CHEMISTRY

Paper 0620/11
Multiple Choice (Core)

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

General comments

Candidates performed well on this paper.

Questions 8, **36** and **40** were particularly straightforward.

Candidates found **Questions 10**, **32** and **39** more challenging.

Comments on specific questions

Question 2 – Response D

Candidates did not appreciate that both parts of the mixture had to be obtained.

Question 4 – Response A

Candidates were confused by the negative temperatures. This response was more popular than the correct one.

Question 5 – Response B

Candidates did not understand the difference between a compound and a mixture. This response was as popular as the correct answer.

Question 10 – Responses A and D

Both responses **A** and **D** were equally popular and were more popular than the correct answer.

Question 19 – Response C

Candidates did not realise that the zinc sulfate was in solution.

Question 27 – Response C

This response was more popular than the correct answer. Candidates may have thought that the reduction of an oxide with carbon showed that the metal is reactive.

Question 28 – Response A

Stainless steel is not commonly used for car bodies.

Question 32 – Responses B, C and D

All responses had an approximately equal numbers of candidates choosing them, suggesting that a high proportion of candidates were guessing the answer.

Question 39 – Response A

Candidates selected the incorrect process for the conversion of ethene into ethanol.

CHEMISTRY

Paper 0620/12
Multiple Choice (Core)

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

General comments

Candidates performed well on this paper.

Questions 3, **28** and **30** were particularly straightforward.

Candidates found **Questions 4**, **12**, **26**, **27** and **36** more challenging.

Comments on specific questions

Question 2 – Response D

Candidates who chose this option may have been recalling an experiment using sand as the only insoluble component.

Question 4 – Response D

Candidates did not realise that pure substances have a sharp melting point. This response was more popular than the correct one.

Question 12– Responses A, B and D

All responses had an approximately equal numbers of candidates choosing them, suggesting that a high proportion of candidates were guessing the answer.

Question 13 – Response A

Candidates were thinking of the increasing volume of gas produced rather than the loss in mass.

Question 16– Response C

Candidates incorrectly thought that oxidation involves the production of oxygen.

Question 23– Responses B, C and D

All responses had an approximately equal numbers of candidates choosing them, suggesting that a high proportion of candidates were guessing the answer.

Question 26– Response D

This response was more popular than the correct answer.

Question 27– Response A

This response was more popular than the correct answer. Candidates may have thought that the reduction of an oxide with carbon showed that the metal is reactive.

Question 36 – Response D

Candidates were may not have noticed the incorrect product in **D**. This answer was more popular than the correct answer.

Question 39 – Response A

Candidates selected the incorrect process for the conversion of ethene into ethanol.

CHEMISTRY

Paper 0620/13
Multiple Choice (Core)

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

General comments

Candidates performed well on this paper.

Questions 3 and **6** were particularly straightforward.

Candidates found **Questions 7**, **19**, **20**, **26** and **27** more challenging.

Comments on specific questions

Question 7 – Response D

This response was more popular than the correct one. Candidates did not realise that statement 4 was about *outer shell* electrons and not total electrons.

Question 13 – Response A

Candidates were thinking of the increasing volume of gas produced rather than the loss in mass.

Question 15 – Response B

Candidates did not read response **B** properly.

Question 16 – Response C

Candidates wrongly thought that oxidation involves the production of oxygen.

Question 19 – Response B

Candidates chose an alternative that gave the two gases in the order stated in the stem but did not read the question carefully. This response was more popular than the correct one.

Question 20 – Response D

Candidates knew about the green precipitate but ignored the other information in the question.

Question 26 – Responses C and D

These responses were both more popular than the correct answer. Candidates may have been guessing substances, which they remembered from the operation of a blast furnace.

Question 27 – Response C

This response was more popular than the correct answer. Candidates may have thought that the reduction of an oxide with carbon showed that the metal is reactive.

Question 28 – Response A

Stainless steel is not commonly used for car bodies.

Question 39 – Response A

Candidates selected the incorrect process for the conversion of ethene into ethanol.

CHEMISTRY

Paper 0620/21
Multiple Choice (Extended)

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

General comments

Candidates performed well on this paper.

Questions 15 and **25** were particularly straightforward.

Candidates found **Question 40** more challenging.

Comments on specific questions

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

Question 1 – Response A

A significant number of candidates did not know what *condensation* means.

Question 8 – Response D

Candidates simply found the ratio of the percentages, ignoring the mass numbers of the elements. This answer was more popular than the correct answer.

Question 9 – Response C

Candidates knew that statement 3 was correct but chose the wrong alternative.

Question 12 – Response C

Candidates did not realise that bond breaking requires energy. This response was more popular than the correct one.

Question 14 – Response A

Candidates confused oxidising agent with the substance being oxidised.

Question 19 – Response C

Candidates did not realise that the zinc sulfate was in solution.

Question 26 – Responses B, C and D

All responses had an approximately equal numbers of candidates choosing them, suggesting that a high proportion of candidates were guessing the answer.

Question 36 – Response A

Candidates recognised the word gasoline but did not know what bitumen was.

Question 38 – Response A

Candidates selected the incorrect process for the conversion of ethene into ethanol.

Question 40 – Responses A, C and D

All responses had an approximately equal numbers of candidates choosing them, suggesting that a high proportion of candidates were guessing the answer.

CHEMISTRY

Paper 0620/22
Multiple Choice (Extended)

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

General comments

Candidates performed well on this paper.

Questions 1, **2**, **3**, **5**, **20**, **21**, **25**, **31**, **32**, **35** and **37** were particularly straightforward.

Comments on specific questions

Question 4 – Response C

Candidates did not appreciate that, as a non-metal oxide, silicon(IV) oxide is an acidic oxide.

Question 9 – Response C

Candidates knew that statement 3 was correct but chose the wrong alternative.

Question 12 – Response C

Candidates did not realise that bond breaking requires energy. This response was more popular than the correct one.

Question 15 – Response D

Candidates knew that the particles move faster but not that the collisions were more energetic.

Question 26 – Response A

Candidates knew that the electrodes were made of carbon but chose the incorrect ionic equation.

Question 38 – Response A

Candidates selected the incorrect process for the conversion of ethene into ethanol.

CHEMISTRY

Paper 0620/23
Multiple Choice (Extended)

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

General comments

Candidates performed well on this paper.

Questions 2, **10**, **21**, **25**, **32**, **35** and **37** were particularly straightforward.

Comments on specific questions

Question 3

Response **A**. Candidates must have misread the question and indicated the apparatus that would be needed.

Question 8 – Response A

Candidates simply found the ratio of the percentages, ignoring the mass numbers of the elements.

Question 9 – Response C

Candidates knew that statement 3 was correct but chose the wrong alternative.

Question 11 – Response D

Candidates may have estimated the value and therefore chosen the incorrect alternative.

Question 12 – Response C

Candidates did not realise that bond breaking requires energy. This response was more popular than the correct one.

Question 19 – Response B

Candidates chose an alternative that gave the two gases in the order stated in the stem but did not read the question carefully. This response was more popular than the correct one.

Question 20 – Response D

Candidates knew about the green precipitate but ignored the other information in the question.

Question 27 – Response B

Candidates may have been thinking of alloys other than brass.

Question 38 – Response A

Candidates selected the incorrect process for the conversion of ethene into ethanol.

CHEMISTRY

Paper 0620/31
Theory (Core)

Key messages

- Many candidates need more practice in reading the question carefully to understand exactly what is being asked.
- Further practice is advised in answering questions about organic chemistry, especially the fractional distillation of petroleum and cracking hydrocarbons.

General comments

Many candidates tackled this Question Paper well, showing a good knowledge of chemistry. The standard of English was generally good. Some of the questions were left unanswered by some candidates.

Some candidates need more practice in reading questions carefully and noting the key words. For example, in **Question 2(c)** many candidates did not give the symbols of the atoms; in **Question 3(c)** many candidates did not read that the substance required was an acidic gas; in **Question 6(c)** some candidates did not read the key word 'bonding'; and in **Question 8(d)** many candidates gave a property rather than a use.

Some candidates need more practice in answering questions requiring extended writing such as **Question 2(b)** (comparing the atmospheres of two planets); **Question 6(a)** (petroleum fractionation); and **Question 7(a)** (diffusion). Candidates should be encouraged to structure their answers logically and avoid writing contradictory statements.

Questions requiring the extraction of information from graphs and tables were generally well done; some candidates need further practice at dealing with negative numbers.

Many candidates need more practice in memorising definitions that appear in the syllabus, such as *element* and *isotopes*. Many candidates also need to revise qualitative tests, especially the chemical test for water.

Many candidates were able to balance symbol equations and undertake simple calculations; other candidates need to revise these areas.

Comments on specific questions

Question 1

(a) (i) Most candidates identified bromine as being diatomic. The commonest error was to suggest **D** (ethene).

(ii) Many candidates identified the ionic compound correctly. The commonest error was to suggest **C** (BrF_3).

(iii) Some candidates identified ethene correctly. Other candidates suggested BrF_3 and a significant number of candidates gave Br_2, despite this being the test reagent.

(iv) Some candidates realised that an ionic compound conducts electricity when molten. A wide variety of incorrect answers were given; the commonest being **D** (ethene) or **E** (dibromoethane).

(v) Many candidates gave the incorrect answer **B** (sodium bromide). Another common error was to suggest **E**, which contains only one type of halogen atom.

(b) A few candidates were able to explain the meaning of the term *element* but many answers were imprecise. The essential words which were often missing were 'only one type of atom'. There were many vague statements referring to the Periodic Table or 'a single atom' being present. The best answers often described 'a substance that cannot be broken down further by chemical means'. Few candidates referred to substances containing atoms each with the same number of protons.

(c) Many candidates realised that at –15°C bromine is a solid. Fewer candidates were able to explain this in terms of –15°C being below the melting point. Many candidates referred to boiling point of bromine. Many candidates had difficulty dealing with the negative numbers.

Question 2

(a) Most candidates calculated the percentage of methane in the atmosphere of Neptune correctly.

(b) Some candidates gave answers that just repeated the values in the table without reference to the percentage of gases on the Earth. Other candidates gave information which was vague or irrelevant. Where percentages of gases in the Earth's atmosphere were quoted, they were not always correct. A common error was to suggest that the Earth's atmosphere has 75% nitrogen.

Many candidates suggested that there is a considerable proportion of hydrogen in the Earth's atmosphere, typically in the range10–30%. Other candidates made comments about carbon dioxide, which were incorrect or could not be substantiated.

(c) Many candidates did not respond to the instruction to include the symbols for the atoms present. Common errors included the addition of further non-bonding electrons; Me in the central atom instead of C; three electrons in each of the overlap areas; or a lack of a pair of electrons in one of the overlap areas. A considerable number of candidates did not respond to this question.

(d) (i) Very few candidates gave a suitable definition of the term *isotopes*. Although many candidates appreciated that there is a variation in the number of neutrons, the commonest error was to omit the essential term *atom*. Many candidates just referred to 'elements' or 'molecules'. Other candidates wrote vague statements such as 'different ways to express the same atom'.

(ii) Many candidates deduced the number of protons and neutrons correctly. The commonest errors were to suggest one neutron, two protons or give three of each.

(e) (i) Most candidates were able to calculate the relative molecular mass of ethane. The commonest errors arose from the use of atomic numbers instead of relative atomic masses.

(ii) Very few candidates gave a correct chemical test for water. The commonest error was to refer to boiling point, melting point or density. Many of those candidates, who identified copper(II) sulfate as a test reagent did not mention 'anhydrous' or 'white' and did not give the correct result. A significant number of candidates did not seem to know the test given in the syllabus and suggested adding potassium or sodium to see if it bubbled; this was not accepted. Many candidates muddled the test with other test reagents, such as bromine or litmus.

Question 3

(a) (i) Many candidates were able to balance the equation. The commonest errors were $2H_2O$ and $4H_2O$. A few candidates added extra symbols, such as C.

(ii) Many candidates drew the structure of ethene instead of ethanol; added double bonds; or drew divalent hydrogen atoms, e.g. C–H–O. Many candidates did not include the O–H bond. A considerable number of candidates did not respond to this question.

(b) (i) The majority of candidates recognised pH 10 as being alkaline. The commonest errors were to suggest either pH 6 or pH 3.

(ii) Few candidates knew the correct colour change of methyl orange. Incorrect colours included orange, green, brown, purple and colourless. It should also be noted that the colour change expected is not for the mixed indicator screened methyl orange.

(iii) A correct word equation was given by many candidates.

(c) A small number of candidates recognised that sulfur dioxide is used a preservative for foods. Many candidates appeared not to have read the information in the question about the preservative being an acidic gas. Common incorrect answers included oxygen, nitrogen (which prevents oxidation rather than kills bacteria), hydrochloric acid, methane and sodium chloride. A considerable number of candidates did not respond to this question.

(d) (i) Some candidates omitted the word 'chromatography' or 'filter' for the paper, **P**. Other candidates suggested that the floor cleaner had been placed in the solvent **Q**.

(ii) Many candidates gave the correct answer. The commonest incorrect answers were 'titration', 'distillation' or 'colour separation'.

(iii) A majority of the candidates placed the cross on the baseline. Other candidates placed the cross just off the baseline or on the bottom of the paper. A significant number of candidates placed the cross halfway up the paper or near the top of the paper.

Question 4

(a) Some candidates understood that both potassium and graphite conduct electricity. Most other candidates suggested that only one of these species conducts; the most common error was stating that molten potassium does not conduct.

(b) Some candidates recognised that the low boiling point of iodine points to iodine being a simple covalent substance. The commonest incorrect answer was to refer to solid iodine not conducting electricity.

(c) A minority of the candidates recognised that zinc chloride is likely to be ionic because it *only* conducts when molten. The commonest incorrect answers referred to boiling points or density.

(d) Some candidates identified the electrode products correctly. Other candidates gave the correct products but at the incorrect electrodes. The commonest incorrect answer was to write chloride instead of chlorine. Other common incorrect answers included hydrogen or oxygen (at either electrode) or to write incorrect equations for the reactions at the electrodes.

A minority of the candidates wrote answers that related to chemical properties and not to electrode products. A considerable number of candidates did not respond to this question.

(e) Few candidates compared the reactivity of the chlorine and iodide. The commonest errors were to relate the reactivity of one of the elements to potassium or to hydrogen or to compare the reactivity of the halide ions rather than the halogens. A large proportion of the answers referred to the ease of mixing or referred to species that were not present. A considerable number of candidates did not respond to this question.

Question 5

(a) (i) A majority of the candidates balanced the equation correctly. The commonest errors were to suggest $4Cl_2$ or 1C.

(ii) The best answers suggested addition of oxygen to carbon. There were many vague answers relating to the titanium oxide, the titanium chloride or the carbon monoxide, rather than the carbon.

(b) Some candidates made the distinction between the physical properties of titanium and sodium; many candidates referred to general properties of metals and tried to make comparisons of electrical conduction or lustre. Other candidates referred to chemical properties including the formation of coloured compounds by titanium.

A considerable proportion of the candidates muddled the properties of transition elements and Group I elements. They suggested, for example, that sodium is very dense or that titanium has a low melting point.

(c) (i) Many candidates deduced a suitable melting point for potassium. Few candidates gave a suitable comment about the relative reactivity of lithium with water. The commonest error was to repeat the observations about sodium or to write that 'bubbles are formed' without any idea of the reaction being slower.

(ii) Some candidates described the general trend in density in terms of it increasing down the group. Other candidates either did not refer to the positions of the elements in the group or suggested that the density decreased.

(d) Many candidates realised that lithium forms a basic oxide; few candidates explained this is terms of lithium being a metal. Common errors included 'lithium is not an acid', 'lithium reacts with water to form an alkaline solution' and 'turns red litmus blue'.

Question 6

(a) Many candidates wrote vague or contradictory statements about the fractional distillation of petroleum. The commonest errors were to suggest that the distillation column is hotter at the top than at the bottom and that the vapours move down the column from the top or the middle.

The idea of vaporisation of the petroleum was generally given. Very few candidates mentioned the condensation of fractions. Other candidates mentioned boiling points but the idea of different fractions having different boiling points was rarely expressed with the required precision. A significant number of candidates did not respond to this question.

(b) (i) Some candidates realised that cracking involved the breakdown of hydrocarbons or molecules but many candidates did not gain credit because they wrote about other substances or even elements decomposing. A few candidates mentioned the use of high temperatures or the breakdown into smaller hydrocarbons. Other candidates disadvantaged themselves by suggesting that alkenes were broken down into alkanes.

(ii) Many candidates realised that gas **X** was hydrogen. The commonest error was to suggest carbon dioxide.

(c) A minority of the candidates identified the bonding as covalent. A significant number suggested ionic or gave answers that did not involve bonding, e.g. compound, saturated, hydrocarbon.

(d) Most candidates recognised the word 'polymer'. The commonest error was to suggest 'gas'.

Question 7

(a) Some candidates explained diffusion in terms of the kinetic particle model. Other candidates did not refer to particles and just suggested that the bromine or the cyclohexane moved. Many candidates did not include the word diffusion in their answers and wrote vague or incorrect statements.

(b) (i) A minority of the candidates wrote the correct molecular formula. Other candidates did not count the atoms correctly and gave formulae such as $C_4H_5O_2Br_2$.

(ii) Some candidates gave the correct name for the COOH functional group. A common error was to call this group an alcohol. Some candidates gave the name of a compound rather than the functional group, e.g. ethanoic acid.

(c) Many candidates selected two correct words from the list to complete the definition of relative atomic mass; few candidates selected all four correct words. The commonest errors were total (instead of average); molecule (instead of atom); and carbon or six (instead of twelve).

(d) (i) 'Increase the temperature' and 'use a catalyst' were the commonest correct marking points seen. Candidates who wrote about changing concentrations or changing the particle size of the magnesium often were often not specific enough to gain credit.

(ii) Most candidates balanced the equation correctly. The commonest error was to try to balance with 2HBr.

Question 8

(a) (i) The majority of candidates recognised the symbol for a reversible reaction. The commonest errors were to suggest that the symbol only referred to the backward reaction or to write vague statements such as 'it applies to both sides of the equation'.

(ii) Most candidates described the purpose of a catalyst correctly. The commonest error was to suggest that a catalyst is needed 'to make a reaction happen'.

(b) (i) Many candidates described how the yield of ammonia varies as the temperature increases. The commonest error was to omit a statement about whether the temperature was increasing or decreasing. A significant minority of candidates suggested that the yield increases with increasing temperature.

(ii) Most candidates gave a correct value for the yield at 400°C. The commonest errors were to suggest 29%, 48% or 24%.

(c) The calculation was well done by the majority of the candidates. Common errors were 134 or errors arising from dividing 20 by 140. A minority of candidates did not respond to this question.

(d) Some candidates gave a suitable use of nylon. Clothing, ropes and nets were the commonest correct answers. The commonest incorrect answer was the unqualified 'bags'. A significant number of candidates gave properties such as 'impermeable', rather than a use.

CHEMISTRY

Paper 0620/32
Theory (Core)

Key messages

- Many candidates need more practice in reading the question carefully to understand exactly what is being asked.
- Many candidates need further practice in answering questions about organic chemistry, especially about the manufacture of ethanol and the formulae of organic compounds.
- Simple calculations and the balancing of chemical equations were generally well done.

General comments

Many candidates tackled this Question Paper well, showing a good knowledge of chemistry. The standard of English was generally good. Some of the questions were left unanswered by some candidates.

Some candidates need more practice in reading questions carefully and noting key words. For example, in **Question 5(d)(ii)** most candidates did not appear to read the word *chloride* and wrote about the elements nickel and potassium instead of the compounds. In **Question 6(a)** many candidates did not note that *two* separate methods for producing ethanol were required and conflated the two methods in their responses. In **Question 6(b)(iii)** many candidates gave a property rather than a use of *Terylene*.

Some candidates need more practice in answering extended questions such as in **Question 2(a)** (comparing the atmospheres of two planets), **Question 6(a)** (manufacture of ethanol) and **Question 7(a)** (diffusion). Candidates should be encouraged to structure their answers logically and avoid writing contradictory statements.

Questions relating to the extraction of information from graphs and tables were generally well done; some candidates need further practice at dealing with negative numbers.

Many candidates need more practice in memorising definitions that appear in the syllabus such as *compound*. Many candidates also need to revise qualitative tests.

Some candidates need further practice in the area of organic chemistry, especially in drawing functional groups and writing molecular formulae for organic compounds.

Many candidates were able to balance chemical equations and do simple calculations; other candidates need to revise these areas.

Comments on specific questions

Question 1

(a) (i) Most candidates identified the element correctly. The commonest incorrect answer was **B** (hydrogen sulfide).

(ii) A majority of the candidates recognised the structure that was similar to ethanol. The commonest incorrect answer was **B** but **D** was also seen.

(iii) Some candidates recognised that sulfur dioxide contributes to acid rain. Other candidates gave incorrect answers such as **B**, or less commonly, **E**.

(iv) A majority of the candidates recognised sulfur dioxide. **B** was occasionally given as an incorrect answer.

(v) Many candidates recognised that **E** contains halogen atoms. The commonest incorrect answers were **C** or **D**.

(b) Many candidates stated at least one suitable property. The commonest correct answers concerned conductivity, lustre, melting point or malleability. Common errors included suggesting that only metals react with oxygen, that metals turn red litmus blue or giving answers relating to bonding only. Some candidates disadvantaged themselves by just giving a property and not referring to metals or non-metals explicitly. A minority of candidates suggested metallic properties for non-metals.

(c) Few candidates gave a convincing definition of the term *compound*. The commonest error was to include the words 'mixtures of elements' in the definition. Many candidates did not refer to the elements being combined or bonded.

Question 2

(a) Some candidates gave answers that just repeated the values in the diagram without reference to the percentage of the gases on the Earth. Other candidates gave information that was vague or irrelevant, e.g. 'people would find it difficult to live on Saturn because you couldn't breathe the gases'. A considerable number of candidates tried to compare the core of Saturn with the core of the Earth.

Where candidates did quote the percentages of gases in the Earth's atmosphere, they were not always correct. A common error was to suggest that the Earth's atmosphere has 70–75% nitrogen. Many candidates suggested that there is a considerable proportion of hydrogen in the Earth's atmosphere, typically ranging from 10% to 30%. Other candidates made comments about carbon dioxide, which were incorrect or could not be substantiated.

(b) (i) Most candidates realised that hydrogen is less dense than helium; a few suggested that the opposite is true. Other candidates gave vague answers such as 'because of the density of liquid hydrogen'. A minority of the candidates referred back to **(a)** of the question and gave answers unrelated to density such as 'to maintain a stable core/atmosphere'.

(ii) Some candidates realised that at –250°C hydrogen is a gas; few candidates were able to explain this in terms of –250°C being above the boiling point. Many candidates referred to melting point or suggested the solid state or the liquid state as the answer. Many candidates appeared to have difficulty in dealing with the negative numbers.

(c) (i) Some candidates gave the correct test for ammonia. Other candidates suggested that blue litmus turned red or suggested the use of sodium hydroxide as a test reagent, muddling the test for ammonia with the test for ammonium ions. A significant minority of candidates suggested the use of a glowing or lighted splint. A considerable number of candidates did not respond to this question.

(ii) Many candidates did not respond to the instruction to write the symbols for the atoms present and consequently could not gain full credit. Common errors included the addition of further non-bonding electrons; NH_3 or Am in the central atom instead of N; three electrons in the overlap areas; or a lack of a pair of electrons in one of the overlap areas. A considerable number of candidates did not respond to this question.

(d) The calculation was well done by many candidates. The commonest error was to suggest 52. Another common error was to suggest values between 88 and 92 obtained by multiplying the relative atomic mass of nitrogen by four (instead of multiplying the relative atomic mass of hydrogen by four).

(e) (i) Many candidates recognised that carbon dioxide is a greenhouse gas. Incorrect answers included hydrogen, nitrogen, helium and carbon monoxide.

(ii) Some candidates wrote about a specific effect of the consequence of an increase in the concentration of greenhouse gases; other candidates mentioned global warming. The commonest error was to try to relate the greenhouse effect to ozone depletion. Other common errors included 'uses up the oxygen'; 'pollutes the atmosphere'; and 'damages the environment'.

Question 3

(a) (i) Few candidates could write the correct formula for the carboxylic acid group. A wide variety of errors were seen, ranging from the structure of hydrocarbons such as ethene to errors in connecting hydrogen atoms correctly, e.g. – CHOOH, CHOO. A few candidates disadvantaged themselves by writing the complete formula for ethanoic acid, so that it could not be certain whether the function group was OH, CH_3 or COOH. A small number of candidates clarified this by circling the COOH group. A significant number of candidates did not respond to this question.

(ii) Most candidates selected pH 4. The commonest error was to suggest pH 9.

(iii) Many candidates realised that the reaction involved neutralisation. The commonest error was to suggest 'polymerisation'.

(iv) Many candidates gave a suitable definition of the term *exothermic*. Other candidates suggested, incorrectly, that 'the reaction is taking heat' or wrote about 'a reaction involving heat'.

(b) Many candidates wrote the molecular formula correctly; others either omitted to count the number of carbon or oxygen atoms correctly, e.g. CO_3H_8 or $3COH_{8,}$ or miscounted the hydrogen atoms, e.g. $C_3H_7O_3$.

(c) Many candidates were able to balance the equation correctly. The commonest errors were in balancing the water, where 2 or 6(H_2O) were given by some candidates.

(d) (i) Some candidates recognised that a single method could be used to separate sodium chloride and water. Others just mentioned evaporation without describing a method for condensing the water. Many candidates did not realise that sodium chloride is soluble in water and suggested that filtration could be used. A significant number of candidates who described distillation thought that a sodium chloride solution evaporates first.

(ii) A minority of candidates referred to measurement of the boiling point or melting point. Other candidates wrote statements that were too vague, e.g. 'at 100°C water boils'. A common error was to suggest that pH could be used to assess the purity of water.

(iii) Few candidates gave the correct qualitative test for chloride ions. The commonest errors were to suggest the use of litmus, the use of sodium hydroxide or the use of nitric acid alone. Some candidates confused the test for chloride ions with that for chlorine and suggested that indicator paper would be bleached. A significant number of candidates did not respond to this question.

Question 4

(a) A majority of the candidates recognised that zinc conducts and calcium iodide is soluble in water. The commonest errors were to suggest that calcium iodide is insoluble.

(b) Many candidates recognised that the low boiling point of phosphorus points to phosphorus being a simple covalent substance. Candidates who stated that phosphorus does not conduct when molten were given credit.

(c) Many candidates recognised that sodium chloride is likely to be ionic because it *only* conducts when molten. The commonest incorrect answers referred to boiling points or density.

(d) Many candidates identified the electrode products correctly; others gave the correct products but at the incorrect electrodes. The commonest incorrect answer was to write iodide instead of iodine. Other common incorrect answers included hydrogen or oxygen (at either electrode) or to write incorrect equations for the reactions at the electrodes. A minority of the candidates wrote answers that related to chemical properties and not to electrode products.

(e) Some candidates deduced the correct number of protons; other candidates either thought that a nucleon was another name for a proton or a neutron alone and gave the incorrect answers 31 protons and 31 neutrons. A significant minority of candidates suggested 16 protons and 15 neutrons.

(f) A minority of the candidates realised that phosphorus forms an acidic oxide; few candidates explained this in terms of phosphorus being a non-metal. Common errors included 'phosphorus is an acid', 'phosphorus is a metal' and 'phosphorus turns litmus red'. Reference to the fact that phosphorus is in Group V was not sufficient to gain the mark.

(g) Many candidates were able to describe sublimation correctly. The commonest errors were to suggest that the change of state was from solid to liquid or vice versa. Common irrelevant incorrect comments included 'atoms change to gas'.

Question 5

(a) The best answers referred to nickel(II) oxide losing oxygen. Many candidates referred to the nickel on the right-hand side of the equation rather than the nickel(II) oxide. A common error was to refer to the carbon monoxide or hydrogen gaining oxygen. This was not acceptable because the question refers to the nickel(II) oxide, rather than other species. Many candidates who referred to oxidation numbers did not gain the mark because they referred to the oxidation number of nickel(II) oxide and not to the oxidation number of nickel. Those candidates who referred to electrons rarely gained credit because they referred to electron loss. Candidates who take the core paper are advised to answer this type of question in terms of oxygen loss or gain.

(b) Most candidates recognised the symbol for a reversible reaction. The commonest error was to suggest that the symbol only referred to the reverse reaction.

(c) (i) Few candidates realised that carbon monoxide is gaseous and nickel is a solid at room temperature. Some candidates realised that their boiling points differed; many candidates gave vague answers such as 'carbon monoxide has a lower molecular mass than nickel' or referred to differences in bonding. Other candidates gave answers that bore no reference to a method of separation, e.g. 'nickel doesn't' react with carbon monoxide'.

(ii) A minority of the candidates realised that carbon monoxide is poisonous. Other candidates wrote vague or incorrect statements such as 'harmful to health', 'damages the lungs' or 'affects the haemoglobin'. Many candidates who wrote about the interaction of 'haem' with carbon monoxide did not mention the essential point that the oxygen carrying capacity of the blood is severely reduced.

(d) (i) Some candidates made the distinction between the physical properties of nickel and potassium; many candidates referred to general properties of metals and tried to make comparisons of electrical conduction or lustre. Other candidates referred to chemical properties including the formation of coloured compounds by nickel. A considerable proportion of the candidates muddled the properties of transition elements and Group I elements, suggesting, for example, that potassium is very dense or that nickel has a low melting point.

(ii) Very few candidates referred to the differences in colour or catalytic properties between the chlorides of nickel and potassium. Most candidates appeared to think in terms of the elements rather than the compounds and gave answers referring to differences in melting points, density or electrical conductivity. A considerable minority of the candidates gave answers that did not specify which compound they were writing about. A considerable number of candidates did not respond to this question.

(e) (i) Many candidates deduced a suitable boiling point for rubidium. Fewer candidates were able to write a convincing statement about the reactivity of rubidium. Many candidates just repeated the statement about the reactivity of potassium. The best answers either specified that 'there is extremely rapid bubbling' or there would be a 'little explosion'.

(ii) Many candidates described that the density increases 'down the Group' or 'from sodium to caesium'. The commonest error was to write 'increases' without qualification.

Question 6

(a) Few candidates could describe the manufacture of ethanol from ethene or by fermentation. Many candidates wrote the answer as if it were a single process involving the fermentation of ethene using a high temperature with yeast as a catalyst. Those candidates who separated the processes often suggested that a high temperature or a metallic catalyst was needed for fermentation. Other candidates referred, incorrectly, to the need for either carbon dioxide or oxygen for fermentation. A few candidates knew that a high temperature was needed for the manufacture of ethanol from ethene; many candidates suggested that hydrogen was needed rather than steam. A significant number of candidates did not respond to this question.

(b) (i) The aqueous bromine test for unsaturation was not well known. Some candidates suggested that the 'bromine water stays orange' and a few gave inexact answers such as 'discolours' or 'goes clear'. Other candidates only gave the answer for the unsaturated hydrocarbon. Many candidates reversed the answers, suggesting that the saturated hydrocarbon decolourised the aqueous bromine.

(ii) A majority of the candidates recognised that a polymer is a large molecule formed from many monomers. The commonest error was to choose the phrase suggesting that polymers are formed by cracking.

(iii) Few candidates gave a suitable use for *Terylene*. The commonest correct answer was to suggest 'clothing'. The commonest error was to suggest that it is used to make another polymer, e.g. 'in making nylon' or 'in making rubber'. Other candidates gave answers that did not reflect a particular use, e.g. 'ester links'. A significant number of candidates did not respond to this question.

Question 7

(a) Some candidates explained diffusion in terms of the kinetic particle theory. Other candidates did not refer to particles and just suggested that the sulfur dichloride moved. Many candidates did not include the word diffusion in their answers and wrote vague or incorrect statements. Some candidates wrote about sulfur dichloride moving or spreading out, neither of which was sufficient because of the lack of the essential word *particles* (or *molecules*).

(b) Many candidates balanced the equation correctly. The commonest errors were 2(C*l*) on the left and SC*l* on the left.

(c) Most candidates identified the correct changes of state. The commonest errors were to suggest boiling, cooling or melting instead of freezing and cooling, evaporation or sublimation instead of condensing.

Question 8

(a) Many candidates completed the calculation correctly. The commonest incorrect answers were 288 and 56. Some candidates tried to use the relationship mass ÷ molar mass instead of calculating the answer by simple proportion.

(b) (i) Most candidates deduced the volume of carbon dioxide correctly. Most errors resulted from a misreading of the scale on the grid, 210 and 240, being the commonest incorrect answers.

(ii) Some candidates deduced when the reaction was complete; a significant number of candidates gave the reading at 55 minutes, long after the volume of carbon dioxide had ceased to change. The commonest incorrect answer was 47 minutes.

(iii) Many candidates realised that the rate of reaction would increase when smaller sized particles of calcium carbonate were used. Other candidates did not gain credit because they referred to time rather than rate. A significant number of candidates thought that the rate would decrease when the particles size decreased.

(c) (i) Nearly all the candidates determined the percentage of limestone used for agriculture. The commonest error was to suggest 84%, the percentage for all other uses.

(ii) Many candidates gave vague answers when explaining the use of lime and limestone in agriculture. Common answers that were too vague included ‘to make the soil more productive’, ‘to improve soil fertility’ and ‘to improve the plants’. The best answers referred to acidic soil being neutralised. A considerable number of candidates thought that the more acidic the soil, the higher the pH.

CHEMISTRY

Paper 0620/33
Theory

Key messages

- Many candidates need more practice in reading the stem of a question carefully in order to understand exactly what is being asked.
- Many candidates need further practice in answering questions about organic chemistry, especially about the manufacture cracking and the formulae of organic compounds.
- Simple calculations and the balancing of chemical equations were generally well done.

General comments

Many candidates tackled this paper well, showing a good knowledge of chemistry. The standard of English was generally good. Some of the questions were left unanswered by some candidates.

Some candidates need more practice in reading questions carefully and noting key words. For example, in **Question 2(d)(i)** some candidates did not read the stem of question carefully and gave alternative names for sulfuric acid, while in **Question 3(e)** some candidates did not follow the instruction to label the apparatus. In **Question 4(f)(i)** some candidates ticked only one box instead of the two requested.

Some candidates need more practice in answering extended questions such as **Questions 3(f)** (diffusion) and **6(d)** (cracking). Candidates should be encouraged to structure their answers logically and avoid writing contradictory statements.

Questions relating to extraction of information from graphs and tables were generally well done; some candidates need further practice at dealing with negative numbers.

Many candidates need more practice with questions involving the particle arrangement and separation in solids, liquids and gases, e.g. **Question 6(e)(iii)**. Other candidates need to revise the process of steelmaking and the uses of steel **Questions 5(d)(i)** and **5(f)**.

Some candidates need further practice in the area of organic chemistry, especially in drawing displayed formulae and revising the essential details of the process of cracking hydrocarbons. Other candidates need further practice at distinguishing between observations (e.g. bubbles seen) and inferences (e.g. gas given off) (**Questions 3(b)(i)**and **3(d)(ii)**).

Many candidates were able to balance chemical equations and extract relevant information from tables of data. Other candidates need to revise these areas and distinguish between stating a trend and explaining the trend (**Question 6(e)(i)**).

Comments on specific questions

Question 1

(a) (i) Most candidates recognised the use of ammonia or ammonium chloride as a fertiliser. The commonest incorrect answer was to choose carbon dioxide.

(ii) A minority of the candidates identified nitrogen as a diatomic molecule. The commonest incorrect answers were **A** (sulfur dioxide) and **E** (carbon dioxide).

(iii) This was almost invariably answered correctly.

(iv) Some candidates identified ammonia as a gas which turns red litmus paper blue. Other candidates suggested the two acidic gases **A** or **E** (sulfur dioxide or carbon dioxide) as answers.

(v) This was generally well answered. Carbon dioxide was the commonest incorrect answer.

(b) (i) Few candidates gave a correct source of sulfur dioxide. The commonest correct answer referred to volcanoes. Many candidates gave vague answers such as 'from factories', 'in the atmosphere' or 'from burning sulfur'. Those who mentioned fossil fuels often omitted the essential words 'burning of'.

(ii) A minority of the candidates suggested a correct adverse effect of sulfur dioxide on health. There were many vague or incorrect answers such as 'causes cancer', 'bad for the lungs' or 'has a chemical effect on the body'.

(c) A majority of the candidates deduced the correct number of at least two of the three sub-atomic particles. The commonest error was to suggest 7 neutrons. A few candidates added the number of neutrons and protons and gave the incorrect answers of 15 protons or 15 neutrons.

Question 2

(a) Some candidates gave answers that just repeated the values in the diagram without reference to the percentage of the gases on the Earth. Other candidates gave information that was vague or irrelevant, e.g. 'it's too hot to live on Venus because it's near the Sun'. Where the percentages of gases in the Earth's atmosphere were quoted they were not always correct. A common error was to suggest that the Earth's atmosphere has 70–75% nitrogen. Many candidates suggested that there is a higher proportion of carbon dioxide in the Earth's atmosphere than is the case; figures between 4% and 10% were typically quoted.

(b) Candidates who knew the limewater test for carbon dioxide generally obtained both marks. A wide variety of incorrect tests were given including 'use a lighted splint', 'add water' or 'add nitric acid'. A number of candidates mentioned bleaching. A few candidates disadvantaged themselves by suggesting that the carbon dioxide is bubbled through solid calcium hydroxide rather than aqueous calcium hydroxide. A significant number of candidates gave answers that did not refer to a test reagent, e.g. 'photosynthesis' or 'carbon + oxygen gives carbon dioxide'.

(c) (i) Many candidates did not respond to the instruction to write the symbols for the atoms present and consequently only gained credit for the arrangement of the electrons. Common errors included the addition of further non-bonding electrons; H placed in the central atom instead of O; three or four electrons in the overlap areas; a lack of a pair of electrons in one of the overlap areas; or additional electrons added to the oxygen atom. A significant number of candidates did not respond to this question.

(ii) Some candidates realised that at –200 °C argon is a solid; few candidates were able to explain this in terms of –200 °C being below the melting point. Many candidates referred to the boiling point or suggested that the answer was the liquid state or the gaseous state. Many candidates appeared to have difficulty in dealing with the negative numbers.

(iii) Some candidates referred to the presence of eight electrons in the outer shell of argon or to a complete outer electron shell. Other candidates did not refer to the outer electron shell. Common incorrect answers included 'weak structure and bonding', 'it's in Group 8', 'it's a noble gas' or 'there are no free electrons'.

(d) (i) Most candidates wrote the correct word equation. Some candidates wrote 'hydrogen sulfate' or 'sulfate hydroxide' instead of sulfuric acid, despite that fact that the name sulfuric acid was given in the stem of the question. Most candidates identified the products as carbon dioxide and water. A few candidates suggested hydrogen instead of water. A greater number of candidates gave the incorrect name for magnesium sulfate; 'magnesium sulfur oxide' was a common error.

(ii) Many candidates calculated the relative molecular mass of sulfuric acid correctly. Those who did not, generally gave the answer 7 (number of atoms in a molecule of sulfuric acid) or 8.

(e) (i) Very few candidates gave a suitable use for sulfur dioxide. A significant number of candidates suggested that it was used to make sulfuric acid. This was not accepted because the raw material for making sulfuric acid is sulfur and the sulfur dioxide is formed as an intermediate in the industrial process. Most candidates gave answers that were vague and did not relate to a specific use, e.g. 'for neutralisation', 'fertiliser' or 'polluting the atmosphere'.

(ii) Nearly all the candidates selected the correct pH. The commonest error was for candidates to circle pH 7. A few candidates circled pH 14.

Question 3

(a) Most candidates identified the compound present in limestone as calcium carbonate. The commonest error was to suggest sodium sulfate. Potassium dichromate was also not infrequently seen as an incorrect answer.

(b) (i) Very few candidates gave a suitable description of what would be seen when a sample of hydrated iron(II) sulfate is heated. The best answers referred to a colourless liquid condensing on the walls of the test-tube or to a colour change of the solid. Many candidates thought that bubbles would be seen or that water would be evaporated. Candidates should realise that the latter is not an observation. A minority of candidates suggested that rust was formed.

(ii) Some candidates described the test for iron(II) ions correctly; many other candidates gave an incorrect test reagent such as cobalt(II) chloride, copper(II) sulfate, litmus or hydrochloric acid. A significant number of candidates suggested a flame test or using a lighted splint. Of those candidates who suggested a correct test reagent, only a few gave the incorrect colour precipitate. A significant number of candidates did not respond to this question.

(c) (i) The equation was completed correctly by a majority of the candidates. The commonest error was to suggest H_2O rather than H_2.

(ii) Many candidates thought that the iron could be removed by filtration. A number of candidates suggested using a magnet, which was acceptable. The commonest incorrect answers referred to the use of heating or the use of a blast furnace (muddling with iron extraction).

(d) (i) Few candidates completed the formula of ethanoic acid correctly. Some candidates knew the structure but did not include the O–H bond. The commonest error was to omit the O of the O–H, so that the structure became an aldehyde. Many candidates added an extra H atom to the COOH carbon atom to make a pentavalent carbon. Other candidates added extra carbon atoms to the chain to make propanoic acid or butanoic acid.

(ii) A minority of the candidates suggested that bubbles are formed or that the magnesium decreases in size. Many candidates did not give an observation but gave statements such as 'gas given off' or 'hydrogen formed', which were not sufficient.

(e) Many candidates gave a suitable diagram of the chromatography apparatus. The commonest errors were to place the spot of dye below the solvent level; lack of labelling; or not showing a solvent at all. Some candidates did not qualify the word 'paper' with the words 'chromatography' or 'filter'. A considerable number of candidates disadvantaged themselves by suggesting that the dye should be placed in the solvent.

(f) Some candidates explained diffusion in terms of the kinetic particle theory. Other candidates did not refer to particles and just suggested that the ink moved. Many candidates did not include the word diffusion in their answers and wrote vague or incorrect statements. Some candidates wrote about ink moving or spreading out, neither of which was sufficient to gain a mark because of the lack of the essential word *particles* (or *molecules*).

Question 4

(a) Many candidates completed the table correctly; the commonest error being to suggest that sulfur conducts electricity.

(b) Many candidates recognised that the low boiling point of sulfur points to the fact that this element is a simple covalent substance. Candidates who stated that sulfur does not conduct when molten were given credit.

(c) Some candidates recognised that potassium bromide is likely to be ionic because it *only* conducts when molten. Other candidates did not gain credit because they referred to boiling points or density.

(d) (i) Many candidates suggested that the low density of aluminium makes it suitable for making aircraft. A few candidates suggested that high density was important. The commonest errors were to suggest 'the density is $2.7\,g/cm^{3}$' (unqualified as to whether this is high or low) and 'aluminium is light' (not a precise enough term). Another incorrect answer seen was 'high boiling point'.

(ii) Few candidates identified the method used to extract aluminium from aluminium oxide. A wide variety of incorrect answers were seen including 'distillation', 'oxidation', 'heating' and 'blast furnace'.

(e) Many candidates identified the electrode products correctly. Other candidates gave the correct products but at the incorrect electrodes. The commonest incorrect answer was to write bromide instead of bromine. A few candidates included hydrogen or oxygen (at either electrode) or wrote incorrect equations for the reactions at the electrodes.

(f) (i) A majority of the candidates ticked the correct two boxes. The commonest incorrect answer was to suggest that diamond is ionic. A significant number of candidates ticked only one box rather than the two requested in the stem of the question.

(ii) Most candidates gave a suitable use for diamond. The commonest error was to suggest using diamond for relatively large objects, e.g. 'hammer'.

Question 5

(a) Many candidates balanced the equation correctly. The commonest error was to attempt to balance the equation with $2(O_2)$ or $1(O_2)$.

(b) (i) The best answers referred to lead(II) oxide losing oxygen. Many candidates referred to the lead on the right-hand side of the equation rather than the oxide. A common error was to refer to the carbon gaining oxygen. This was not acceptable because the question refers to the lead(II) oxide rather than other species. Some candidates who referred to oxidation numbers did not gain the mark because they referred to the oxidation number of lead(II) oxide and not to the oxidation number of lead. Those candidates who referred to electrons rarely gained the mark because they referred to electron loss. Candidates who take the core paper are advised to answer this type of question in terms of oxygen loss or gain.

(ii) Many candidates suggested two correct physical properties of transition elements; some candidates gave chemical properties including the ability to act as catalysts and formation of coloured ions. Other answers were not specific enough to be able to award a mark, e.g. 'they are metals' or 'they are insoluble'.

(c) This was almost invariably correctly answered. A few candidates omitted either water or oxygen / air. A few candidates did not give specific enough answers, e.g. 'put in a dry place'.

(d) (i) Very few candidates realised that oxygen is needed in steelmaking to oxidise impurities such as carbon, sulfur and phosphorus, which are present in the iron. Many candidates gave answers that seemed to refer to the blast furnace, e.g. 'to react with the carbon to form carbon monoxide', 'to react with carbon dioxide to form carbon' or 'to remove the oxide from the iron oxide'. Other candidates gave answers that related to the oxidation or neutralisation of iron or cooling the reaction mixture.

(ii) Some candidates realised that potassium forms a basic oxide. The commonest incorrect choice was carbon dioxide and a few candidates chose nitrogen dioxide. Few candidates explained their answer in terms of potassium being a metal. Common errors included 'potassium is a base' and 'potassium in water turns red litmus blue'.

(e) Some candidates realised that an alloy is a mixture. Other candidates implied that the metals were just 'added to each other' or 'one is coated with another'. A few candidates just referred to elements and did not mention a metal. Another common error was to suggest that an alloy is 'a metal that is very strong'.

(f) (i) Some candidates gave a suitable use for mild steel. Other candidates gave a use more often associated with stainless steel or gave answers that were not specific enough, e.g. 'decorations' or 'machines'.

(ii) Many candidates gave a suitable use for stainless steel; cutlery being the commonest correct answer. Other candidates gave a use more often associated with mild steel or gave answers that were not specific enough, e.g. 'basins' or 'utensils'.

Question 6

(a) Some candidates identified the place in the fractionation column where bitumen is removed. The commonest error was to suggest tubes higher up the column. Few candidates placed the **X** in the correct place to show where the temperature in the column is highest. Many placed the **X** outside the column; the commonest errors being to place it with the bitumen fraction or half way up the tube. A significant number of candidates placed the **X** at the top of the column. A considerable minority of the candidates did not respond to this question.

(b) Some candidates identified the naphtha fraction correctly. Other candidates gave non-specific answers such as 'petroleum fraction' or 'gas fraction'. The commonest error was to suggest 'kerosene' despite this being given on the diagram.

(c) (i) Some candidates gave the correct structure for ethane. The commonest error was to include a double bond or draw the structure of ethene. Another common error was to draw the structure of ethene but with a single C–C bond. A minority of the candidates drew the structure of ethanol.

(ii) Many candidates balanced the equation correctly. The commonest errors was to suggest either $2(H_2)$ or $4(H_2)$.

(iii) Some candidates gave simple correct answers such as 'a reaction which absorbs heat'. Other candidates introduced unnecessary complications by referring to bond making and bond breaking, which often resulted in contradictions. Some candidates wrote vague answers such as 'the temperature decreases' or 'cooling down'. Many candidates did not mention heat.

(d) Few candidates gained all four marks for describing cracking and giving the essential conditions for this process. Many candidates suggested that heat is needed; few candidates gained credit for the idea of breaking down hydrocarbons, molecules or alkanes. A considerable proportion of the candidates just mentioned 'breaking' without mentioning what was being broken. Other candidates thought that alkenes were broken down to alkanes. Few candidates wrote about larger or longer hydrocarbons being broken down to small alkanes and alkenes. Many candidates suggested that polymers were being broken down to monomers. A considerable number of candidates did not respond to this question.

(e) (i) Many candidates described how the boiling point of the alkanes depends on the number of carbon atoms. Other candidates disregarded the negative values and suggested that the boiling point decreased. A small number of candidates tried to explain the difference instead of describing the trend, e.g. 'it takes more energy to break the forces between the molecules'.

(ii) Most candidates gave the boiling point of propane within the range allowed. The commonest error was to omit the negative sign.

(iii) Few candidates appeared to understand the meaning of the term *arrangement* as applied to particles in a liquid. The commonest errors were to suggest that the particles were close together or slightly apart. A considerable number of answers had nothing to do with particles and focussed on reactivity or size of the particles.

A greater number of candidates described the separation of the particles correctly. Some candidates repeated their answers about the arrangement of the particles. A common incorrect answer was to suggest that 'the particles are apart from each other'. Other candidates referred to the movement of the particles rather than the separation. A considerable number of candidates did not respond to this question.

CHEMISTRY

Paper 0620/41
Theory (Extended)

Key messages

When a question asks for observations, the answer should be something that can be seen. Hence 'gas made' or 'copper formed' are **not** observations, they are conclusions. The appropriate observations would be 'effervescence' and 'brown solid formed' respectively. Vague observations such as 'there is a colour change' do not gain credit; the colour change should be specified.

When the required conditions for a process are asked for, numerical answers for temperature or pressure should have units. Responses such as 'optimum temperature and pressure' are not creditworthy because they give no indication of what the optima are.

When a chemical equation is asked for, this means a balanced equation using correct symbols/formula and not a word equation.

General comments

Most candidates completed the entire paper in the allocated time and attempted all of the questions.

Candidates must read questions carefully to ensure they address in their answers all that is asked in the questions.

Working should be shown for calculations and this working should be set out clearly. This allows 'method marks' to be awarded in calculations, even if the final answer is incorrect.

Comments on specific questions

Question 1

(a) (i) The vast majority of candidates were able to identify **B** as having an atomic number of 12. The most common errors were to select **A**, presumably by adding the number of electrons to the number of protons, or **E**, which had 12 neutrons.

(ii) The majority of answers were correct, although a significant number of candidates opted for **C**, which has 14 neutrons rather than 14 nucleons.

(iii) This proved to be the most demanding part of **Question 1(a)**, with some candidates giving multiple answers. The most common error was to select **D**, which had more electrons than protons. This means that while **D** was an ion, it would have had a negative charge, rather than a positive charge.

(iv) This was very well answered and almost all candidates gained credit.

(b) The majority of candidates correctly identified **D** as an ion formed from oxygen, although a significant number of candidates ignored the instruction to write the formula **D**. Some candidates thought that **D** was neon.

Question 2

(a) (i) Most candidates realised that the particles would have the most energy at the highest temperature. The most common error was to select **Z**, which was the lowest temperature.

(ii) The vast majority of candidates answered this correctly.

(iii) Most candidates answered this correctly; **X** and **Y** were common errors.

(b) The majority of candidates realised the left-hand horizontal section of the graph represented freezing; many candidates read the graph carelessly and gave answers of 150 °C or below the minimum accepted temperature of 130 °C. Some candidates ignored the data provided and guessed a temperature that was not covered by the range on the graph.

(c) The term *sublimation* was known by the majority of candidates.

(d) (i) Most candidates could not recall the term *Brownian motion*; the most common incorrect answer was 'diffusion'.

(ii) This area of the syllabus was not very well understood by candidates, many of whom thought that smoke was a gas, rather than a colloidal suspension of a solid in air, meaning that the particles just move randomly. The correct explanation that many much smaller molecules in the air move randomly and collide with the smoke particles, resulting in them moving, was seen very rarely.

Question 3

(a) (i) Most candidates gave an answer which, while true, was not something that could be observed and so was not creditworthy. A common example of this was 'magnesium loses electrons', which is something that you cannot see.

(ii) The fact that a redox reaction is one that involves both oxidation and reduction was well known.

(iii) The most common error was to identify copper as the oxidising agent. The oxidising agent must be on the left-hand side of the equation and so could only be Mg or Cu^{2+}. Some candidates were able to go on to say what an oxidising agent does in the reaction given.

(iv) Many candidates were unable to write the formula of iron(III) oxide correctly and so were unable to score credit. A significant number of candidates did not balance the equation and made the iron produced diatomic.

(b) (i) Many candidates scored credit by stating the paint prevents oxygen and water from making contact with the iron.

(ii) Many candidates could correctly explain why magnesium prevented rusting; common errors included stating the magnesium acted as a barrier or that the magnesium rusted.

(iii) A comparison of the reactivity of copper and iron was required. Some vague answers were seen, such as 'copper is unreactive' as well as some incorrect ones, such as 'copper is a transition element and so will rust'.

Question 4

(a) (i) Most candidates were able to give carbon dioxide as a product and go onto write a balanced equation. A common error was to have water as a product.

(ii) Vague answers were seen, such as 'warm'. A number of improbable temperatures and pressures were seen, presumably due to candidates getting fermentation confused with other industrial process on the syllabus.

(b) (i) The catalyst was known by very few candidates; 'iron' was a very common error.

(ii) Many fully correct answers were seen; answers showing no working were common. Working should always be shown, as it may be possible to award method marks even if the final answer is incorrect.

(c) (i) Only a small minority of candidates could state the name of a suitable oxidising agent.

(ii) Many candidates answered this question correctly; a common error was to show all bonding electrons correctly but to omit the non-bonding electrons on the oxygen atoms.

(d) (i) Only a small minority of candidates could explain the meaning of the term *weak* in reference to an acid. The most common incorrect answers stated weak acids have a higher pH than strong acids; this is incorrect as a very dilute strong acid may have a higher pH than a much more concentrated weak acid. Candidates are expected to know that weak acids are only partially dissociated in aqueous solution.

(ii) Almost all candidates omitted to state that the two acids used should be of the same concentration. Many answers gave a suitable test/reagent; some of these did not then state how the results would show that ethanoic acid was weaker than hydrochloric acid.

(e) A small number of fully correct answers were seen. Common errors included missing off the hydrogen joined to the oxygen atom in either structure or showing the –OH group of the alcohol as bonded to the carbon via the H atom (O–H–C). The name of the alcohol, butan-1-ol was rarely correct.

Question 5

(a) (i) The colours of copper(II) carbonate and copper(II) oxide were known by only a very small minority of candidates.

(ii) Many candidates could not write the correct formula of copper(II) carbonate. Some of those candidates who did still did not gain credit because they gave oxygen as a product.

(b) (i) The qualitative test for copper(II) ions was better known than that for nitrate ions. Fully correct answers were not common. The addition of an acid rather than sodium hydroxide was common in the nitrate test.

(ii) Many fully correct answers were seen.

(c) (i) This proved to be a very demanding question for many candidates. Only a minority of candidates were able to state that the colour would become paler and then explain this in terms of the equilibrium moving to the right because there were fewer moles of gas on the right.

(ii) Candidates found this a demanding question. Only a minority of candidates were able to link the colour change to the position of equilibrium moving to the right. A common incorrect explanation was to say the equilibrium moved to the exothermic side. There is no exothermic (or endothermic) *side* in any reaction; there is an exothermic and an endothermic *direction.*

Question 6

(a) Some candidates were able to state that aluminium is more reactive than carbon. A significant number of candidates incorrectly stated that the aluminium oxide would react with the carbon to make either carbon dioxide or aluminium carbonate.

(b) (i) Many fully correct answers were seen, although it was common to show the oxide ion with eight dots in the outer shell rather than six dots (representing the electrons from derived from oxygen) and two crosses (representing the electrons derived from aluminium).

(ii) Many answers contained contradictory statements, such as ‘ionic bonding’ followed by comments about attractive forces between atoms or molecules, rather than between ions.

(c) (i) The particles responsible for the conduction of electricity were not well known.

(ii) Very few candidates gave two correct reasons why cryolite is used. Common errors were claiming that it changed the melting or boiling point of aluminium, or implying that it acted as a coolant and so reduced the temperature, rather than lowering the operating temperature.

(iii) Many fully correct answers were seen although errors in the charge of the aluminium ion were also common.

(iv) Very few candidates were able to give a full and logical explanation as to why carbon dioxide is produced. The most commonly missing point was the one concerning oxygen being made at the anode; most answers just talked about oxygen from the aluminium oxide and so did not score this marking point. It was not uncommon for candidates to claim that the carbon came from the cryolite, rather than from the anode.

(d) Only a minority of candidates knew that aluminium was coated with a layer of aluminium oxide. Most answers gave incorrect explanation based either on the low reactivity of aluminium or the fact that the acid was not concentrated.

Question 7

(a) (i) The majority of answers just stated that there would be more particles of acid rather than more particles per unit volume. Many candidates correctly talked about collision frequency rather than there just being more collisions.

(ii) The majority of candidates stated that the particles would have more energy or would move faster; very few candidates went on to state that more of the particles now had energy greater than the activation energy or that a greater proportion of collisions would be successful.

(b) (i) Many fully correct answers were seen; answers showing no working were common. Candidates should always include the working in their numerical answers, so that method marks can be awarded where possible.

(ii) The most common error in this solution based calculation was not to convert the volume of hydrochloric acid from cm^3 to dm^3.

(iii) Very few candidates completed this last step of the calculation.

(c) Many fully correct answers were seen. A common error was to miss out the first step of calculating the number of moles of each element and instead go straight to dividing each by the smallest; this will give the simplest ratio of percentage composition by mass and not the simplest ratio of moles, which is required to deduce an empirical formula.

CHEMISTRY

Paper 0620/42
Theory (Extended)

Key messages

Candidates should try to cover all of the syllabus topics during their revision. It was noticeable that many candidates were unsure of the causes of Brownian motion in **Question 1(a)**.

Candidates need to be reminded that if, for example, **two** uses of a substance is asked for, then no more than *two* uses should appear in the candidate's answer as any incorrect uses given may be viewed as a contradiction of correct uses. Such occurrences were seen in **Question 3(d)(iii)** and various parts of **Question 3(e)**.

When drawing organic structures, candidates should be aware of the valencies of the atoms they are representing. Divalent hydrogen atoms and trivalent oxygen atoms were frequently seen.

General comments

Candidates seemed well prepared for the Question Paper. Some good examination technique was seen, such as underlining of command words in the questions.

Candidates should look to make answers clear and concise. Use of bullet points may help candidates target the key points of an answer.

Comments on specific questions

Question 1

(a) (i) Although the majority of candidates knew the correct name of the term 'Brownian motion', many candidates thought that the answer was diffusion.

(ii) Many candidates knew that 'molecules' were responsible for the Brownian motion of the dust particles, but the expected identity of these molecules ('nitrogen' or 'oxygen') was frequently omitted or occasionally contradicted by referring to 'hydrogen' as well.

(iii) Many candidates were not familiar with the reasons why Brownian motion occurs. Many candidates thought that the cause of Brownian motion was the dust (a solid) particles colliding with each other. Very few candidates stated that it was the air molecules hitting the dust particles which caused the dust particles to move and that the random movement of air molecules therefore caused the movement of the dust particles to be random.

(b) (i) Most candidates knew that diffusion was the term required.

(ii) Very few candidates noticed the instruction to use **data** from the Periodic Table to account for the different rates of diffusion. General phrases such as 'bromine is heavier' received no credit. Good candidates related the different molecular masses of Br_2 and Cl_2 (160 and 71) to the relative rates of diffusion.

(iii) Most candidates knew that an increased temperature increased the kinetic energy of the gas particles, thus increasing the rate at which the gas particles spread out.

Question 2

(a) Most candidates gave the correct electronic structures of the species shown although candidates who performed less well tended to given the electronic structures of Ca atoms and N atoms, rather than the ions.

(b) Most candidates wrote the correct formula of Ca_3N_2. Responses which left the ionic charges explicit did not receive credit.

(c) The dot-and-cross diagrams were generally done very well. Candidates are advised that it was the structure of the ions present which received credit, rather than diagrams showing electron transfer from atoms to form the ions.

(d) The dot-and-cross diagram of Cl–S–Cl was done very well. Candidates should show covalent bonds as a shared pair of electrons within the overlap region rather than including 'sticks' within the covalent bond.

(e) This proved to be a very difficult question for nearly all candidates. Succinct responses which gained full credit included, 'The ionic bonding in LiCl is stronger than the intermolecular forces of attraction in SCl_2'. However, many responses contained contradictions and inaccuracies.

(f) Most candidates suggested SiO_2 as being a covalent compound having a higher melting point than LiCl. Many candidates incorrectly gave 'graphite' or 'diamond' (both elements) or MgO (ionic).

Question 3

(a) Many candidates were unaware of how to complete an energy level diagram. Better-performing candidates realised that, as the reaction was exothermic, the product line would be below the level of the reactant line. Very few candidates drew a vertical **single-headed** arrow showing the direction of the energy change from reactant level to product level.

(b) Most candidates knew that **X** represented the activation energy.

(c) The bond energy calculation proved challenging for many candidates. Very few candidates realised that because **two** moles of methanol were included in the reaction, the energy change calculated for the reaction had to be halved to determine the energy change for combusting **one** mole of methanol.

(d) (i) Most candidates knew that cracking was the name of the process

(ii) Candidates who performed less well often failed to balance the chemical equation, or only achieved credit by writing the correct formula of $C_{12}H_{26}$ as a reactant. No credit was given for word equations.

(iii) Candidates need to know that a catalyst and heat are the two essential condition needed for the reaction. The name of the catalyst wa not required although the vast majority of candidates knew that the catalyst was phosphoric acid.

(iv) Most candidates knew this reaction was hydration.

(v) Testing for purity of ethanol was challenging for many candidates. Vague responses such as 'heat it' or 'burn it' were seen frequently. Of those candidates who knew that the boiling point of the ethanol should be determined, many did not describe making a comparison of the empirical result with known data.

(e) (i) Two conditions for fermentation of glucose were known by most candidates. Some candidates included a third contradictory condition.

(ii) The equation for the fermentation of glucose was known by nearly all candidates.

(iii) Many different incorrect suggestions were given for why the concentration of ethanol produced by fermentation did not exceed 15%.

(iv) and (v) Many candidates knew a disadvantage and an advantage of using fermentation to produce ethanol.

(vi) Most candidates knew that fractional distillation was the technique used to obtain ethanol from an aqueous mixture, although chromatography was a popular incorrect response.

(f) (i) Many candidates did not deduce the empirical formula of ethane-1, 2-diol, despite the structure being given. A common response was the molecular formula, $C_2H_6O_2$.

(ii) Many candidates realised that ethane-1, 2-diol cannot undergo addition polymerisation due to its lack of unsaturation.

(iii) Many candidates gained full credit but there was also large proportion of candidates who gained no credit. Many candidates drew atoms with incorrect valencies, such as divalent hydrogen atoms (–H–) or trivalent oxygen atoms (–O=). The most common error was to omit continuation bonds.

(iv) A large proportion of candidates gave *Terylene* as the answer. This received no credit as it is the name of a specific condensation polymer. Polyester was the type of condensation polymer formed.

Question 4

(a) The definition of electrolysis was not familiar to many candidates.

(b) (i) and (ii) Most candidates gave the gas (oxygen) and the test for it.

(iii) The writing of ionic half-equations proved challenging for candidates.

(c) Most candidates knew that electrons are responsible for the transfer of charge in a wire and that ions are responsible for the transfer of charge in an electrolyte. A considerable proportion of candidates thought the negative ions only transferred charge in an electrolyte.

(d) Many good suggestions were seen. Most suggestions focussed on the idea that chlorine would be liberated in place of oxygen and suggested that the student would observe a green gas at the anode. Candidates should realise that the response 'chlorine forms at the anode' is not an observation.

(e) (i) This answers to this question were well known by many candidates.

(ii) This was a demanding question which was based upon candidates' knowledge of the relative reactivity of silver, copper and zinc. Better-performing candidates realised that silver would remain as an element due to its lack of reactivity in comparison to copper, and that zinc would dissolve into solution due to its greater reactivity compared to copper.

Question 5

(a) This question proved difficult for most candidates. Most candidates realised that the addition of sulfuric acid would shift the equilibrium to the right-hand side and that the colour would become (more) orange. Very few candidates stated that an increase in concentration of a reactant was responsible.

Most candidates realised that addition of sodium hydroxide would shift the equilibrium to the left-hand side and that the colour would become (more) yellow. Many candidates explained that this was because the alkali reacted with the acid on the reactant side, thus decreasing the concentration of one of the reactants.

(b) (i) This unstructured calculation proved difficult for most candidates. Only a small minority of candidates determined the correct answer of 210 cm^3. A considerable proportion of candidates left the volume produced at 300 cm^3, failing to appreciate that the yield was only 70%.

(ii) Candidates stated that the equilibrium shifted to the left-hand side but frequently failed to explain that this was because there were fewer moles (of gas) on the left-hand side.

(iii) Most candidates realised that, if an increased temperature gave a decreased yield, then the (forward) reaction must be endothermic.

(iv) Either the idea of increasing the rate of reaction or lowering the activation energy was known by nearly all candidates.

CHEMISTRY

Paper 0620/43
Theory (Extended)

Key messages

- Candidates are advised not to give vague answers to questions on environmental chemistry. The nature of the problems caused by pollutants, e.g. the toxicity of gaseous pollutants, must always be specified.
- Candidates are required to know and understand meaning and precise definitions of terms such as *molecule*, *element*, *acid*, *homologous series* and *structural isomerism*.
- Candidates need to familiarise themselves with details of the action of heat on the nitrates of those metals listed on the syllabus. This includes the nature of the products and the chemical equations for the decomposition reactions.
- The precise meaning of the term *excess*, as used in chemistry, should be known by candidates.

General comments

Most candidates completed the entire paper in the allocated time and attempted all of the questions.

Candidates must read questions carefully to ensure they address all that is asked in the questions in their answers.

Working should be shown for calculations and this working should be set out clearly. This allows 'method marks' to be awarded in calculations, even if the final answer is incorrect.

Comments on specific questions

Question 1

(a) Many candidates thought that brass was a compound.

(b) This question was answered very well.

(c) This question was answered very well. A small number of candidates thought that butane was a mixture.

(d) This question was answered very well.

Question 2

(a) (i) Candidates are advised to begin their answer with 'a molecule is a particle'. Many candidates began by stating that a molecule is a substance. It was essential to state that a molecule contains atoms that are combined.

(ii) Candidates are advised to begin their answer with 'an element is a substance'. Many candidates stated or suggested that an element is a particle or a single atom.

(b) (i)–(v) These questions were answered very well. There were no common errors.

(c) The number of protons and electrons in a sodium atom was well known. Candidates found determining the number of electrons in a sulfide ion more challenging. The fact that a chlorine molecule contains two chlorine atoms was often ignored.

Question 3

(a) This question was answered quite well. Bauxite was the most common incorrect answer.

(b) Many good answers were seen here. The most frequent omission was that the fact that the combustion of coke is exothermic (and therefore provides the heat energy required for other reactions occurring in the blast furnace).Carbon dioxide reacting with oxygen to form carbon monoxide was occasionally seen.

Some candidates were under the impression that if a compound is named as iron(III), as in iron(III) oxide, the formula must begin with 'Fe_3': thus Fe_3O_2 was occasionally seen. The nature of the impurities that are removed by limestone was often omitted. Some candidates gave answers which referred to the correct names of substances (such as silica, silicon(IV) oxide, slag and calcium silicate) but gave incorrect chemical formulae.

(c) (i) Protons or atoms were often referred to instead of positive ions. Negative ions were sometimes referred to instead of electrons. The attraction between positive ions and electrons was the creditworthy point most frequently omitted.

(ii) Many candidates stated that iron is malleable because particles can slide, but omitted reference to *layers* of particles.

(iii) Candidates frequently stated that layers of particles were unable to slide, but omitted to explain that this was because steel contains particles of different sizes.

(d) (i) The formula of iron(II) sulfate was frequently incorrect. Products other than hydrogen were sometimes seen.

(ii) Iron as a reactant and hydrogen as a product were occasionally seen. The formula of iron(III) sulfate was incorrect in many cases.

(e) Candidates are required to know the colour changes that occur when acidified potassium manganate(VII) and potassium iodide are used to test for the presence of reducing agents and oxidising agents respectively. In addition, it is expected that candidates can recall the observations occurring when aqueous sodium hydroxide is used to test for the presence of cations.

Question 4

(a) Distillation alone was sometimes seen, as opposed to *fractional distillation*. Electrolysis was occasionally seen.

(b) (i) This question was answered quite well. Candidates were expected to realise that the process involved was electron loss, corresponding to oxidation, because electrons were shown on the right-hand side of the ionic half-equation. Reduction was occasionally seen as an incorrect answer.

(ii) This was answered well by some candidates. There were no common wrong answers.

(c) This was answered well by some candidates. The reaction occurring in a hydrogen fuel cell is the same as the reaction occurring when hydrogen undergoes complete combustion in oxygen.

(d) (i) and **(d)(ii)**
Many answers to this question were too vague. Specific advantages and disadvantages were required.

(e) (i) Oxygen was often missing as a reactant in the equation. The reaction occurring in an ethanol fuel cell is the same as the reaction occurring when ethanol undergoes complete combustion in oxygen.

(ii) The vast majority of candidates achieved this mark. The most common correct answers referred to the greenhouse effect or global warming.

(iii) The majority of candidates achieved credit for this question. There were no common incorrect answers, although hydration was occasionally seen.

(f) The vast majority of candidates achieved credit for this question.

Question 5

(a) (i) The action of heat on nitrates was unfamiliar to the majority of candidates. Sodium oxide and nitrogen oxide were commonly seen.

(ii) The action of heat on nitrates was unfamiliar to the majority of candidates. Products containing different elements from those present in copper(II) nitrate, such as water and carbon dioxide, were often seen. Copper was commonly seen as a product.

(b) (i) Many vague statements such as 'the forward reaction equals the backward reaction' were seen. Only a few candidates referred to rates of the forward and reverse reactions in their answers and even fewer related their answers to concentrations.

(ii) The endothermic nature of the forward reaction was hardly ever mentioned. Confusing statements such as 'the equilibrium moves to the right and then moves to the left to oppose the change' were often seen.

(iii) The command *Suggest what you would see* is a request for an observation. The majority of candidates ignored this and attempted answers in terms of explanations only. Those candidates who referred to a shifting of the position of equilibrium rarely answered this in terms of the number of molecules on both sides of the equation.

Question 6

(a) (i) This question was answered well; the word *only* was sometimes absent.

(ii) This question was answered very well. There were no common errors.

(iii) This question was answered fairly well. Candidates should be able to state precisely the general characteristics of members of the same homologous series.

(iv) Many candidates answered by drawing the same alkene molecule as in the question, either back-to-front or with a straight chain drawn at an angle to make it look like a branched chain. Candidates should realise that each carbon atom in a compound must have four bonds.

(v) Many candidates referred to isomers, but only a few candidates mentioned structural isomers. Isotopes were the most common incorrect answer. 'Allotropes' was seen very occasionally.

(b) (i) This was extremely poorly answered. The meaning of the term *excess* in chemistry specifically refers to more than enough of a reactant than is required to react with all of the other reactant.

(ii) This question was answered very well. There were no obvious common errors.

(iii) This question was answered quite well. There were no obvious common errors.

(iv) This was answered well by some candidates. A common error was the lack of realisation that four water molecules would lead to eight hydrogen atoms in the hydrocarbon.

Question 7

(a) (i) Photosynthesis was a very common answer, presumably due to the reference to green plants in the question. This illustrates the need to read questions extremely carefully.

(ii) Most candidates looked for answers more complicated than the simple answer that silicon(IV) oxide is a solid (and thus cannot move through the air).References to mass, density structure or bonding were common.

(iii) This was answered quite well.

(b) (i) Addition polymerisation was very often seen as well as the correct answer.

(ii) This was only answered correctly by a small number of candidates. Hydration and condensation were seen as well as a variety of other incorrect types of reaction.

(iii) This was only answered correctly by a small number of candidates. There were many incorrect answers but no common ones.

CHEMISTRY

Paper 0620/51
Practical

Key messages

- Candidates should use a sharp pencil for plotting points, which should be clearly indicated, and for drawing lines of best fit on graphs. The line of best fit may be a curve or a straight line, as appropriate to the question. 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.
- In qualitative analysis exercises, candidates must follow the instructions given and record all observations. There is a tendency for candidates to describe white precipitates as cloudy or milky solids; this should be avoided.
- Candidates should be aware that the mark allocation reflects the number of different creditworthy points to be made for each part of the question.
- Candidates should be prepared to answer Question 3 which requires the planning of an investigation.

General comments

The majority of candidates successfully attempted and completed both **Questions 1** and **2** and supervisors' results were submitted with all of the candidates' scripts. These results were used when marking to compare with candidate responses, particularly in **Question 1**.

Some candidates seemed were ill-prepared for the requirements of **Question 3**.

Comments on specific questions

Question 1

(a) and **(b)**
Almost all candidates completed the tables of results and gained results that showed a decrease in temperature in **(a)** and an increase in temperature in **(b)**, which was in good agreement with the results submitted by the supervisor.

(c) Points were usually correctly plotted. The scale on the *y*-axis caused problems for a minority of candidates. Some of the lines drawn were not smooth.

(d) (i) Some candidates misread the graph scale on the *x*-axis or did not clearly show on the grid from where on the graph they had read the value.

(ii) Better-performing candidates were able to add 6 °C to the initial temperature of the solution and use the graph to deduce the time taken to reach this temperature.

(e) The majority of candidates identified the energy change in Experiment 2 as exothermic. There were some vague responses referring to the production of energy, which scored no credit.

(f) This was generally not well answered, with many candidates stating that the reaction mixture would return to room temperature or the initial temperature in the table but with no explanation provided.

(g) A variety of possible sources of error were cited, with appropriate improvements. Common correct answers referred to the use of a measuring cylinder and improving by using a burette, or heat losses and improving by insulating the apparatus. Vague answers such as those mentioning stirring problems were ignored.

(h) A common misconception was that taking fewer readings would make the readings less accurate or less precise. If a reading is subject to an error, just taking fewer readings will not make that error disappear. However, less frequent readings gives fewer data points, resulting in the graph drawn being less good.

Question 2

(a) This was generally well answered. Credit was given for describing a blue colour.

(b) (i) Many responses lacked sufficient detail. The formation of a green precipitate was often described as a green solution. Some candidates used terms such as milky, cloudy or solid, which were ignored.

(ii) Many responses lacked sufficient detail. Many candidates did not record the observation that the precipitate dissolved or that a green solution was formed. Some answers referred to the precipitate changing colour.

(iii) This was generally well answered, with the recognition of the test for a nitrate. Credit was given for naming the indicator paper used and the expected result.

(c) This was generally well answered. Credit was awarded for any pH reading in the range 8–11. A minority of candidates did not follow the instructions and recorded a colour change instead of a pH value.

(d) (i) This was generally not well answered. Blue and light blue solutions were common incorrect answers. Many candidates did not follow the instructions and described a blue precipitate. They often used terms such as milky, cloudy or solid, which were ignored.

(ii) The incorrect use of terms was prevalent. The expected observation was that a blue precipitate formed. The use of the terms soluble, insoluble, dissolves and solution were often confused.

Reference to the formation of a deep blue solution showed either a lack of care in observing the reaction or not following the instructions. Results suggested that many candidates were adding solution **Z** to aqueous copper(II) sulfate, rather than the other way round, as instructed.

(e) The expected observation was that a grey-green precipitate formed. References to green precipitates were common.

(f) Many candidates recognised the presence of nitrate ions but did not identify chromium; iron(II) was a common incorrect answer.

(d) Many candidates correctly identified solution **Z** as ammonia. The presence of copper ions was often noted, which showed confusion. Many candidates related their observations to the presence of an alkali or hydroxide ions and named sodium hydroxide as solution **Z**.

Question 3

Many candidates scored credit for weighing and then heating the washing soda either to dryness or condensing the water. References to ‘exposing the crystals to air’ or ‘leaving the washing soda in the Sun’ instead of using heat were prevalent and showed a lack of knowledge and understanding. Some candidates were confused by the reference to a new substance and described mass changes associated with this transition and not the percentage of water in the new substance.

CHEMISTRY

Paper 0620/52
Practical

Key messages

Question 1

- Candidates should use a sharp pencil for plotting points, which should be clearly indicated, and for drawing lines of best fit on graphs. The line of best fit may be a curve or a straight line, as appropriate to the question. 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.
- Candidates should be familiar with the technique of carrying out a flame test.
- In qualitative analysis exercises, candidates must follow the instructions given and record all observations. There is a tendency to describe white precipitates as cloudy or milky solids; this should be avoided.
- Candidates should be aware that the mark allocation reflects the number of creditworthy points to be made for each part of the question.
- Candidates should be prepared to answer Question 3 which requires the planning of an investigation.

General comments

The majority of candidates successfully attempted and completed both **Questions 1** and **2** and supervisors' results were submitted with all of the candidates' scripts. These results were used when marking to compare with candidate responses, particularly in **Question 1**.

A number of candidates did not follow the instructions as detailed in certain parts of **Question 2**.

Comments on specific questions

Question 1

(a) and **(b)**

The tables of results were completed by all of the candidates. The majority of candidates recorded temperature readings that were comparable to the supervisor for both experiments.

Some candidates recorded temperatures that did not show the expected magnitude of temperature change.

(c) Most candidates plotted the points for both experiments on the grid correctly. The vast majority of candidates did not plot the initial temperatures. Points were sometimes plotted wrongly because the scale on the *y*-axis was misread. Some graphs were not labelled and the use of a ruler to join the points to give a straight line of best fit was sometimes absent.

(d) (i) Most candidates worked out the maximum temperature of the reaction mixture and showed clearly how they had extrapolated their graph. Some errors in reading the scale of the *y*-axis were evident.

(ii) Most candidates worked out the minimum temperature of the reaction mixture and showed clearly how they had used their graph to do so. A significant minority of candidates did not follow the instructions and did not show clearly on the grid how they worked out their answer. Some errors in reading the scale of the y-axis were evident.

(e) This was well answered, with most candidates giving the energy change as exothermic.

(f) To gain full credit, the suggested change had to be linked to the stated source of error.

Most correct responses referred to accuracy as a problem when using a measuring cylinder and suggested replacing it with a burette or pipette. References to heat losses and covering the polystyrene cup with a lid or insulation were also creditworthy.

Vague references to parallax errors, errors reading the thermometer and using the thermometer as a stirrer were common and gained no credit. Mention of using a digital thermometer was not creditworthy as this would not result in more accurate results.

(g) The idea of repeating the experiments was known by the majority of candidates. A large number of responses just suggested taking an average, which was insufficient.

(h) The idea of smaller or lower temperature changes was recognised by the better-performing candidates. Many answers referred to the temperature changes doubling, which showed a lack of understanding.

Question 2

(a) Most candidates were able to describe the appearance of solid **U** as a white solid, powder or crystals. The colour of the salt was sometimes missed and a few answers mistakenly referred to the presence of a precipitate.

(b) Detailed observations were rare. References to fizzing, or bubbles/effervescence were often missing. It was apparent that some candidates had not followed the instruction to test the gas produced. Better-performing candidates realised that when a dilute acid causes instantaneous effervescence when added to a salt, testing with limewater is the first course of action.

A number of positive tests for chlorine, using litmus paper, and oxygen, using a splint, were recorded when, in practice, carbon dioxide was the gas evolved.

(c) Carbon dioxide was identified by the majority of candidates; chlorine, oxygen and hydrogen were also identified.

(d) A wide range of flame colours were recorded; blue, green, lilac and often red. A yellow or orange flame was the expected observation.

(e) The metal given followed from the result in **(d)**. The carbonate anion was often missed.

(f) This was generally well answered with the recognition of a white precipitate. Some candidates noted the formation of a cloudy or milky solution but did not describe the colour appropriately.

(g) (i) A significant number of candidates obtained the expected white precipitate Other candidates described effervescence and precipitates dissolving.

(ii) Detailed observations were often not given and the instructions were sometimes not followed. If an excess of dilute hydrochloric acid was not added to the mixture from **(g)(i)**, then the precipitate did not dissolve.

(h) Many candidates scored credit by referring to the presence of chloride ions in solid **W**. A majority of candidates realised that the tests on the solid indicated the presence of a Group II cation, such as calcium, magnesium or barium. Better-performing candidates realised that a white solid showed that ions of a transition element were not present.

Question 3

There was evidence that some candidates were ill prepared for this planning question and did not attempt it.

Many candidates seemed unaware of how long rusting takes. Experiments were often run for minutes or even seconds. Some candidates did not plan an investigation to compare the rusting of iron nails in tap water and distilled water but stated what they expected to happen.

CHEMISTRY

Paper 0620/53
Practical

Key messages

- Candidates should use a sharp pencil for plotting points, which should be clearly indicated, and for drawing lines of best fit on graphs. The line of best fit may be a curve or a straight line, as appropriate to the question. 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.
- In qualitative analysis exercises, candidates must follow the instructions given and record all observations. There is a tendency for candidates to describe white precipitates as cloudy or milky solids; this should be avoided.
- Candidates should be aware that the mark allocation reflects the number of different creditworthy points to be made for each part of the question.
- Candidates should be prepared to answer Question 3 which requires the planning of an investigation.

General comments

The majority of candidates successfully attempted and completed both **Questions 1** and **2** and supervisors' results were submitted with all of the candidates' scripts. These results were used when marking to compare with candidate responses, particularly in **Question 1**.

Some candidates seemed were ill-prepared for the requirements of **Question 3**.

Comments on specific questions

Question 1

(a) and **(b)**
Almost all candidates completed the tables of results and gained results that showed a decrease in temperature in **(a)** and an increase in temperature in **(b)**, which was in good agreement with the results submitted by the supervisor.

(c) Points were usually correctly plotted. The scale on the *y*-axis caused problems for a minority of candidates. Some of the lines drawn were not smooth.

(d) (i) Some candidates misread the graph scale on the *x*-axis or did not clearly show on the grid from where on the graph they had read the value.

(ii) Better-performing candidates were able to add 6 °C to the initial temperature of the solution and use the graph to deduce the time taken to reach this temperature.

(e) The majority of candidates identified the energy change in Experiment 2 as exothermic. There were some vague responses referring to the production of energy, which scored no credit.

(f) This was generally not well answered, with many candidates stating that the reaction mixture would return to room temperature or the initial temperature in the table but with no explanation provided.

(g) A variety of possible sources of error were cited, with appropriate improvements. Common correct answers referred to the use of a measuring cylinder and improving by using a burette, or heat losses and improving by insulating the apparatus. Vague answers such as those mentioning stirring problems were ignored.

(h) A common misconception was that taking fewer readings would make the readings less accurate or less precise. If a reading is subject to an error, just taking fewer readings will not make that error disappear. However, less frequent readings gives fewer data points, resulting in the graph drawn being less good.

Question 2

(a) This was generally well answered. Credit was given for describing a blue colour.

(b) (i) Many responses lacked sufficient detail. The formation of a green precipitate was often described as a green solution. Some candidates used terms such as milky, cloudy or solid, which were ignored.

(ii) Many responses lacked sufficient detail. Many candidates did not record the observation that the precipitate dissolved or that a green solution was formed. Some answers referred to the precipitate changing colour.

(iii) This was generally well answered, with the recognition of the test for a nitrate. Credit was given for naming the indicator paper used and the expected result.

(c) This was generally well answered. Credit was awarded for any pH reading in the range 8–11. A minority of candidates did not follow the instructions and recorded a colour change instead of a pH value.

(d) (i) This was generally not well answered. Blue and light blue solutions were common incorrect answers. Many candidates did not follow the instructions and described a blue precipitate. They often used terms such as milky, cloudy or solid, which were ignored.

(ii) The incorrect use of terms was prevalent. The expected observation was that a blue precipitate formed. The use of the terms soluble, insoluble, dissolves and solution were often confused.

Reference to the formation of a deep blue solution showed either a lack of care in observing the reaction or not following the instructions. Results suggested that many candidates were adding solution **Z** to aqueous copper(II) sulfate, rather than the other way round, as instructed.

(e) The expected observation was that a grey-green precipitate formed. References to green precipitates were common.

(f) Many candidates recognised the presence of nitrate ions but did not identify chromium; iron(II) was a common incorrect answer.

(d) Many candidates correctly identified solution **Z** as ammonia. The presence of copper ions was often noted, which showed confusion. Many candidates related their observations to the presence of an alkali or hydroxide ions and named sodium hydroxide as solution **Z**.

Question 3

Many candidates scored credit for weighing and then heating the washing soda either to dryness or condensing the water. References to ‘exposing the crystals to air’ or ‘leaving the washing soda in the Sun’ instead of using heat were prevalent and showed a lack of knowledge and understanding. Some candidates were confused by the reference to a new substance and described mass changes associated with this transition and not the percentage of water in the new substance.

CHEMISTRY

Paper 0620/61
Alternative to Practical

Key messages

- Candidates should use a sharp pencil for plotting points, which should be clearly indicated, and for drawing lines of best fit on graphs. The line of best fit may be a curve or a straight line, as appropriate to the question. 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.
- In qualitative analysis exercises, candidates must follow the instructions given and record all observations. There is a tendency for candidates to describe white precipitates as cloudy or milky solids; this should be avoided.
- Candidates should be aware that the mark allocation reflects the number of different creditworthy points to be made for each part of the question.
- Candidates should be prepared to answer Question 3 which requires the planning of an investigation.

General comments

The majority of candidates attempted all of the questions. Some candidates were clearly not well prepared for this examination and showed a lack of experience of and knowledge of practical procedures.

Candidates found **Questions 3** and **4** the most demanding.

Comments on specific questions

Question 1

(a) A minority of candidates identified the evaporating basin. There were many references to petri dishes, watch glasses, plates and bowls, which were ignored. A number of answers named the apparatus as a flask or beaker, which showed a lack of practical experience.

(b) References to zinc oxide were not creditworthy. Zinc chloride solution and hydrochloric acid were common incorrect answers.

(c) (i) The majority of candidates named the process as filtration. (Fractional) distillation and crystallisation were common incorrect responses.

(ii) Many candidates realised that the apparatus would not work as a filter paper was missing. A significant number of candidates referred to the size of the funnel or stated that the wrong separation method was being used, which showed a lack of understanding.

(d) A large number of candidates did not realise that the question asked for a description of the method to obtain crystals and that the mark allocation was three marks. Consequently, the one-word response 'crystallisation' gained no credit. Better responses described heating the solution to the crystallising point and leaving to cool.

Question 2

(a) The times in the tables of results were completed correctly from the stopclock diagrams by the majority of candidates. A few candidates did not give the time in seconds, as required.

(b) Most candidates plotted the results for the experiments on the grid correctly. The point at (31 °C, 111 s) was often wrongly plotted. Points were sometimes plotted wrongly because the scale on the *y*-axis was misread. Some graphs were not labelled. The use of a ruler to join points dot-to-dot was penalised.

(c) Most candidates worked out the time for the printed words to disappear at an average temperature of 72 °C and showed clearly how they had extrapolated their graph. A number of candidates ignored the instruction 'show clearly on the grid how you worked out your answer'. Some errors in extrapolating the curve were evident and a number of responses included the wrong unit or missed out the unit.

(d) A significant number of candidates did not attempt this question. A line sketched above the original graph would represent the experiments being repeated at a lower temperature.

(e) (i) This was well answered, with Experiment 5 commonly given.

(ii) The best responses clearly communicated the idea that at higher temperatures particles move faster / have more energy and collide more frequently. A significant number of candidates just restated the question and referred to the experiment being the fastest reaction, rather than explaining in terms of particles.

(f) (i) Vague references to the relative sizes of a burette and a measuring cylinder were common.

(ii) Some candidates realised that a smaller flask would result in the cross disappearing faster as the depth of the reaction mixture would be greater. The common misconception was that the rate of the reaction would change, which showed a lack of knowledge and understanding. There were lots of references to spillages of liquid using a smaller flask or inaccurate results being obtained.

Question 3

(a) A red-brown precipitate, insoluble in excess of aqueous sodium hydroxide was not well known. References to effervescence, gas tests and white precipitates were common.

(b) The formation of a red-brown precipitate was the expected observation. References to a precipitate dissolving and a solution forming showed a lack of knowledge.

(c) Some responses showed that some candidates had never experienced this test and therefore observations were incorrect. Better-performing candidates recognised the nitrate test and correctly deduced that the litmus paper would turn blue.

(d) Ammonium was a common error and guesses such as hydrogen and carbon dioxide were frequent.

(e) Many candidates identified solid **G** as lithium carbonate or calcium carbonate; other metal carbonates were commonly cited.

Question 4

Many candidates were ill prepared for this planning question and did not attempt it.

The commonest method chosen was to react the metals with dilute hydrochloric acid and then measure the volume of gas over a specific time interval using a gas syringe or a measuring cylinder over water. Many candidates forgot to measure the time and just referred to greatest volume of gas given off, which showed a lack of understanding. There was a general lack of quantitative information with no reference to the volume of acid used or mass of the metals. A large number of candidates referred to measuring the volume of the metals. Some candidates mistakenly planned to react the metals with water, despite the information given in the stem of the question.

A large number of responses lacked sufficient detail, e.g. ‘add hydrochloric acid to each metal and see how long it takes to start reacting or to stop reacting’.

A significant number of answers referred to the addition of dilute hydrochloric acid to separate samples of the metals and testing the gas produced with a lighted splint. Descriptions of checking which one gave the loudest pop or first pop showed a lack of knowledge and understanding.

CHEMISTRY

Paper 0620/62
Alternative to Practical

Key messages

- Candidates should use a sharp pencil for plotting points, which should be clearly indicated, and for drawing lines of best fit on graphs. The line of best fit may be a curve or a straight line, as appropriate to the question. 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.
- There was a tendency to describe effervescence or bubbles as 'gas given off', which is not an observation.
- Candidates should be aware that the mark allocation reflects the number of creditworthy points to be made for each part of the question.
- Candidates should be prepared to answer Question 3 which requires the planning of an investigation.

General comments

Passing steam over heated magnesium did not seem to be a familiar experiment for many candidates in **Question 1**.

In **Question 2** plotting graphs was generally done accurately but several candidates used very small dots to mark their points, which were difficult to see.

Some candidates did not read the questions carefully and did not seem to understand what was required. This was particularly noticeable in **Question 3** where often observations were not given but instead equations or named products.

Question 4 was generally well attempted.

Comments on specific questions

Question 1

(a) Many candidates identified the liquid as water. Steam was a common incorrect answer. Confusion was evident with responses such as magnesium, magnesium hydroxide, acid and hydrogen showing a lack of understanding.

Some candidates thought this was the cracking experiment and specified hydrocarbons or other organic compounds.

(b) (i) This was generally well answered. A significant number of candidates did not show an arrow under the mineral wool and indicated an arrow under the tubing connecting the glass tubing.

(ii) Test-tube or boiling tube were common correct answers. References just to 'tube' scored no credit.

(c) The minority of candidates correctly identified the cleaning method as using an abrasive, such as sandpaper. Steam, water, acid and cloths were common incorrect answers.

(d) (i) Many candidates did not attempt this question, which asked candidates to complete the diagram to show how the gas could be collected and measured. (Gas) syringe was the commonest correct answer. Diagrams that had no graduations or were closed and would not work were common. Some diagrams were not labelled as requested.

(ii) The vast majority knew that a 'pop' would be the result of this test.

(e) The idea of a large amount of (heat) energy released by the reaction was missed by many candidates who just referred vaguely to heating the tube. The possibility of water condensing, from it sucking back and cracking the tube was credited.

Question 2

(a) and **(b)**

The temperatures in the tables of results were completed correctly by the majority of candidates using the thermometer diagrams. There were some errors reading the diagram showing 48 °C diagram in Experiment 1.

(c) Most candidates plotted the points for both experiments on the grid correctly. The vast majority of candidates did not plot the initial temperatures. Points were sometimes plotted wrongly because the scale on the *y*-axis was misread. Errors were made plotting the final points for both experiments using a mass of 4 g or 5 g instead of 5 g and 6 g. Some graphs were not labelled and the use of a ruler to join the points to give a straight line of best fit was sometimes absent.

(d) (i) Most candidates worked out the maximum temperature of the reaction mixture and showed clearly how they had extrapolated their graph. Some errors in reading the scale of the *y*-axis were evident.

(ii) Most candidates worked out the minimum temperature of the reaction mixture and showed clearly how they had used their graph to do so. A significant minority of candidates did not follow the instructions and did not show clearly on the grid how they worked out their answer. Some errors in reading the scale of the y-axis were evident.

(e) This was well answered, with most giving the energy change as exothermic. A significant number of candidates gave endothermic or wrote about types of energy or about energy changing from chemical energy to heat energy.

(f) To gain full credit, the suggested change had to be linked to the stated source of error.

Most correct responses referred to accuracy as a problem when using a measuring cylinder and suggested replacing it with a burette or pipette. References to heat losses and covering the polystyrene cup with a lid or insulation were also creditworthy.

Vague references to parallax errors, errors reading the thermometer and using the thermometer as a stirrer were common and gained no credit. Mention of using a digital thermometer was not creditworthy as this would not result in more accurate results.

(g) The idea of repeating the experiments was known by the majority of candidates. A large number of responses just suggested taking an average, which was insufficient.

(h) The idea of smaller or lower temperature changes was recognised by the better-performing candidates. Many answers referred to the temperature changes doubling, which showed a lack of understanding.

Question 3

(a) Most candidates were able to give the appearance of the solid as white. References to colourless and clear were ignored. Confused responses described solid **U** as a precipitate.

(b) Detailed observations were rare. Many candidates gave the limewater turning milky but omitted the bubbling/effervescence observation. Some candidates gave the bubbling but no test for the gas.

(c) This was generally well answered with the identification of carbon dioxide. Some candidates used the wrong test in **(b)** and then identified the gas from that test as hydrogen or chlorine.

(d) This was well answered. There were some candidates who appeared to think that a flame test is a test for a gas using a splint.

(e) Many candidates identified solid **W** as a chloride salt. Vague references to halides scored no credit. A majority of candidates realised that the tests on the solid indicated the presence of a Group II cation, such as calcium, magnesium or barium. Better-performing candidates realised that a white solid showed that ions of a transition element were not present.

Question 4

There was evidence that some candidates were ill prepared for this planning question and did not attempt it.

Many candidates seemed unaware of how long rusting takes. Experiments were often run for minutes or even seconds. Some candidates did not plan an investigation to compare the rusting of iron nails in tap water and distilled water but stated what they expected to happen.

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Paper 0620/63
Alternative to Practical

Key messages

Observations can be seen. For example, 'fizzing' is an observation, whereas 'a gas was given off' is not.

When a question asks for the name of a chemical, a correct formula is acceptable. However, if a candidate answers with an incorrect formula only, then credit will not be awarded.

General comments

The vast majority of candidates successfully attempted all of the questions.

The vast majority of candidates were able to complete tables of results from readings on diagrams and plot graphs, as in **Question 2**.

Question 4 was a planning task and proved more challenging for candidates. However, nearly all candidates made a creditworthy attempt at this question.

Comments on specific questions

Question 1

(a) Many candidates stated pestle and dropper or pipette; incorrect terms were seen regularly.

(b) This question was well answered.

(c) A small minority of candidates suggested acids such as hydrochloric and sulfuric acid.

(d) This question was well answered; answers such as excess, precipitate and filtrate were seen frequently.

(e) This question was not well answered. Some responses included metals such as sodium, which would not have been appropriate. A few candidates reacted the lead(II) nitrate, or the lead(II) oxide formed by heating, with carbon. Most candidates thought that this question required a crystallisation process and a significant number of candidates thought that lead could be obtained by simply filtering the solution.

Question 2

(a) The vast majority of candidates answered this correctly.

(b) The vast majority of candidates answered this correctly.

(c) Most candidates performed well on the graph. The plotting of the points was good. The drawing of smooth line graphs was variable in standard, with a significant proportion of responses not going through or near all of the points. Drawing the smooth line graphs to the starting temperatures of 22°C and 23°C caused some problems for candidates with many candidates drawing the smooth line graphs to the wrong initial temperatures. Most candidates successfully labelled their lines.

(d) The majority of candidates performed well in **(i)**; sometimes the tie lines could have been drawn more clearly. Some candidates drew the tie line to the wrong curve.

In **(ii)**, some candidates did not draw the correct tie line, because they did not correctly add 6° to the starting temperature.

(e) This question highlighted that some candidates were confused about exothermic and endothermic reactions. Many candidates named the energy transfer, rather than the type of energy change.

(f) The majority of candidates thought that once the reaction had finished the solution would remain at the final temperature. Better performing candidates appreciated that the solution would cool down to room temperature but many candidates could not give a reason for that change.

(g) Many candidates appreciated two sources of error and went on to give satisfactory improvements. Some candidates gave answers that were not relevant, such as reading instruments at eye level, while many candidates referred to doing the experiment with the same starting temperatures or that a thermometer should not be used to stir the solutions.

(h) This question was poorly answered with most candidates making statements about readings being inaccurate.

Question 3

(a)(i) Many candidates gave a correct observation; the most common error was a reference to a grey-green or white precipitate.

(ii) Some candidates wrongly thought that, on dissolving, the colour would change significantly. The most common example of this was stating that a green precipitate would give a colourless solution.

(iii) Some candidates gave correct observations; other candidates confused the test with one that would produce hydrogen and gave observations to match.

(b) Ammonia was correctly identified by most candidates.

(c) A minority of candidates identified solution **Z**. A common error was to identify the solution as sodium hydroxide.

Question 4

Many candidates found this task challenging. Better performing candidates suggested heating the crystals to constant mass.

Most candidates could suggest how the final calculation should be carried out from their results. It was not uncommon for calculations to correspond to the percentage of sodium carbonate in the starting material rather than the percentage of water.