreased. Very little credit was achieved by merely restating the information in the question with very little explanation. The question was asking for an explanation of why the reactions with the four acidic solutions proceeded at different rates.

Some candidates calculated that if the concentration of propanoic acid doubled, the time taken would be 115 seconds, and did similar calculations for the other acids. This does not address the question.

Strength of acids relates to the degree that an acid dissociates or splits up into ions. Both hydrochloric and sulfuric acids are strong, whereas propanoic acid is weak. Concentration refers to the number of moles of acid in 1 dm^3 of solution. B and D are of equal concentration, although D is stronger than B which is why D reacts faster than B. Sulfuric acid is diprotic, whereas the other two acids are monoprotic. Thus sulfuric acid produces a greater concentration of H^+ ions than hydrochloric acid of the same concentration, which is why A reacts faster than C.

(b) Some candidates ignored the statement in the question that the concentration of the acid and the mass of magnesium were kept the same, and suggested changing the concentration. Changing the pressure in a reaction between a solid and an aqueous solution will have no effect on the rate of reaction. Increasing the pressure will affect the rate of reactions between gases, because at higher pressure gaseous molecules are closer together and will collide more often.

Question 7

(a) (i) The empirical formula represents the smallest whole number ratio of atoms of each element in a compound. The empirical formula is CH_2 in all alkenes. C_nH_{2n} was by far the most common answer.

(ii) Compounds in the same homologous series or with the same functional group or with the same general formula do not necessarily have the same empirical formula. Alkenes have the empirical formula CH_2 because the formulae of all alkenes cancel down to a smallest whole number ratio of 1C : 2H. Members of **all** homologous series (not just alkenes) differ from the preceding member by a $-CH_2-$ group of atoms.

(b) (i) Amongst the many correct answers it was fairly common to see ethanoic acid and methanoic acid, instead of propanoic acid and ethanoic acid respectively. Organic compounds are named according to the total number of carbon atoms in each molecule, and this includes the carbon atom in the functional group in the case of carboxylic acids.

(ii) Any symmetrical alkene was accepted as a correct answer. Ethene was seen fairly regularly, as well as the non-existent methene.

(c) (i)(ii) Many products of both reactions were seen to have double bonds, which is not the case in addition reactions.

In **(c)(i)** $CH_3CH_2CH_2Br_2$ was occasionally seen. In an addition reaction the two added atoms are not added to the same carbon atom.

(d) Most candidates drew polyethene (polythene), with a chain containing three carbon atoms, i.e. —CH_2-CH_2-CH_2— (or more usually a fully displayed version), as opposed to poly (propene).

Any number of correct repeat units could have been drawn. It is important to draw extension bonds on both ends of the polymer to achieve full credit. It was unnecessary to use brackets with or without an n outside the brackets, but there was no penalty for doing so.

(e) Although the number of 'moles of O_2' (molecules) was requested, the number of moles of O (atoms) i.e. 2.4/16 = 0.15 was often seen. This error could have been rectified in subsequent steps to score full credit. Some candidates approximated the number of moles of O_2 from 0.075 to 0.08 and were unable to recover from this severe over approximation to achieve any credit.

The easiest way to deduce the formula of the alkene is to calculate the number of moles of CO_2 which is 2.2/44 = 0.05. The mole ratio between the alkene and carbon dioxide is 0.01 : 0.05 which in whole numbers is 1 : 5. Therefore it must follow that 1 molecule of the alkene must contain 5 carbon atoms and because alkenes have the general formula C_nH_{2n} the molecular formula of the alkene is C_5H_{10}.

Question 8

Candidates found **(c)** and **(d)** amongst the most difficult parts of the whole paper.

(a) Acids are defined as **proton donors**. This was the only acceptable answer.

(b) Candidates were expected to give a <u>very</u> brief description of an experiment, such as measure pH/add Universal Indicator, and an observation, such as ethylamine has a lower pH, rather than giving a great deal of underlying theory.

Universal Indicator produces different colours when added to strong and weak bases rather than different shades of the same colour. Litmus cannot be used to distinguish between strong and weak bases, because it changes to the same colour (blue) in both. Weak bases and strong bases do not require different volumes of acid to neutralise them, assuming that equal numbers of moles of the base are present. The reaction between aqueous solutions of ethylamine or sodium hydroxide and acids does not proceed with any visible differences, and therefore it is not possible to compare the rates of reaction.

(c) Ammon**ium** salts, such as ammon**ium** chloride, react when heated with strong bases such as sodium hydroxide to produce ammonia; therefore ethylammon**ium** salts such as ethylammon**ium** chloride would be expected to react similarly when heated with strong bases such as sodium hydroxide to produce ethylamine. Those who were aware that a strong base was required, usually omitted to mention that heat was also necessary.

(d) Some candidates recognised the fact that an aqueous solution of ethylamine behaved in a similar manner to aqueous solutions of ammonia and sodium hydroxide when added to an aqueous solution of an iron(III) salt. Candidates were aware that the precipitate indicated a positive test for iron(III) ions in aqueous solution. Although hydroxide ions are commonly used to carry out a test for iron(III) ions in aqueous solution, the converse is also true, which means that aqueous solutions containing iron(III) ions can be used to show the presence of hydroxide ions in aqueous solution.

The question asked for and explanation of the chemistry and a correct response required the knowledge that the hydroxide ions formed reacted with the iron(III) ions to produce a brown precipitate of iron(III) hydroxide.

Candidates commonly identified the brown precipitate as either iron or rust.

CHEMISTRY

Paper 0620/04

Coursework

General comments

This year saw a significant increase in the number of Centres entering for coursework assessment. Centres who enter regularly continued to produce work of the correct standard to justify the credit awarded and used tried and tested investigations which allow candidates to show their abilities to the best effect.

This was also true of the majority of new Centres.

There were, however, a number of Centres where the credit awarded did not accord with the standards expected. In these cases it was due either to teachers at the Centre being too generous in their marking or, more commonly to Centres choosing assessment tasks which were not appropriate to the skills being assessed.

It is important that these Centres take heed of the comments in the Moderator's report which is sent to the Centre, and that they consider carefully the criteria which are used for the awarding of credit.

Comments on specific skills

Skill C1 Using and Organising Techniques, Apparatus and Materials.

This skill involves following instructions and as such cannot be combined with skill C4 which involves writing instructions. The credit awarded depends on the complexity of the instructions followed, which may be simple one step instructions, more complex multi-step instructions, or instructions which are branched, that is where there are, at some point, two possible routes to take. The decision as to which route is taken depends on interpretation of an observation. This may be as simple as stopping heating when crystallisation point has been reached or judging the end point of a titration.

Skill C2 Observing, Measuring and Recording.

This skill involves making and recording observations. Tasks may be quantitative, involving measurements of qualitative observations such as colour changes and precipitates.

Care must be taken not to provide too much guidance on exactly what to observe and how to record it. The provision of tables and other formats, even in outline, limits the credit which can be awarded.

Candidates should have opportunities to make both types of observation, although not necessarily in the same task.

Trivial exercises involving one or two readings or a single colour change are not sufficient evidence for the higher credit.

Skill C3 Handling Experimental Observations and Data.

This skill involves processing results and finding patterns to arrive at a conclusion. It is much easier to demonstrate this skill if there is data to process. Most suitable of all are tasks from which a graph is produced as this makes it easier to find and explain patterns.

Again care must be taken to not give too much help in the way of leading questions or pre-drawn axes. In this skill also such assistance lowers the credit available.

Skill C4 Planning and Evaluating Investigations.

Here a detailed plan must be written before the investigation is started. It is also essential that the plan is then carried out as this enables an evaluation to be made and improvements suggested.

Very simple exercises are not really suitable as there must be opportunity to explain how variables are to be varied, measured or held constant. Exercises on rate of reaction are very well suited to the assessment of this skill.

Mark schemes should be related both to the task and to the criteria in the syllabus and should not be a slight rewording of the assessment criteria.

It is more straightforward, and can save extra work, if a Centre finds a number of suitable tasks and then sticks with them.

CHEMISTRY

Paper 0620/51
Practical Test

Key messages

Follow the advice given to 'read all the instructions **before** starting the experiment' in **Question 1**.

Only observations, and no conclusions, should be written in the table for **Question 2**.

General comments

The majority of candidates successfully completed both questions and there was no evidence that candidates were short of time. Supervisors' results were submitted with the candidates' scripts and few problems were reported with the requirements of this practical examination. The Examiners used Supervisors' results for both questions when marking the scripts to check comparability.

A number of candidates failed to follow the instructions as detailed in certain parts of the questions.

Comments on specific questions

Question 1

(a) The table of results was completed by all of the candidates. A minority of candidates did not add the volumes of aqueous potassium chloride as listed. Some added 3 cm^3 of solution, while others added a variety of volumes of their own choice for which they lost credit. The heights of the solid formed were often measured in centimetres.

(b) Inappropriate scales on the *y*-axis were penalised. At least half of the grid should have been used. The majority of candidates were able to plot the points on the grid, however, a significant number plotted the 4 cm^3, 5 cm^3, 6 cm^3 and 7 cm^3 points for the volume of aqueous potassium chloride at 3 cm^3, 4 cm^3, 5 cm^3 and 6 cm^3 respectively. Only the more able candidates plotted a point at the origin. Best-fit straight lines were rare, and many graphs were badly drawn curves, or showed all points joined with a ruler in numerous straight lines.

(c) The unit was sometimes omitted.

(d) Very few candidates realised that the reaction was a precipitation. Redox, displacement and exothermic/endothermic were common incorrect answers.

(e) (f) The idea that the heights would increase and then level off due to all of the aqueous lead nitrate reacting was only understood by the more able candidates.

(g) A good discriminating question. Many answers referred to a different rate of reaction or vaguely mentioned different heights of precipitates or colours of products.

(h) Meaningful improvements usually referred to using a burette instead of a measuring cylinder, or repeating the experiment. Many vague answers suggested using a more accurate ruler, thinner test-tubes, heating the reactants or cleaning the apparatus more thoroughly.

Question 2

Solid **W** was sodium hydrogen carbonate although the observations obtained by some candidates bore no resemblance to those expected.

(a) The appearance of **W** was usually correctly described as white. Some candidates omitted the colour and simply wrote 'powder'.

(b) (i) The descriptions of the effect of heat on **W** varied from Centre to Centre. Condensation or the appearance of water/liquid drops was expected but many responses just described the solid. The effect of dilute acid on the cooled residue was often badly described. Only a minority of candidates reported the observation of effervescence and the extinguishing of a lighted splint. Answers such as 'gas formed' were common. A number of candidates noted that the splint popped or that a glowing splint relit.

(ii) The addition of hydrochloric acid to the solid was often well described, with the limewater turning milky. A large number of candidates tested for hydrogen, oxygen and chlorine, and some obtained positive results.

(iii) The recording of observations here was a good discriminator. Credit was awarded to those who reported effervescence and a green colour seen on heating.

(iv) Only the more able candidates scored full credit here. The smell of the gas and the effect on damp pH indicator paper were often missing. Many candidates wrote 'ammonia gas is formed', which is not an observation. Above the table, the stem of the question states 'conclusions must not be written in the table'.

(c) A number of candidates recorded temperature rises when the dissolving of **W** in water is actually an endothermic process. Some values for the initial temperature of the water were recorded from 65 °C-100 °C when room temperature was expected. The pH of the solution was often given as 7 or less, or just as a colour.

(d) (e) The conclusions were often correct.

(f) Exothermic and neutralisation were common incorrect answers.

(g) Most candidates successfully identified solid **W** as a carbonate or hydrogen carbonate. However, many responses indicated the presence of lead, copper or ammonium carbonate, showing a lack of knowledge and understanding of the tests carried out.

CHEMISTRY

Paper 0620/52

Practical Test

Key messages

It is important to read and follow the instructions in the qualitative tasks in **Question 2** to avoid using the wrong substances.

Only observations, and no conclusions, should be written in the table for **Question 2**.

General comments

The majority of candidates successfully completed both questions and there was no evidence that candidates were short of time. Supervisors' results were submitted with the candidates' scripts; few problems were reported and no candidate who followed the instructions provided would have been disadvantaged by any of the reported problems. The Examiners use Supervisors' results for both questions when marking the scripts to check comparability.

The results obtained by some Supervisors and candidates suggested that a few Centres did not use a newly purchased sample of anhydrous magnesium sulfate for solid **C** (as stated in the Confidential Instructions provided). During storage anhydrous magnesium sulfate will absorb water from the air and become hydrated. This results in the enthalpy of solution becoming less exothermic or, in cases of near complete hydration, endothermic.

Comments on specific questions

Question 1

(a) (b) All candidates completed the two tables of results. Most obtained results that showed a steady increase or decrease in temperature. A few candidates had erratic temperature changes which could have been caused by sporadic stirring.

(c) Many candidates produced inappropriate scales on the *y*-axis, for which credit could not be awarded. The plotted points should occupy a minimum of half the available grid. This can always be achieved by selecting scales that are sensible, (such as 2 cm = 1 °C), however, some candidates chose to use awkward scales, (such as 3 cm = 2 °C), which often resulted in points being plotted incorrectly or errors in reading the graphs in **(d)**. Many candidates drew excellent smooth curves of best fit, however, a curved line which goes from point to point is not a line of best fit (unless the points happen to lie on a perfect curve), and nor is a series of straight lines joining the points. Some candidates drew inappropriate straight lines which had little relationship to the points plotted.

(d) In both **(d)(i)** and **(d)(ii)** there were errors in reading the graph scales. The required working was usually shown on the graph, but sometimes in the wrong place. In **(d)(ii)** some candidates ignored the word 'initial' in the question and just measured the time taken for a 1 °C temperature change at any point during the experiment.

(e) This proved unexpectedly difficult for many candidates. Many just stated that the temperature dropped but did not relate this to the process being endothermic.

(f) This question was a good discriminator. The main error was for candidates to relate the greater volume of water to greater dilution and so a slower reaction. The more able candidates realised that twice the volume of water would require twice the heat energy, and so the temperature change was halved.

(g) Most candidates realised that all of the solid would have dissolved after an hour, but many thought this would just mean that the temperature would stop changing. Better candidates explained clearly that the solution would gain energy from the atmosphere and so return to the initial or room temperature.

(h) Many answers referred to improved accuracy, but few commented on the increased frequency of the readings.

Question 2

Solid **E** was basic copper carbonate and liquid **F** was dilute ethanoic acid. Some candidates obtained observations that would not be possible with these reagents.

(a) The appearance of **E** was usually correctly described as green, although a number of answers stated it to be blue.

(b) The effect of heat on solid **E** produced a wide range of observations and gas test results. Some reported ‘fizzing’, but this could not be observed as the substance remains solid throughout the process. Most reported that the solid became black, but very few noted the condensation formed at the top of the test-tube. When testing the gas, a surprising number of candidates obtained positive results for gases which could not have been present.

(c) (i) Many candidates failed to report the violent effervescence that occurred and while most noticed the blue colouration obtained, they failed to note that it was a solution or liquid (rather than the solid).

(ii) The action of sodium hydroxide was familiar to the vast majority of candidates, but it must be noted that a solid formed from the reaction between two solutions should be described as a precipitate.

(iii) This part produced some excellent answers, but a few contradictions were made, such as claiming the solid dissolved to give a deep blue precipitate.

(d) It was common for candidates to report that liquid **F** was clear or transparent. Neither of these terms describes the colour of the liquid and so are not acceptable alternatives for colourless. A wide range of descriptions of the smell of dilute ethanoic acid were accepted and most candidates gained credit here. Acceptable descriptions were pungent, sharp, sour, strong or vinegar. Vague descriptions such as ‘bad’ or ‘horrible’ scored no credit.

(e) Due to the large variety of pH indicator paper available and their differing sensitivities, a wide range of pH values were accepted. However, pH values of 1 or 7 (or in some cases greater than 7) were not accepted.

(f) The reaction of copper carbonate with dilute ethanoic acid is slow, but if observations are made carefully then effervescence can be seen, as can the blue-green solution obtained. Many candidates failed to gain credit here by simply not observing carefully, or possibly not leaving the mixture to stand as instructed. Some observations made it clear that the candidates had not used solid **E** but had used the decomposition product (copper oxide).

(g) Most candidates successfully identified solid **E** as a copper carbonate.

(h) Most candidates were able to state that liquid **F** was an acid. Many correctly identified it as ethanoic acid or vinegar.

CHEMISTRY

Paper 0620/53
Practical Test

Key messages

It is important to read and follow the instructions in the qualitative tasks in **Question 2** to avoid using the wrong substances.

Only observations, and no conclusions, should be written in the table for **Question 2**.

General comments

The majority of candidates successfully completed both questions and there was no evidence that candidates were short of time. Supervisors' results were submitted with the candidates' scripts; few problems were reported and no candidate who followed the instructions provided would have been disadvantaged by any of the reported problems. The Examiners use Supervisors' results for both questions when marking the scripts to check comparability.

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Comments on specific questions

Question 1

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(c) Many candidates produced inappropriate scales on the *y*-axis, for which credit could not be awarded. The plotted points should occupy a minimum of half the available grid. This can always be achieved by selecting scales that are sensible, (such as 2 cm = 1 °C), however, some candidates chose to use awkward scales, (such as 3 cm = 2 °C), which often resulted in points being plotted incorrectly or errors in reading the graphs in **(d)**. Many candidates drew excellent smooth curves of best fit, however, a curved line which goes from point to point is not a line of best fit (unless the points happen to lie on a perfect curve), and nor is a series of straight lines joining the points. Some candidates drew inappropriate straight lines which had little relationship to the points plotted.

(d) In both **(d)(i)** and **(d)(ii)** there were errors in reading the graph scales. The required working was usually shown on the graph, but sometimes in the wrong place. In **(d)(ii)** some candidates ignored the word 'initial' in the question and just measured the time taken for a 1 °C temperature change at any point during the experiment.

(e) This proved unexpectedly difficult for many candidates. Many just stated that the temperature dropped but did not relate this to the process being endothermic.

(f) This question was a good discriminator. The main error was for candidates to relate the greater volume of water to greater dilution and so a slower reaction. The more able candidates realised that twice the volume of water would require twice the heat energy, and so the temperature change was halved.

(g) Most candidates realised that all of the solid would have dissolved after an hour, but many thought this would just mean that the temperature would stop changing. Better candidates explained clearly that the solution would gain energy from the atmosphere and so return to the initial or room temperature.

(h) Many answers referred to improved accuracy, but few commented on the increased frequency of the readings.

Question 2

Solid **E** was basic copper carbonate and liquid **F** was dilute ethanoic acid. Some candidates obtained observations that would not be possible with these reagents.

(a) The appearance of **E** was usually correctly described as green, although a number of answers stated it to be blue.

(b) The effect of heat on solid **E** produced a wide range of observations and gas test results. Some reported ‘fizzing’, but this could not be observed as the substance remains solid throughout the process. Most reported that the solid became black, but very few noted the condensation formed at the top of the test-tube. When testing the gas, a surprising number of candidates obtained positive results for gases which could not have been present.

(c) (i) Many candidates failed to report the violent effervescence that occurred and while most noticed the blue colouration obtained, they failed to note that it was a solution or liquid (rather than the solid).

(ii) The action of sodium hydroxide was familiar to the vast majority of candidates, but it must be noted that a solid formed from the reaction between two solutions should be described as a precipitate.

(iii) This part produced some excellent answers, but a few contradictions were made, such as claiming the solid dissolved to give a deep blue precipitate.

(d) It was common for candidates to report that liquid **F** was clear or transparent. Neither of these terms describes the colour of the liquid and so are not acceptable alternatives for colourless. A wide range of descriptions of the smell of dilute ethanoic acid were accepted and most candidates gained credit here. Acceptable descriptions were pungent, sharp, sour, strong or vinegar. Vague descriptions such as ‘bad’ or ‘horrible’ scored no credit.

(e) Due to the large variety of pH indicator paper available and their differing sensitivities, a wide range of pH values were accepted. However, pH values of 1 or 7 (or in some cases greater than 7) were not accepted.

(f) The reaction of copper carbonate with dilute ethanoic acid is slow, but if observations are made carefully then effervescence can be seen, as can the blue-green solution obtained. Many candidates failed to gain credit here by simply not observing carefully, or possibly not leaving the mixture to stand as instructed. Some observations made it clear that the candidates had not used solid **E** but had used the decomposition product (copper oxide).

(g) Most candidates successfully identified solid **E** as a copper carbonate.

(h) Most candidates were able to state that liquid **F** was an acid. Many correctly identified it as ethanoic acid or vinegar.

CHEMISTRY

Paper 0620/61
Alternative to Practical

Key message

Questions requiring candidates to plan an experiment should be answered with details of the apparatus to be used, reactants/substances involved and quantitative information clearly specified.

General comments

The paper discriminated well with Examiners reporting almost the full range of credit being awarded. The paper differentiated successfully between candidates of different abilities but was accessible to all.

The majority of candidates were able to complete tables of results from readings on diagrams as in **Questions 2** and **4**, and plot points successfully on a grid in those questions. A minority of candidates did not attempt **Question 6**.

Comments on specific questions

Question 1

(a) Most candidates identified the pieces of apparatus. 'Spoon' was a common incorrect response instead of spatula. 'Tripod' or 'stand' received credit for the lower box. A minority of candidates mistook the tripod for a Bunsen burner.

(b) A good discriminating question. Gas evolution stopping and excess iron powder visible expressed in a number of ways scored full credit. Many answers showed a lack of understanding and discussed colour changes, the lack of iron visible and the continuation of effervescence.

(c) This was not well answered. Most candidates gave answers connected with the rate or speed of a reaction taking place, not realising that there were no reactants involved. Creditworthy answers described evaporation, crystal formation and the possibility of the formation of anhydrous iron(II) sulfate after several minutes.

Question 2

(a) This was generally well answered. The table of results was correctly completed by most candidates.

(b) Candidates generally plotted the points correctly. Some candidates did not use a ruler to draw a straight line and therefore were not awarded full credit.

(c) The line was usually correctly extrapolated. Curves were drawn in some cases. A number of candidates lost credit for omitting the temperature unit.

(d) Confusion was evident between the terms conductor and insulator. Many answers were concerned with the temperature rises decreasing as the copper was a good conductor of heat, when in fact the temperature rises would be greater or faster.

Many candidates referred to the copper can melting or reacting with either water or the alcohols, which showed a lack of knowledge and understanding.

Question 3

(a) Mostly correct, and phonetic spellings of pestle and mortar were credited. Vague references to bowls, crushers and hammers were penalised.

(b) Confused answers referred to 'using hot water' even though this had already been specified in Stage 2. The idea of stirring or mixing and heating the mixture scored credit. The use of a catalyst was penalised.

(c) Many good answers scored full credit. Some diagrams mistakenly focused on a distillation method.

(d) Correct responses specified heating the solution to crystallising point. Confused answers referred only to the filtering and cooling of the solution.

(e) This was well answered but a common misconception was to check the boiling point of the crystals instead of the melting point. Other answers described crystallisation and examination of the shape of the crystals.

Question 4

(a) The table of results was completed by the majority of candidates, although it was a good discriminating question. Many candidates were able to successfully measure the heights of the solid in each test-tube. Unfortunately some did not follow instructions to record the heights in mm and therefore lost some credit. Surprisingly some candidates also used a ruler to measure what they thought was the volume of aqueous potassium chloride, despite having been told in the stem of the question the volumes that were added.

(b) The points were usually plotted correctly although the two straight lines were often randomly drawn. It was expected that one straight line would join the points through the origin and the second shorter line would join the two points at the same height of 24 mm.

(c) The majority of answers were correct. Some candidates misread the question and showed the height of solid formed when 3 cm^3 of potassium chloride solution was added. The unit was sometimes omitted.

(d) Many incorrect responses referred to the reaction as a displacement instead of precipitation. Redox, neutralisation and exothermic were also common incorrect answers.

(e) Most candidates realised that the heights were the same, and explained this in terms of the reaction being finished, or all of the aqueous lead nitrate being used up.

(f) Some gave well-explained correct responses. Other predictions lacked an explanation and some guesses were evident in terms of the heights of the solid decreasing or increasing.

(g) Many answers referred to no reaction occurring or that the rate of reaction would change. The correct response was that a yellow precipitate or solid would form. Many responses suggested that no solid would form while vague answers referred to a different solid or different colour.

(h) References to temperature changes, human errors, inaccurate measurement of the heights and different starting volumes scored no credit. Meaningful improvements were only given by more able candidates. Good answers referred to the use of a measuring cylinder and not leaving the solids long enough to settle, which could be remedied by using a burette/pipette and leaving for longer. Suggestions of repeating the experiments to obtain an average scored credit.

Question 5

(c) A range of credit was scored. Good answers referred to effervescence or bubbles. Those who stated that a gas, or carbon dioxide, is given off were penalised as that is not an observation. The limewater test was generally well known.

(e) Some candidates found it difficult to identify the gas as ammonia.

(f) A variety of conclusions were drawn as to the nature of solid **W**. The candidates who realised that the solid was an ammonium compound or ammonium carbonate scored full credit. A large number of references to ammonium chloride, sulfate or nitrate were penalised. Many responses referred to calcium carbonate, ammonia or other inorganic compounds.

Question 6

This was a good discriminating question with the full range of credit being achieved. More able candidates described a fair test using the three inhibitors, nails and water, and detailing essential measurements to be recorded.

A surprising number of descriptions made no mention of using the inhibitors, while others used radiators instead of the nails provided. Credit was given for other descriptions of adding nails to a measured volume of inhibitor without water present. There were suggestions of leaving the experiment for a suitable time interval, but the proposed intervals varied from minutes to many weeks. Credit was awarded for leaving the experiment for at least one day before observing and comparing the results.

Many incorrect answers suggested that the purpose of the experiment was to investigate the conditions necessary for rusting, and discussed nails in water only, air only and various combinations of both air and water.

CHEMISTRY

Paper 0620/62
Alternative to Practical

Key message

Questions requiring candidates to plan an experiment should be answered with details and/or a diagram of the apparatus to be used, reactants/substances involved and quantitative information clearly specified.

General comments

The vast majority of candidates successfully attempted all of the questions. The full range of available credit was awarded. The paper discriminated successfully between candidates of different abilities but was accessible to all.

Candidates found **Questions 6** and **7** to be the most demanding.

The majority of candidates were able to complete tables of results from readings on diagrams and plot points successfully on a grid as in **Questions 2** and **5**.

Comments on specific questions

Question 1

(a) Most candidates identified the beaker correctly.

(b) Drawing a condenser proved to be challenging for many candidates, although there were a lot of excellent labelled diagrams.

(c) There were a variety of ways in which candidates correctly described and explained what was happening. The most common answer was that the cobalt chloride was rehydrated, but 'reversible reaction' and the test for water were also often seen.

(d) This was not well-answered, with responses that scored full credit being rare. Candidates were unaware of the danger of steam condensing and the water running back into the hot boiling tube. 'Suck back' was a common incorrect response.

Question 2

(a) Most candidates drew a smooth curve, missing the anomalous point.

(b) Candidates generally successfully identified the anomalous point.

(c) Many responses referred to the reaction slowing down rather than stopping. Others thought that the nitric acid would run out, despite being told that it was in excess. However, there were many excellent answers.

(d) The sketch graph was nearly always below the original, but often did not stop at half the height.

Question 3

(a) The most common correct answer was that the bulb would light. References to the colour of the chlorine and the level of the concentrated acid scored credit.

(b) Many candidates missed this question, whilst others labelled the wires or the test-tubes.

(c) Hydrogen and its test are almost universally known. A few incorrectly gave chlorine, however, these candidates were allowed the credit for a correct test for chlorine.

(d) This was found to be more difficult, but the more able candidates realised that the gas was chlorine, which is slightly soluble in the acid.

Question 4

(a) Most candidates realised that the fizzing would stop when the reaction finished.

(b) Whilst there were many correct answers, others talked about time rather than rate, as asked for in the question. Most realised that **Y** was by far the best catalyst.

(c) Nearly all answers suggested repeats and many went on to add more, such as calculating an average.

Question 5

(a) (b) The tables of results were usually completed correctly.

(c) A very small number of candidates misread the scale on the *y*-axis, missing some of the available credit. There were many excellent attempts at smooth curves, with far less thick, wobbly and multiple lines than in previous years. Probably the most common errors were flat upper and lower sections of the curves. Labels were still omitted far too often.

(d) Most candidates could take correct readings from their graphs and a lack of visible working was rare.

(e) Most answers referred to the decrease in temperature, but not all went on to say that the reaction was endothermic, which was required for credit to be awarded.

(f) Too many answers concentrated on the rate of the reaction, rather than the temperature change. Even those who talked about temperature often expressed themselves badly, for example, 'the temperature was halved' rather than 'the temperature change was halved'. A significant minority thought that the temperature change would double because twice the quantity of water had been used.

(g) Credit was given for realising that the reaction had finished and that the solution would return to room temperature/20 °C - 21 °C.

(h) Candidates gave good descriptions that more frequent readings would produce a smoother graph which would limit the effect of anomalies.

Question 6

(d) (e) Most candidates realised that ethanoic acid is colourless, but some confused it with vinegar, giving it as a brown solution. Its smell was less well known, with a variety of very general descriptions such as 'bad' and 'awful'. Although its pH was well-known, many answers were given as colours.

(f) Most answers correctly identified the gas as carbon dioxide.

(g) Most were able to give at least part of the name, copper carbonate. There were also many correct formulae, including a few very impressive correct formulae for basic copper carbonate,

Question 7

This was a very good discriminating question. Few candidates scored full credit or failed to score, but most got over half the available credit.

Credit was awarded for:

- realising that the volume of the drink (or the bottle) needed to be known
- a suitable method for collecting and measuring the volume of the gas, such as a syringe
- connections
- using heat or shaking
- until no more gas is evolved
- measuring the final volume

There were many answers which followed the plan above, but full credit was given for other innovative answers. These included measuring the change in mass of the bottle and then using the density (or molar volume) of carbon dioxide to calculate its volume. Others used a balloon over the neck of the bottle to collect the gas.

CHEMISTRY

Paper 0620/63
Alternative to Practical

Key message

Questions requiring candidates to plan an investigation should be answered with details of apparatus to be used, reactants/substances involved and quantitative information clearly specified.

General comments

The vast majority of candidates attempted all of the questions. The full range of credit was awarded. The paper discriminated successfully between candidates of different abilities but was accessible to all.

Candidates found **Questions 2**, **4**, **6** and **7** to be the most demanding.

The majority of candidates were able to complete the tables of results from readings on diagrams and plot points successfully on a grid as in **Question 3**.

Comments on specific questions

Question 1

(a) Most candidates answered this correctly. Credit was given for dropper or pipette as well as teat pipette. Pestle was an incorrect answer.

(b) This was a good discriminating question. More able candidates discussed the speeding up of the reaction by increasing the surface area of the solid.

(c) (d) The majority of the responses were correct.

(e) The idea of adding a more reactive metal to displace the zinc or the use of electrolysis scored credit. Common answers were evaporation, crystallisation or distillation of the zinc sulfate solution to obtain zinc which showed a lack of knowledge and understanding.

Question 2

A significant number of candidates were unable to state chemical tests and hence results to identify any of the three liquids. Guesses were common with some candidates filling in results without specifying a test.

The use of red litmus indicator, which turns blue, in ammonia was known by some candidates. References to using bromine to test for pentene were rarely seen and some answers referred to barium solution instead of bromine. The test for an iodide was sometimes attempted using nitric acid to obtain a yellow precipitate omitting the aqueous silver nitrate.

Question 3

(a) The table of results was completed correctly by the vast majority of candidates.

(b) (c) Most candidates plotted the points on the grid correctly, although many graphs drawn were not smooth lines and included the anomalous point, despite successfully identifying it in **(c)**.

(d) Some candidates could not read the scale on the *x*-axis. A common error was to indicate the time at 14 seconds instead of 12 seconds.

(e) Many responses referred to the manganese(IV) oxide or reactants being used up or all reacted. Credit was given for recognising that all of the hydrogen peroxide had decomposed or that the reaction had finished. Vague answers such 'no more gas was given off' were seen.

(f) (i) Using ice or a refrigerator were common creditworthy answers, whereas 'leave in a cold room' or the use of a freezer did not score credit.

(ii) Most candidates scored partial credit. A common error was to level the curve out at half the level of the original graph which showed a lack of understanding. Lowering the temperature would only affect the rate of reaction and not change the final volume of oxygen produced.

Question 4

(a) The use of a burette or pipette to measure accurately 25.0 cm^3 of the aqueous sodium hydroxide was the required piece of apparatus. Many responses referred to a measuring/graduated cylinder which would not have been appropriate.

(b) (i) Many responses showed that few candidates could name a suitable indicator such as litmus or phenolphthalein. Universal Indicator was a common unsuitable choice. Copper sulfate, cobalt chloride, iodine and ammonia were also suggested.

(ii) Colours were often given despite no attempt having been made to name an indicator in **(i)**.

(c) This was a good discriminator. Nitric acid could be identified as the less concentrated solution because a greater volume was used to neutralise the alkali. Some answers mentioned that the acid was dilute and therefore must be the less concentrated.

(d) A minority of candidates realised that the experiment should be repeated without using an indicator. The evaporation of this solution would yield pure crystals of sodium nitrate which had not been contaminated by the indicator.

Question 5

Answers to this qualitative analysis question were Centre dependent. It was evident that many candidates had no knowledge of the tests required to complete the observations in table for **(c)** and **(d)**.

(c) 'Gas evolved' is not an observation. The use of terms such as effervescence, bubbles or fizzing indicates that a gas is evolved.

(d) There was some confusion shown by those candidates who realised a blue precipitate would be formed. Some thought that in excess ammonia the precipitate would dissolve and turn dark blue and become insoluble.

(e) Meaningful conclusions were rare. Chloride ions were sometimes successfully identified but the identity of solid **G** as barium chloride or calcium chloride was often absent.

Question 6

(a) The realisation that a heat source, such as a Bunsen burner, would be needed to melt the lead iodide was often lacking. Common responses were a switch, battery, ammeter or voltmeter.

(b) Many labels showed the battery as the electrodes.

(c) This was a good discriminating question. Those candidates who realised that there was a bulb in the circuit deduced the observations that the bulb would light up during electrolysis and go out when the lead iodide solidified. Others discussed the formation of different products at the electrodes, many of which would not have occurred.

(d) Credit was awarded for answers expressing that a gas would be formed and that unless it escaped pressure would build up with resultant consequences.

(e) Much confusion was evident between the terms iodine and iodide. 'Iodine ions attracted to the anode to form iodide gas' was a typical response.

(f) The formation of a toxic gaseous product was often recognised. However, suitable safety precautions do not include advice about not inhaling the gas or a variety of descriptions of gas masks. A fume cupboard or well ventilated room were creditworthy. Gloves also scored credit if reference was made to the toxic solid lead iodide.

Question 7

This was a good discriminating question. The quality of answers spanned the entire spectrum. Many candidates suggested using the fertilisers to grow beans or seeds, but gave no mention of soil conditions and little experimental detail.

Other candidates did not mention measuring the amounts of fertiliser, or chose to use water to aid the growth of the plants. Vague references to the chemical composition of fertilisers in terms of N, P and K were common. Many candidates just analysed the fertilisers to obtain ammonia. Some candidates discussed testing the soils for acidity to see if the fertilisers would neutralise them.

Well planned answers from more able candidates gave essential experimental detail with a clear practical method and a means of comparing the effects of the fertilisers on plant growth.

Credit was awarded for:

- measured amount of fertiliser
- soil in named apparatus or description of land area in which to plant beans
- use of water
- observation of plant growth over suitable time interval
- comparison of results/conclusion

Some candidates did not attempt this question.