CHEMISTRY

Paper 0620/11
Multiple Choice

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

Candidates performed well on this paper. **Questions 1**, **4**, **8**, **10**, **11**, **18**, **21**, **26**, **27**, **28**, **33** and **38** proved to be particularly straightforward with a large majority selecting the correct answer.

Questions 2, **30** and **40** proved to be the most difficult with less than half the candidates selecting the correct answer.

<u>**Comments on Specific Questions**</u>

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

Question 2

Response **A.** Candidates chose this response because they knew a burette was used in a titration for accurate measurement but did not consider the other responses fully.

Question 9

Response **A**. Candidates found a total which corresponded to 78 but did not realise that argon does not form compounds of this formula.

Question 15

Response **D**. Candidates knew that alternative 3 was correct but did not know that (II) referred to the oxidation state of copper.

Question 22

Response **B**. Candidates probably misread electron shells as electrons and so chose this alternative instead of the number of outer shell electrons.

Question 23

Response **B**. Candidates chose the first alternative which had a high melting point without taking into account the coloured nature of transition metal compounds.

Question 35

Response **D**. Candidates knew that answer 1 was wrong but then, not knowing sufficient about carbonate chemistry, chose the wrong one of the remaining alternatives.

Question 39

Response **B**. Candidates correctly knew that ethene decolourised bromine water and that ethane did not. They did not realise that ethene is a gas.

Question 40

Response **D**. This response was slightly more popular than the correct response. Candidates clearly did not appreciate that the reaction between ethene and steam was an addition reaction.

CHEMISTRY

Paper 0620/12
Multiple Choice

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

Candidates performed well on this paper. **Questions 1**, **3**, **4**, **5**, **9**, **10**, **11**, **13**, **21**, **22**, **25**, **26**, **29**, **31**, **34** and **38** proved to be particularly straightforward with a large majority selecting the correct answer.

Question 40 proved to be the most difficult with less than half the candidates selecting the correct answer.

Comments on Specific Questions

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

Question 15

Response **D**. Candidates knew that smaller pieces would give a more rapid reaction but did not take into account the effect of concentration.

Question 17

Response **A**. Candidates did not know the colours of cobalt chloride when hydrated and anhydrous, and many appeared not to have read the question, where this information was given, carefully. They did, however, know that the reaction was reversible.

Question 18

Response **D**. Candidates did not appreciate that a metal would not be formed in experiment 1 as the sodium chloride was in solution.

Question 24

Response **C**. Candidates had to understand the trends in groups as the elements were unfamiliar. Many chose the wrong group for increasing reactivity down the group.

Question 32

Response **B**. Candidates knew that rusting involves oxygen but were not aware of the use of oxygen in welding torches.

Question 40

Response **C**. Candidates did not recognise addition of steam to ethene as a way of making ethanol.

CHEMISTRY

Paper 0620/13

Multiple Choice

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

Candidates performed well on this paper. **Questions 1**, **9**, **10**, **11**, **19**, **24**, **26** and **37** proved to be particularly straightforward with a large majority selecting the correct answer.

Questions 2, **28**, **31** and **40** proved to be the most difficult with less than half the candidates selecting the correct answer.

Comments on Specific Questions

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

Question 2

Response **A.** Candidates chose this response because they knew a burette was used in a titration for accurate measurement but did not consider the other responses fully.

Question 4

Response **B**. Candidates did not appreciate that filtration would be needed to remove an insoluble substance.

Question 6

Response **A**. Candidates realised that two further electrons were required, but appeared not to have read all the responses.

Question 8

Response **A**. Candidates found a total which corresponded to 78 but did not realise that argon does not form compounds of this formula.

Question 13

Response **A**. Candidates did not realise that hydrogen is always formed at the negative electrode.

Question 16

Response **D**. Candidates knew that alternative 3 was correct but did not know that (II) referred to the oxidation state of copper.

Question 20

Response **B**. Candidates knew that one piece of litmus paper would change colour, but chose the wrong one, not knowing the test for ammonium ions.

Question 22

Response **B**. Candidates chose the first alternative which had a high melting point without taking into account the coloured nature of transition metal compounds.

Question 36

Response **D** Candidates knew that answer 1 was wrong but then, not knowing sufficient about carbonate chemistry chose the wrong one of the remaining alternatives.

Question 38

Response **B** Candidates correctly knew that ethene decolourised bromine water and that ethane did not. They did not realise that ethene is a gas.

Question 40

The topic of ethanol production was not well understood. All responses were chosen by a significant number of candidates with response **D** being slightly more popular than the correct response and response **C** being the least popular.

CHEMISTRY

Paper 0620/21
Core Theory

Key Messages

- Questions about electronic structure were generally done well, as were questions involving calculation of molecular mass and some aspects of graphical work.
- Questions on practical procedures, e.g. separation techniques using filtration and ideas of control experiments, may need further practice.
- Some candidates need more practice at answering questions requiring extended answers, e.g. **Questions 4(a)** and **7(a)**.
- It is important that candidates read the question carefully in order to understand exactly what is being asked.
- Many candidates need more practice at answering questions on electrolysis and qualitative analysis tests for specific ions and molecules.
- Some candidates need more practice in drawing diagrams carefully to show the exact arrangement of particles, e.g. **Question 4(c)**, or apparatus, e.g. **Question 6(a)(i)**.

General comments

Many candidates tackled this paper well, showing a very good knowledge of core chemistry. Good answers were seen to most parts of **Questions 1** and **5**. Nearly all candidates were entered at the appropriate level. The rubric was occasionally misinterpreted, for example in **Question 2(d)** some candidates wrote about chemical properties instead of physical properties, whilst in **Question 7(c)(i)** many candidates tried to write symbol equations instead of word equations. A considerable number of candidates did not attempt **Question 3(d)**, test for unsaturation, and **4(b)(ii)**, calculation of relative molecular mass. The extraction of information from tables of data was generally well done. Candidates performed less well on questions where the information was given in unfamiliar terms. For example, in **Question 6(a)(i)** a considerable number of candidates wrote about the separation of sand and salt with water rather than the separation of sugar and salt using propanol. In **Question 7(a)** many candidates did not write about particles although the stem of the question instructed them to do so. The standard of English was good, and a few candidates wrote their answers in the form of short phrases or bullet points; candidates are less likely to write vague statements or contradict themselves if this is done. As in previous sessions, quantitative tests for specific groups were not well known. For example, a considerable number of candidates were challenged by **Question 3(d)** where the bromine water test for unsaturation was required. Few candidates knew the test for iron(II) ions. In organic chemistry, many candidates could write the formula for ethane and link formulae to particular homologous series.

Comments on specific questions

Question 1

(a) Most candidates were able to interpret the atomic structures. Many scored well, but few were awarded full credit.

(i) The majority of candidates realised that the number of electron shells correspond with the period number. A few incorrectly gave the answer as **A** or **D**.

(ii) Many candidates correctly identified the noble gas. The commonest errors were to suggest **A** or **D**.

(iii) Most candidates correctly identified **E**, but some confused group number with period number and gave the incorrect answer **D**.

(iv) Many candidates recognised **A** as having five electrons in its outer shell. A minority of candidates chose **D**.

(v) This was the least well answered part of the question. Many candidates confused atomic number with group number and consequently selected element **D** instead of **A**.

(vi) A wide variety of answers were seen to this part, the commonest incorrect answers being **C** and **A**.

(b) Most candidates were able to select the term 'atom' and identify transition elements. A common incorrect answer was in the second space where the word 'monatomic' was often inserted instead of the word 'two'.

Question 2

Parts **(b)** and **(c)** were generally done well. Many candidates did not answer part **(a)** fully enough. A wide variety of general physical and chemical properties of elements were given in part **(b)** instead of focusing on the physical properties of metals. In part **(c)**, many candidates gave the names of products instead of giving observations.

(a) Few candidates correctly explained why caesium is a liquid at room temperature. The majority described only the melting point in their answer and ignored the boiling point.

(b) Many candidates correctly estimated the boiling point of potassium. Some candidates lost credit for giving answers that were slightly outside the acceptable range or by trying to find a relationship between density and melting point to calculate a value.

(c) (i) Most candidates identified the general trend in density, although some again tried to link density to melting point, giving statements such as 'the melting point decreases as the density decreases'.

(ii) Most candidates suggested either potassium or sodium as not following the trend. A minority suggested either caesium or rubidium, and a few added metals that were not in the table, such as francium. Some suggested mercury, presumably because of its unusual properties.

(d) Few candidates scored full credit. Many candidates gave at least two physical properties, and others gave chemical properties which indicated some confusion between physical and chemical properties. Some of those who scored full credit gave more than the three required properties. Often, candidates did not make the distinction between the property, e.g. soft, and an example of this property, e.g. can be cut with a knife, however, these types of answers were not penalised. A significant minority gave general properties of transition metals, suggesting that potassium is hard or has a high density.

(e) (i) About half the candidates scored some credit. The commonest error was to describe the inference, e.g. hydrogen is released, rather than the observation. A large number of candidates described observations which were not part of the question, such as adding a lighted splint or indicator.

(ii) Many candidates balanced the equation correctly. The most common error was to put H or H_2O as a product.

Question 3

Although many candidates scored some credit on this question, few were awarded full credit. Parts **(c)** and **(d)** were least well done. Few candidates gave convincing explanations of the difference between saturated and unsaturated hydrocarbons and fewer knew the bromine water test.

(a) Most candidates scored at least partial credit for this question. Most identified the alcohol and carboxylic acid and confused the alkene with the alkane.

(b) The majority of candidates drew the correct structure of ethane. The commonest errors were omitting one or more hydrogen atoms or including a double bond.

(c) Few candidates scored full credit for this question. Many described the difference between unsaturated and saturated hydrocarbons in terms of making more bonds. Many linked unsaturation to the presence of double bonds and did not mention the bonding in a saturated compound as being exclusively single bonds. Others explained the difference between ethane and ethene rather than hydrocarbons in general. The commonest error was to reverse the definitions of saturated and unsaturated.

(d) Many candidates did not attempt this part. The test using bromine water was not well known. A wide variety of incorrect suggestions were given, e.g. 'burning', 'adding to water to see if hydrogen is given off', 'adding sodium hydroxide'.

Question 4

Many candidates gave good answers to parts **(b)**. Fewer could describe the test for ammonia or give two reasons why farmers use fertilisers. Many were able to deduce a molecular formula from a diagram of a molecule and calculate the relative atomic mass of urea. Many candidates need to improve their drawing skills when showing the arrangements of molecules

(a) Many candidates scored partial credit for this part, generally for giving the names of the elements commonly present in fertilisers. Sulfates and magnesium were often suggested as being the essential elements in fertilisers. A significant number of candidates ignored the term 'element' in the stem of the question and named nitrates and phosphates. Replacing depleted elements in the soil or making more protein were rarely suggested as answers. A significant minority of the candidates confused the roles of fertilisers with those of pesticides and liming soil in order to change the pH.

(b) (i) Many candidates were able to deduce the correct molecular formula of urea. The main errors were suggestions that there were either two carbon atoms or two oxygen atoms per molecule.

(ii) Many candidates calculated the relative molecular mass of urea correctly. A significant number were awarded credit for identification of the correct relative atomic masses. A significant minority used atomic numbers rather than atomic masses.

(c) Many candidates scored full credit for their diagrams of the structure of a solid. Some diagrams were not drawn with enough care. In many cases, the first few circles representing molecules were well drawn but subsequent ones were either drawn so that there were significant spaces between the molecules, or the regularity of the structure was lost.

(d) A minority of candidates scored full credit for the test for ammonia. Many thought that the litmus paper turned red rather than blue.

Question 5

Most candidates gained some credit in this question. The relationship between structure and properties in part **(a)** was generally well known. Some candidates need practice at interpreting graphs and drawing lines to show the plot when conditions are changed (parts **(b)(ii)** and **(b)(iv)**).

(a) Many candidates scored partial credit. In part **(iii)** the metallic structure was usually identified correctly. Fewer candidates chose **D** as being a giant covalent structure in part **(i)**.

(b) (i) A minority of candidates explained that the loss of gas resulted in a decrease in the mass of the reaction mixture. Common errors were the implication that dissolving or disappearance of the solid led to a loss of mass, that gases are lighter than solids and so the mass fell, or that the reactants were used up and so disappeared. A significant number of candidates disadvantaged themselves by giving two answers, e.g. gas is given off and the solid dissolves.

(ii) A minority of candidates correctly detemined when the reaction stopped. Careful analysis of the curve was required. The majority of candidates suggested 350 s, (where the curve still has not flattened off completely), rather than a slightly higher value.

(iii) Almost all of the candidates correctly deduced from the graph the loss of mass in the first 100 seconds.

(iv) Fewer than half of the candidates drew a correct line to show how the loss of mass changes when smaller pieces of calcium carbonate are used. The commonest error was to assume that smaller pieces of calcium carbonate would lead to a smaller loss in mass.

(v) This part was well answered. A majority of the candidates gave more information than was needed and provided an explanation in terms of the kinetic particle theory rather than simply stating that the rate increased.

Question 6

Many candidates scored about half of the available credit for this question. Very few scored full credit. The unusual context of the separation in part **(a)** (solution in propanol) allowed discrimination between those candidates who had read the stem of the question carefully and those who had made the assumption that the question was about the separation of sand and salt (rather than sugar and salt). Most candidates could deduce a formula from a diagram and identify ionic bonding in part **(b)**. Fewer were able to identify the products formed when a concentrated aqueous solution of sodium chloride is electrolysed in part **(c)(ii)**.

(a) (i) Almost all of the candidates scored some credit in this part. Many misread the question and described how to separate sand from salt. Others disregarded the information in the stem of the question and suggested that water should be used as the solvent instead of propanol. A considerable proportion of the candidates suggested separating the salt from the sugar without adding a solvent. Other common errors included: suggesting that solid sugar goes through the filter paper rather than sugar solution; stating that the sugar remains on the filter paper; the use of distillation to separate the salt from the sugar. Errors in drawing the filtration apparatus sometimes led to candidates not scoring the credit available for 'filtration'.

(ii) Fewer than half the candidates suggested that solid sodium chloride could be separated from a solution of sodium chloride by the processes of evaporation or distillation. The majority suggested filtration.

(b) (i) Many gained credit for the deduction of the formula of sodium chloride from the diagram. Common errors included giving a charge to one of the ions but not the other, or giving multiples, e.g. Na_6Cl_6.

(ii) The majority of candidates identified sodium chloride as being ionic. Most of the others chose 'covalent', while a few selected 'metallic' or 'weak'.

(c) (i) The majority of candidates identified the electrolyte correctly. The commonest error was to suggest **C**.

(ii) Few candidates scored full credit. The commonest incorrect answer was to suggest chlorine and sodium. A significant minority of candidates misread the question and named the electrodes as anode and cathode, or used labels from the diagram in the stem of the question, i.e. **B** and **C**.

Question 7

A few candidates performed well on this question. Others did not score well because they wrote vague statements in parts **(a)** and **(d)**. Only a minority of candidates identified the correct name for NH_4Cl or understood the concept of control experiments. The test for iron(II) ions was only known by a small number of candidates.

(a) Many candidates scored partial credit but few scored full credit. Many answers did not mention particles. Others repeated the same comment several times, e.g. particles diffuse, particles diffuse more, particles are fully diffused. Some candidates made vague statements about 'hydrogen chloride moving up the tube' or described the observations about the litmus changing colour without any theoretical explanation of the process of diffusion.

(b) Fewer than half of the candidates correctly identified the name of the salt NH_4Cl. As well as the commonly seen 'ammonia chloride', there were many guesses, such as 'nitrogen hydrochloride'.

(c) (i) A minority of candidates wrote the word equation successfully despite the fact that all the required information was in the stem of the question. Common errors included omission of one of the reactants or products, giving water as a product instead of hydrogen, omission of the (II) from the iron(II) chloride and attempting to write a symbol equation.

(ii) Very few candidates knew the test for iron(II) ions. Common errors included the addition of silver nitrate, the addition of litmus, the limewater test and reference to rusting. Many of those who realised that the test involved adding sodium hydroxide suggested that a red-brown precipitate is formed.

(d) (i) Few candidates answered this question correctly. More practice is needed in areas relating to experimental methodology.

(ii) Most candidates correctly identified air/oxygen and water as the requirements for rusting.

(iii) Most answered this correctly. A minority of candidates simply stated what was in the tube without giving any further explanation.

(iv) Many candidates simply described what was in the tube without any further explanation. Others mentioned only one of the substances required for rusting rather than naming both.

Question 8

A few candidates performed well on this question. Others did not score well because they did not write comparative statements in parts **(a)(i)-(iii)** or explain the word 'insulator' in part **(a)(iv)**.

(a) (i) About half of the candidates correctly identified a reason for using copper but did not make a comparison between the metals, only stating the property of the metal, e.g. 'copper is a good conductor', rather than stating that copper is a better conductor.

(ii) Only a minority of the candidates gave a specific enough answer to gain credit. 'Silver is expensive' is insufficient on its own.

(iii) About half of the candidates correctly identified a reason for using tungsten but did not make a comparison between the metals, only stating the property of the metal, e.g. 'tungsten has a high melting point', rather than 'tungsten has a higher melting point'.

(iv) About half of the candidates scored some credit. Few mentioned (electrical) insulation. The commonest incorrect responses were 'to protect against corrosion' and 'for strength'.

(b) Many candidates correctly identified the alloy as diagram **B**. The commonest incorrect choice was diagram **C**.

CHEMISTRY

Paper 0620/22
Core Theory

Key Messages

- Questions requiring simple answers to organic chemistry were usually done well as were questions involving equations and calculations of molecular mass.

- Questions on aspects of practical procedures, e.g. separating a mixture of solid sucrose and solid sulfur and laboratory fermentation, need to contain a more focused explanation and attention to detail. Candidates also need to think more carefully when constructing their answers.

- Some candidates need more practice in answering questions requiring extended answers, e.g. **Questions 5(a)** and **8(a)**. The credit allocation is a good indication of the relevant points required in the answer.

- It is very important that candidates read the questions carefully in order to understand exactly what is being asked. Practice at reading off graphical scales may also be helpful for some candidates.

- Many candidates need more practice at answering questions on inorganic chemistry, for example electrical chemistry questions and those involving pollution and air composition, and practical tests. More specific revision of the uses and sources 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 seen to a number of different questions, however, most candidates found parts of every question challenging. Nearly all candidates were entered at the appropriate level. The general standard of answering was much better than in previous years and it was obvious that the candidates are using past paper practice as part of their revision programme. The standard of English was good. Some candidates wrote their answers as short phases or bullet points; candidates are less likely to write vague statements or contradict themselves if this is done. The answering of the longer type questions is improving as demonstrated in **Question 8(a)** on the 'kinetic particle theory', which many candidates answered well using the correct chemical terms. The other longer question on the composition of air and its pollutants, **Question 5(a)**, was not answered so well. Candidates have improved their writing of word equations, although the correct spelling of chemical compounds still needs some practice. The balancing of chemical equations was excellent this year.

Candidates' knowledge of organic chemistry was encouraging and many could draw the structure for methane and name, with the correct spelling, another member of the alkane homologous series. However, some candidates did not know that 'different boiling points' was the correct physical property on which fractionation depends and incorrectly suggested 'temperature' or another physical property such as 'density'. Many candidates could write easy molecular formulae.

There was some misinterpretation or misreading of the rubric, for example in **Questions 4(a)(iii)**, **2(b)** and **2(d)**. Some candidates had difficulty reading values from the graph in **Question 3(b)(i)**. The definition of reduction was not known by some candidates and there was some confusion with reactivity, the extraction of metals and their position in the reactivity series. Candidates coped well with the atomic theory.

A considerable number of candidates did not attempt **Question 8(b)(iii)** but most other questions were attempted by every candidate.

Candidates did not perform well in questions that required knowledge of practical techniques, for example **Questions 7(c)** and **8(b)(v)**.

<u>Comments on specific questions</u>

Question 1

Quite a few candidates found this first question difficult even though there was no continuous writing required.

(a) Only a small minority of candidates scored full credit on this question. Not many answered part **(i)** correctly, with some thinking that **B** and **C** were elements. Part **(ii)**, however, was answered well. Many candidates suggested in part **(iii)** that chlorine would turn damp red litmus blue; the candidates probably remembered that the presence of chlorine is tested using damp litmus paper. More candidates answered the last two questions correctly but different incorrect answers were seen on numerous occasions.

(b) Candidates found this hard and struggled with the definition of a compound; the word 'metal' was quite frequently chosen instead of 'atom'. Candidates found it hard to distinguish between a 'simple molecule' and a 'giant ionic' structure.

Question 2

In this question, parts **(c)** and **(e)** were done very well. Some candidates were unsure about the differences between Group I and the transition metals, although many understood the unique properties of the transition metals.

(a) Many candidates answered this correctly but some used poor descriptive words such as 'higher' rather than 'increases'. Some incorrectly described the fact that some elements stayed the 'same' which is not correct for a 'general' pattern.

(b) The majority of candidates gave a value in the correct range here. However, some did not read the question correctly and put a range of values instead, the most common being 'between 4.50 and 7.20' (the densities of the elements on either side of vanadium).

(c) This was by far the most successfully answered question part on the whole paper. The definition for a catalyst was very well remembered by the majority of candidates. However, the suggestion that a catalyst 'affects' or 'alters' a chemical reaction is not correct.

(d) There were some really good answers here with most candidates earning most or all of the available credit and answering this question with the correct level of accuracy required. However, there were quite a few candidates who gave good conductors of 'heat' or 'electricity' as at least one of their answers; this is not a **difference** between the two groups and it was obvious that the question had not been read properly.

(e) This part was again very well answered. Candidates balance this type of equation with much success.

(f) Quite a few candidates did not know that 'sulfuric acid' gives 'sulfate' and wrote down 'sulfide' instead. 'Water' was given instead of 'hydrogen' in a few instances and some candidates wrote down three answers for this question instead of two.

Question 3

This was probably the best answered question on the paper. A minority of candidates had difficulty with naming the equipment in part **(a)** but on the whole the question was answered well with most candidates scoring some credit. The questions in part **(b)** were answered well.

(a) This was well answered with most candidates achieving at least half of the available credit. Some candidates had difficulty with the correct spelling of the laboratory equipment. Most candidates correctly named 'pipette' and 'burette'. However, 'round-bottomed flask' was given instead of 'conical flask' in a few cases, and some candidates omitted 'funnel', and just wrote down 'filter' instead of 'filter funnel'.

(b) (i) Quite a few candidates misread the scale for this part and gave the answer '13' instead of '13.2'.

(ii) This was a very well answered question and despite the difficulties encountered in **(b)(i)** nearly all candidates read this value correctly from the graph.

(iii) There were very few incorrect answers here indicating an excellent knowledge of the pH scale.

(c) (i) Although most candidates recognised that one of the calcium salts is used to control the pH of acidic soils, surprisingly few recognised that both calcium compounds are used. Candidates need to be looking for bases that will react with acids.

(ii) Most candidates could state that the 'plants might die' or 'they would not grow' or 'so that crops grow well'. Only a few did not relate their answer to the growing of plants and just suggested that there would be a problem with the soil (the soil would not be good enough).

Question 4

Parts **(a)(i)**, **(ii)** and **(iv)** of this question were very well answered showing that candidates' knowledge of organic chemistry and writing equations is very good. Some candidates struggled with physical properties, fractional distillation and the uses of the fractions.

(a) (i) A vast majority of candidates could draw the full structure of methane. Only a few of the less able candidates were unable to do this.

(ii) The correct naming of another member of the alkanes was very encouraging. Most candidates named 'ethane' here with very few incorrect spellings.

(iii) Some candidates were unable to name a natural source of methane; 'pollution', 'greenhouse gas' or another substance such as 'carbon monoxide' were seen in many instances. However, the most able candidates correctly gave 'decomposition of vegetation'.

(iv) This was completed very well. In a few cases two molecules of carbon dioxide were seen.

(b) (i) Some candidates were unable to state the physical property of oil upon which fractional distillation depends. Quite a few did, however, suggest 'boiling point', but some candidates incorrectly gave 'temperature' or 'density'. A lot of candidates appeared to have been confused by the term 'physical property'.

(ii) A very small minority achieved the maximum available credit here. Candidates are confused by the uses of the fractions obtained from crude oil. 'Kerosene' for 'making chemicals' and 'naptha' for 'fuel for jet aircraft' were seen in quite a few different cases.

Question 5

Most candidates struggled with parts **(a)**, **(b)(ii)** and especially **(c)(i)** which was found to be the hardest question part on the paper. However, **(c)(ii)** was answered very well, showing that the candidates have now mastered molecular formulae.

(a) Many candidates find it difficult to answer the questions that require longer answers. This is something that can be concentrated on using lots of examples from the syllabus. Most candidates gave the names of the two main gases present in clean air, but a few gave the formulae instead. Many were unable to give the exact percentages of these gases. Invariably the percentage composition was wrong – too high for oxygen and too low for nitrogen. Big percentages of hydrogen, carbon monoxide and carbon dioxide were also seen. Few candidates were able to state the source of each individual pollutant and many resorted to 'cars' or 'factories' for them all, which were much too vague. Candidates were asked to give a source for 'each of the pollutant gases' rather than for them all lumped together, so in many cases credit was lost. Few were able to give a source of oxides of nitrogen. A few candidates suggested that carbon monoxide was made from carbon dioxide.

(b) (i) This question was well answered and many candidates have mastered writing correct ionic formulae. A few gave 2PbS or 6PbS. There were a few answers with formulae that had oxygen atoms in them such as $PbSO_4$. Candidates should be reminded not to include any charges in their formulae.

(ii) This question was answered reasonably well by most candidates who were able to pick out that the lead oxide had been reduced by the 'loss' or removal' of oxygen. However, there were a few instances where the answer was just too vague to be awarded credit; most prevalent was just stating that 'carbon and oxygen combine' without any explanation. The candidates must also realise that using the word 'reduced' in their answer is not a good idea when they are trying to describe what this word actually means.

(c) (i) Many candidates found this question very difficult, not because it is a really challenging question but just because the candidates found it hard to understand what 'arrangement' and 'closeness' meant and to find adequate words to describe this for a liquid. Many candidates talked about movement of particles for arrangement or simply compared the arrangement to a solid or a gas which was not enough to qualify for credit. A few candidates did not answer at all. Candidates struggled with the word 'closeness' and settled for vague answers or did not realise that, in fact, the particles are very close together in a liquid.

(ii) Most candidates could write the molecular formula correctly. The main error was taking a common number out of the formula and giving $2(CH_2Cl)$ or C_2H_42Cl.

(iii) This question was very well done. It was obvious that most candidates have now mastered working out relative formula masses using the periodic table. Some candidates highlighted their answers by circling or underlining them which makes marking mathematical answers easier. A few candidates multiplied the masses together instead of adding them up. However, some used the atomic numbers and so used 17 for chlorine. Candidates should be reminded to use a calculator as there were a few instances where the numbers were correct but simple addition let them down.

Question 6

This was a reasonably well answered question. The vast majority answered parts **(a)** and **(c)(i)** correctly showing a good understanding of interpreting reactivity data and being able to do electronic configurations. However, some candidates had difficulty with methods of extraction of metals, and some with working out neutron numbers.

(a) Candidates dealt really well with this question, indicating that they have been practising these types of questions. There were very few incorrect answers or responses where the order of the metals had been reversed.

(b) This question was not answered as well as expected and showed that many candidates lack knowledge about the extraction of metals and the reactivity series. Many candidates did not realise that zinc and iron can only be extracted using carbon for the reactivity series given in this question. Anything below carbon can be extracted by it but because of this lack of knowledge there were not many correct answers.

(c) (i) This electronic configuration question was completed very well by many. Only the less able candidates failed to gain full credit. In very few instances there were more than two electrons shown in the outer shell.

(ii) There were many different answers given here. A very common answer was 12 instead of 14, where candidates used the mass of magnesium from the periodic table and not that given in the actual question for that particular isotope of magnesium. More practice in working out the number of neutrons would be beneficial.

Question 7

Many candidates found most of this question challenging. The structures of compounds and their properties were not well understood. The separation in part **(c)** was poorly done in some cases, mainly because candidates failed to use the information that was given in the table. Most candidates succeeded in part **(d) (i)** and **(ii)** but found part **(iv)** hard.

(a) Most candidates knew that zinc chloride is an ionic compound, (which was stated in the table), but few then went on to say that it conducts electricity because of the 'movement of ions'. Many candidates incorrectly stated that it conducts electricity because it contains a metal. A few also talked about 'movement of electrons'.

(b) Again there were a few gaps in the knowledge of structure, bonding and compound properties. The answer for this question was in the information given, but many candidates failed to say 'it is molecular' and again talked about the fact that 'it does not contain a metal'. More practice using and applying given information to questions is definitely needed.

(c) Again quite a few candidates did not use the information given in the table to answer this question. From the table the candidates should have seen that the sulfur is insoluble in water and the sucrose is soluble. They could then apply their practical knowledge to the situation. Most candidates did this but then forgot to 'stir the mixture' to ensure that the sucrose dissolved before filtering. Most only earned partial credit. Various other separation techniques were suggested such as 'heating them together' and 'separating one off'.

(d)(i) This question was answered correctly by the vast majority of candidates although a few incorrectly chose **A**.

(ii) Compared to the previous question fewer candidates answered this correctly. Quite a few incorrectly chose 'copper', probably because they had carried out electrolysis experiments themselves using copper electrodes. These candidates did not have the knowledge of which electrodes need to be used for which particular electrolysis experiment.

(iii) This question was answered correctly by about half of the candidates although 'chloride' was seen quite a few times. Some candidates named the correct products but the wrong way around. 'Hydrogen' and 'oxygen' were seen a few times and candidates should be reminded to look out for either the 'aqueous' or 'molten' conditions for the electrolysis.

(iv) Many candidates found this question difficult and only a few achieved full credit. There appeared to have been a lack of revision of the chemical tests. Quite a few gave the result as 'bleaches damp red litmus paper', presumably confusing 'chloride' with 'chlorine gas'. Some candidates named the correct test but then gave the wrong coloured precipitate.

Question 8

In most cases candidates answered this longer 'kinetic particle theory' question better than in previous years. Parts **(b)(i) and (ii)** were attempted well although many had difficulty with part **(iii)**. The laboratory fermentation question in part **(b)(v)** proved challenging to many, and some could not give an appropriate use of ethanol in part **(b)(vi)**.

(a) Most candidates scored at least partial credit for this part. The answers were mainly good and candidates showed a very good knowledge of kinetic particle theory. Many candidates described the particles dissolving and diffusing for which they were credited. Some wrote about the movement of the particles and that they spread themselves out. A few also mentioned the random movement and collisions of the particles, but these tended to be the most able candidates who went on to achieve full credit. Comment misconceptions were that the sugar particles rose up because they were less dense and that the sugar and water particles reacted with each other. Some candidates forgot to mention 'particles' so lost credit.

(b)(i) Most candidates were able to answer this question correctly but a very small minority just named the elements rather than stating how many as asked in the question.

(ii) Again this was well answered and on most papers it was evident that candidates had either numbered the hydrogens or crossed them out when they had been counted. This is good practice. A common incorrect answer, due to miscounting, was 11.

(iii) As with most questions that require candidates to have to mark something on a diagram, this caused problems for some candidates. A considerable number of candidates did not attempt to answer this, and many of those who did included two or more carbons in the alcohol functional group. Candidates need to practice identifying the functional groups named in the syllabus.

(iv) This was well answered with most candidates correctly giving ‘carbon dioxide’. Some thought that more than one answer was required so lost credit. Most candidates realised that the formula of carbon dioxide was not appropriate as a word equation was required.

(v) This question was not answered very well. Relatively few candidates mentioned ‘yeast’ and even fewer realised that no ‘oxygen’ or ‘air’ was needed. A few candidates talked about the industrial production of ethanol but most showed a lack of knowledge of the laboratory process.

(vi) Some candidates were able to suggest another use of ethanol, for example as a ‘fuel’ or ‘solvent’. Some, however, wrote down ‘alcoholic drinks’ even though it was stated in the question that these were not to be used. Vague answers such as ‘used in esters’, ‘used in hospitals’ and ‘medical purposes’ were also seen. Candidates should concentrate on the uses of detailed chemicals listed in the syllabus.

CHEMISTRY

Paper 0620/23
Core Theory

Key Messages

- Questions about atomic structure were often done well as were questions relating to graphical work.
- Some candidates may need further practice at questions involving practical procedures, e.g. separation techniques using chromatography and filtration.
- Some candidates need more practice at answering questions requiring extended answers, e.g. **Question 3(a)**.
- It is important that candidates read the question carefully in order to understand exactly what is being asked.
- Many candidates need more practice at answering questions on particle theory, e.g. **Question 3(a)**, and qualitative analysis tests for specific ions and molecules.
- Some candidates need more practice in aspects of organic chemistry, e.g. homologous series and structure of functional groups such as carboxylic acids.

General comments

Some candidates tackled this paper well, showing a good knowledge of core chemistry. Good answers were seen to many parts of **Questions 1** and **3**. Nearly all candidates were entered at the appropriate level. In **Question 3(b)** some candidates wrote about chemical properties instead of physical properties, whilst in **Question 4(e)** many candidates tried to write a symbol equation instead of a word equation. A considerable number of candidates did not attempt to answer **Questions 4(c)(i)** and **7(a)(i)**. The extraction of information from tables of data was generally well done. Candidates performed less well on questions about particles. For example, in **Question 3(a)** a considerable number of candidates thought that the particles in liquids are well separated and that particles in solids move slightly. The standard of English was good. A few candidates wrote their answers in the form of short phrases or bullet points; candidates are less likely to write vague statements or contradict themselves if this is done. As in previous sessions, quantitative tests for specific groups were not well known. For example, a considerable number of candidates were challenged by **Question 4(b)** where the test for water was required. Few candidates knew the test for iodide ions in **Question 7(c)(iii)**. In organic chemistry, few candidates could write the formula for ethanoic acid or explain the term 'homologous series'.

Comments on specific questions

Question 1

Most candidates were able to interpret the atomic structures in part **(a)** and select the correct words to fill in the gaps in part **(c)**. Fewer were able to write the atomic structure showing the correct mass number and atomic number.

(a) Many candidates scored most of the available credit. Most parts were well answered, parts **(iii)** and **(iv)** being invariably correct. The most common incorrect answers were **B** and **D** (helium isotopes) in part **(i)**, and **A** and **D** in part **(ii)**.

(b) A minority of candidates correctly identified atom **D** as helium. The commonest errors were to suggest helium-2 or helium-4. A significant number of candidates gave elements other than helium, hydrogen and lithium being the commonest of these incorrect answers. A considerable number of candidates drew structures showing electron shells.

(c) The majority of candidates correctly identified the words to be placed in the gaps. The main errors were 'atoms' placed in the first gap, and 'protons' and 'neutrons' being reversed. Nearly all of the candidates correctly identified 'radioactive' and 'energy'.

Question 2

Parts **(b)** and **(c)**, involving interpretation of the figures from a table, were done well by a minority of candidates. About half knew the colour of chlorine. Few could explain why iodine does not react with potassium bromide. The parts that were answered best related to the electronic structure of chlorine and the balancing of the equation between chlorine and potassium bromide.

(a) (i) About half of the candidates gave a convincing explanation as to why chlorine is a gas at room temperature. Common errors were vague statements such as 'has a low boiling point', or references to the melting point rather than the boiling point.

(ii) Only a minority of candidates realised that a reference needed to be made to both melting and boiling points. The best answers suggested that room temperature is between the melting point and the boiling point. Common errors included reference to melting point alone, reference to boiling point alone or just stating that the melting point is lower than the boiling point.

(b) Many candidates identified the general trend in atomic radius. Some gave unnecessarily long answers or tried to link the atomic radius to the boiling point.

(c) A minority of candidates estimated the atomic radius of fluorine correctly from the data provided. Many gave values above 0.08 nanometres, 0.084 being the commonest answer outside the range accepted.

(d) Many of the candidates gave the correct colour of chlorine, but a significant number stated bluish-green or blue. A number suggested that chlorine is either colourless or orange, the latter arising through confusion with the colour of bromine.

(e) Most candidates drew the electronic structure of chlorine correctly. Some incorrectly drew five outer shell electrons and ten middle shell electrons, or drew a single electron in the overlap area rather than a pair of electrons. Few candidates drew chlorine molecules. A minority of candidates did not answer the question.

(f) (i) A significant number of candidates realised that bromine is a diatomic molecule and consequently wrote the correct formula and balanced the equation correctly. Other candidates balanced the equation with 2 and 2Br and a small number of candidates wrote H or H_2O instead of Br_2.

(ii) The majority of candidates did not realise that a comparison of the reactivity of iodine and bromine was required. Many compared incorrect species, e.g. bromine is more reactive than potassium, or bromine is more reactive than potassium bromide. Other candidates gave vague answers such as 'iodine is unreactive'.

Question 3

Although many candidates scored partial credit on this question, few scored highly. Parts **(c)** and **(d)** were particularly well done. The candidates' comparisons of solids and liquids in part **(a)** were often written in a confused manner. Many did not know the structure of liquids in terms of arrangement or proximity of particles.

(a) Many candidates scored credit for comparing the structures of solids and liquids. Few compared the arrangement of the particles, but more compared the motion and closeness. Comments about the changes which occur when a solid changes into a liquid were occasionally seen. Common incorrect answers suggested that liquid particles are some distance from each other, particles in solids move (rather than vibrate), omitted mentioning particles, or described bulk properties of solid and liquids rather than particle properties.

(b) Some candidates gave chemical properties instead of physical properties. Others gave properties of transition elements which were not relevant, e.g. coloured compounds or Group I elements.

(c) Many candidates gave the correct molecular formula for gallium chloride. The commonest incorrect formulae were $GaCl_3$ and Ga_2Cl_3.

(d) (i) Most candidates extracted the relevant information from the table correctly to explain that aluminium is used because it has a lower density than tungsten. The commonest error was to omit a comparison, e.g. 'aluminium has a low density' rather than 'aluminium has a lower density'.

(ii) Most candidates correctly deduced from the table that steel, rather than copper, is used as a core for overhead power cables because it is stronger. Some omitted to give a comparison and just stated that 'steel is strong'.

(iii) Most candidates correctly stated that aluminium is used because it has a lower density or is cheaper than copper. The commonest error was to omit a comparison, e.g. 'aluminium has a low density' rather than 'aluminium has a lower density'.

(e) Most candidates were able to give a correct use of aluminium. Those who did not gave vague answers such as sheets, foils or in buildings.

Question 4

Many candidates gave good answers to parts **(a)** and **(d)**. Fewer could describe the test for water or understood 'dot-and-cross' diagrams and covalent bonding.

(a) (i) A significant number of candidates gave a suitable explanation of the reason for filtering water and wrote about chlorine killing bacteria. The main errors were vague explanations, such as 'purifying the water' or 'removing impurities', and suggesting that chlorination is used as part of the filtration process.

(ii) This part was very well answered. Very few gave industrial uses.

(b) A minority of candidates gave a correct chemical test for water. Most suggested incorrectly that litmus or pH measurement should be used. Some suggested adding sodium hydroxide or even potassium. Others, following on from part **(a)**, suggested filtration or sedimentation.

(c) (i) Fewer than half the candidates completed the 'dot-and-cross' diagram for water correctly. The commonest errors were to put extra non-bonded electrons around the oxygen or hydrogen or to draw a single bonding electron rather than a pair of electrons.

(ii) A minority of the candidates linked covalent bonding to pairs of shared electrons. Some incorrectly suggested covalent bond formation because of the combination of non-metals, wrote 'covalent' but did not give a reason, or suggested that electrons are shared in ionic bonding.

(d) Most candidates identified pH 7 as being neutral. A few incorrectly suggested pH 0.

(e) Fewer than half the candidates were able to answer this correctly even though all the information was given in the stem of the question. Some candidates gave symbol equations (almost invariably incorrect), attempted to write an equation without the arrow or + signs, e.g. 'sodium and water gives sodium hydroxide plus hydrogen', or failed to read the stem of the question properly and suggested that water is formed instead of hydrogen.

Question 5

Most candidates gained some credit for this question. Most were able to plot a graph correctly, knew the term 'exothermic' and identified a use of gasoline. Very few knew the conditions for cracking or could explain the term 'homologous series'.

(a) Most candidates gave the correct name for a reaction which releases energy. The commonest incorrect answer was 'combustion'. Only a few candidates suggested 'endothermic'.

(b) Over half the candidates realised that oxygen is a diatomic molecule and consequently wrote the correct formula and balanced the equation correctly. Other candidates balanced the equation with 2 and 2O, while a small number wrote O or H_2O instead of O_2.

(c) (i) Almost all candidates answered this correctly although a few gave the incorrect answer, **D**.

(ii) The majority of candidates answered this correctly. Incorrect answers suggested fuel for heating or industry, or just gave 'fuels' or 'cars' without further qualification.

(d) (i) The majority of candidates plotted the graph correctly. A significant number did not draw the line between the points or drew a series of straight lines between each point with a ruler. A small number drew a single straight line. Some candidates did not extend the line to the *y*-axis.

(ii) Most candidates deduced the value for the boiling point of the 7 carbon hydrocarbon from the line they had drawn in part **(i)**. Candidates who did not draw a line in part **(i)** were not awarded credit because the question clearly stated that the information had to be obtained from the graph.

(e) (i) Very few candidates explained the meaning of the term 'homologous series'. Some suggested that 'they belong to the same group', or named particular groups, e.g. 'alkenes' or 'all alkanes belong to the same series'. Of those who mentioned functional groups, very few stated that the functional group was the same. Similarly, the few candidates who mentioned general formulae, did not gain credit because they were not specific enough, e.g. 'they all have a general formula' rather than 'they have the same general formula'.

(ii) The conditions required for cracking were not well known. Many just suggested enzymes or large alkanes.

Question 6

Many candidates were able to interpret information from a chromatogram. Fewer were able to explain the process of chromatography convincingly. The majority of candidates were able to interpret the structure of an unfamiliar compound in terms of counting the number of atoms of particular types, but few were familiar with the structure of the carboxylic acid group.

(a) Some candidates drew clear, well-labelled diagrams to explain chromatography. The majority, however, did not explain the procedure sufficiently or drew diagrams which were confusing, e.g. a cross between filtration and chromatography. A large number of candidates suggested using coffee filters as chromatography paper. Incorrect answers suggested placing the mixture to be chromatographed in the bottom of the beaker, placing the chromatography paper with the spot below the solvent level, or omitted to state or show that the chromatography paper should be dipped into the solvent. Few candidates mentioned the solvent moving up the paper and separating the spots, although some showed this on the diagram.

(b) (i) This was almost invariably answered correctly. Some incorrectly chose **E**.

(ii) Most candidates identified **G** as containing none of the dyes.

(iii) Most candidates correctly identified **G** as having the greatest number of different dyes, although some chose **F** or **D**.

(c) A minority of candidates drew the correct structure of the carboxylic acid group. Some incorrect answers put O or OH in place of COOH, showed an aldehyde group, or omitted oxygen atoms from the structure.

(d) A minority of the candidates explained the term 'solvent' correctly. Many confused the term with either solution or solute. Others gave vague or confused answers for which credit could not be given, e.g. 'a substance which makes another soluble when it dissolves in it'. Some candidates just gave the name of a solvent, 'water' being the commonest of these.

(e) (i) The majority of candidates identified the number of different types of atom correctly. The commonest errors were to suggest 2, 6 or 10 instead of 4.

(ii) Many candidates counted the number of carbon atoms correctly. The commonest incorrect answers suggested six or larger numbers such as 15.

Question 7

A few candidates performed well on this question. Others did not score highly because they wrote vague statements in parts **(a)** and **(d)**.

(a) (i) A minority of candidates were able to explain the term ‘enzyme’. Most answers referred to substances which decompose others. Many gave ‘biological’ answers and described types of enzymes rather than focusing on their function as catalysts.

(ii) Most candidates balanced the equation successfully. Incorrect answers either placed a 2 in front of the oxygen molecule on the right (despite the lack of a dotted line here) or balanced the hydrogen peroxide with the number 3 rather than 2.

(b) (i) Most candidates did not refer to rate, but just to volume of oxygen produced or time taken. Those who wrote a straightforward answer such as ‘rate increases as concentration increases’ were generally awarded credit. Some candidates did not refer to concentration increase (or decrease).

(ii) Most candidates drew the graph correctly. A few drew a line above the line for the $0.4\,mol/dm^3$ level.

(iii) Many candidates read the volume and time from the graph correctly. Some gave the volume as $20\,cm^3$ rather than $26\,cm^3$, or the time as 350 s or 100 s.

(c) (i) Some candidates realised that *reduction* is loss of oxygen or gain of electrons. Others gave simplistic answers referring just to reducing or lowering something.

(ii) A minority of candidates completed the equation correctly. The commonest incorrect answers gave calcium hydroxide, hydrogen or hydrogen peroxide instead of water, products containing completely different elements from those in the reactants, e.g. iodine, or compounds with guessed names, e.g. sulfuric hydroxide

(iii) Very few candidates remembered the test for iodide ions. Incorrect answers used universal indicator or pH paper, sodium hydroxide, or limewater. Of those who suggested that silver nitrate can be used for the test, most gave an incorrect colour for the precipitate. The commonest incorrect colours were cream and brown.

CHEMISTRY

Paper 0620/31
Extended Theory

Key Message

Candidates must be reminded to read each question carefully and thoroughly before answering the question.

General Comments

The allocated space should be sufficient to answer the question and to be awarded full credit. There is no advantage in reducing handwriting size in order to include a greater content; this increases the likelihood of contradiction or ambiguity. Filling the entire space, the margins and down to the next question causes comparable disadvantages to small handwriting.

Many examples of illegible handwriting were encountered. Candidates should be reminded that if their work cannot be read, it cannot be marked.

Comments on Specific Questions

Question 1

(a) (i) The majority of candidates knew that hydrocarbons contain hydrogen and carbon. Far fewer then added that hydrocarbons contain only these two elements. There were some incorrect suggestions that hydrocarbons contain oxygen or molecules of carbon and hydrogen.

(ii) Candidates were familiar with the concept that fractional distillation is a technique used to separate mixtures of liquids which have different boiling points.

(b) Many responses were not sufficiently explicit to be awarded credit. For example, rather than just stating 'fuel', more detail was required, e.g. paraffin is used as jet fuel; gasoline as fuel for cars, trucks, etc. To state that the lubricating fraction is used to lubricate was also not credited as the idea needed more explanation.

Question 2

(a) It was generally recognised that element **M** was in Group III.

(b) Element **M** was known to be a good conductor of electricity as it is a metal or it has delocalised electrons. The reason why it is a good conductor was essential for credit to be awarded.

(c) There were some good responses to this unfamiliar type of question. The most popular suggestion was nitrogen, but phosphorus, arsenic and antimony were also mentioned.

(d) The majority gave the correct formula.

(e) It was widely appreciated that amphoteric oxides and hydroxides have both acidic and basic properties. They will react with both acids and alkalis. For full credit a suitable acid and alkali needed to be named; the majority failed to do this and were only awarded partial credit.

Question 3

(a) (i) Many candidates concentrated on the need for a fair comparison without discussing the effect of both the size and shape of the pieces of marble on the reaction rate. The influence of surface area on the rate was recognised by almost all, but the effect of size was ignored by most. A large piece of marble has a greater number of moles and will take longer to react. Both surface area and quantity determine the time taken for the piece to react completely.

(ii) The two most popular suggestions were the correct ones – the time taken for the piece of marble to dissolve/disappear and the time at which effervescence stops. Another common suggestion was when the temperature became constant, but as this would not give such a clear result as the other methods, it was not credited.

(b) Writing ionic equations is a skill which needs more attention. Very few were able to complete this ionic equation correctly.

(c) (i) The majority of candidates correctly stated that the concentration of hydrochloric acid in experiment 1 was greater than that in experiment 2. A small minority referred to the amount of acid, rather than to its concentration.

(ii) Almost all the candidates recognised that the reason for the difference in rates was that ethanoic acid is a weak acid, whereas hydrochloric acid is a strong acid. However, few went on to develop the argument – ethanoic acid is only partially ionised with a lower concentration of hydrogen ions (or the corresponding argument for hydrochloric acid) to be awarded full credit.

(iii) There were two routes for obtaining full credit. Activation energy is not required knowledge but if used correctly was credited.

Question 4

(a) Most of the candidates were awarded at least partial credit.

(b) More candidates were able to correctly give the molecular formula than the empirical formula.

(c) The “cyclo” designation was not the problem, but pentanes, hexanes and occasionally heptane were seen, all with the wrong number of carbon atoms.

(d) (i) The majority gave the correct molecular formula.

(ii) This definition was well known, although some need reminding that a chemical formula is not the same as molecular formula.

(e) A commendable proportion of correct descriptions were given based on bromine.

Question 5

(a) (i) Any metal above zinc, no matter how reactive, was accepted. The symbol, upper case followed by lower case, the charge on the ion and the electron transfer all had to be correct to be credited.

(ii) The majority of candidates struggled with the construction of the ionic equation. Common mistakes were $Zn + Ag^+ \rightarrow Zn^+ + Ag$, the inclusion of molecular formulae, writing oxidation numbers in molecular formulae, and divalent silver.

(iii) There were some quite thoughtful explanations as to why cations/positive ions are oxidants. These included statements that they can be reduced, they can accept electrons from another species which has been oxidised, and that they can change into atoms.

(iv) Silver is the poorest reductant, so silver ions are the best oxidants.

(v) From the reactivity series given in the question, silver and copper are below lead in the series so their ions, Cu^{2+} and Ag^+ can oxidise lead metal.

(b) Many candidates gave only three metals, omitting copper, and/or gave the list in decreasing order of reactivity, i.e. zinc first instead of last.

Question 6

(a) (i) The required definition of a base as specified in the syllabus is a proton (hydrogen ion) acceptor. Alternative definitions were not credited. A typical example was ‘a base reacts with an acid to form a salt and water’.

(ii) Very few candidates suggested a comparison of electrical conductivity, but at least one candidate suggested a thermochemical method, which was an alternative correct choice.

Two common misconceptions were that litmus is a suitable indicator and a titration method based on the belief that the stronger base would require a larger titre of acid.

(b) The question required an analysis of the conditions and their impact on rate and yield. There were many descriptions of the Haber process, including the source of nitrogen and hydrogen, and the analysis, if given, was cramped at the end of the answer.

(c) A significant number of candidates completed the equation correctly.

(d) Many were able to give a diagram showing the arrangement of the valency electrons in one molecule of hydrazine. The most common error was to omit the non-bonding pairs on the nitrogen atoms so there were only six electrons around each nitrogen atom. A similar error was to omit the non-bonding pairs, but to include a double bond between the nitrogen atoms.

(e) (i) The most frequently seen correct response was that the pH would increase, or the water would become more alkaline.

(ii) Most of the candidates gave the correct and precise reason that hydrazine removes oxygen which is needed for steel to rust.

Question 7

(a) (i) Most candidates correctly suggested repeating the experiment using the same volume of hydrochloric acid, but not adding the indicator. A less popular alternative was to add carbon/animal charcoal to absorb the indicator, and then filter.

(ii) For those who were familiar with the preparation, presumably through direct experience, this was an easy question. Others, to whom this was unfamiliar, suggested precipitation or titration with an insoluble magnesium compound.

(b) The most frequent error was to confuse the volumes:

number of moles of HCl = 0.025 x 2.20 = 0.055
number of moles of LiOH = 0.055
concentration of LiOH = 0.055/0.020 = 2.75(mol / dm^3)

Partial credit was awarded for this.

(c) This is not a common type of calculation, but it was pleasing to note the number of methods devised by the candidates to identify the hydrate.

Question 8

(a) (i) A lattice is defined as a regular arrangement or repeating pattern of alternate ions. Mention of arrangement alone did not suffice; the idea of pattern or regularity was essential to gain full credit.

(ii) Attraction between opposite charges, or electrostatic attraction, holds the ions in the lattice. Intermolecular forces, or Van der Waals’ forces, have no relevance to an ionic lattice or bonding in metals. Many candidates do not understand these terms sufficiently well for them to have a positive influence on their answers.

(b) Metallic bonding is the electrostatic attraction/attractive force between metallic cations and negative delocalised electrons.

(c) Many candidates stated simply that ionic compounds are poor conductors when solids but good conductors in the liquid phase, thus repeating the information given in the table. What was required was an explanation of this difference in conductivity in terms of the mobility of the ions.

CHEMISTRY

Paper 0620/32
Extended Theory

Key Messages

- Where a comparison between two things is asked for, or if candidates are asked to make a statement about two different things in a question, **both** things must be referred to if maximum credit is to be achieved. This applied particularly to **Questions 4(a)(i)**, **4(a)(ii)**, **5(c)** and **6(a)(i)**.

- If candidates are asked to give a specific number of answers, e.g. in **Question 1(b)(iii)**, it is not advisable, nor is it in the candidate's interests, to give more than the specific number of answers requested.

- Definitions such as those required in **Questions 8(a)(i)** and **(ii)** should be learned thoroughly.

General Comments

Candidates should be aware that it is not always necessary or advisable to write answers in sentences, or in in the form of extended prose. Simple phrases, bullet points, diagrams, formulae and equations can often convey the essential requirements of an answer more clearly than extended prose. Those who write complicated long sentences run the risk of not making themselves clearly understood, or contradicting themselves.

Comments on Specific Questions

Question 1

(a) (i) Many candidates gave named noble gases as correct answers, although non-gaseous elements such as carbon, as well as compounds, were also frequently seen.

(ii) A considerable number of candidates gave elements, (including oxygen), instead of compounds. Names were sometimes given instead of formulae.

(b) (i) Some candidates knew that oxides of nitrogen are formed when nitrogen and oxygen in the air react together at high temperatures, such as those encountered inside a car engine (as opposed to car exhausts). N, (instead of N_2), was often given as the formula of nitrogen. Other reactions and processes unrelated to pollution were frequently mentioned.

(ii) Many candidates knew that sulfur is an impurity in fossil fuels, and that when the fuel is burned, sulfur dioxide forms when the sulfur reacts with oxygen in the air. It was very common to see reference to sulfur burning in air or oxygen, without mention of fuels.

(iii) Most candidates were familiar with at least one, and usually two, harmful effects of acid rain.

(c) (i) A large number of candidates were aware that the copper turns black because the copper reacts with oxygen in the air forming copper oxide.

(ii) Only a small number of candidates stated that the volume of a gas varies with its temperature. Some candidates thought that the reaction would continue if the temperature was higher, even though all the oxygen had been used up. Reference to accuracy alone was insufficient to gain credit. Other candidates gave safety issues as the main consideration.

(iii) Although the stem to the question states that ‘the small pile of copper is heated’, many thought that the lack of heat, rather than the absence of oxygen, was the reason that the small pile of copper did not turn black. Others considered that the relevant factor was related to the surface area of the small pile.

(iv) Because air contains approximately 21% of oxygen by volume, the approximate volume of gas remaining can be calculated by subtracting 21% of 50 cm^3 from 50 cm^3.

Question 2

(a) A large number of candidates achieved all the available credit in this question. Some candidates omitted the charges on the potassium ion and the oxide ion. Some of those who gave the charges omitted the mass number and atomic number.

(b) There were some excellent and very clear answers to this question, although it was not uncommon for candidates to discuss atoms that ***formed*** positive and negative ions depending on the number of electrons in the outer shell of their atoms or their positions in the Periodic Table. Some candidates who did realise that the question required reference to the number of protons and electrons in the particle omitted to mention both protons and electrons in all three parts of their answer.

Question 3

(a) (i) Most candidates knew that combustion causes an increase in the percentage of carbon dioxide in the atmosphere. Some achieved all the available credit by giving an equation showing complete combustion of a suitable carbon compound. A minority of candidates referred to the sources of carbon, such as fossil fuels, and a few referred to complete combustion or excess oxygen.

(ii) Most candidates knew that respiration causes an increase in the percentage of carbon dioxide in the atmosphere. Some excellent equations were seen, and were a sensible alternative method of gaining credit. Reference to living organisms or cells was less frequent.

(b) (i) The majority of candidates identified glucose and oxygen as suitable products of photosynthesis.

(ii) Light/sunlight/UV light were seen frequently as correct answers, but reference to temperature was more common than reference to chlorophyll. There was no penalty for reference to carbon dioxide and/or water, but they are both reactants rather than conditions.

Question 4

(a) (i) The ability to give a correct answer depended on the knowledge that the first equation had different numbers of moles on both sides of the equation, but in the second equation the number of moles was the same on both sides. Many candidates seemed to have an idea of the reason why changes in pressure affected the first equilibrium and not the second equilibrium, but were unable to express their answers clearly. Statements such as ‘the first reaction has a different number of moles in the forward direction compared to the reverse direction’ do not make a great deal of sense.

(ii) The words *endothermic* for the first reaction and *exothermic* for the second reaction were required to achieve credit.

(b) (i) The majority of candidates knew that the missing formula was C_4H_8.

(ii) The correct half equation was very well known.

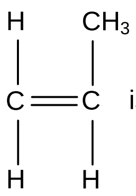
(iii) The word ‘use’ refers to commercial or domestic applications of a particular substance in everyday life, as opposed to reactions in school laboratories such as using sodium hydroxide to test for cations or make salts. Chlorine and sodium hydroxide both have several uses, but sodium hydroxide is far too corrosive, and would cause severe harm to plants, if used to neutralise soil acidity. Chlorine is involved in *sterilisation* rather than *purification* of water.

Question 5

(a) (i) The majority of candidates knew the properties of PVC, although a small number confused properties with uses.

(ii) Carbon monoxide and chlorine were frequently correctly mentioned. Hydrogen chloride was mentioned less often. A number of candidates named carbon ***di***oxide as a toxic gas. It would be impossible to produce sulfur dioxide or oxides of nitrogen since there is no sulfur or nitrogen in PVC.

(b) (i) A large number of candidates gave the correct structural formula of propene. Candidates should ensure that, if they are drawing displayed or semi-displayed formulae, the correct connectivity (showing how atoms bonded together) is used. Therefore



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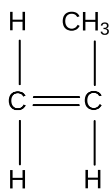

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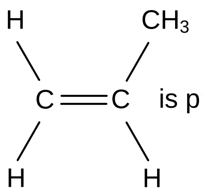

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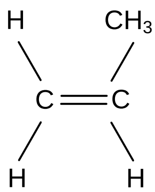
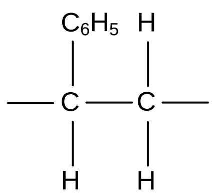


(ii) A large number of candidates drew the structure of the polymer correctly. Some candidates drew a double bond in the polymer.



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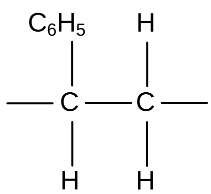

(c) This question requested comments about the type of polymerisation rather than the type of polymer, and therefore answers which commented on the difference being to do with natural or synthetic polymers did not receive credit. It was also common to see comments about the differences between the monomers instead of the polymers.

The correct term for the polymerisation of phenylethene is ‘addition’, not ‘additional’. A positive statement about the polymerisation of phenylethene was required, such as only one substance (the polymer) being produced, rather than a negative statement such as water not being produced.

Question 6

(a) (i) There was much more reference to electrons than ions. Some commented about why conduction occurred in the liquid phase, but did not mention the solid phase, and therefore could not achieve full credit.

(ii) A considerable number of candidates were aware that dissolving aluminium oxide in molten cryolite meant that the process could be carried out at lower temperatures or that conductivity was improved. Some candidates referred to boiling point instead of melting point, or mentioned the melting point of aluminium instead of aluminium oxide.

(iii) Many candidates knew that the oxygen given off at the anode reacts with the graphite anode forming carbon dioxide.

(iv) Many candidates stated that graphite was unreactive, inert or cheap.

(b) Several candidates knew of the presence of the protective layer of aluminium oxide which prevents the aluminium beneath from reacting. A common incorrect answer was that aluminium is not reactive enough to react with the weak acids in food. The wording used by candidates often did not make it clear whether they were talking about the aluminium oxide or the aluminium itself being unreactive.

(c) (i) Aluminium's low density was a common correct answer. Good electrical conduction was commented on less frequently. 'Good' was often missing when referring to electrical conductivity. Some candidates thought that aluminium was chosen because of its properties as an insulator.

(ii) Some answers commented on electrical conductivity rather than strength.

Question 7

(a) (i) This was drawn well by a large number of candidates. Methyl propanoate was a common alternative.

(ii) The correct answer was given by many candidates, as was methyl butanoate.

(b) (i) There were several types of response to this question, giving both naturally occurring and synthetic substances as answers. A small number of candidates thought that the word 'group' referred to a group in the Periodic Table rather than a group of organic substances. Oil (which could refer to crude oil) did not receive credit, but vegetable oil did.

(ii) There were several excellent answers to this question, scoring all the available credit. Boxes were only accepted if a key was used to indicate the contents of the boxes. Some candidates attempted to draw the displayed formula of C_6H_4. This was not considered to be necessary, but did receive full credit if it was done correctly. Dimers were sometimes drawn instead of polymers. It was not uncommon to see some or all of the ester linkages represented incorrectly.

(c) (i) Many candidates were aware that bromothymol blue is a locating agent which made the invisible samples visible.

(ii) It is much easier to explain the meaning of R_f by writing an equation than by writing a sentence. Credit could have been achieved from a correct sentence so long as the sentence made it clear that the distance travelled by the sample has to be divided by the distance travelled by the solvent. It was insufficient to state that R_f was merely the ratio between the two distances.

(iii) The majority of candidates were able to calculate the R_f values of the two acids, and subsequently identify the acids correctly.

Question 8

(a) (i) Some candidates gave an explanation or an expression of how to calculate moles, rather than giving a definition of the mole.

(ii) Quoting a correct value of the Avogadro constant gained full credit, as did a comment which stated that the Avogadro constant is the number of particles in one mole.

(b) Many candidates were able to calculate the numbers of moles of all four substances and deduce that the given quantities of methane and sulfur dioxide had the same number of moles and thus the same number of molecules.

(c) (i) It was common to see the number of moles of H_2O given as 0.1 instead of 0.2, presumably because of the two moles of H_2O in the equation leading to an incorrect M_r of 36 instead of 18. Some candidates decided that because the number of moles of Ca was 0.12, the number of moles of water had to be 0.24, using the mole ratio in the equation to calculate this rather than the mass of water that was given.

(ii) Candidates generally found this to be quite difficult. A variety of methods were used, but for full credit the explanation had to include comments about the *reacting* masses or *reacting* moles compared to the masses or moles that were given in the question.

(iii) The mass of calcium remaining is calculated by subtracting the mass of calcium that reacted from the original mass of calcium.

CHEMISTRY

Paper 0620/33

Extended Theory

Key Messages

- It is important that candidates 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.

- 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.

- 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 teachers.

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, to 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

Candidates who were well-prepared for the examination were able to tackle all of the questions. There was no evidence that the candidates had insufficient time to complete the paper.

Candidates are reminded of the importance of careful reading of the question before they attempt an answer.

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.

This report should be read in conjunction with the published mark scheme for this paper.

Comments on Specific Questions

Question 1

(a) (i) Candidates generally answered this question well. A typical error was from those candidates who described the structure of an atom.

(ii) Many candidates were able to give the correct definition.

(iii) Quite a few candidates failed to recognise that a mixture contains substances that are not chemically joined together.

(b) Many candidates gained full credit here. The most common error was stating that brass is a compound.

(c) Many candidates answered this correctly.

Question 2

(a) (i) Most candidates correctly identified that using powdered aluminium would lead to an increased surface area, although many candidates did not explain this effect in terms of collisions.

(ii) Many candidates gained some credit here for recognising that the amount of reactants decreases. However, only a small minority of candidates correctly stated that there is a decrease in the concentration of reactants.

(iii) Candidates generally answered this question well, although a number did not explain the effect of an explosion in terms of collisions.

(b) (i) The most common correct answers were carbon, flour and sugar. However, a number of candidates incorrectly stated a metal or phosphorus.

(ii) This answer required planning to give a coherent method. Although stronger candidates gave two reactions involving a named solution with a named solid with two different particle sizes, weaker candidates omitted some or all of these. A small number of candidates who suggested sodium and potassium for use in chemical experiments should be aware that these are dangerous substances and would not be allowed for routine experiments in schools.

Only the more able candidates gave an expected result for their test.

Question 3

(a) (i) Most candidates gave a correct response. The most popular answers were car bodies and bridges.

(ii) Many candidates gained credit here. The most common answers given were stainless steel and cutlery.

(b) This was not a question about the extraction of iron, but was concerned with the conversion of impure iron into pure iron. A number of candidates identified that oxygen and limestone were added to the impure iron but did not link them correctly to the removal of the relevant oxides.

Question 4

(a) (i) This proved to be a difficult question for many, and only a small proportion of candidates gave the correct structure.

(ii) Only the more able candidates gave the correct answer Ge_nH_{2n+2}. A common error was to quote a molecular formula in this series, for example Ge_3H_8.

(b) Examiners had to be able to count the dots and crosses in order to mark this question, and candidates should be reminded to draw clear, large diagrams. Candidates generally answered this question well, although a number of candidates omitted the non-bonded electrons from chlorine.

(c) This caused problems for a significant number of candidates who were unable to draw upon knowledge of the structure of SiO_2. Many candidates were able to recall that GeO_2 had a tetrahedral structure. Only a small number stated that four oxygen atoms are around each germanium atom and that two germanium atoms are around each oxygen atom.

(d) A wide variety of answers to this question were seen. Only the more able candidates identified that this was an oxidation reaction due to the germanium losing electrons (increasing their oxidation number).

Question 5

Many candidates found this question difficult.

(a) (i) A variety of different metals were seen. Only Group I elements were given credit.

(ii) Only the stronger candidates gained any credit here. Most candidates incorrectly identified lead, Pb, as the unknown product, instead of PbO.

(iii) This question was marked independently of the answer given to **(a)(i)**. However, only a small number of candidates gained any credit.

(b) (i) The expected answer was that at equilibrium, the rate of the forward reaction is equal to the rate of the back reaction. Many candidates omitted the reference to rate.

(ii) Candidates were expected to comment that the mixture would turn darker and explain this in terms of the position of equilibrium moving to the left since the reactant has more moles of gas. This question was marked consequentially, for consistency, and almost half the candidates stated that the gas would go colourless, so gained no credit. Only the more able candidates managed to gain full credit; weaker candidates usually omitted that reactants have more moles of gas.

(iii) Many candidates identified the reaction as exothermic, although only the stronger candidates stated that low temperatures favour the exothermic reaction.

(iv) Some very good answers were seen. Many candidates recognised that the reaction was exothermic due to the fact that a bond is being formed.

Question 6

(a) (i) Candidates generally answered this question well. The most common incorrect answers suggested chromatography and solubility in water.

(ii) This was usually answered correctly.

(iii) Most candidates gained some credit here, usually for the correct formula of ethanoic acid. The correct formula, incorrectly named as methanoic acid, was a common error.

(iv) The most common mistakes were carboxylic acid and alcohol.

(b) (i) This caused problems for a significant number of candidates. Only stronger candidates gave an answer in terms of relative acid strength relating to the degree of dissociation or splitting up into ions. Common errors were answers stating that malonic acid is more acidic and a stronger acid than sulfuric acid.

(ii) Some candidates ignored the statement in the question about giving a test other than measuring pH. Many candidates gained some credit here for a valid test, although only the more able candidates gave the expected result of the test.

(c) (i) This caused problems for a significant number of candidates. Only the stronger candidates identified the correct names of the two products. Sodium malonide was a common incorrect answer.

(ii) Most candidates were able to identify the correct formulae of the products.

(iii) This proved to be one of the most difficult questions on the paper. A number of candidates identified that H_2 was formed as a product. However, only a minority of candidates gave the correct formula of the carboxylate salt.

(iv) Most candidates were able to identify the correct formulae of the products.

Question 7

(a) (i) Hydrocarbons are defined as a compound/molecule containing carbon and hydrogen only. This was the only acceptable answer.

(ii) Most candidates gained some credit here. Candidates lost credit for imprecise answers, for example statements that alkanes contain single bonds and alkenes contain double bonds scored partial credit only.

(b) C_8H_{18} was the only acceptable answer. A common error seen was $2C_4H_9$.

(c) (i) This question required any unambiguous structure of $C_2H_4Br_2$. The formula $C_2H_4Br_2$ was not sufficient.

(ii) Many candidates achieved full credit.

(iii) Most candidates were awarded partial credit, but only a few gave the correct structure of the alcohol product. Both butan-1-ol and butan-2-ol were credited.

(iv) Candidates generally answered this question well. The hydrogenation of ethene was the most popular response seen.

(d) Most candidates gained some credit here. However, only the more able candidates deduced a formula of a hydrocarbon with a balanced equation for the reaction. Candidates were expected to deduce that the molar ratio of oxygen used : carbon dioxide formed is 3 : 2. Since water is the only other product, this would indicate that the hydrocarbon was either an alkene or a cycloalkane.

CHEMISTRY

Paper 0620/04

Coursework

General comments

Many of the Centres who entered for this component have done so for many years and have a tried and tested range of practical exercises, which were marked accurately, with candidates often scoring well deserved high marks.

A good proportion of other Centres also performed well and marked their candidates' work accurately. There were, however, a few who need to take note of the comments made in the reports written by their Moderator. In some cases the marking was overgenerous and not really in line with the marking criteria printed in the syllabus. In others, the tasks were not well chosen and did not give the candidates the opportunity to show their true abilities.

Tasks set by Centres were usually of the right standard, but on occasions were too simple and did not allow candidates access to the full range of marks. At the other extreme, some Centres set quite difficult tasks. Whilst these tasks are more complex than is really necessary, the candidates seemed to cope very well with them and gained justifiably high marks.

The comments on each skill below are designed to help Centres who have found the setting of appropriate tasks, or applying the correct marking standards, difficult. It is the job of a Moderator to ensure that the standards applied by each Centre are in line with the standards applied by other Centres throughout the world.

Comments on specific skills

Skill C1 Using and Organising Techniques, Apparatus and Materials

Since this task assesses the ability of the candidate to follow instructions, it is essential that the instructions provided by the Centre are appropriate. To gain the highest credit, the instructions should include a number of separate steps which the candidates must follow in sequence. In addition there should be a point in the investigation where the candidate has to decide what to do next as a result of an observation made.

This instruction sheet, together with a mark scheme explaining how the candidate is to be assessed, must be included in the sample of work sent to the Moderator. This mark scheme must be linked to the assessment criteria, but should not simply be a copy of them.

Skill C2 Observing, Measuring and Recording

The tasks set should allow candidates to both take measurements and to make other observations, although not necessarily in the same task. Visual observation should be detailed and complete. Measurements should be as accurate as is feasible using the apparatus available to the candidate. Simple single observations or measurement do not give sufficient justification for high credit. There should always be a range of data values or a number of observations as part of the task.

Observations and measurements should be recorded appropriately, (usually in a table), in a manner designed by the candidate. The provision of an outline table or detailed instruction on how to record results limits the maximum credit available.

Again the instruction sheet given to the candidates should be included with the sample, along with a mark scheme.

Skill C3 Handling Experimental Observations and Data

In this skill processing is important. This is easier to assess where the tasks include some numerical data. The most straightforward way to assess this skill is by incorporating a graph into the assessment. Simple arithmetical processes do not usually provide sufficient evidence, although more complex calculations may do so. Graphs should be accurately drawn and fill at least half of an A4 sheet.

If the candidate has only undertaken tasks which involve observation rather than data measurements it is difficult to justify the highest credit.

Where calculations are involved, e.g. in titration exercises, any assistance given decreases the credit available.

Conclusions given in answer to leading questions are rarely worth high credit, although a question prompting the candidate to give a conclusion is fair.

At the highest level conclusions should describe and explain patterns/trends found in the results and should comment on any results which do not fit the pattern.

Skill C4 Planning, Carrying Out and Evaluating Investigations.

This is the skill where the selection of an appropriate task is most important. To gain access to the higher credit it is essential that a number of variables are involved, as part of the skill is the ability to control variables. Very simple investigations are, therefore, unlikely to give access to the highest credit.

The most obvious examples are concerned with rate of reaction where a number of variables could affect the rate. Explaining how these variables will be controlled, varied, or measured is the key to performing well. Another good example would be comparing the amount of heat produced by different fuels.

It is also essential that candidates perform the investigation which they have planned as indicated in the title for this skill. A candidate who has not carried out the investigation has not fully complied with the criteria for minimal credit.

Another part of the assessment criteria is the evaluation of the method, and suggestions of improvements. This clearly cannot be done if the investigation has not been attempted.

This is the most difficult skill on which to score well. It is not recommended that C4 tasks should be the only way of assessing C2 and C3.

In a well-structured task there is no reason why the majority of candidates should not score well in skills C1 and C2.

Credit in C3 is dependent on having good data with which to work. This is sometimes not the case in an investigation planned by the candidate.

It is impossible to assess C1 and C4 on the same task since one involves following instructions and the other involves writing them.

CHEMISTRY

Paper 0620/51

Practical

Key Messages

Candidates should be encouraged to carry out the tests as instructed in **Question 2** and not guess the results expected.

Candidates should be instructed to record details of **all** observations in **Question 2**.

General comments

The majority of candidates successfully completed both questions and there was no evidence that candidates were short of time. Supervisors reported very few problems with the requirements of this practical examination. A small number of Centres used the wrong solids in Experiments 4 and 5, for which candidates were not penalised. The Supervisors' results for **Question 1** were used when marking the scripts to check comparability.

Comments on specific questions

Question 1

(a), (b) and (c)

All of the candidates carried out the four experiments. The table of results was fully and successfully completed by most. The majority of candidates recorded the masses of solid **C** used, although a few incorrectly gave 4 g for Experiment 4. Credit was awarded for recording the initial temperatures of the solutions and then for completing the maximum temperatures. Credit was awarded for calculating the temperature changes and for the relative magnitude of these changes increasing as the amount of solid used increased.

A minority of candidates showed results which were not comparable to the Supervisor's results.

(d) Candidates successfully carried out Experiment 5 and recorded the temperatures. However, a significant number of candidates did not indicate, by using a minus sign, that the temperature change was negative. A few candidates noted a temperature increase.

(e) A significant number of candidates did not choose an appropriate scale for the *y*-axis. Points were usually plotted correctly, although a significant number of candidates plotted the point for Experiment 4 at 4 g instead of 5 g. Straight line graphs were often not drawn despite being asked for in the question. Curves and dot-to-dot connected lines were common.

(f) (i) A large number of candidates successfully extrapolated their graph to obtain the temperature change when 6 g of solid was added. Some candidates estimated the answer and were penalised for not showing clearly on the grid how they had worked out their answer. For some candidates the extrapolation extended beyond the grid which was given appropriate credit.

(ii) Some answers linked a tie line to the wrong temperature rise.

(g) Some candidates described the chemical reaction as exothermic instead of endothermic, which showed a lack of understanding. Other common incorrect answers concerned reference to neutralisation or displacement reactions.

(h) A significant number of candidates thought that using twice as much acid would result in a greater temperature change/faster reaction for which no credit was awarded. Good answers, which received full credit, referred to the temperature decreasing by half.

(i) This was generally well answered. Some candidates failed to explain that the reaction mixture would return to the initial temperature or room temperature because the reaction had finished. Some did not answer the question, instead giving vague statements such as 'heat would be lost to the surroundings and it would cool down'.

(j) The advantage of taking the temperature readings for all of the experiments at exactly one minute caused confusion. The idea of comparability of the results or a fair test was only realised by the more able candidates. Confused references to reliability and accuracy were common.

A disadvantage of this procedure was often well answered in terms of the reaction still taking place after one minute. Weaker answers referred to problems with taking the measurements and inaccuracies.

Question 2

(a) A significant number of candidates failed to describe both the colour and smell of the liquid. In the second part, both the colour and pH were required, but a number of candidates failed to give a pH number. A few candidates gave a value lower than 3 and were penalised.

(b) This was generally well answered, although a number of candidates recorded no reaction or change, and failed to record the formation of bubbles or effervescence. Good answers specified the use of a lighted splint and the result of the test as a pop sound. Many answers specified the use of a splint but gave no result, or mentioned the pop without reference to a splint. References to hydrogen were frequent despite the instruction that conclusions should not be written in the table.

(c) This test showed a lack of detail in recording the observations. Good answers included a description of the evolution of a gas with descriptions of how slowly the bubbles were evolving. Many responses stated that no change or reaction was occurring.

(d) A number of candidates did not record the formation of a blue solution, although other candidates from the same Centre successfully described the change. Descriptions of blue or green precipitates forming were penalised. Many descriptions of black solids forming showed a lack of understanding that excess copper oxide was present.

(e) (i) The observations expected were that the orange/yellow solution turned green on heating. Most candidates did not record the initial colour of the mixture and most answers noted that the mixture turned colourless on heating.

(ii) In many cases the colours given were not those expected and many described a gas being evolved.

(f) Many answers lacked sufficient detail. Vague answers such as 'the splint relit' were common, despite a lighted splint being used. Descriptions of the liquid igniting were poor and few candidates described the colour of the flame produced.

(g) Credit was awarded for concluding that liquid **A** was an acid. Many incorrectly named acids such as sulfuric and hydrochloric acid were identified, despite there being no evidence from the preceding tests for these conclusions. More able candidates named ethanoic acid or vinegar.

Most answers referred to the presence of various cations and anions, which showed a lack of knowledge and understanding of the tests for these ions.

(h) The presence of a fuel or organic compound was recognised by some candidates. The presence of an alcohol/ethanol was only noted by the most able candidates.

CHEMISTRY

Paper 0620/52

Practical

Key messages

Where a qualitative test asks for a reagent to be added drop-wise and then in excess, it is important that candidates give an observation of what happens when a few drops have been added and then an observation of what happens when an excess is added.

Centres must ensure that solutions used are of the concentrations specified in the Confidential Instructions. It should not be assumed that stock solutions are of the required concentration; solutions should be freshly made up shortly before the examination, and the concentration can be checked by titration.

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 Supervisors' results were used when marking the scripts to check comparability.

The results obtained by some Supervisors and candidates suggested that a few Centres did not use solutions of the concentrations specified in the Confidential Instructions. The expected formation or re-dissolving of precipitates in qualitative exercises may not occur if the concentrations of the solutions used are too low. Ammonia solution in particular can become less concentrated when it is stored, and so its concentration should be checked shortly before the examination.

Comments on specific questions

Question 1

(a) (b) Almost all candidates completed the two tables of results. A few incorrectly recorded initial burette readings which were greater than the final readings. Most candidates obtained the expected larger titre in **(a)** than in **(b)**. Burette readings should be taken to at least one decimal place, including the reading at $0.0\,cm^3$.

(c) In **(i)** most candidates realised that heating would increase the rate of reaction, although a few thought that the purpose of heating was to increase the concentration of the solution by evaporation of the water. The colour change required in **(ii)** was the colour change seen at the endpoint, where the colourless solution becomes pink. The most common error was to have this the wrong way round. The fact that potassium manganate(VII) is coloured and is self-indicating was well known in **(iii)**.

(d) Almost all candidates answered **(i)** correctly. In **(ii)** a quantitative comment about the relative magnitudes of the two titres was required, not just a repeat of the volume difference shown in the results tables. In **(iii)** the explanation for the differences in titres was very often the wrong way round, with candidates stating that **C** was more concentrated than **B**. Some candidates thought that the concentration of solution **A** had changed, despite using the same solution for both titrations.

(e) This was well answered, although a few candidates lost credit for the omission of units (cm^3) or for not stating that the volume of solution **C** had been halved.

(f) Most candidates understood that redox involved both reduction and oxidation, although some incorrectly thought it was reduction **or** oxidation.

(g) Most candidates realised that measuring cylinders are quick or easy to use but not very accurate; some candidates thought that measuring cylinders were accurate but slow to use. Answers based on human error in their use were not accepted because all items of apparatus that can be used to measure volume are subject to human error in their use.

Question 2

Solid **R** was hydrated aluminium sulfate and solid **S** was calcium carbonate. Some candidates obtained observations that would not be possible with these reagents.

Relatively few candidates noted the formation of bubbles or effervescence in the first part of this question.

(a) Most candidates obtained a suitable pH, although a small minority obtained alkaline or even strongly acidic values. It should be noted that when asked to measure the pH, a number is required and not a colour.

(b) In **(i)** most candidates obtained a white precipitate in the first test, although in some cases it was not reported to re-dissolve; this could be due to the use of sodium hydroxide solution of a concentration of less than the specified 1 mol/dm^3. In **(ii)** some candidates obtained the expected results, while others reported no precipitate (probably due to the concentration of the ammonia solution being too low), or even a precipitate which did re-dissolve, which was not possible given the reagents used.

(c) A number of candidates obtained a positive result for the halide ion test. If solutions are made up using distilled or deionised water, then this is impossible given the reagents specified. Negative tests (tests where nothing happens) are useful in the elimination of ions that are not in a solution.

(d) Most candidates obtained a white precipitate in this test, although some reported different colours, no change or precipitates dissolving.

(e) This part of the quantitative exercise was high scoring for most candidates. Credit was most commonly lost for not stating that there were bubbles or effervescence when the acid was added; almost all candidates correctly stated the test and result using limewater. However, some candidates reported the relighting of glowing splints or squeaky pops with lighted splints, neither of which could have been obtained. The white precipitate on addition of excess sodium hydroxide was reported by most candidates, although some incorrectly reported fizzing or stated that the precipitate dissolved.

(f) Most candidates identified solid **R** as a sulfate, although a wide selection of answers were given for the metal ion.

(g) Most identified the gas as carbon dioxide, although hydrogen, oxygen, chlorine and ammonia were all seen.

(h) The identity of solid **R** was usually given correctly.

CHEMISTRY

Paper 0620/53

Practical

Key messages

Burette readings should be recorded to one decimal place.

Candidates should be aware that it is not possible for the initial reading on the burette to be greater than the final reading.

In qualitative exercises, candidates must follow the instructions given and not add in additional tests of their own devising.

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; some Centres reported problems with obtaining some of the required solids for **Question 2**, but acceptable alternatives had been agreed with Cambridge International Examinations in advance of the examination.

A number of candidates did not follow the instructions as detailed in certain parts of the questions.

Comments on specific questions

Question 1

(b) The table of results was completed by all of the candidates. A minority of candidates recorded initial burette readings that were greater than the final burette readings. Some candidates recorded to the nearest whole number only for which they were penalised.

(c) The colour change in a titration is the colour change seen at the end-point. A significant proportion of candidates reported the colour of the methyl orange indicator in the potassium hydrogen carbonate solution (which should have a pH of approximately 8) as being orange, despite this indicator being yellow in solution of around pH 4.5 and higher.

(d) Despite having conducted the experiment, very few candidates noted the chemical reaction as being endothermic, although many stated that it was neutralisation.

(e) The majority of candidates were able to use their results to determine which titration had required the smallest volume of hydrochloric acid.

(f) In **(i)** very few candidates were able to give an answer based on the relative magnitudes of the two titres; most just stated the difference in the two titres, and so were not awarded credit. Part **(ii)** was almost always correctly answered.

(g) A significant number of candidates halved their titre for Experiment 2 rather than doubling it, and credit was often lost because units were omitted, or given incorrectly, cm^2 being a common incorrect unit.

(h) Having used a burette in the experiment, almost all were able to identify a burette as a more accurate alternative to using a measuring cylinder.

(i) Only the very best candidates scored here. Most stated that the reaction would be faster, despite having just done the titration where the reaction occurs almost instantaneously.

(j) All that was required here was an outline method. A number of candidates described experiments based on measuring the pH with universal indicator; this would not work, since unless there is a very large difference in concentration (in the order of a factor of 10 or more), universal indicator would not be able to differentiate between them. The most common successful answers were based on rate of reaction, although some answers omitted to state the reagent to be added to the acid, while others did not state how the results would tell us which acid was the more concentrated.

Question 2

Solid **H** was hydrated copper ethanoate and solid **I** was calcium ethanoate. The observations stated by some candidates would not have been possible given the reagents provided.

(a) Most candidates were able to state that the solution of **H** was blue or green, although some thought that it became colourless on the addition of $1\,cm^3$ of hydrochloric acid. The colour could only become so pale that it appears colourless if a great deal more than $1\,cm^3$ of hydrochloric acid was added.

(b) The formation of a blue precipitate was commonly reported, but the colour change on heating was sometimes ignored and the smell (of ethanoic acid) was very rarely noted. The addition of nitric acid was often reported to have resulted in a blue solution, but some candidates just stated that the previously formed solid disappeared and ignored any colour change.

(c) In the first part, some candidates clearly added more aqueous ammonia than was required to cause a change, since they reported deep blue solutions at this stage. The deep blue solution is not formed until after a light blue precipitate is formed.

(d) Almost all candidates missed the formation of condensation and the fact that the gas given off burns; many stated that a glowing splint relit, despite being told to test the gas with a lighted splint (not a glowing splint). Many gained credit for stating that the solid becoming black, but some reported it becoming hard or burning, neither of which are possible observations. The effervescence on the addition of the hydrochloric acid was commonly noted, but some very unexpected results of testing with a lighted splint were noted, with some candidates using a glowing splint.

(e) Most candidates noted the smell, although some said there was no smell. A common error was to claim that the smell was ammonia. Ethanoic acid and ammonia both have pungent smells, but they are not at all similar.

(f) Many candidates scored credit for deducing that solid **H** contained copper ions, but as the smell of vinegar had been noted by very few in **(b)**, most were not able to state it was an ethanoate.

(g) Most candidates gained partial credit here, for stating that a carbonate was involved in one of the reactions of **I**.

CHEMISTRY

Paper 0620/61

Alternative to Practical

Key messages

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.

Candidates should be clear about when to use terms such as reliable, precise and accurate when answering questions.

General comments

The vast majority of candidates attempted all of the questions.

Candidates found **Question 6** 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.

Comments on specific questions

Question 1

(a) Most candidates answered this correctly. Credit was given for any type of electrodes, anode and/or cathode. The most common error was to name the material from which the electrodes are made. The bulb was sometimes incorrectly identified as a voltmeter, circuit or battery.

(b) The majority of the responses were correct. The use of a glowing splint was commonly given and was not credited.

(c) More able candidates suggested the use of a measuring cylinder filled with the electrolyte. Vague references to upward and downward delivery were common and it was apparent that many candidates had never experienced this practical procedure. Many less able candidates suggested the use of gas syringes, which would not work.

(d) Sodium hydroxide was the solution formed but many answers stated chlorine, water or even sodium chloride. The test for sodium hydroxide was often given but the expected result was omitted which lost credit.

Question 2

(a) Most candidates realised that the purpose of the airlock was to prevent entry of oxygen or air, although many responses were concerned with preventing gases escaping.

(b) Most candidates answered this well. Some answers suggested a lack of laboratory experience, e.g. masher, grinder, crusher, hammer, etc.

(c) Most candidates attempted to draw filtration apparatus. Diagrams were sometimes unlabelled and filter paper was sometimes missing. Some incorrect separation methods were shown such as chromatography and distillation.

(d) This was answered well. Most answers referred to the killing or denaturing of the yeast. Incorrect answers were often in terms of fair test or optimum temperature.

(e) (i) The observation expected was the formation of bubbles, fizzing or effervescence. 'Gas given off' is not an observation. Other incorrect answers were based on colour changes or changing liquid level.

(ii) Only the more able candidates scored full credit. Most candidates gave either the timing aspect or measuring the volume of gas, but failed to give both, and only gained partial credit.

(f) Fractional distillation was the method required, and distillation unqualified scored no credit. A variety of incorrect methods were seen such as chromatography, filtration and crystallisation.

Question 3

(c) The table of results was completed correctly by the vast majority of candidates. Other than misreading the thermometers, the most common error was to omit the masses in the first blank column or to give the mass for Experiment 4 as 4 g instead of 5 g.

(d) Most candidates gave the temperature readings correctly. The correct temperature change was –8 °C, but the minus sign was often omitted.

(e) Most candidates plotted the points on the grid correctly. There were some errors in the scale (two small squares = 1 °C rather than four small squares), and plotting the fourth point at 4 g instead of 5 g.

The majority of candidates used a ruler to draw straight lines, but some graph lines were so light that they were barely visible.

(f) (i) Most candidates extrapolated the graph and scored full credit. A significant minority of candidates lost credit because they did not follow the instruction to show clearly on the grid how they used the graph to work out their answer.

(ii) The scale on the *y*-axis was sometimes misread and tie lines were often not evident.

(g) Endothermic was often correctly given, but a variety of incorrect answers were also seen, e.g. neutralisation and displacement. Some confused responses mentioned exothermic.

(h) Most candidates thought, incorrectly, that a larger volume of acid would result in a faster reaction and/or larger temperature change. Better candidates realised that the temperature changes would be lower because of the larger volume of acid while the best answers referred to the temperature reached decreasing by half.

(i) Many candidates realised that the temperature of the solution would return to the initial temperature of 24 °C, or room temperature. Many failed to explain that this was because the reaction would be finished. Vague answers were seen, such as 'the temperature will decrease' or 'heat would be lost to the environment'.

(j) Only the more able candidates scored credit here. The advantage was the idea of comparability of results or a fair test. More candidates realised that the disadvantage was that the reaction may not have ended after one minute. Some candidates were confused and thought that the temperature would be taken every minute.

Question 4

Answers to this qualitative analysis question were Centre dependent. It was evident that some candidates had no knowledge of the tests required to complete the observations in the table.

(a) Some very unexpected descriptions were given. Many candidates correctly stated that the filtrate was colourless. A significant number described it as clear for which credit was not awarded. Those candidates who described a white solid appeared to have no understanding of the term filtrate.

(b) White precipitate was generally well known. Some candidates thought that the precipitate would be insoluble. Additional incorrect observations such as effervescence were penalised.

(c) This was well answered with the correct observation, that a soluble white precipitate formed, was frequently seen.

(d) Most candidates realised that a white insoluble precipitate would be formed.

(e) A common answer was that a yellow or white precipitate would be formed. This showed a lack of knowledge and understanding.

(g) Meaningful conclusions were variable. Carbonate ions were sometimes successfully identified, but the identity of solid **F** as a transition metal compound was rare. The presence of copper carbonate was given by the more able candidates for full credit, although iron was a common response. Vague references to carbon dioxide were ignored.

Question 5

(a) The idea that mass was lost in both liquids gained credit. Vague answers referred to the mass changing or increasing.

(b) The best answers referred to the greater mass loss in **A**, and that **A** continued to lose mass while **B** levelled out. There was some careless reading of the scales which lost credit. Many did not notice the mass scales, and thought that the rate of mass lost in **B** was faster, as the line looked steeper.

(c) This was generally well answered with reference to protective clothing and/or a fume cupboard. Some candidates misinterpreted the question and gave answers based on how to improve accuracy or control of variables. Vague references to keeping clear of the liquids, avoid splashing the liquids, etc. and tying hair back were ignored.

Question 6

The quality of answers spanned the entire spectrum. Many candidates scored partial credit for weighing the mixture and adding it to sulfuric acid. Some candidates forgot to take the initial mass of the mixture and many failed to use excess sulfuric acid. Often candidates thought that a gas would be produced.

Washing of the residue after filtration was rarely seen, but drying was slightly more common. There were some excellent descriptions of how to calculate the percentage of copper oxide after weighing the carbon residue.

The weakest answers involved not starting with the mixture and using pure copper oxide, which would not work. Others focused on the filtrate after reaction of the mixture with acid, and crystallising copper sulfate. The method was penalised at this point.

Some candidates did not attempt this question.

CHEMISTRY

Paper 0620/62

Alternative to Practical

Key Message

Candidates should use a sharp pencil for plotting points and for drawing lines of best fit on graphs. This allows any errors to be easily corrected. The question might require the line of best fit to be a curve or a straight line, as appropriate. Straight lines should be drawn with a ruler, but rulers should not be used to join the points on a curve. Lines of best fit should avoid anomalous points. When requested to draw two straight intersecting lines, then a ruler must be used and there should be only two lines.

When candidates are asked to compare volumes, they should look for simple relationships, such as "twice as much" or "half as much".

General comments

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

No question proved to be more demanding than the others; all discriminated equally well.

The majority of candidates were able to complete tables of results from readings on diagrams and plot points successfully on a grid as required in **Questions 3** and **5**.

Comments on specific questions

Question 1

(a) The filter funnel was better known than the mortar.

(b) Most could label the solution correctly and any of the possibilities were acceptable. There was only one acceptable answer for the solvent, however, and this proved more difficult.

(c) (i) There were a lot of correct answers for the solvent front, but labels to every other part of the diagram were also seen.

(ii) Many candidates ignored the colour that had not moved and hence the most common answer was that there were two colours present.

Question 2

(a) Most candidates knew that the copper oxide was black, although a lot thought that it was blue.

(b) This question was well answered by the majority, showing a good understanding of the chemistry involved.

(c) This answer depended on water having been identified in the part **(b)**. Those who had correctly identified water either went on to give a correct answer, or incorrectly gave a chemical test for water.

Question 3

(a) The table of results was often completed correctly, with the exception of the 0.0 cm^3 point, which was actually given in the question. Many candidates recorded this point simply as 0, losing the idea of the precision of a burette. The most common error was to omit the decimal place on all readings. A large minority recorded the initial volume as 25 cm^3. This caused problems for these candidates later in the question, although marking was based on their answers to this part.

(b) Most correctly answered this part as the lack of a decimal place was not penalised again.

(c) (i) There was a fairly even distribution between the correct colour change, which had to include colourless, and an incorrect colour change involving purple and pink.

(ii) A significant number of candidates realised that an indicator was not needed because the colour change in the reaction itself was sufficient.

(d) Most candidates could identify which experiment required the larger volume, but fewer realised that it was twice as much, and fewer still realised that this meant that one solution was twice as concentrated as the other.

(e) There were some very good, well explained, predictions here.

(f) The vast majority could explain, in simple terms, what was meant by a redox reaction.

(g) Most candidates correctly gave the advantage of using a measuring cylinder as ease of use, and the disadvantage as limited accuracy.

Question 4

(a) As always, analysis was well known. Most realised that the filtrate would be a colourless solution.

(b) Most candidates realised that there would be a white precipitate with sodium hydroxide solution, which would redissolve in excess.

(c) Similarly, with ammonia solution, most correctly said that there would be a white precipitate which would not redissolve.

(d) Nearly everyone realised that in this case there would be no white precipitate with silver nitrate solution.

(e) A white precipitate with barium nitrate solution was correctly given by almost all candidates.

(g) Nearly all candidates correctly identified carbon dioxide.

(h) Most answers identified calcium carbonate but any Group II carbonate was accepted.

Question 5

(a) As always, taking readings from the thermometers was well attempted by almost all candidates.

(b) This was also well answered, with the majority correctly using a ruler and drawing two lines which intersected above the highest plotted point. A significant minority either drew the lines so that they intersected at the highest plotted point, or drew a third straight line, or did not use a ruler.

(c) Most could use the graph, even if it was incorrectly drawn, to work out the volume of nitric acid needed for neutralisation.

(d) Almost all candidates realised that room temperature was 23 °C.

(e) About half of the candidates realised that polystyrene was used because it is a good insulator. Common incorrect responses focused on the possibility of the glass beaker being broken or damaged by the heat.

(f) This question differentiated well and produced some excellent answers.

(g) Most realised that it was an exothermic reaction.

Question 6

This proved to be a question that differentiated well. The majority of candidates made an attempt and the full range of available credit was awarded. There were several acceptable methods given, including timing the rate of evolution of gas, the rate of loss of mass, the temperature change and the time taken for the reaction to finish. The most common incorrect suggestion was to measure the total volume of gas evolved. Even incorrect methods were awarded credit for fair testing. Several candidates used an imaginative approach, reacting one metal with the acid to get a solution of the salt, and then using the other metal to see if there was a displacement reaction. This route could also gain full credit.

CHEMISTRY

Paper 0620/63
Alternative to Practical

Key message

Questions requiring candidates to plan an experimental method should be answered with details of apparatus to be used, reactants/substances involved and practical procedures clearly specified.

General comments

The majority of candidates attempted all of the questions although a significant minority left many questions unanswered. Some candidates appeared not to have been well prepared for this examination.

Candidates found **Questions 1**, **2**, **3** and **6** 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.

Comments on specific questions

Question 1

(a) Most candidates scored credit for indicating where the heat was applied. The arrow indicating where the water would collect was often wrongly located at the exit tube or in the beaker of ice. Some arrows were not labelled.

(b) Credit was given for red/brown colours which were often unknown. Blue, white and green were common incorrect answers.

(c) Reference to reaction of the water with copper oxide was common and missed the point that the water would interfere with the results of the experiment.

(d) The idea of using cobalt chloride or anhydrous copper sulfate scored credit. Common answers referred to physical tests or confused the names of the latter reagents, e.g. 'cobalt turns blue' (sic), which showed a lack of knowledge and understanding.

Question 2

(a) The idea that bubbles/effervescence would be observed was rarely seen. Reference to colours and the bulb were common. 'Gas given off' is not an observation.

(b) Metals were commonly given instead of graphite or carbon.

(c) This was generally well answered although there were a number of variations in the spelling of 'electrolysis'.

(d)(i) Only the more able scored credit by referring to the presence of an alkali. There were many references to pH and acidity or the basic nature of the solution, which scored no credit.

(ii) Green and blue were commonly given. Credit was awarded for realising that chlorine would form at the positive electrode and that the indicator would turn red or would be bleached.

Question 3

(b) The full range of responses was seen in the completion of the table of results. Very few candidates gave burette readings to one decimal place as expected. The initial reading for Experiment 1 was often incorrectly recorded as 20 or 9 instead of 0.0.

(c) Few candidates could give the colour changes for methyl orange indicator, suggesting that they had possibly never seen or carried out this type of experiment in the laboratory.

(d) A minority of candidates realised that the reaction was a neutralisation. Exothermic and displacement were common incorrect answers.

(e) Experiment 2 was often correctly identified but a number of candidates gave Experiment 1 despite having the correct volumes in the table of results.

(f) (i) There were many vague answers such as 'more or less acid'. Only the more able realised that three times as much acid was used in Experiment 1.

(ii) Many candidates incorrectly related the greater volume of acid **F** being used due to it being more concentrated than acid **G**.

(g) Few candidates answered this correctly. Many omitted or gave an incorrect unit, and answers were often given for Experiment 1 rather than 2 as requested.

(h) This was generally well answered by candidates who suggested using a pipette or burette. Some incorrect answers suggested measuring cylinders or beakers.

(i) The idea of cleaning out the burette was commonly realised, but little detail was forthcoming.

(j) The majority of candidates thought that warming the solutions would result in a faster reaction, and discussed particles at length. There would, in fact, be no effect on the results as this neutralisation reaction depends on the concentration of the reactants.

(k) Only the more able candidates were able to answer this correctly. Good answers referred to a specific reagent such as magnesium or calcium carbonate and compared the rates of the reactions with the two acids. The majority of candidates thought, incorrectly, that the relative concentrations of the acids could be determined by the use of a named indicator. Answers referring to evaporation or boiling the acids showed a worrying lack of knowledge and understanding.

Question 4

Answers to this qualitative analysis question were Centre dependent. It appeared that many candidates had no knowledge of the tests required to complete the observations in the table for **(a)**, **(b)** and **(c)**. Many candidates did not attempt these parts. References to blue colours, which were expected, were rarely given.

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

(e) Meaningful conclusions were rarely seen. Credit was awarded for mentioning the presence of carbon dioxide or a carbonate. Poor use of language to explain this was ignored.

Question 5

For some candidates this question scored most of the credit for the entire paper.

(a) The table of results was frequently completed correctly. The volume at 0 minutes was sometimes incorrectly recorded as 10 or 11 instead of 0.

(b) Most candidates plotted the points on the grid correctly. Some inappropriate scales were chosen for the *y*-axis and thus lost credit. Many graphs drawn were **not** smooth lines; the points were joined with dot-to-dot straight lines using a ruler, and were penalised.

(c) Some candidates did not read the scale on the *x*-axis correctly.

(d) The better candidates realised that the sketch should level out at about 40 cm^3.

(e) This was well answered, with most candidates realising that the particles would have less energy and would move slower, resulting in less chance of collisions between reactant particles.

Question 6

This was a good discriminating question. Most candidates scored some credit for mentioning an appropriate solvent for one of the substances with subsequent filtration. A large number of answers referred to crystallisation methods when evaporation was required.

Some candidates ignored the information given in the table and made up their own methods, which would not work. These types of answers frequently involved heating or melting the mixture, chromatography or distillation methods. Some candidates made up their own question without using the mixture, and used pure samples of the substances.

Well planned answers from more able candidates gave essential experimental detail with a clear practical method and a means of separating pure dry samples of each of the solids from the mixture.

Some candidates did not attempt this question.