CHEMISTRY

Paper 0620/11
Multiple Choice (Core)

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

General comments

Candidates performed reasonably well on this paper.

Comments to specific questions

Questions 14, **25** and **32** proved to be particularly straightforward.

Questions 7, **10** and **18** proved to be more difficult.

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

Question 1

Response **B**. Candidates did not realise that, at this temperature sodium chloride is not solid.

Question 3

Response **A.** Candidates knew a filter paper was needed but picked the wrong solvent.

Question 10

Response **D**. This response was more popular than the correct one. Candidates knew the products but missed the wrong electrodes.

Question 11

Response **B** This response was again more popular than the correct one. This is a common error where candidates think that, because energy is absorbed, the temperature of the surroundings must go up.

Question 18

Response **A**. This response was again more popular than the correct one. Candidates did not realise that evaporating the mixture would mean that the salt was contaminated with sodium hydroxide.

Question 29

Response **B**. Candidates realised that 1 and 3 caused pollution but not that carbon monoxide does not cause acid rain.

Question 33

Response **A**. Candidates knew that limestone is calcium carbonate but did not know this process.

Question 38

Response **B**. Candidates knew it could be made by fermentation but did not understand the meaning of 'unsaturated'.

Question 40

Response **D**. Candidates ignored the word 'polymers'.

Questions 5, **6**, **17**, **19**, **21**, **26** and **31** had approximately equal numbers of candidates selecting each response. This indicates that many candidates were guessing.

CHEMISTRY

Paper 0620/12
Multiple Choice (Core)

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

General comments

Candidates performed reasonably well on this paper.

Questions 1 and **25** proved to be particularly straightforward.

No questions proved to be particularly difficult.

Comments on specific questions

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

Question 2

Response **B**. This response was more popular than the correct one. Candidates did not realise the significance of the two decimal places requiring accuracy.

Question 3

Response **C**. Candidates did not realise that it was necessary to dissolve first.

Question 4

Response **C**. Candidates did not realise that the solvent must be below the base line.

Question 7

Response **B**. This response was again more popular than the correct one. Candidates knew about the shared pair of electrons but were confused about the second statement.

Question 11

Response **D**. Candidates realised that energy was released but were confused as to where the energy comes from. This is a common error.

Question 15

Response **B**. This response was more popular than the correct one. Candidates did not realise that burning is the same as combustion.

Question 22

Response **D**. Candidates were unclear about the properties of transition elements in terms of melting point and catalytic activity.

Question 23

Response **B**. Noble gases are monatomic. Candidates did not realise this.

Question 24

Response **D**. Candidates did not realise that alloys are mixtures not compounds.

Question 33

Response **A**. Candidate knew that limestone was calcium carbonate but were not familiar with this process.

Questions 17, **19**, **26**, **29** and **31** had approximately equal numbers of candidates selecting each response. This indicates that many candidates were guessing.

CHEMISTRY

Paper 0620/13
Multiple Choice (Core)

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

General comments

Candidates performed reasonably well on this paper.

Questions 20 and **23** proved to be particularly straightforward.

Questions 3, **21** and **39** proved to be more difficult.

Comments on specific questions

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

Question 1

Response **B**. This response was more popular than the correct one. Candidates did not realise that particles in a liquid are touching.

Question 6

Response **C**. Candidates confused covalent with ionic bonding.

Question 7

Response **D**. This response was again more popular than the correct one. Candidates were not able to describe the formation of covalent bonds.

Question 11

Response **D**. Candidates knew that the temperature went up but did not understand oxidation.

Question 12

Response **D**. This response was again more popular than the correct one. Candidates may have thought this was a reversible process.

Question 19

Response **C**. This response was again more popular than the correct one. Candidates did not know the test for a sulfate.

Question 24

Response **A**. Candidates did not know that alloys are mixtures not compounds.

Question 25

Response **B**. Candidates realised that M was most reactive but put it at the wrong end.

Question 37

Response **A**. Candidates chose the prefix rather than the suffix as the deciding factor.

Questions 17, **21**, **26**, **33** and **39** had approximately equal numbers of candidates selecting each response. This indicates that many candidates were guessing.

CHEMISTRY

Paper 0620/21
Multiple Choice (Extended)

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

General comments

Candidates performed well on this paper.

Questions 1, **2**, **7**, **14**, **22**, **28**, **32** and **36** proved to be particularly straightforward.

No questions proved to be particularly difficult.

Comments on specific questions

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

Question 5

Response **B**. Candidates knew about shared electrons but were confused by the second statement.

Question 18

Response **B**. Candidates did not realise that Y was a metal even though it was positioned towards the right of the Periodic Table.

Question 19

Response **B**. Candidates confused 'weak' with 'dilute'.

Question 20

Response **A**. Candidate mistook A for an alkali metal and did not think further.

Question 24

Response **A**. Candidates did not know that alloys are mixtures not compounds.

Question 33

Response **D**. Candidates picked the correct catalyst but chose the conditions for the Haber process.

Question 34

Response **A**. Candidates knew that limestone was calcium carbonate but were not familiar with this process.

CHEMISTRY

Paper 0620/22
Multiple Choice (Extended)

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

General comments

Candidates performed very well on this paper.

Questions 1, **4**, **7**, **14**, **19**, **20**, **21**, **23**, **26**, **27**, **29** and **30** proved to be particularly straightforward.

Question 8 proved to be particularly difficult.

Comments on specific questions

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

Question 5

Response **B**. Candidates knew about the shared pair of electrons but were confused about the second statement.

Question 8

Response **C**. This response was more popular than the correct one. Candidates did not realise 2 moles of NaOH neutralise 1 mole of sulfuric acid.

Question 11

Response **C**. Candidates did not know about fuel cells and answered about a combustion engine.

Question 17

Response **A**. Candidates clearly did not know about neutral oxides.

Question 18

Response **B**. Candidates failed to spot that Y is a transition metal.

Question 22

Response **B**. Noble gases are monatomic. Candidates did not realise this.

Question 33

Response **D**. Candidates picked the correct catalyst but chose the reaction conditions of the Haber process.

Question 38

Response **A**. Candidates wrongly thought that ethanoic acid decolourised bromine water.

CHEMISTRY

Paper 0620/23
Multiple Choice (Extended)

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

General comments

Candidates performed reasonably well on this paper.

Questions 4, **14**, **20** and **35** proved to be particularly straightforward.

No questions proved to be particularly difficult.

Comments on specific questions

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

Question 1

Response **B**. Candidates got the maths right but did not know sulfur dioxide was acidic.

Question 3

Response **C**. Candidates were unsure of how to calculate R_f.

Question 8

Response **A**. Candidates were wrong by a factor of 10.

Question 21

Response **B**. Candidates assumed that all of the halogens were gases at room temperature.

Question 29

Response **D**. Candidates knew what catalytic converters do but not where the oxides of nitrogen are produced.

Question 32

Response **A**. Candidates knew the effect of temperature on rate but not on the equilibrium.

Question 33

Response **D**. Candidates chose the correct catalyst but opted for the reaction conditions of the Haber process.

Question 34

Response **A**. Candidates knew that limestone was calcium carbonate but were unfamiliar with this process.

Question 40

Response **D**. Candidates gave as an answer the number of units not the number of types of unit.

CHEMISTRY

Paper 0620/31
Theory (Core)

Key messages

- It is important that candidates read the stem of the question carefully in order to understand what exactly is being asked.
- Some candidates need more practice in answering questions involving salt preparation and qualitative tests.
- Many candidates need further practice in answering extended questions.
- Interpretation of data from tables and graphs was generally well done, as was completion of simple symbol equations.

General comments

Some candidates tackled this paper well, showing a good knowledge of core Chemistry. Nearly all candidates were entered at the appropriate level. Many candidates answered every part of each question. The exceptions were **Questions 2(d)(iii)**, **4(e)**, **5(a)(ii)**, **6(a) and 7(b)(iii)** where a significant number of candidates did not respond. The standard of English was generally good.

Some candidates need more practice in reading and interpreting questions. In some questions, the rubric was misinterpreted or ignored by a significant number of candidates. For example, in **Question 2(e)**, many candidates gave answers which only referred to transition elements rather than metals in general. In **Question 3(a)(ii)**, many candidates did not take note of the word 'non-metal' in the stem of the question. In **Question 3(c)(i)**, some candidates did not refer to the electronic structure. In **Question 4(a)**, some candidates wrote about general properties of solids and gases and did not refer to the kinetic particle theory as requested in the stem of the question. Candidates might be advised to learn how to read the stem of the question carefully in order to get the correct interpretation of what is being asked.

Many candidates need practice in answering questions relating to qualitative analysis and the preparation of salts. Some knew the test for iodide ions in **Question 4(e)**; many did not know the correct reagent that should be used. A minority of the candidates knew the result of the test to distinguish between methane and ethene in **Question 5(a)(iii)**. Most candidates need practice in describing the preparation of salts and understanding the stepwise processes involved.

Some candidates need more practice in writing specific answers rather than providing vague, unqualified statements. For example, in **Question 1(b)** (definition of an element), many wrote vaguely about 'same sort of atoms' or 'substances in the Periodic Table'. In **Question 3(a)(iii)**, some candidates wrote about groups of elements rather than singling out specific elements. In **Question 4(b)**, some candidates just wrote a single word 'decreases' instead of describing that the volume decreases as the pressure increases.

A minority of the candidates wrote good answers to the extended **Questions 4(a)** and **6(a)**. Others did not organise their work and seemed to write their answers down in a disordered fashion as the ideas came to them. Some candidates need more practice in answering questions about salt preparation. Candidates should be encouraged to answer these questions as a series of bullet points.

Many candidates were able to extract information from tables and diagrams. Others need more practice in answering questions involving graphical work. For example, in **Question 7(b)(iii)**, many candidates need more practice in interpreting given information and drawing a graph line carefully so that it does not involve unnecessary large humps or dips.

Many candidates were able to undertake simple calculations involving relative formula mass and calculations involving simple proportion; others need to revise these areas.

Questions involving general chemistry including, atomic and molecular structure, balancing symbol equations and the structure of organic molecules were generally well known.

Comments on specific questions

Question 1

This was one of the best answered questions on the paper. Many candidates identified at least three of the structures correctly in **(a)** with **(iii)**, **(v)** and **(vi)** often being correct. Fewer gave a convincing definition of an element in **(b)**.

(a) (i) Some candidates identified the covalently-bonded structures of diamond and nitrogen. The commonest errors were to suggest **C** (lithium chloride) and/or **E** (copper).

(ii) A minority of the candidates identified a diatomic molecule. The commonest incorrect answer was **B** (diamond). Other candidates suggested **C** (lithium chloride).

(iii) Many candidates identified the structure **C** as a compound. The commonest incorrect answer was to suggest **A** (helium).

(iv) A minority of candidates identified **C** lithium chloride as soluble in water. The commonest error was to suggest **B** (diamond).

(v) This question was answered well. Many candidates recognising that diamond is used for cutting tools. The commonest error was to suggest **C** (lithium chloride).

(vi) This was the best answered of the **(a)** questions. The commonest error was to suggest B (diamond).

(b) Few candidates were able to define the term *element* with sufficient precision. The best answers referred to all the atoms having the same number of protons or the fact that there was only one type of atom present. Others suggested that an element cannot be broken down into another substance without including the essential phrase ‘by chemical means’. Many wrote statements that were too vague e.g. ‘a substance with the same atoms in it’. This could refer for example to methane and ethane, which both have carbon and hydrogen atoms. Others did not gain credit because they referred to molecules containing the same types of atom – a definition of a diatomic molecule rather than an element. A considerable number of candidates gave examples of elements e.g. nitrogen in place of a general definition.

Question 2

Many candidates were able to balance the equation in **(b)** and to explain the oxidation of carbon in **(c)**. Some candidates were able to give two general properties of metals in **(e)**. Others gave properties that were specific to either transition elements or Group I metals. Part **(d)** was the least well answered. Few candidates recognised the thermal decomposition reaction or the basic character of calcium oxide.

(a) Some candidates gave the correct name of an ore of iron. The commonest error was to suggest bauxite. Others gave non-specific names such as ‘iron ore’ or just ‘metal ore’. A significant minority gave properties such a ‘high melting point’ rather than the name of an ore.

(b) Most candidates balanced the equation correctly. The commonest error was to suggest O or 2O instead of O_2.

(c) Many candidates were able to explain why carbon was oxidised by referring to the equation. Others wrote statements that were too vague such as ‘the carbon changes to carbon monoxide’ or ‘the carbon ends up with oxygen’. Some candidates did not refer to the equation as instructed and just gave a definition of oxidation.

(d) (i) Few candidates recognised the reaction as thermal decomposition. Some realised that it was a decomposition reaction but omitted the word ‘thermal’. Others gave ‘exothermic’ or ‘endothermic’. A majority of the candidates gave incorrect answers such as ‘oxidation’ or ‘melting’.

(ii) A minority of the candidates gained full credit for recognising that calcium oxide is a basic oxide and relating this to the metallic nature of calcium. The commonest incorrect answers were 'metal oxide' or 'Group II oxide'. Some tried to explain the basic nature by referring to the reaction of calcium with water. Some candidates thought that calcium was a non-metal. A significant number of candidates did not respond to this question.

(e) Some candidates were able to give two general properties of metals. Few gave three correct properties. A common error was to give properties of transition elements such as high density or high melting point or to refer to coloured compounds. Others gave properties of Group I elements such as low density, low melting point or reference to cutting with a knife. The best answers referred to electrical conductivity and lustre (shiny).

(f) Many candidates counted the number of atoms correctly. Fewer were able to translate the numbers into a correct formula. Many just wrote the numbers down as iron 2, carbon 9 and oxygen 9 or Fe2 + C9 + O9. Another common error was to write the formula as Fe_2CO_9. A significant number of candidates miscounted the oxygen atoms.

Question 3

This was the best answered question on the paper. Many candidates gained full credit for **(a)(i)**, **(a)(ii)** and **(b)**. In **(a)(iii)**, many candidates either gave too generalised answers or did not read the question fully. Part **(c)** was answered well by some candidates. Others gave vague answers to **(c)(i)** or gave uses of other noble gases in **(c)(ii)**.

(a) (i) Most candidates deduced the correct percentage of the other elements present in the Earth. The commonest error was to give very large numbers by multiplying some of the figures instead of undertaking a subtraction from 100.

(ii) Many candidates identified oxygen correctly. The commonest error was caused by not reading the stem of the question carefully enough and suggesting iron, which has the highest percentage but is not a non-metal. Silicon was another incorrect answer that was commonly seen.

(iii) Some candidates gave two correct differences in the percentage by mass. The best answers focused on the differences in the composition of helium, hydrogen or iron. Many candidates just repeated the percentages in the table without writing that one was a greater percentage than another. e.g. 'There is 0.1% hydrogen on Earth and 76% in the Universe'. Many candidates gave answers that were too generalised such as 'there are more non-metals in the Universe' or 'there are more gases in the Universe and less in the Earth'.

(b) A majority of the candidates completed the diagram to show the electronic structure of an oxygen atom. The commonest errors were either to add another ring of electrons or to draw four electrons in the outer shell. A minority of candidates drew an inner shell with four electrons or an outer shell with eight electrons.

(c) (i) Some candidates explained the unreactive nature of neon in terms of a full outer shell of electrons or eight electrons in the outer shell. Others did not mention the outer shell or did not heed the command word *explain* and gave simplistic answers such as 'it is in Group 8 of the Periodic Table'. A significant number of candidates wrote about low melting or boiling points rather than concentrating on the electronic structure.

(ii) Many candidates gave a suitable use for argon. The best answers referred to lamps or lighting. A common misconception was that argon is used for the filament in the (old fashioned) light bulb. Many candidates muddled argon with helium and suggested that argon is used in balloons or airships.

Question 4

Many candidates were able to explain the shape of the graph in **(b)** and to balance the equation in **(d)(i)**. Parts (**c)(ii)** (relative reactivity of the halogens), **(d)(ii)** (explaining the energy level diagram) and **(e)** (describing the chemical test for iodide ions) were the least well answered.

(a) Some candidates gave good answers and described both the separation and motion of the particles correctly. Others wrote about separation or motion, but not both. The commonest omission was not to write about the degree of separation of the particles in the gas. Some answers were rather vague e.g. 'the particles in the gas move more than in the solid'. Some candidates wrote about the general properties of solids and gases without reference to particles e.g. 'the particles in the solid have a fixed shape'.

(b) Most candidates described how the volume of gas changes as the pressure increases. A minority of the candidates wrote answers that were not specific enough e.g. 'it decreases with pressure'. Candidates should be encouraged to write the direction (increase or decrease) of both volume and pressure. The best answers suggested that volume decreases as the pressure increases.

(c) (i) Some candidates gave the correct reactants. Others recognised one of the reactants but made naming errors such as potassium iodine or bromide. Other common errors included the suggestion of interhalogen compounds such bromine iodide or to repeat the products iodine and potassium bromide as the reactants. A significant number of candidates included chlorine compounds in the equation, even though there was no chlorine in the products.

(ii) Few candidates explained the reaction in terms of the reactivity of the halogens. Common errors were to compare the relative reactivity of potassium with one of the halogens; to state that chlorine is above iodine in Group VII without reference to reactivity; to state that iodine is not very reactive or that potassium is very reactive; to suggest that both iodine and potassium chloride were unreactive.

(d) (i) Most candidates balanced the equation. The commonest error was to suggest 4NaI.

(ii) The best answers compared the relative energy levels of the reactants and products. The commonest error was to give a definition of exothermic rather than interpreting the diagram.

(e) Few candidates knew the qualitative test for iodide ions. A greater number knew that a yellow precipitate would be formed. Common errors included the use of sodium hydroxide, ammonia or barium nitrate for the test reagent and a white precipitate for the result. Other candidates suggested a starch test, mistaking iodine for iodide ions. Some suggested adding chlorine or suggested changes in physical properties. A considerable number of candidates did not respond to this question.

(f) Some candidates identified iodine as the electrode product. The commonest incorrect answers were sodium or iodide.

Question 5

This question was the least well answered on the paper. Most candidates were able to identify the alkane in **(a)(i)**. Few candidates were able to draw the correct structure of ethene in **(a)(ii)** or explain how aqueous bromine can be used to distinguish methane and ethene in **(a)(iii)**. In **(b)(iii)**, most candidates did not focus on the bio- in the phrase non-biodegradable and gave generalised answers. In **(b)(iv)**, many gave imprecise answers to the question about the pollution problem caused by non-biodegradable plastics. Few knew the other reactant needed to make ethanol from ethene in **(c)**, although more stated a correct condition.

(a) (i) Most candidates identified methane. The commonest errors were to suggest either ethene or carbon monoxide.

(ii) Some candidates drew the structure of ethene correctly. The commonest errors were to draw a C=C double bond but keep three hydrogen atoms on each carbon, to omit the double bond or to draw the structure of propene (often incorrectly). Others drew structures that included oxygen or omitted hydrogen atoms.

(iii) Few candidates described how aqueous bromine is used to distinguish ethene from methane. Many only mentioned the effect of bromine on ethene and ignored the effect on methane. Others mentioned incorrect colour changes or referred just to double and single bonds or saturated or unsaturated hydrocarbons rather than describing the observations on adding bromine. A few wrote vague statements about functional groups. A considerable number of candidates did not respond to this question.

(b) (i) Some candidates realised that the name of the type of reaction was polymerisation. Others gave the general name of the substance formed (polymer) or the name of the specific substance formed (poly(ethene)). Other common errors included ‘thermal decomposition’, ‘reduction’ or ‘oxidation’.

(ii) Many candidates identified monomers as the correct answer. The commonest error was to suggest ‘polymer’. A few candidates selected ‘mixtures’.

(iii) Very few candidates explained the term non-biodegradable. Better responses referred to lack of bacterial, fungal or biological action on the plastic. Most suggested that the plastic does not break down without any further detail. Others did not heed the word ‘non’ in the phrase ‘non-biodegradable’ and wrote about the plastics breaking down. Many wrote about landfill sites or litter.

(iv) The best responses gave full answers such as ‘the plastic blocks drains and leads to flooding’ or ‘the plastic gets stuck in the digestive system of animals and they die’. Others did not write in enough detail and did not mention the consequence of the actions. Many just mentioned waste or litter. Others wrote about not recycling or reusing, which does not answer the question.

(c) Many candidates thought that the question was about fermentation rather than the addition of steam to ethene. Many suggested alcohol, glucose or oxygen instead of steam as a reagent. The conditions often included incorrect statements about enzymes and room temperature. The most commonly awarded mark was for the suggestion of high temperature as a condition.

Question 6

Some candidates performed well on this question, especially in **(b)(i)**, **(c)** and **(d)**. Fewer candidates gave a convincing description of the preparation of a salt in **(a)** and many gave imprecise descriptions about alloys in **(e)**.

(a) The best answers for the salt preparation included heating the mixture, filtering and heating the filtrate or the solution to the point of crystallisation. Many candidates did not suggest heating the mixture of copper oxide and sulfuric acid and few mentioned filtering. Many of those who did mention filtering, filtered the wrong substance – many thought that the copper(II) sulfate was the residue on the filter paper at this stage. Others were unclear what was being crystallised or gave the implication of heating to dryness. A considerable number of candidates did not respond to this question.

(b) (i) Most candidates recognised a reversible reaction. The commonest errors were to suggest that it was either the backward reaction only or that it was an equal sign in the equation.

(ii) The best responses gave the simple answer ‘heat it’. Others suggested removing the water but did not explain how it could be removed. Many suggested adding water or hydrogen or gave vague answers referring to reversible reactions.

(c) Many candidates carried out the calculation successfully. The commonest errors arose either from not including all the results in the addition of the last column or incorrect multiplication. Another common error arose from not multiplying the molar mass of the oxygen by 4, giving the incorrect result of 112.

(d) The commonest errors seen were: 29 for the number of electrons in the Cu^{2+} ion (not taking into account the 2+ charge); 18 for the number of protons (number of neutrons calculated rather than number of protons) and 34 and 63 for the number of neutrons (mass number taken).

(e) (i) The best answers mentioned a mixture of a metal with another element. Many candidates did not state that an alloy is a mixture. Others suggested that an alloy was a mixture of metals or a mixture of non-metals.

(ii) The best answers used comparative terms e.g. ‘the alloy is stronger’. Errors often arose because candidates made incorrect statements about the copper or the alloy e.g. ‘copper is soft and the alloy is hard’. Many candidates wrote about differences in cost or reactivity. Reactivity is unacceptable because it depends on the nature of the alloying atoms. Many candidates wrote about rusting, which was not accepted since this only relates to iron.

Question 7

This question was one of the least well answered on the paper. Many candidates named the salt in **(a)** correctly and deduced the loss in mass in **(b)(ii)** and **(b)(iv)**. Few gave a good reason why the mass of the reaction mixture decreases in **(b)(i)**. Many candidates drew the line in **(b)(iii)**.

(a) Many candidates identified the salt as calcium chloride. Some wrote carbon dioxide and water as well. The commonest errors were calcium hydroxide or a made-up name such as ‘calcium hydrochloride carbonate’. The latter type of answer suggests that these candidates are not identifying the salt but are conflating the products. A significant number of candidates suggested sodium chloride.

(b) (i) The better responses realised that the gas which escapes has a mass and so the overall mass of the reactants and vessel decreases. The commonest errors were either to refer to evaporation of the contents of the flask or evaporation of the acid or to write vague statement about mass of the products or reactants decreasing with time.

(ii) Some candidates realised that subtraction of 199.3 from 200.0 was required and gave the correct answer. Others just read the value on the graph and gave the incorrect answer 199.3.

(iii) The best answers showed a line of steeper gradient, which clearly started at 200.0,0 and levelled off at 199.0 g before 100 s. Many candidates drew lines with a shallower gradient, but which did level off at the correct value. Others drew lines with a steeper gradient, which did not level off at 199.0 g or reached the line after a dropping well below 199.0 g. Candidates should be advised to draw their lines carefully so that there are no significant bumps in them. A considerable number of candidates did not respond to this question.

(iv) Many candidates calculated the loss of mass of calcium carbonate correctly. Others gave the answer 0.44 (dividing 0.88 by 2) or tried to do partial mole calculations. Candidates should be advised that there are no mole calculations in this sort of question in the core paper, only calculations involving simple proportion.

(v) Some candidates deduced the order of size of the pieces of calcium carbonate correctly. Others either inverted the order or, more commonly, did not realise that there should be a relationship between rate and size. Some candidates put numbers in the left-hand column rather than size of particles. Sometimes these numbers were the inverse of the rate. This suggests that these candidates did not read the stem of the question.

Question 8

This question was well answered by some candidates. Most candidates gave good answers to **(a)(ii)**, **(a)(iii)** and **(d)**. Others did not appreciate the meaning of the word ‘source’ in the stem of the question in **(a)(i)** or give a suitable adverse effect of sulfur dioxide on buildings in **(a)(iv)**. Some candidates answered **(b)** and **(c)** well. Others need more practice in writing with precision in questions requiring explanations and in naming salts formed from ammonia.

(a) (i) The best answers suggested burning fossil fuels or from volcanoes. Many candidates gave answers that were too vague e.g. ‘pollution’, ‘from factories’. Others did not appear to understand the meaning of the word ‘source’ and gave answers such as ‘it’s a toxic gas’ or ‘it forms acid rain’. A considerable minority of the candidates gave carbon dioxide as a source of sulfur dioxide, despite the lack of sulfur in the former.

(ii) Most candidates understood that catalysts speed up the rate of reaction. A few candidates just mentioned that they change or slow the rate. This is not sufficient for an answer; a substance which decreases the rate of reaction is an inhibitor.

(iii) A majority of the candidates gave the correct pH value. The commonest error was to suggest pH 13. A few chose pH 7.

(iv) Few candidates gave a good explanation of the effect of acid rain on buildings. The best answers used the terms *corrodes* (metalwork) or *erodes* (stonework). Most candidates suggested, incorrectly, more drastic effects such as ‘destroys them’, breaks them’ or ‘the building collapses’. Many suggested effects on paintwork or on colour. Others suggested that it speeds up rusting. Candidates should be advised to use the term *rusting* only with respect to the reaction of water and oxygen with iron.

(b) Many candidates correctly deduced that sulfur dioxide is liquid at –20 °C. Fewer gave a full reason for this. Some mentioned higher than melting point or lower than boiling point but only a minority mentioned that –20 °C is between the melting point and boiling point. Many wrote vague partial answers that referred to ‘not reaching the boiling point’ or ‘it’s near the boiling point’.

(c) A minority of the candidates correctly identified the salt as ammonium sulfate. Common errors included ‘ammonia sulfate’, ‘ammonium hydroxide’ or fabricated names such as ‘nitrogen hydrogen sulfide’. Some candidates suggested sodium chloride, despite the fact that there is no sodium or chlorine present in either ammonia or sulfuric acid.

(d) Many candidates interpreted the order of reactivity from the table. A few candidates put the word ‘metal’ in one of the boxes rather than one of the named elements. Candidates should be advised that they should be able to discriminate between the heading of a table and the contents of a table.

CHEMISTRY

Paper 0620/32
Theory (Core)

Key messages

- Questions where candidates have to match a chemical structure to a statement were answered well.
- Questions requiring simple answers to calculations were usually answered well, as were questions involving balancing equations and rate of reaction definitions.
- Questions on the more detailed aspects of the kinetic particle theory need to contain a more focused explanation and attention to detail. Candidates also need to think more carefully when constructing their answers to ensure responses are not confused.
- Some candidates need more practice on answering questions requiring extended answers e.g. **Question 6(a)**. Questions involving extended writing need to contain the same number of relevant points as the number of marks available. This also should be applied to any other question that has more than one mark available.
- It is very important that candidates read the question carefully in order to understand what exactly is being asked. The reading of questions properly and not quickly skipping through them became more evident this year, as in **Question 6(a)**. Practice of reading and interpreting data-based questions should also be prioritised.
- Most candidates need more practice on answering questions on the practical side of this course. In this paper, the main practical question was about making a salt from an acid and a carbonate. Many candidates struggled to answer this question with very mixed up stages. The answering of chemical test questions was generally poorly done, showing large gaps in the knowledge of many candidates. This is a part of the syllabus that needs to be practiced.
- Organic questions were answered well and many candidates could draw structures of organic compounds.

General comments

Many candidates tackled this paper well, showing a good knowledge of Core Chemistry. Good answers were shown throughout the paper to a number of different questions. However, most candidates found parts of every question challenging; longer questions in particular were poorly answered. Nearly all candidates were entered at the appropriate level but there were a few candidates scoring very low marks leaving vast amounts of the paper blank. The general standard of answering was comparable with previous years, if not slightly better. It was evident that many candidates are now using past paper practice as part of their revision program.

Misinterpretation of the rubric was seen. The most common misinterpretation or simply not reading of the rubric was in the question that asked ‘describe how the rate of reaction changes with time’. The use of ‘bromine’ instead of ‘bromide’ and ‘bromide’ instead of ‘bromine’ was seen and needs to be practiced. For example, in halogen displacement most candidates thought that the answer should be ‘bromine chloride’ instead of ‘potassium bromide’. The balancing of equations was good, showing that the candidates had practiced these as part of their revision from past papers. Definitions from across the syllabus were poorly done and candidates need to concentrate on these both when being taught for the first time and during the revision period.

The vast majority of candidates were able to 'calculate the relative molecular mass'. However, a few candidates used atomic numbers instead of mass numbers in this question. Most candidates could compare differences in two sets of data; others need to practice this as they were just quoting figures instead of writing down comparisons. Data handling questions could have been answered better. Candidates lost marks for slight mistakes and not being precise enough when answering questions. Candidates were able to draw the structure of ethane, which showed much practice in drawing the structures of organic compounds. Candidates, however, need to be more explicit when talking about certain concepts and not use the words 'it' and 'they' to answer questions as this often makes it unclear what their response is referring to.

The standard of English was reasonably good. Some candidates wrote their answers as short phases or bullet points. Candidates are less likely to write vague statements or contradict themselves if this is done. The answering of the longer type questions was slightly better than last year.

Comments on specific questions

Question 1

Candidates tackled this question reasonably well. Some struggled with **(a)(ii)** and **(b)**. A few candidates found it hard to relate the formula to the structure shown and further practice is needed here.

(a) **(i)** Most candidates could recognise the alcohol functional group.

(ii) Candidates struggled with this question and could not relate the charges to the fact it was an ionic compound. Once positive and negative charges and a metal and a non-metal are seen, candidates should be thinking of ionic bonding. More work on these observations would be an advantage.

(iii) This was a well answered question. Candidates knew that metals conduct electricity as a solid and correctly identified iron.

(iv) Candidates struggled with this question. Many could not relate the structure of SO_2 shown to its formula.

(v) Quite a few candidates could not identify that a metal oxide, calcium oxide, is able to react with an acid to give a salt and water.

(b) Candidates struggled with this definition. There were a few who wrote down excellent definitions but these were in the minority. More practice and testing of definitions would be advantageous. There were some references to mixtures, especially with the lower scoring candidates.

Question 2

Candidates struggled with this question, especially **(b)(i)**, **(iii)**, **(iv)** and **(d)**.

(a) **(i)** Some candidates answered this question correctly but many included iron in the answer. Some wrote a word equation instead. Not reading the question properly was the problem for many here.

(ii) Many candidates missed out the reason so this is something to be concentrated on.

(b) **(i)** There were many no responses for this question and quite a few wrong answers. Candidates appeared not to have read the question properly.

(ii) Most candidates knew what sublimation was. There were very good answers here.

(iii) Most candidates could not relate this question to the previous question and did not make the 'sublimation' link. Candidates need to be encouraged to make links between part questions.

(iv) Candidates struggled with this question and could not relate the 'decomposition' to the equation given. Candidates need to practice this type of question.

(c) This question was answered well with many candidates using the correct answers of 'water' and 'oxygen'. However, some candidates did not read the question properly and stated 'bromine' and 'iodine', which were already given in the question.

(d) Candidates appeared to have struggled with the learning of the chemical tests that are in the syllabus. This question was very poorly answered with many candidates putting completely the wrong test down, getting mixed up between tests or not putting down a chemical test at all. Some candidates got the correct test but then went on to put the incorrect observations. For example, 'brown precipitate', which is wrong.

Question 3

Candidates coped well with this question especially **(a)(i)**, **(ii)** and **(b)(i)** and **(ii)**. They found **(b)(iii)** challenging.

(a) (i) Candidates did really well on this question and most got it correct. It was obvious that some candidates had a problem with the maths element. The use of calculators is a must in this type of question.

(ii) This was a well answered question.

(iii) This was more of a challenging question and some candidates failed to recognise the fact that there must be a comparison in both of the answers and not just the writing down of percentages. For example, 'oxygen has 46.60% in the Earth's crust and 85.80% in the oceans'. Most candidates attempted to write down something and some misinterpreted the question only putting information down about either the Earth's Crust or the Oceans and not a comparison of both.

(b) (i) This question was answered well, with most candidates knowing that the answer was 'bauxite'. Some candidates thought that the answer was 'hematite'.

(ii) The answering of the electrolysis product prediction questions is improving each year. This year the answers improved with more candidates achieving the two marks for the correct products. This is a concept that can be easily practiced. There were also some candidates who got the answers the wrong way around.

(iii) Candidates struggled with this question and many forgot about the reactivity of aluminium compared to carbon. Some also thought that carbon was more reactive and that electrolysis was a cheap process.

Question 4

Some candidates did well on this question with some excellent answers. Parts **(a)**, **(b)** and **(d)(i)** were answered really well, whereas candidates struggled with the other parts especially **(c)(ii)** and **(d)(ii)**. The chemical test part was poorly answered.

(a) This year the kinetic particle model question was answered well, showing that candidates are revising and understanding how to answer these types of questions. Some candidates were answering in terms of bulk properties (take the shape of the container and fixed volume).

(b) This question was very well answered by candidates and showed much practice. Most candidates achieved the mark. However, some candidates forgot to write down what was happening to both the volume and the temperature.

(c) **(i)** This year candidates forgot the difference between a halogen and a halide and wrote down 'chloride' and 'potassium bromine'. More practice was needed here. Candidates incorrectly thought that one of the answers was 'bromine chloride'.

(ii) Candidates struggled with the reactivity of the halogens and this needs to be something that is concentrated on when teaching and revising this particular topic. Candidates incorrectly wrote about the reactivity of 'chloride and bromine' and also 'potassium and bromine'.

(d) **(i)** This year, chemical equations were written and balanced reasonably well. The only mistake here was that some candidates thought that it was '2Br' instead of 'Br_2'. The diatomic nature of the halogens needs to be reinforced.

(ii) Candidates struggled with this question. This is because they did not read the question properly and therefore, did not explain what was happening in the diagram. Instead, they just wrote down the definition for an exothermic reaction. Using the words 'reactants' and 'products' would have helped most candidates.

(e) This chemical test question was poorly answered. Candidates need to concentrate on revising the chemical tests more and including being tested on them during the course. A few candidates got 'silver nitrate' but then did not get the correct colour of the precipitate.

Question 5

This organic question was answered reasonably well by most candidates. Some found **(c)(ii)** and the chemical test question **(f)(ii)** very difficult, showing more revision of the harder parts of this topic is needed.

(a) Most candidates could draw the structure of ethane. A few candidates struggled with the number of carbons it had. On the whole, this question was well answered.

(b) Most candidates knew that 'butane' was in the same homologous series as 'methane'.

(c) **(i)** This was the only filling in the blanks question from pre-determined words in the paper and most candidates performed well. Some candidates got 'larger' and 'smaller' the wrong way around. Candidates need to make sure that they read back the sentence after putting the words in to check that it makes sense.

(ii) Candidates struggled with this question and did not seem to know the conditions needed for cracking. Many had forgotten that a catalyst was involved. Some candidates knew that it was 'high temperature' or 'heat'.

(d) Most candidates went for the double-bonded structure. These candidates had forgotten that in this type of polymerisation the double bond breaks to give single bonds only.

(e) **(i)** Candidates struggled to remember a 'common use of nylon'. Better performing candidates ensure they know at least two common uses for anything that 'uses' are needed for in the syllabus.

(ii) Candidates struggled with this question and many appeared to have misread the question. More practice on this type of question would help.

(f) **(i)** Many candidates struggled with this question and could not identify the 'carbon-carbon double bond'. Candidates needed to be more specific as 'double bond' was not accepted. This answer was seen many times.

(ii) This chemical test question was very poorly answered by most candidates. Candidates are likely to benefit from more teacher-led practice of the chemical tests shown in the syllabus.

Question 6

Candidates struggled with **(a)** and **(d)** on this question. They did well on **(b)** and **(c)**, showing more knowledge on these particular topics. Candidates struggled with alloys in **(e)(i)**.

(a) Candidates struggled with this experimental question. More practice is needed on the steps to produce a pure sample of a salt. There were many confused answers here. Many candidates did not notice that excess cobalt(II) carbonate was being used so forgot to filter this off, which led to a restricted mark answer. Candidates could also not state what was left on the filter paper and what went through the funnel as the filtrate. They also did not know the exact process of crystallisation and mostly talked about evaporating off all the water, which would not give crystals. Many candidates also forgot about how the crystals are dried at the end of the process by either 'drying between filter papers' or 'drying in a drying oven'. More practice of practical-based questions would be helpful here.

(b) Candidates answered this question well and were able to work out the relative formula mass of the stated compound. Some candidates got really large numbers as they thought there were more cobalt atoms than shown in the compound.

(c) Most candidates gained some credit for this question. They struggled mostly on the number of electrons in the cobalt ion and this is something that needs to be practiced. Working out the number of neutrons was a problem, for some candidates. Continual practice of these concepts throughout the duration of this course would be advantageous.

(d) Very few correct answers were seen here as candidates forgot the colour change for the test for water using anhydrous cobalt(II) chloride. Some also stated the anhydrous copper(II) sulfate colours. Numerous other colours were also seen.

(e) (i) Many candidates thought that the answer to this question was **C**. The definition for an alloy was forgotten by many candidates.

(ii) Most candidates knew that 'stainless steel' was used to make 'cutlery'. This was a well answered question.

Question 7

Parts of this question were answered well including **(a)** and **(b)(ii)**. However, many candidates struggled with **(b)(i)** as they did not read the question properly.

(a) Most candidates got the correct answer of magnesium chloride as the salt formed. Some candidates wrote the complete word equation, which was not what the question asked for.

(b) (i) Candidates found this question the most challenging on the question paper. Many did not read that the question was asking for 'how the rate of reaction changes with time'. Most candidates just described the graph according to what happened in terms of time, instead of the correct rate and so gained no marks. The question was asking to comment on how the 'rate' changed not just how the graph changed with time.

(ii) This question was answered reasonably well and most candidates got the correct answer.

(iii) It was clear that many candidates had practiced this type of question and many performed well. Most candidates realised that it was a faster rate of reaction and so drew the line accordingly. However, some did not realise that it plateaued at exactly the same point as the line already drawn, so lost a mark here. Some candidates did not ensure that the line started at 0,0.

(iv) Some candidates got this mathematical question correct; others would benefit from more practice with this type of question.

Question 8

Candidates answered **(a)(iii)**, **(iv)**, **(c)** and **(d)** well but struggled with **(a)(i)** and **(ii)**.

(a) **(i)** Candidates struggled with this question and many would benefit from further revision on this type of 'source' question. Many candidates wrote down 'cars', which was not specific enough as 'car engines' or 'car exhausts' is required.

(ii) Some candidates recalled the adverse effects.

(iii) This was a very well answered question. Very few incorrect responses were seen.

(iv) Most candidates were able to select the correct pH.

(b) Candidates were not specific enough and did not talk about the crops being able to 'grow faster' or that there was an 'increase in plant growth'. Many just talked about 'plant growth' or 'to make plants grow', which was not enough.

(c) Most candidates were able to put the four metals into their order of reactivity. Some candidates got two consecutive ones reversed and some got the four metals the wrong way round, so had not read the question properly.

(d) The last question on the paper was very well answered with the majority of candidates stating 'gas'.

CHEMISTRY

Paper 0620/33
Theory (Core)

Key messages

- It is important that candidates read the stem of the question carefully in order to understand what exactly is being asked.
- Some candidates need more practice in answering questions involving salt preparation, organic chemistry and qualitative tests.
- Many candidates need further practice in writing specific answers.
- Interpretation of data from tables and graphs was generally well done, as was completion of simple symbol equations.

General comments

Some candidates tackled this paper well, showing a good knowledge of Core Chemistry. All the candidates were entered at the appropriate level. Many candidates answered most parts of each question. There were about ten parts of various questions where a significant number of candidates did not respond (see comments on specific questions). The standard of English was generally good.

Some candidates need more practice in reading and interpreting questions. In some questions, the rubric was misinterpreted or ignored by a significant number of candidates. For example, in **Question 2(b)** many candidates gave answers that referred to metals in general and not transition elements and also gave chemical rather than physical properties. Many candidates also gave physical rather than chemical properties when answering **5(c)**. In **Question 3(a)(ii)**, many candidates did not take note of the word metal in the stem of the question and selected a non-metal. In **Question 4(b)**, some candidates tried to explain the graph using kinetic particle theory rather than describing the relationship between pressure and temperature. In **Questions 7(b)(iv)** and **7(b)(v)**, where candidates were asked to answer the question in terms of rate, many answered in terms of time taken for the reaction to be completed. Candidates might be advised to learn how to read the stem of the question carefully in order to get the correct interpretation of what is being asked. If candidates practice looking out for key words and underline them, it may help.

Many candidates need practice in answering questions relating to qualitative analysis, organic chemistry and the preparation of salts. Very few candidates knew the test for water (**Question 3(b)(ii)**) and many did not know the details of the test for nitrate ions (**Question 7(c)**). Candidates should be prepared to revise qualitative tests for this paper as well as for the practical papers. Many candidates need further practice in memorising organic structures, including functional groups and in understanding that ethanoic acid has typical acidic properties. Most candidates need practice in describing the preparation of salts and understanding the stepwise processes involved. They should be advised to concentrate on understanding the point at which filtration is necessary and describing crystallisation in greater detail. Candidates should be encouraged to answer these questions as a series of bullet points.

Some candidates need more practice in writing specific answers rather than providing vague unqualified statements. For example, in **1(b)**, many wrote vaguely about the properties of mixtures. In questions involving environmental chemistry and uses (**5(e)(ii)**, **8(a)** and **8(f)**) most candidates need more practice in avoiding generalised answers such as ‘causes pollution’, ‘for plastics’, or ‘from factories’. Other candidates need to concentrate on their understanding and use of scientific vocabulary such as the words ‘alloys’, ‘arrangement of particles’, ‘physical properties’ and ‘chemical properties’.

A few candidates wrote good answers to the extended **Questions 4(a)** and **6(a)**. Others did not organise their work and seemed to write their answers down in a disordered fashion, as the ideas came to them. Candidates should be encouraged to answer these questions as a series of bullet points.

Many candidates were able to extract information from tables and diagrams. Others need more practice in answering questions involving graphical work. For example, in **Question 7(b)(iii)**, many candidates need more practice in interpreting given information and drawing a graph line carefully so that it does not on involve unnecessary large humps or dips.

Many candidates were able to undertake simple calculations involving relative formula mass and calculations involving simple proportion. Others need to revise these areas.

Questions involving atomic structure and balancing symbol equations were generally well known.

Comments on specific questions

Question 1

This was the best answered question on the paper. Many candidates identified at least three of the structures correctly in **(a)**, with **(i)** and **(vi)** often being correct. Few candidates gave two characteristics of a mixture in **(b)**.

(a) (i) Most candidates identified the two compounds. The commonest errors were to suggest structure **C** (bromine) and/or structure **D** (zinc).

(ii) A minority of the candidates identified the monoatomic structure. The commonest incorrect answer was **C** (bromine).

(iii) Many candidates realised that structure **D** was a metal and therefore conducted electricity in the solid state. The commonest incorrect answer was to suggest the ionic structure, **B**.

(iv) Some candidates realised that methane is the main constituent of natural gas. The commonest error was to suggest the other gaseous structure, **E** (argon).

(v) Many candidates realised that the ionic structure, **B**, is a solid that is insoluble in water. The commonest error was to suggest either **D** (zinc) or **C** (bromine). The latter was not accepted because it is a liquid at room temperature.

(vi) This was the best answered of the part **(a)** questions. A few candidates suggested structure **E** (argon).

(b) Few candidates were able to give two properties of a mixture. Many wrote statements that were too vague or gave conflicting statements such as 'it is a compound which can be separated' or 'it contains several different elements bonded that can be separated'. Many candidates used the word 'combined', which implies chemical bonding. The best answers were those that mentioned that the components in a mixture can be separated by physical means. Very few candidates referred to the variable composition of mixtures or that the chemical properties are those of the individual components.

Question 2

Many candidates were able to balance the equation in **(c)(i)** and to explain the symbol for a reversible reaction in **(c)(ii)**. Some candidates recognised hematite as an ore of iron in **(a)(i)** and deduced the molecular formula of the ion in **(d)**. Fewer candidates used the equation to explain reduction in **(a)(ii)** or used the diagram in **(a)(iii)** to explain why the reaction was endothermic. In **(b)**, many candidates did not appear to read the stem of the question and gave general metallic properties and not physical properties specific to the transition elements.

(a) (i) Some candidates recognised hematite as being an ore of iron. The commonest error was to suggest bauxite.

(ii) The best answers referred to oxygen being removed from the iron oxide. Many candidates did not gain credit because they suggested that oxygen is removed from the iron, which is on the right-hand side of the equation, rather than being removed from iron oxide. Some of these also referred to the iron on the right having oxygen removed from it. Other candidates gave statements that were too vague e.g. 'there is iron oxide on the left and iron on the right' or 'the carbon removes the oxygen' (no reference to the iron oxide). Some candidates just gave a definition of reduction rather than referring to the equation as requested.

(iii) Many candidates did nor refer to the diagram. The best answers compared the relative energy levels of the reactants and products. The commonest error was to give a definition of endothermic rather than interpreting the diagram. Other candidates did not give full enough answers e.g. 'the products are above the reactants' (no reference to energy).

(iv) The best answers compared the relative reactivity of carbon and iron. A common error was to compare the reactivity of iron and hydrogen. Some wrote about electron transfer without mentioning relative reactivity. Others wrote about the metallic properties of iron. A significant number of candidates did not respond to this question.

(b) A few candidates were able to give two specific physical properties of transition metals. Hardly any gave three correct properties. The commonest error was to give general metallic properties, such as electricity conductivity or ductility. Many candidates suggested that transition elements are coloured or referred to the compounds rather than the elements. Others did not read the stem of the question carefully enough and gave chemical properties instead of physical properties.

(c) (i) Most candidates balanced the equation correctly. The commonest error was to suggest $6Cl_2$ instead of $3Cl_2$.

(ii) Many candidates recognised that the reaction was reversible. The commonest errors were to suggest that only the backward reaction takes place, the formulae are interchangeable or that 'the sign means equals'.

(d) Some candidates counted the number of atoms correctly. Others miscounted and gave formulae such as FeC_4N_4. Many candidates were able to translate the numbers into a correct formula. Many just wrote the numbers down as iron 1, carbon 6 and nitrogen 6 or Fe + 6C + 6O. Another common error was to write the formula as $FeCN_6$. A significant number of candidates wrote incorrect formulae such as $FeCN_4CN_2C_4$.

Question 3

Many candidates gained credit for **(a)(i)** and **(b)(i)**. In **(a)(ii)**, some candidates did not appear to read the stem of the question carefully enough and chose an incorrect element. In **(a)(iii)**, many candidates either gave too generalised answers or did not read the question fully. Hardly any candidates knew the test for water in **(b)(ii)**.

(a) (i) Many candidates deduced the correct percentage of the other elements present in the biosphere. The commonest errors involved incorrect subtraction from 100 or incorrect addition of the elements shown.

(ii) Many candidates identified sodium correctly. The commonest error was caused by not reading the stem of the question carefully enough and suggesting oxygen, which has the highest percentage but is not a metal. Magnesium was another commonly seen incorrect answer.

(iii) Some candidates gave two correct differences in the percentage by mass. The best answers focused on the differences in the composition of carbon, oxygen or chlorine. Many candidates just repeated the percentages in the table without writing that one was a greater percentage than another. e.g. 'There is 0.05% calcium in the ocean and 0.4% in the biosphere'. Many candidates gave answers that were too generalised, such as 'there are more non-metals in the biosphere' or 'there are more element in the oceans and less in the biosphere'.

(b) (i) A majority of the candidates realised that carbon dioxide is a product of respiration. The commonest incorrect answer was oxygen. A few candidates suggested energy, which is not a chemical product.

(ii) Very few candidates knew the chemical test for water. The commonest incorrect answers related to the use of litmus, hydrogen or copper. Others suggested that the pH would be 7 or wrote about the boiling point of water. These are not chemical tests. A few narrowly missed the correct reagents (anhydrous copper(II) sulfate or anhydrous cobalt(II) chloride) and suggested copper(II) carbonate instead. Few mentioned that the reagent should be anhydrous. A significant number of candidates did not respond to this question.

Question 4

Many candidates were able to explain the shape of the graph in **(b)** and to balance the equation in **(d)**. Parts **(a)** (using the kinetic particle model), **(c)(i)** (word equation) and **(c)(ii)** (relative reactivity of the halogens) were the least well answered.

(a) Some candidates gave good answers and described both the arrangement and motion of the particles correctly. Others wrote about motion, but few wrote about the arrangement of the particles. Most confused the arrangement of particles with the proximity of the particles and wrote about particles being close or far apart. Some answers were rather vague e.g. ‘the particles in the gas move more than in the solid’. Some candidates wrote about the general properties of solids and gases without reference to particles e.g. ‘the particles in the solid have a fixed shape’. Others wrote about the shapes of particles e.g. tetrahedral.

(b) Most candidates described that the pressure of gas increases as the temperature increases. A minority of the candidates wrote answers that were not specific enough e.g. ‘it increases with temperature’. Candidates should be encouraged to write the direction (increase or decrease) of both pressure and temperature. Others misunderstood the question and answered in terms of the motion of the particles rather than interpreting the graph.

(c) (i) Some candidates gave the correct reactants. Others recognised one of the reactants but made naming errors such as sodium iodine or chloride. Other common errors included the suggestion of interhalogen compounds such chlorine iodide or just repeated the products iodine and sodium chloride as the reactants. A significant number of candidates did not respond to this question.

(ii) Very few candidates explained the reaction in terms of the reactivity of the halogens. Common errors were to compare the relative reactivity of sodium with one of the halogens; to state that bromine is above iodine in Group 7 without reference to reactivity; to state that iodine is not very reactive or that sodium is very reactive; to suggest that both iodine and sodium chloride were unreactive. A significant number of candidates did not respond to this question.

(d) Many candidates balanced the equation. The commonest errors were to suggest 18HCl or 24HCl or 4C and 8HCl.

Question 5

Most candidates were able to identify the correct number of atoms in **(a)(ii)** and explain why a catalyst is used in **(d)(ii)**. Few candidates were able to describe the chemical properties of ethanoic acid in **(c)** or draw the structure of ethanol in **(d)(iii)**. In **(e)**, few candidates knew the name of the polymer of ethene or could give a use of *Terylene*.

(a) (i) Some candidates identified the carboxylic acid group. Others included the carbon atom next to this group or put a circle around the COH or HC=C groups.

(ii) Many candidates identified the number of different types of atom in the structure correctly. The commonest error was to suggest two different types. The numbers four or six were also not uncommonly seen.

(b) (i) Some candidates realised that structure **S** was a solid at 100 °C. Fewer gave a full reason for this. Some mentioned that 100 °C is lower than the melting point. Others did not refer to the 100 °C or reference this value in some way. Many wrote vague partial answers, which referred to ‘not a high enough temperature to melt’ or ‘it becomes liquid after its melting point’. Some candidates were so used to this type of question referring to liquids, that they suggested ‘liquid because it is between its melting and boiling points’.

(ii) Some candidates realised that if a substance is impure, its boiling point is elevated and its melting point is reduced. The commonest error was to tick the second box down (melting point is reduced but boiling point is the same).

(c) A minority of the candidates realised that ethanoic acid had typical acid properties e.g. reaction with carbonates, turns litmus red, reacts with (reactive) metals. Most candidates gave answers that referred to its structure e.g. 'has a COOH group', 'contains hydrogen' or has C-O (or C=O) bond. Others wrote about physical properties instead of chemical properties, referring to melting points or pH values. Many candidates wrote imprecise answers, such as 'very reactive' or 'dangerous'.

(d) (i) Some candidates recognised that water would be formed. Others suggested OH or oxygen. A significant minority of the candidates repeated substances given in the stem of the question, either aluminium oxide or ethanol.

(ii) Most candidates understood that catalysts speed up the rate of reaction. A few candidates just mentioned that they change or slow the rate. This is not sufficient for an answer; a substance which decreases the rate of reaction is an inhibitor.

(iii) Some candidates drew the correct structure of ethanol. Others drew structures with C–H–O bonding. Many candidates drew hydrocarbons instead of an alcohol, ethane being the commonest incorrect answer. Others included an oxygen atom but drew carbon=carbon, carbon=oxygen or carbon=hydrogen double bonds. A significant number of candidates did not respond to this question.

(e) (i) A minority of the candidates gave the correct name, poly(ethene). Many suggested ethanol gas or polyester. A significant number of candidates did not respond to this question.

(ii) Few candidates gave a correct use for *Terylene*. The commonest errors appeared to be guesses e.g. 'medicine', 'curing cancer', 'nylon'. Others gave vague references to the fact that *Terylene* is a polymer e.g. 'used for plastics' or 'used to cover things'. A significant number of candidates did not respond to this question.

Question 6

Some candidates performed well on this question especially in **(b)(ii)**, **(c)** and **(d)**. Few candidates gave a convincing description of the preparation of a salt in **(a)** and many gave imprecise descriptions about alloys in **(e)**.

(a) The best answers for the salt preparation included heating the mixture, filtering and heating the filtrate or the solution to the point of crystallisation. Many candidates did not suggest heating the mixture of zinc and sulfuric acid and few mentioned filtering. Many of those who did mention filtering, filtered the wrong substance – many thought that the zinc sulfate was the residue on the filter paper at this stage. Others were unclear about what was being crystallised or gave the implication of heating to dryness. A significant number of candidates did not respond to this question.

(b) (i) Some candidates recognised the (thermal) decomposition reaction. The commonest errors were to suggest displacement or oxidation.

(ii) Many candidates calculated the mass of zinc oxide correctly. Others gave the answer 1.99 (dividing 12.6 by 6.34) or subtracted 6.34 from 12.6. A few tried to do partial mole calculations. Candidates should be advised that there are no mole calculations in this sort of question in the core paper, only calculations involving simple proportion.

(c) Most candidates carried out the calculation successfully. The commonest errors arose either from not including all the results in the addition of the last column or incorrect multiplication.

(d) Many candidates gained partial credit. For the number of electrons, the commonest errors were 36 and 67 (using the mass numbers) or 30 or 32 for the number of electrons in the Zn^{2+} ion (not taking into account the 2+ charge). For the number of neutrons, 36 and 67 (mass number) were the commonest error. For the number of protons, 36 (mass number) or 20 (neutron number) were common errors.

(e) The best answers mentioned a mixture of a metal with another element. Many candidates did not state that an alloy is a mixture. Others suggested that an alloy was a mixture of metals or a mixture of non-metals.

Question 7

This question was generally well answered. Many candidates deduced correctly the time taken to finish the reaction in **(b)(i)** and the volume of carbon dioxide produced in **(b)(ii)**. Many candidates drew the line in **(b)(iii)**. Fewer candidates knew the test for nitrate ions in **(c)**.

(a) Some candidates identified the salt as magnesium nitrate. Others wrote carbon dioxide and water as well. This type of answer suggests that these candidates are not identifying the salt but are conflating the products. The commonest errors were made up names such as 'magnesium nitroxide' or 'magnesium nitrohydroxide'.

(b) (i) A majority of the candidates correctly deduced the time taken for the reaction to go to completion. Incorrect answers were usually considerably different from the correct answer e.g. 80 s or 140 s, the latter being the point where the horizontal line ended on the graph.

(ii) A majority of the candidates deduced correctly the volume of carbon dioxide produced after 50 s. The commonest errors were 35 cm^3 and 38 cm^3.

(iii) The best answers showed a line of steeper gradient, which clearly started at 0,0 and levelled off at 41 cm^3 before 90 s. Many candidates drew lines with a shallower gradient, which levelled off below the correct value. Others drew lines with a steeper gradient, which did not level off at 41 cm^3 or dropped back to the horizontal line after rising well above 41 cm^3. Candidates should be advised to draw their lines carefully so that there are no significant bumps in them. A considerable number of candidates did not respond to this question.

(iv) Many candidates realised that increasing the temperature, increases the rate of reaction. Common errors included reference to time taken for the reaction to be completed rather than rate or trying to explain the difference using kinetic particle theory rather than stating the effect.

(v) Some candidates realised that decreasing the concentration of nitric acid, decreases the rate of reaction. Common errors included reference to time taken for the reaction to be completed rather than rate or trying to explain the difference using kinetic particle theory rather than stating the effect. Others suggested that less carbon dioxide was produced.

(c) The test for nitrate ions was not well known. Common errors included ammonia instead of aluminium and nitrate instead of ammonia. Many candidates suggested incorrectly that damp blue litmus would turn red when exposed to ammonia.

Question 8

Most candidates gave good answers to **(b)**, **(d)** and **(e)**. In **(a)**, the source and adverse effect of lead compounds was not well known. In **(c)**, very few candidates interpreted the diagram correctly to explain why graphite is used as a lubricant. Some candidates identified a greenhouse gas and its effect on the environment in **(f)**. Others muddled the effects with other atmospheric pollutants and suggested effects on health.

(a) (i) Few candidates knew the source of lead compounds in leaded petrol or (old) paints. Most either gave answers that were too vague, such as 'cars' or 'factories'. Others gave incorrect sources such as 'burning carbon' and many suggested 'carbon dioxide'. A significant number of candidates did not respond to this question.

(ii) A few candidates knew that lead compounds cause brain or nerve damage, especially in children. Most of those referred to the poisonous nature of lead compounds. Incorrect answers commonly seen included 'contaminants', damages lungs' and 'damages skin' (perhaps muddling with the effects with other atmospheric pollutants). Candidates should be advised to learn the sources and effects of each of the pollutant substances named in the syllabus.

(b) Many candidates could interpret the order of reactivity from the table.

(c) A minority of the candidates referred, correctly, to the layers sliding. Most did not refer to the layers and wrote vaguer statements such as 'the bonds are not difficult to break' or 'its structure is weak so the atoms can move away easily'. Others wrote about bulk properties such as 'it is flexible' or 'it is soft'.

(d) Many candidates recognised that carbon monoxide is a toxic gas formed when carbon burns in a limited supply of air. The commonest errors were to suggest 'carbon dioxide' or 'greenhouse gas'.

(e) Most candidates chose the correct pH for a solution that is slightly acidic. The commonest error was to suggest pH 8.

(f) (i) Some candidates realised that methane is a greenhouse gas found in the atmosphere. Others selected gases that are not present in the atmosphere to a great extent, such as hydrogen (the commonest incorrect answer) or gases that are not greenhouse gases, such as nitrogen.

(ii) The best answers focused on global warming or ice-caps melting. Many candidates gave generalised answers such as 'health problems', 'pollutants' or 'toxic'. Others incorrectly concentrated on the mechanism rather than results e.g. 'they absorb u.v. rays'.

CHEMISTRY

Paper 0620/41
Theory (Extended)

Key messages

- Candidates must read questions carefully to ensure that the answer they give addresses what has been asked. Responses seen in **Question 3(c)** where chemical properties were asked for, but physical properties were given and **Question 4(b)(ii)** where descriptions of the reactions rather than observations were given, were typical examples where candidates did not address the question.
- When drawing organic structures, candidates should be aware that structures will require all bonds to be drawn and thus the valency of the atoms needs to be correct. Trivalent or pentavalent carbon atoms were often seen.
- When a chemical equation is asked for, this means a balanced symbol equation using correct symbols/formulae and not a word equation.
- If, for example, two properties are asked for such as in **Question 3(c)**, more than two properties should not be given as incorrect statements may contradict correct answers.

General comments

Most candidates appeared to be well prepared for this paper, with only a relatively small proportion who would have benefitted from being entered for the core level paper.

Most candidates attempted to show full working in the two calculation questions; this is good examination practice.

Candidates should be encouraged to learn the definitions in the syllabus, as these tend to be straightforward marks and are very accessible.

Very few candidates felt the need to write on extra pages. Any candidate who uses the blank pages should clearly identify which question they are answering.

Comments on specific questions

Question 1

(a) Most candidates were awarded both marks for this recall of a syllabus statement. A significant number of candidates only gave a vague reference to the location of protons. e.g. ‘in an element’. Some responses demonstrated a misunderstanding about the nature of sub-atomic particles and incorrect phrases such as ‘positive ions’ or ‘positive atoms’ appeared.

(b) (i) Most candidates performed well. A common error was to use the nucleon numbers of 24 and 26 for the numbers of neutrons.

(ii) The answer was usually correct; occasionally ‘isomers’ appeared.

(iii) There were many instances where the candidates provided the definition of isotopes, ‘same number of protons but a different number of neutrons’ rather than answering the question set.

(c) Very few responses gained no credit. Common errors were showing Be with a charge (typically +1 or +2), using a mass number for C*l* of 35.5 or simply just omitting mass and atomic numbers.

(d) Most candidates gained full credit; a number did not recognise the electronic structure of the sulfide ion was required and gave the electronic structure of the sulfur atom.

Question 2

(a) and **(b)**
Most candidates recognised the typical temperature graph and were able to state the melting point was 80 °C and that at boiling, the graph would become horizontal at 220 °C.

(c) Many answers indicated misunderstandings about what happens when a substance is melting. Some showed understanding that bonds or forces are being broken but did not relate that to heat or energy being supplied and vague responses such as 'the attractive forces were being broken down so that its state could change' were seen. Where candidates did refer to energy being used to break the attractive forces, only a minority went on to say that these forces were between molecules.

(d) This question proved challenging for many candidates. The idea of vibrating particles was often known; many candidates then went on to describe the change of particle behaviour after melting rather than up to melting.

(e) Most candidates realised that a melting point would decrease and a boiling point would increase when impurities are present.

(f) Sketching the cooling of the sample so it fitted within the given limits of temperature and time caused problems for many candidates. Numerous candidates, who had generally handled the data associated with heating up **Z**, did not include a horizontal line for the period of **Z**'s freezing. Other candidates displayed a weak command of graphical skills and drew incorrect horizontal lines at, typically, 60 °C and a final temperature of 0 °C .

Question 3

(a) The processes involved in the extraction of zinc were well known. Common errors associated with **step 1** were using zinc rather than zinc blende as a starting material, omitting roasting and using oxygen instead of air. The difficult equation was known by many candidates. **Step 2** enabled many candidates to compare the reduction with that which occurs in a blast furnace. However, this comparison led to erroneous responses about the removal of zinc where 'tapping off as a liquid' was frequently seen.

(b) The majority answered this correctly. Some incorrect suggestions for brass were seen including ZnCu, CuZn, Copper Zincate and tin.

(c) Some candidates did not understand the difference between physical and chemical properties and so provided physical rather than chemical properties. Many had the idea of coloured compounds and catalytic activity but occasionally the erroneous response of 'coloured elements' was seen.

(d) (i) Despite the instruction to state the full name, 'anhydrous' was almost invariably omitted from those who realised copper(II) sulfate was the compound used to test for water.

(ii) The colour change associated with the test for water was generally well known. 'Colourless' was a popular alternative offered for 'white'. 'Blue to pink' was often seen, showing confusion with cobalt(II) chloride.

(e) (i) The correct balancing of this equation was achieved by many candidates. Some candidates were tempted to amend formulae in order to achieve correct stoichiometry and incorrect substances such as KI_3 appeared.

(ii) Many candidates were able to state '+1' as the answer; others gave a vague 'positive' as the response and gained no credit.

(iii) Many candidates chose to ignore the instruction 'In terms of electron transfer'; those who addressed the question often correctly stated copper was gaining electrons.

(iv) Only the better performing candidates tended to realise that potassium iodide was responsible for the reduction process.

Question 4

(a) (i) Very few candidates kept to the syllabus definition of an acid being a proton donor and wrote at length of other properties of acids.

(ii) Despite 'proton donor' being written in **Question 4(a)(i)**, very few of these candidates were able to show ethanoic acid dissociating into a proton, despite an example of an acid dissociating into protons being given in the question. Better performing candidates were able to give the correct anion.

(b) (i) Many candidates did not appreciate the significance of the word *observations* and many answers provided no description of what would be seen, only statements about the process. Examples of such responses included 'quicker reaction' or 'stronger reaction'.

(ii) Many candidates correctly identified at least two conditions. Better performing candidates gave precise statements such as 'concentration of acids and surface area of calcium carbonate' rather than simply 'concentration' or 'surface area'.

(c) This question provided an opportunity for many candidates to gain full credit. The major difficulty, apart from calculating the number of moles of HCl, was correctly applying the stoichiometry to determine the number of moles of $MgCO_3$.

(d) Candidates found this question on salt preparation challenging.

(i) Most candidates knew that excess $MgCO_3$ was added to react with any HCl present, but poorly expressed responses sometimes implied that the reason was to make sure all the $MgCO_3$ reacts e.g. 'to make sure it all reacts'.

(ii) Only a minority realised that the rinsing associated with filtration was, in this case, done to retrieve the maximum yield of $MgCl_2$(aq). The common error was to state 'to remove any HCl' – despite giving this exact response in **(i)**.

(iii) As the candidates now had a solution to deal with, filtration (included by many) was not needed. Simply evaporating, crystallising and drying the resultant crystals were the steps needed. Commonly, carelessly phrased answers were seen, that implied the saturated solution formed after heating was to be dried between two filter papers.

(e) (i) The knowledge that a precipitate is the product formed when two aqueous species react to form one insoluble product was not known by many. Vague responses about a solid forming gained partial credit, but it was evident many thought any solid in a reaction was a precipitate.

(i) The knowledge behind this common laboratory test was not well known. Some candidates identified the nitrate as being a suitable silver salt. There were relatively few candidates who could write the formulae of all the missing species correctly. Consequently, the equation was rarely correct. Candidates were asked to name the silver salt and incorrect spellings of the name were common. Candidates who chose to give a formula risked losing the mark as only the correct formula could be credited.

Question 5

(a) This was well known.

(b) The concept of molecular formula was not always known and abbreviated structural formulae, such as $CH_2CHCH_2CH_2CH_3$ were often seen.

(c) Most candidates correctly identify **E**; a large proportion struggled to give a correct explanation. The misconception that the bonds in the molecules break when a substance boils was frequently evident in responses e.g. 'it has the highest number of covalent bonds, which would require more energy to break'. Other explanations often suggested that **E** had the 'largest number of molecules' showing confused terminology.

(d) Compound **A** was usually identified; the knowledge that rate of diffusion is linked to M_r was less well known.

(e) Most candidates were able to give the correct colour change; the reverse was also seen frequently. Some incorrect products were given, usually incorporating Br but retaining double bonds leading to pentavalent C atoms. Sometimes hydrogen atoms were missing, leading to trivalent carbon atoms. Incorrect responses, but with correct valencies, were seen such as: 1,1–dibromobutane, 1,4–dibromobutane and 2,3–dibromobutane.

(f) (i) Some candidates drew structures with incorrect numbers of bonds on C atoms. Generally, candidates appreciated that propan-1-ol and propan-2-ol would form. Candidates were asked to show every atom and every bond. Frequently, the hydroxy group appeared as –OH rather than –O–H. Poor connectivity cost some candidates marks e.g. OH–C.

(ii) Most candidates could access this question and there were many candidates who gained full credit. A common error amongst those who knew this industrial process was to state water, rather than steam, as the reagent. Some candidates opted to describe a fermentation process.

(g) (i) Addition (polymerisation) was known by most candidates. Additional was not accepted.

(ii) Many candidates struggled to correctly name this addition polymer as 'poly(but-1-ene)'.

(iii) Candidates realised that addition polymerisation included the breaking of the double bond, to form a single bond and that the rest of the structure would remain untouched. Many did not realise that they were completing an equation and omitted the use of a subscript 'n'.

(iv) Terminology associated with organic chemistry was not known and many candidates gave the molecular formula or structural formula rather than the empirical formula.

CHEMISTRY

Paper 0620/42
Theory (Extended)

Key messages

- The use of fractions as numerical answers to calculations should be avoided.

- Candidates should understand what the word 'observation' means and how to answer questions that ask for observations. They should describe:
  - colour changes
  - physical states i.e. solid, liquid or gas
  - the formation of precipitates
  - effervescence or bubbling when a gas is evolved.

  It is unnecessary to give the names of substances when asked for observations or to give tests for gases, unless they are requested.

General comments

Substances that conduct electricity do so because they have either ions that are moving or electrons that are moving. The words 'free' and 'delocalised' are inappropriate when explaining why substances conduct electricity.

Candidates should be aware that when they are asked to draw the structures of two (or more) isomers it is a mistake to draw the same molecules in different ways e.g. back to front or with the longest carbon chain drawn at an angle.

When discussing collision theory of reaction rates, it is essential to refer to collision *frequency* as opposed to collisions alone.

Details of methods of preparation of salts and the reasons for each part of the procedure should be revised more thoroughly.

Comments on specific questions

Question 1

(a) This was the only part of **Question 1** that was not answered well. Nitrogen was a common answer. Natural gas was possibly confused with air.

(b) This was answered very well. Ethanol was seen occasionally as an incorrect answer, possibly illustrating some confusion between respiration and fermentation.

(c) This was answered very well. Iron(III) oxide was seen occasionally as an incorrect answer.

(d) This was answered extremely well. Ethanol was seen occasionally as an incorrect answer, possibly illustrating some confusion between respiration and photosynthesis.

(e) This was answered very well. Nitrogen was commonly seen amongst the small number of incorrect answers. There was possible confusion between greenhouses and fertilisers.

(f) This was answered very well.

Question 2

(a) (i) This was answered extremely well. There were no common incorrect answers.

(ii) The reason why the overall charge is zero is that isotopes contain equal numbers of protons and electrons. Therefore, the number of positive charges in an isotope is equal to the number of negative charges. Many candidates found it difficult to express this using the correct terminology. Common answers did not refer to protons or electrons.

(iii) Many candidates realised that the reason for isotopes of the same element having the same chemical properties was related to the fact such isotopes contain the same number of electrons. However, reference to the outer shell was less common.

(iv) Sodium ions have one positive charge because the number of protons they contain is one more than the number of electrons. Candidates found it difficult to express this precisely enough.

(b) (i) This was answered very well. Silicon(IV) oxide was seen occasionally, as were oxides of carbon.

(ii) This was answered extremely well.

Question 3

(a) (i) This was answered extremely well. Ionic and metallic were seen very infrequently.

(ii) It was essential to refer to weak forces of attraction *between molecules* in order to gain credit. The most common answer was that attractive forces between particles (without reference to molecules) are weak.

(iii) Substances conduct electricity if they contain charged particles that are moving. Many candidates incorrectly used the words 'free' or 'delocalised' as alternatives to moving.

(b) (i) This was answered extremely well.

(ii) This was answered quite well. Candidates should be aware that redox is a type of reaction. Oxidation only describes what one reactant undergoes, as does reduction. Neither oxidation nor reduction should be described as a type of reaction.

(c) There were some extremely good answers to this difficult equation. Many candidates were able to write the formula of sodium phosphate and carry out the balancing perfectly.

(d) This was answered extremely well.

(e) (i) Candidates gave a wide variety of descriptions of the term *base.* Only proton acceptor was acceptable.

(ii) Candidates found this equation difficult. The salt produced often was given the formula $(NH_3)_2SO_4$, as well as many others. The minority that wrote a correct formula for ammonium sulfate usually included other products such as water or hydrogen. It seemed that only a few candidates knew that the product was an ammonium salt and that the formula of the ammonium ion is NH_4^+.

Question 4

(a) Many candidates suggested that hydrogen is extracted from air. The question asked for the 'source', as opposed to naming the method of extraction.

(b) This question was answered quite well; very few candidates gained full credit as a wide variety of errors were seen. Catalysts increase the rate of both forward and reverse reactions in an equilibrium.

The question asked candidates to respond, 'using only the words *increases*, *decreases* or *no change*'. Some candidates decided to ignore this instruction.

(c) (i) This was answered well. Similar physical properties were occasionally seen. Better performing candidates were aware that the words 'same' and 'similar' have different meanings.

(ii) Candidates are advised to draw all the carbon atoms in the longest carbon chain horizontally rather than with a bend. Many drew the same alcohol twice, thinking that they had drawn two different structures. There is no alcohol simply called propanol. The O-H bond was often missing on both structures.

(iii) The word 'structural' was often missing from structural isomer. Isotope was seen occasionally as was 'structural isotope'.

(d) (i) This was answered quite well with many names spelt correctly. Methyl ethanoate was an occasional incorrect answer.

(ii) This was answered quite well. Methanol and ethanoic acid were occasionally seen.

(iii) Candidates found this challenging. Many drew the ester in **(d)(i)** in a different way, usually backwards. Carboxylic acids were seen often.

Question 5

(a) This was answered very well. Some used a 1:6 mole ratio (for no obvious reason) giving an answer of 3.75 g. Some used a 1:5 mole ratio giving an answer of 3.125 g.

(b) This was the least well-answered question on the paper. Many assumed impurities were present, without any evidence in the question. Carbon dioxide escaping and even copper(II) sulfate vaporising were common errors.

It was common to see answers that stated, 'yield is less than 100%'. This was rewriting the question rather than answering it. The question is essentially asking '*why* is the yield less than 100%?'.

(c) Despite the request for observations, many answers gave names and/or explanations rather than observations. The presence of a solid and the absence of effervescence/fizzing/bubbling are the statements that were required, although rarely seen. Common incorrect errors were that the copper(II) carbonate stops dissolving or that a gas stops forming; neither is an observation.

(d) Correct reference to surface area was common. Collisions were referred to only occasionally. Less *frequent* collisions was mentioned even more rarely.

(e) Salts such as copper(II) nitrate and copper(II) chloride were more common than bases.

(f) This was answered very well.

(g) (i) There was much discussion of single and double bonds as found in saturated and unsaturated hydrocarbons, rather than saturated solutions. Those who answered in terms of solutions often stated that there is more solute than solvent (the words solute and solvent were often confused). Temperature was only mentioned occasionally.

(ii) The formation of crystals (or any solid) was only seen occasionally.

(iii) The removal of water *of crystallisation* by heating to dryness was only mentioned occasionally.

Question 6

(a) This was answered quite well. Colours of other halogens e.g. brown/green/purple were occasionally seen.

(b) (i) Candidates found this challenging. Some candidates gave the colour of chlorine rather than that of aqueous potassium bromide at the start. A variety of final colours was seen. Some gave the colour change the wrong way round.

(ii) This was answered quite well. Br and C*l* were seen occasionally as the formulae of the halogens.

(c) This was answered well by the majority of candidates.

Question 7

(a) (i) This was answered quite well.

It oxidises/it oxidises itself/it is itself oxidising are all phrases that should be avoided. All are ambiguous and could mean that they are oxidised or that they oxidise other things.

'A reducing agent is oxidised' is the best way to express one version of the correct answer.

(ii) Oxidation and reduction were just as common as the correct answer. 'Electrolysis' and 'ionic reaction' were seen quite often.

(b) The standard of writing ionic half-equations has improved considerably. Ag^{2+} and unbalanced equations were seen occasionally.

(c) This was answered quite well. The reverse order was seen occasionally.

(d) It was essential that candidates made it clear whether they were referring to nickel or sodium in their answer. Chemical properties were mentioned occasionally.

(e) This was answered quite well. There were no common errors.

(f) (i) In some answers there was no form of nickel in either of the electrodes or the electrolyte. Some used copper and copper salts or graphite electrodes. Only aqueous solutions can be used as electrolytes in electroplating.

(ii) In some cases, **N** was drawn outside the electrolyte. A significant number of candidates did not attempt this question.

CHEMISTRY

Paper 0620/43
Theory (Extended)

Key messages

- Candidates must ensure that they read questions carefully to ensure that the answer they give addresses what has been asked. Candidates often did not answer what had been asked.
- Carbon forms four covalent bonds and hydrogen one; errors in the numbers of bonds formed by atoms in organic molecules were common.
- Candidates need to be able to write the formulae for compounds involving ions found on the syllabus. Knowing the charges on the common ions will enable them to work out the correct formula for a compound. This is important when writing a chemical equation; if a formula is wrong, it is often not possible to award any marks.

General comments

Candidates who read the questions carefully and had prepared for the examination thoroughly, produced some excellent answers which were well structured and detailed.

Candidates who gave working in the calculation in **Question 3(e)** were often able to gain partial marks, despite their final answer being incorrect.

Comments on specific questions

Question 1

(a) Many fully correct answers were seen. The most common errors were in the mass of the proton and/or neutron or leaving some table cells blank.

(b) Most candidates performed well. Common errors included stating the ion had 44 neutrons (possibly some confusion with nucleons) or 20 electrons (missing the fact the particle was an ion rather than an atom).

Question 2

(a) Fully correct answers were common. Some candidates ignored the instruction in the question to state in terms of electrons, neutrons and protons and gave answers which did not address what had been asked.

(b) (i) Overall, this was well answered. The best answers linked the same number of electrons leading to identical electronic configurations and so the same chemical properties.

(ii) Many fully correct equations were seen. A common error was to give the formula of magnesium chloride as ‘$MgCl$’.

(iii) The gas test for hydrogen was well known by most candidates. It was common for candidates to give the result of the test (a pop) without giving the test itself. It should be noted that placing a lit splint at the mouth of a test-tube containing gas is **not** a flame test.

(c) Some fully correct answers were seen. However, the majority of candidates struggled with this question. A common error was to describe the structure and bonding in magnesium oxide; it is essential for candidates to read the questions with care. The most commonly scored mark was for the idea of the delocalised electrons; relatively few candidates considered the attractions between cations and electrons.

(d) (i) The majority of candidates gave the charges on the two ions. It was common for there to be errors in the numbers of electrons (or the symbols used for them) in the outer shells of each ion.

(ii) The best answers referred to the strong attraction between the oppositely charged ions. However, many candidates were under the misconception that the properties of the elements that make up a compound give information on the properties of the compound and so used the reasoning that as magnesium has a high melting point so does magnesium oxide (ignoring the fact that oxygen has a low melting point).

(iii) The best answers referred to the mobility of ions. It should be noted that 'free' or 'delocalised' alone are insufficient, the ions need to be free to move throughout the substance. Many candidates were under the misconception that the properties of the elements that make up a compound give information on the properties of the compound and so used the reasoning that as magnesium conducts electricity, so does magnesium oxide.

Question 3

(a) (i) Many fully correct answers were seen; there were many answers which scored zero. The most common error was to give chemical properties rather than physical ones.

(ii) This was very well answered. The vast majority of answers were based on the fact that a gas is made and so bubbling would be seen.

(b) There was a significant improvement in the standard of the answers to this moles calculation compared with answers seen in previous years. Relatively few blank responses were seen. The way in which the question was structured meant far more candidates than in previous years were able to gain marks for their working.

(c) A minority of candidates gained full credit. The most common error was to state that silicon(IV) oxide is amphoteric.

(d) (i) The best responses gave the correct formula for the unfamiliar azide ion. There was some confusion over the meaning of 'formula' as a significant number of candidates tried to write an equation for a reaction.

(ii) The majority of candidates were able to give the correct state symbols for the products. However, errors in the formula of sodium nitrate were common.

(iii) Many good answers based on filtering and then washing the residue were seen. It was evident that not all of the candidates read the information in the question carefully and so described how to obtain a sample of the soluble product rather than the insoluble one.

(e) This was designed to be a demanding empirical formula calculation. More fully correct answers than has been the case in previous years were seen. Most candidates made some progress, with only a minority of candidates not knowing where to start with this calculation. One of the most common errors involved rounding. Dividing the percentage composition figures by the A_r of each element and then diving the numbers obtained to give a ratio to 1 gives the ratio 1.33: 2.33: 1. This ratio should not then be rounded to 1:2:1, it should be multiplied by integers until numbers very close to whole numbers are obtained.

Question 4

(a) (i) Despite the question telling candidates that platinum was a good conductor of electricity and then asking for one other property of platinum, many candidates stated that platinum was a good conductor of electricity. Candidates must read the questions carefully.

(ii) Most candidates were able to correctly state that bubbles would be seen. However, some candidates did not state something that could be **seen** – 'chloride ions losing electrons' was given in a number of responses and while this is a true statement as to what happens, it cannot be seen.

(iii) Some very good answers to this question were seen. A number of candidates incorrectly attributed the mass change to the loss/gain of electrons.

(iv) Many candidates were able to correctly state that the solution would fade or become colourless. Only the best responses explained why in terms of copper ions being removed from the solution. A common error was to attribute the green colour to the chlorine.

(v) Few candidates scored both marks. Most related oxidation to a loss of electrons; very few candidates could state what had been oxidised. The species oxidised in any reaction must be on the <u>left</u> (a reactant) in the equation, hence it could not be chlorine since it was a product in the equation given. The species oxidised was chloride ions.

(b) (i) It was rare to award full marks for this question. The most common marks awarded were for correctly identifying the materials from which the two electrodes should be made. It was common for candidates to omit what should be used as the electrolyte. Vague answers such as 'a silver salt solution' were not credited. Candidates should have given the name of a suitable salt.
Silver chloride (and bromide and iodide) were not accepted as candidates should be aware that these are insoluble (formed as precipitates in the halide ion identification tests). Very few candidates could write the half-equation for the formation of silver. The most common error was to give the incorrect charge on the silver ion.

(ii) This was generally well answered. A common error was to say that it enabled spoons to conduct electricity.

Question 5

(a) (i) The name of the ester formed was well known.

(ii) Despite the structural formula of the ester being given in the equation, many candidates drew structures with the incorrect number of atoms of each element. Pentavalent carbons were common as were divalent hydrogens.

(b) Almost all candidates were able to gain at least one mark on this question. Very few gained full credit. It was common to omit the labelling of the energy change, ΔH. The energy change, ΔH should be shown by a labelled arrow, which goes from the reactants to the products.

(c) Many candidates gained both of the available marks. The most common error was to state 'catalysts do not take part in the reaction'. If catalysts did not take part in some way, then they would not change the rate of the reaction; the key thing is that they are unchanged at the end of the reaction.

(d) The majority of answers gained at least two marks, normally for using the idea of particles colliding and the particles having more energy. It was less common to see explanations that stated there were a greater frequency of collisions rather than there just being more collisions. Very few responses noted that a greater proportion of collisions were successful or that more of the particles had energy greater than or equal to the activation energy. Just stating there are more successful collisions is insufficient as if there are more frequent collisions there must be more successful collisions.

(e) Candidates found the question on equilibria demanding.

(i) This question asked for the effect on the amount of ester at equilibrium, hence answers which did not state this could not gain full credit. The expected explanation should have linked the movement of the equilibrium to the fact that the (forward) reaction was exothermic. It should be noted that there is not an ‘exothermic side’, it is the change from reactants to products that is exothermic and so it is an ‘exothermic direction’ or ‘exothermic reaction’.

(ii) This question asked for the effect on the amount of ester at equilibrium. Responses which did not state this could not gain full credit. In the explanation, very few candidates considered the move in equilibrium position to replace the water that had been removed

Question 6

(a) (i) The majority of candidates were able to score at least one mark on this question. The most common error was omission of the idea that carbon and hydrogen were the **only** elements in the compounds.

(ii) The test for unsaturation should have been straightforward marks, and for many candidates this was the case. There were a large number of candidates who seemed to have no knowledge of the routine test for unsaturation.

(b) Pentavalent carbon atoms were not uncommon in the structures drawn.

(c) (i) Most candidates were able to state that alkenes form addition polymers.

(ii) The best responses correctly identified and included the structure of but-2-ene. The most common errors were pentavalent carbon atoms, but-1-ene and ethene.

(iii) This question was designed to stretch the most able candidates. Many candidates scored one mark for identifying carbon monoxide as the missing product but only the very best responses deduced that both missing stoichiometric coefficients were ‘2n’.

(d) Candidates found drawing the structure of a monomer for a condensation polymer to be very demanding. Most candidates seemed to try and draw the repeat unit rather than the monomer.

CHEMISTRY

Paper 0620/51
Practical Test

Key messages

- The planning question (**Question 3**) needs to be carefully read so that time is not wasted with irrelevant planning to prepare materials which are provided.
- Plotted points on a grid should be clearly visible e.g. crosses. Smooth line graphs should be curves with no straight-line sections and labelled as required.
- Straight-line graphs should be drawn with a ruler.
- Observations are those which you can see. For example, 'fizzing, bubbles or effervescence' are observations, 'a gas or carbon dioxide was given off' is not.
- Lists of answers with correct and incorrect responses are penalised if contradictory. For example, if the correct answer is 'precipitate dissolves/is soluble' and a candidate writes 'precipitate dissolves and a white solid forms', no mark will be awarded as 'white solid forms' contradicts the correct answer.

General comments

There was no evidence of candidates running out of time in this practical examination.

The vast majority of candidates successfully attempted all of the questions. The full range of marks was seen. The paper discriminated successfully between candidates of different abilities but was accessible to all. Almost all centres were able to gain the expected results in **Question 1** and **Question 2**.

Candidates found the last question, **Question 3**, less demanding than in previous years.

A small number of centres did not submit the required Supervisor's results.

Comments on specific questions

Question 1

(a) The table of results was often completed correctly. A common error was recording the values in cm instead of mm. Some candidates recorded fluctuating values instead of the general expected trend of increasing.

(b) Most plotted the points correctly but often not clearly. A common error was to plot the point for $4\,cm^3$ at $3\,cm^3$ and so all subsequent points were incorrect. Most candidates drew a straight line using a ruler, but some drew lines that had no relationship to the last three points. Others drew a straight line when a smooth curve was clearly more appropriate. Graphs with lines joining each point, cross to cross, giving a zig zag effect were penalised.

(c) Candidates should be encouraged to show clear construction lines on the graph and ensure that these lines are parallel to the axes. A significant number of candidates did not show clearly on the grid how they worked out their answer. A minority of candidates omitted the unit.

(d) Almost all candidates understood that the height of the solid was increasing.

(e) Using a burette instead of a measuring cylinder to pour the barium nitrate was a common correct answer. Many candidates just stated the use of a burette or pipette and scored no credit. A burette was already used for the sodium carbonate. A small number understood that leaving the solids to stand for longer would be an improvement but could not articulate the idea of better compaction over time.

(f) Many candidates gave complicated methods based on weighing the reactants before and after the experiment, thinking this would tell them the mass of the product. These responses ignored the law of conservation of mass. Confused answers referred to filtration and then evaporated the filtrate and dried the crystals, which showed a lack of understanding.

Good answers referred to filtration of the solid and weighing the dry solid.

(g) A common mistake was to simply state 'repeat the experiment'. Once repeated, the results obtained need to be compared to the original results to check their reliability.

(h) Few candidates identified precipitation as the type of reaction. Common incorrect responses were neutralisation, evaporation, displacement and titration.

Question 2

Solution **F** was aqueous hydrochloric acid.

Solid **G** was calcium carbonate.

(a) The majority correctly identified the pH of hydrochloric acid in the range of 0–3. Evidence of guessing was seen.

(b) Candidates were required to realise that the gas produced was hydrogen and then give the test for hydrogen. The use of a lighted splint to test the gas was often missing with comments such as 'squeaky pop test' alone, scoring no credit. Many candidates did not record the observation of effervescence/bubbles or fizz.

(c) The expected observation was white precipitate formed. Some answers referred to no reaction.

(d) The expected observation was no reaction, but many candidates recorded that a white precipitate was formed.

(e) The appearance of solid **G** was correctly described by most candidates.

(f) Effervescence was often not described and only a minority managed to test the gas with limewater and obtain the correct result. References to glowing splints relighting and lighted splints popping were unexpected answers.

(g) Formation of a white precipitate was often described but only the better performing candidates recorded that the precipitate was insoluble in excess sodium hydroxide.

(h) This was well-answered, with no precipitate or very slight white precipitate correctly recorded.

(i) Partial credit was awarded for identifying the presence of a chloride or an acid. Full credit was gained for identifying hydrochloric acid.

(j) The identity of solid **G** as a calcium compound was common; many candidates thought it was calcium oxide or calcium chloride.

Question 3

The full range of marks was seen for this question. A number of candidates spent time explaining, often in detail, how to paint the nails or electroplate nails with zinc, despite being informed that coated nails were already provided.

Many answers showed a lack of detail with vague statements such as 'add the nails to water' with no idea of any suitable container or quantity of nails or mass of nails. Other candidates omitted using an uncoated nail or having little understanding of the time needed to leave the nails to rust. Times from a few hours to using a stopwatch to note the observations every 10 minutes were common.

Many candidates did not say what would need to be done to determine which coating is more effective, despite having given details of how to set up the investigation. Instead of looking at the nails and explaining how the results obtained could be used to answer the question, these candidates often simply predicted the results.

Marks were awarded for:

- set number of nails/weigh nails
- nails in a suitable container
- add water
- leave for a suitable time (1 week)
- observe nails/compare/reweigh nails
- repeat with other nails
- nail with least rust/mass increase has best coating.

A minority of candidates did not attempt the question.

CHEMISTRY

Paper 0620/52
Practical Test

Key messages

- Solutions are clear, they cannot be white or cream. If a liquid looks white or cream, it will be because a solid has formed. The solid formed should be called a *precipitate*.
- Centres must ensure that they provide the materials as specified on the confidential instructions. If there is a problem obtaining the specified materials, then centres should contact Cambridge Assessment for advice.
- Supervisor results should be provided by centres for both the quantitative and the qualitative tasks.
- In the planning question (**Question 3**), there is no need to write a list of apparatus at the start of the answer. Any apparatus used should be referred to in the description of the experiment so that it is clear for what purpose that apparatus has been used.
- Candidates should complete graph work in pencil, so they are able to correct errors.
- It should be noted that graph scales should:
    - result in the plotted points occupying over half the space on that axis
    - use sensible scales where each major gridline represents e.g. 5, 10, 20, 30 etc.; scales where each major gridline represents 7, 8, 12 etc. are not acceptable.

General comments

There was no evidence of candidates running out of time in this practical examination.

Overall, the quality of results obtain in the experiment in **Question 1** were very high. Almost all centres were able to gain the expected results in **Question 1**, with *Experiment 1* showing an increase in time from Experiments 1 to 4.

Solutions should be made up using distilled or deionised water to avoid 'false positive' tests for ions such as chloride.

Comments on specific questions

Question 1

(a) Almost all candidates obtained four times, with times increasing as the table was descended. Only a very small minority of candidates recorded times in minutes and seconds rather than seconds.

(b) Almost all candidates picked up some of the marks available with many gaining full marks. Despite the question instructing candidates to test the gas with a lighted splint, some candidates did not report the result of the test or reported the results of other tests (such as using a glowing splint or litmus paper). The majority of candidates correctly reported seeing fizzing and also noted the temperature increase or the fact that the magnesium ribbon disappeared.

(c) Most graphs seen were fully correct. The most common error was to plot the point for 0.8 mol/dm^3 at either 0.5, 0.75 or 0.9 mol/dm^3 . Most candidates drew an acceptable smooth curve; other lost the mark for the line by drawing a series of straight lines between the points or drawing multiple lines.

(d) Almost all candidates correctly drew a suitable extrapolation on their graph. A minority simply joined their existing line to the bottom right hand corner of the grid or drew a continuation line that did not follow the pattern of their existing line. Almost all candidates could then read correctly from their scale and remembered to include units.

(e) (i) The idea of 'fair-testing' was well known. Some candidates used the phrases 'control variable', 'independent variable' and 'dependent variable'. It should be noted that a control variable is one you do not change during the experiment, the 'independent variable' is the one that the experimenter changes during the experiment (in this case, concentration) and the 'dependent variable' is the result obtained from the experiment (in this case, time).

(ii) Most candidates were able to gain the mark here. Some candidates incorrectly explained that as there was less magnesium, it would react more slowly and so take longer to disappear completely.

(f) Many very good answers, which gained full credit, were seen. A significant number of candidates described how to investigate a different independent variable rather than a different method for investigating the same variable. It should be noted that a measuring cylinder is not a suitable item of apparatus for collecting a gas unless it is accompanied by a water bath and is filled with water.

(g) (i) Most candidates gave an acceptable identification for the reaction type. It should be noted that while substitution reactions in organic chemistry are sometimes called single displacement, inorganic displacement reactions involving a redox reaction are not considered to be substitution reactions.

(ii) Almost all candidates correctly identified the gas as hydrogen; chlorine was seen by some (presumably from the hydrochloric acid).

Question 2

(a) Solid **L** was hydrated iron(III) ammonium sulfate (ferric alum). From the Supervisor's results provided by centres it was evident that some centres had used iron(II) ammonium sulfate. It is essential that centres check carefully they are using the materials specified in the confidential instructions and that if there is a problem acquiring the correct materials, they contact Cambridge Assessment for advice.

As the colour of solid hydrated iron(III) ammonium sulfate can vary widely, a wide range of descriptions was accepted.

(b) Some full and clear descriptions of what was observed were seen. However, the fact that the solid formed a liquid was often missed (it dissolves in its own water of crystallisation) and some candidates stated the cobalt(II) chloride paper became blue – which would only happen if it was held above the Bunsen flame but not above the tube of heated salt. The condensation that should have formed on the inside walls of the test-tube was often missed.

(c) Most candidates correctly reported a low pH; a small minority thought the pH was greater than 7.

(d) (i) Many candidates correctly described the formation of a brown precipitate; others did not mention the precipitate or described the colour as red. The colours 'red-brown' or 'brown' alone are acceptable descriptions of the colour of the precipitate, 'red' alone is not.

(ii) Many fully correct answers were seen. Some candidates reported obtaining impossible results, such as glowing splints relighting. It should be noted that when candidates are asked to test a gas, without being told how to test the gas, they should report the test for which they obtained a positive result and the positive result, they do not need to list every possible gas test stating for each one that there was no change.

(e) Despite the precipitate formed being the same as the precipitate in **(d)(i)**, some candidates reported different colours.

(f) The expected answer was that either there was no change or that the solution became paler in colour. A number of candidates reported precipitates forming, which were not reported on the Supervisor's report. This may have been because they had decided that solid **L** was a chloride as they reported bleaching of the cobalt(II) chloride paper in **(b)** and so had incorrectly decided that chlorine was produced (having confused blue cobalt(II) chloride paper with litmus paper).

(g) Most candidates reported the expected white precipitate; some just reported a white solution. Solutions are clear and cannot be white. If a 'white solution' is formed, that is in fact a white precipitate suspended in the liquid.

(h) Better performing candidates correctly stated that solid **L** was hydrated. However, it was not uncommon for candidates to try and draw conclusions from other tests, rather than the test in **(b)** as instructed in the question.

(i) A number of fully correct answers were seen. It should be noted that when the word 'identify' is used, names of correct formulae are accepted but incorrect formulae will not be credited with a mark. Candidates who tried to use only formulae sometimes did not get the mark for the NH_4^+ ion since they made an error when writing it down.

Question 3

There were three suitable methods for obtaining copper from the ore. In summary they were:

1. heat the solid ore with a suitable reducing agent
2. convert the copper(II) carbonate in the ore to a solution of a soluble salt by reaction with an acid and then carrying out a displacement reaction
3. convert the copper(II) carbonate in the ore to a solution of a soluble salt by reaction with an acid and then conducting electrolysis.

Fully correct answers for each of these approaches were seen. However, all three routes required the ore to be broken down into small pieces (preferably a powder) at the start – this step was missing from many answers. In order to obtain a solution, many candidates added water rather than a named acid. As metal ores obtained from the ground are not water soluble, this approach will not work. Another common error was to treat the ore as impure copper rather than as a rock containing a copper compound and so purification was attempted by electrolysis with an azurite anode; as the azurite does not contain copper as an element, this method will not work.

Weaker answers, which used an appropriate method, were often let down by not including any descriptions of the reactions involved or observations. Despite being told that they had *common laboratory apparatus*, some candidates decided to use a blast furnace.

CHEMISTRY

Paper 0620/53
Practical Test

Key messages

- Solutions are clear, they cannot be white or cream. If a liquid looks white or cream, it will be because a solid has formed. The solid formed should be called a *precipitate*.
- Centres must ensure that they provide the materials as specified on the confidential instructions. If there is a problem obtaining the specified materials, then centres should contact Cambridge Assessment for advice.
- Supervisor's results should be provided by centres for both the quantitative and the qualitative tasks.
- In the planning question (**Question 3**), there is no need to write a list of apparatus at the start of the answer, any apparatus used should be referred to in the description of the experiment so that it is clear for what purpose that apparatus has been used.

General comments

Most candidates were able to complete the examination in the time available.

Almost all candidates obtained the quantitative results expected in **Question 1**.

Candidates should complete graph work in pencil so that any errors can be easily corrected.

Solutions should be made up using distilled or deionised water to avoid 'false positive' tests for ions such as chloride.

Comments on specific questions

Question 1

(a)(b)(c) Almost all candidates obtained three sets of results, giving temperature changes in line with those expected.

(d) Many of the graphs seen were fully correct. A number of other candidates incorrectly joined the points with a series of straight lines rather than curves. Despite the instruction to 'clearly label your lines' some candidates did not.

(e) The majority of candidates clearly showed their working on the grid and correctly read the temperature from the *y*-axis scale. However, some candidates showed no working on the grid or made their working very unclear. It is strongly recommended that candidates should draw tie-lines from both axes to the line. A number of candidates read the temperature from the graph line for an incorrect experiment.

(f) (i) The vast majority of candidates were able to identify *Experiment 2* as being the most exothermic and linked this to it having the larger temperature change. A number of other candidates incorrectly identified *Experiment 3*, giving the fact it had the lowest temperature change as the reason.

(ii) The majority of candidates linked *Experiment 1* being faster with the powder having a greater surface area. However, despite the question clearly asking for a comparison in the rates of reaction in *Experiments 1* and *3*, some candidates included *Experiment 2* in their answer. A common error was for candidates to claim the powder had a smaller surface area and so reacted faster. Each individual piece of zinc in a powder will have a smaller surface area that than a larger granule, as there are many more pieces of zinc in the powder the total surface area is much greater.

(g) Most candidates realised that the reaction would have been over after 2 hours and that the temperature would return to room temperature. A few candidates were unsure and stated 'the temperature would be room temperature or even lower' – in doing this they have given two different answers for the temperature and so the mark cannot be awarded as one of them is incorrect (the temperature cannot drop below room temperature). A small minority of candidates thought the temperature would continue to increase or decrease and gave improbably high or low temperatures.

(h) A very common misconception was that taking more readings increases the accuracy. Taking lots of readings only increases accuracy if the mean is then found, which would not be appropriate in this case as each reading is taken at a different time. More frequent readings would mean that you have more data to plot on the graph and so are able to draw better graph lines – in this experiment this is particularly useful between 60 and 90 seconds where there is a rapid temperature change.

(i) Better responses correctly stated that copper is a good conductor of heat and so there would be greater heat loss to the surrounding. Stating copper would 'absorb the heat' was insufficient. The most common incorrect answer was to state that copper would take part in the reaction.

Question 2

(a) Solid **M** was hydrated aluminium potassium sulfate (potassium alum). Almost all candidates were able to correctly describe the appearance of the solid as white.

(b) Some full and clear descriptions of what was observed were given. However, the fact that the solid formed a liquid was often missed (it dissolves in its own water of crystallisation) and some candidates stated the cobalt(II) chloride paper became blue – which would only happen if it was held above the Bunsen flame but not above the tube of heated salt. The condensation that should have formed on the inside walls of the test-tube was often missed.

(c) (i) Most candidates correctly reported the formation of a white precipitate. Some incorrectly reported the formation of a white solution.

(ii) Most candidates correctly state the precipitate re-dissolved; others gave impossible observations, such as fizzing.

(d) (i) Most candidates correctly reported the formation of a white precipitate; others incorrectly reported the formation of a white solution.

(ii) Most candidates correctly stated the precipitate did not re-dissolve. Other responses included impossible observations, such as fizzing. It should be noted that where aqueous ammonia is added as a reagent, it is not expected that candidates report on the smell of the reaction mixture. Aqueous ammonia will always release ammonia gas and deliberate smelling of aqueous ammonia should be avoided.

(e) Most candidates correctly reported the formation of a white precipitate; others incorrectly reported the formation of a white solution or impossible colours.

(f) Stronger responses correctly stated that solid **M** was hydrated. However, it was not uncommon for candidates to try and draw conclusions from other tests, rather than the test in **(b)**, as instructed in the question.

(g) A number of fully correct answers were seen. A greater proportion of candidates correctly identified the sulfate ions than identified the aluminium ions.

Question 3

Some excellent and well-planned answers to this question were seen.

The expected responses either involved mixing together a known volume of acid with a known mass of each calcium compound and then comparing the pH of the resulting mixtures or adding one reactant gradually to the other in the presence of an indicator and comparing how much needed to be added in order for the indicator to change colour.

Common errors and omissions included:

- using the word ‘amount’ rather than ‘volume’ for describing controlling how much hydrochloric acid was used
- stating that calcium compounds were liquids and so candidates measured their volume or even tried to put them in a burette
- not to mention stirring or mixing the reactants
- using samples of soil, despite the fact that the question stated that they were provided with dilute hydrochloric acid and common laboratory chemicals.

Candidates should plan out their answers before starting to write them. This would avoid the need for lots of changes, insertions and footnotes. There is no need to write a list of apparatus at the start of the plan. It must be clearly stated what each piece of apparatus is used for in the appropriate place within the method.

CHEMISTRY

Paper 0620/61
Alternative to Practical

Key messages

- Plotted points on a grid should be clearly visible e.g. crosses. Smooth line-graphs should be curves with no straight line sections drawn with a ruler
- Observations are those which you can see. For example, 'fizzing' is an observation, whereas 'a gas was given off' is not. Smells, such as 'the pungent smell of ammonia and the bleach or swimming pool smell of chlorine', are acceptable as observations.
- When a question asks for the name of a chemical, a correct formula is always acceptable. However, if a candidate answers with an incorrect formula, then the mark will not be awarded.
- Lists of answers with correct and incorrect responses are penalised if contradictory. For example, if the correct answer is 'precipitate dissolves/is soluble' and a candidate writes 'precipitate dissolves and a white solid forms', no mark will be awarded.
- In the planning question, **Question 4**, there is no need to write a list of apparatus at the start of the answer. Any apparatus used should be referred to in the description of the experiment so that it is clear for what purpose that apparatus has been used.

General comments

The vast majority of candidates successfully attempted all of the questions. The full range of marks was seen. The paper discriminated successfully between candidates of different abilities but was accessible to all. Candidates found the last question, **Question 4**, less demanding than previous years.

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

Comments on specific questions

Question 1

(a) Some candidates had difficulty identifying the gas jar. Measuring cylinder, gas cylinder and test-tube were common incorrect answers.

(b) Most candidates gained credit on this question. Some candidates incorrectly suggested that the gas jar should be replaced with a gas syringe or that the delivery tubes were wrongly positioned. The suggestion that the chlorine should be collected over water showed a lack of understanding.

(c) This was generally well-answered with most candidates realising that the sulfuric acid removed water or impurities from the chlorine. Some thought that the chlorine needed to be acidified/neutralised or that the chlorine was made in the second conical flask.

(d) Most candidates could recall the test for chlorine. The most common answer was to give a test for chloride ions rather than chlorine gas.

(e) Marks were awarded for realising that a fume cupboard was used because chlorine is toxic/poisonous. Confused answers were common, with candidates giving answers based on heat loss, corrosive acids and explosions.

Question 2

(a) The table of results was often completed correctly. A common error was incorrect measurement of the heights of the precipitates in one or more of the test-tubes, with a minority recording the values in cm instead of mm. Some candidates measured the height of the liquid above the precipitate.

(b) Most plotted the points correctly but often not clearly. A common error was to plot the point for 4 cm^3 at 3 cm^3 and so all subsequent points were incorrect. Most candidates drew two straight lines using a ruler, but some drew lines that had no relationship to the last three points. The *x*-axis was sometimes incorrectly labelled as 'test-tube number'; there could not be a test-tube zero. Some responses omitted the unit and/or the term 'volume'.

(c) Candidates should be encouraged to show clear construction lines on the graph and ensure that these lines are parallel to the axes. A significant number of candidates did not show clearly on the grid how they worked out their answer.

(d) Almost all candidates understood that the height of the solid was increasing but some did not comment on the fact that the heights remained constant in the last three test-tubes.

(e) Good responses referred to the heights of precipitate being the same as the last three test-tubes but did not give a clear explanation. Some excellent responses in terms of barium nitrate being the limiting reagent were seen. A number were unsure and suggested the heights remained the same and increased or decreased; these responses were penalised.

(f) Many candidates just stated use a burette or pipette and scored no credit. A burette was already used for the sodium carbonate and it would not be appropriate to use in place of a test-tube. Credit was given for comparison to the measuring cylinder used to measure the aqueous barium nitrate.

(g) Many candidates gave complicated methods based on weighing the reactants before and after the experiment thinking this would tell them the mass of the product; these responses ignored the law of conservation of mass. Good answers referred to filtration of the solid and weighing the dry solid.

(h) A common mistake was to just state 'repeat the experiment'. Once repeated, the results obtained need to be compared to the original results to check their reliability.

Question 3

(a) The majority correctly identified the pH of hydrochloric acid in the range of 0–3. Evidence of guessing was seen.

(b) Candidates were required to realise that the gas produced was hydrogen and then give the test for hydrogen. The use of a lighted splint to test the gas was often missing with comments such as 'squeaky pop test' scoring partial credit. Many candidates gave contradictory observations such as white precipitate, pungent smelling or coloured gases and missed the effervescence.

(c) The expected observation was white precipitate formed. Many answers referred to no reaction, which showed a lack of knowledge of the chloride test.

(d) The expected observation was no reaction, but many candidates thought a white precipitate would be formed.

(e) The identity of solid **G** was correctly given by most candidates.

Question 4

The full range of marks was seen for this question. A number of candidates spent time explaining, often in detail, how to paint the nails or electroplate nails with zinc, despite being informed that coated nails were already provided.

Many answers showed a lack of detail with vague statements such as ‘add the nails to water’ with no idea of any suitable container or quantity of nails or mass of nails. Other candidates omitted using an uncoated nail or having little understanding of the time needed to leave the nails to rust. Times from a few hours to using a stopwatch to note the observations every 10 minutes were common.

Many candidates did not say what would need to be done to determine which coating is more effective, despite having given details of how to set up the investigation. Instead of looking at the nails and explaining how the results obtained could be used to answer the question, these candidates often simply predicted the results.

Marks were awarded for:

- set number of nails/weigh nails
- nails in a suitable container
- add water
- leave for a suitable time (1 week)
- observe nails/compare/reweigh nails
- repeat with other nails
- nail with least rust/mass increase has best coating.

A minority of candidates did not attempt the question.

CHEMISTRY

Paper 0620/62
Alternative to Practical

Key messages

- Observations are those which you can see. For example, 'fizzing' is an observation, whereas 'a gas was given off' is not. Smells, such as 'the pungent smell of ammonia and the bleach or swimming pool smell of chlorine', are acceptable as observations.
- When a question asks for the name of a chemical, a correct formula is always acceptable. However, if a candidate answers with an incorrect formula, then the mark will not be awarded.

General comments

The vast majority of candidates successfully attempted all of the questions and the full range of marks was seen. The paper discriminated successfully between candidates of different abilities but was accessible to all. The paper was generally well answered, with very few blank spaces.

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

This session, **Question 4** was a planning task based on the extraction of copper from one of its carbonate ores. There were various acceptable methods, including reduction by carbon or a more reactive metal. Other methods also gained credit, such as dissolving the ore in an acid followed by either electrolysis or displacement.

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

Comments on specific questions

Question 1

(a) (i) Most candidates knew that a spatula would be used to add zinc oxide to hydrochloric acid. It was clear that a lot of candidates were not aware that zinc oxide was a solid.

(ii) The most common answer here was the correct one, a Bunsen burner; other answers, such as spirit burners and water baths, were acceptable.

(b) Many candidates knew unreacted zinc oxide would be visible once all the hydrochloric acid had been used up. Others assumed incorrectly that zinc oxide would fizz when it reacted.

(c) (i) Most candidates could explain what was meant by 'excess'. This was usually the text book definition 'more than enough', but the specific reference to step 3 meant that 'unreacted zinc oxide' was also accepted.

(ii) Nearly all responses stated that filtration would remove the excess zinc oxide.

(d) Most candidates realised that the three steps are evaporation, to crystallisation point, followed by cooling.

(e) Candidates found this a challenging question. There were many good answers, focussing on either that the reaction would not need heating or that you could tell when the acid was neutralised because the fizzing stopped. Weaker responses missed the key word 'method' in the question and answered in terms of observations or products.

Question 2

(a) Most candidates could read the stop-clocks correctly; although a minority gave the answers in terms of minutes and seconds rather than seconds alone.

(b) Nearly all candidates chose the most suitable scale for the *y*-axis, where each large square was 10 s. The points were usually plotted correctly; the first point was most likely to cause a problem as it was the only one not on a major grid line. The curve was generally well drawn.

(c) Most candidates successfully extrapolated their graph line and went on to correctly read the time, including the unit.

(d) (i) A large number of candidates realised that the length of the magnesium ribbon was a control variable and should not be changed. This was expressed in a variety of ways, notably in terms of fair testing.

(ii) Most candidates suggested that reducing the length of the magnesium ribbon would reduce the time taken to dissolve. A few did not read the question and answered in terms of rate.

(e) Better responses were in terms of measuring the volume of gas evolved at time intervals using a gas syringe. Other methods were acceptable, such as mass loss. Unfortunately, a large number missed the '**different** method' in the question and incorrectly investigated a different variable or suggested how to improve the accuracy.

(f) (i) The majority of candidates gave a correct answer here. Displacement, neutralisation, redox and exothermic were all acceptable answers.

(ii) Nearly all responses identified hydrogen correctly.

Question 3

(a) Most candidates realised that ammonium sulfate is white; there was a variety of incorrect colours.

(b) The colour change of cobalt(II) chloride paper was well known. A minority reversed the colours. Condensation was seen less frequently, despite the 'hydrated' in the question.

(c) The test for ammonia was very well known.

(d) Most answers referred to the white precipitate.

(e) The identity of solid **M**, iron(III) chloride, was known by many candidates.

Question 4

Candidates found this planning task more challenging compared with recent papers. There were three common routes through the process. The first was by reduction of the ore, either as one step or as two steps. The second was by dissolving the copper(II) carbonate in an acid and then either electrolysing the solution to obtain copper at the cathode or by using a more reactive metal to displace the copper.

Common errors in these methods were not to crush the ore at the beginning or to assume that it could be dissolved in water or an alkaline solution.

The most common incorrect method was to use the lump of ore as the anode in a method similar to the purification of copper. This would not work as the ore would not conduct electricity and therefore was unsuitable to use as an electrode.

Candidates would be well advised to plan their answers before starting to write. This would avoid the need to try and insert missing parts at a later stage. There is no need to write a list of apparatus at the start. It must be clear what each apparatus is being used for and so this must be mentioned in the method.

CHEMISTRY

Paper 0620/63
Alternative to Practical

Key messages

- Plotted points on a grid should be clearly visible e.g. crosses. Smooth line-graphs should be curves, with no straight-line sections drawn with a ruler.
- Observations are those which you can see. 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 always acceptable. However, if a candidate answers with an incorrect formula, then the mark will not be awarded.
- Lists of answers with correct and incorrect responses are penalised if contradictory. For example, if the correct answer is 'precipitate dissolves/is soluble' and a candidate writes 'precipitate dissolves and a white solid forms', no mark will be awarded.
- In the planning question, **Question 4**, there is no need to write a list of apparatus at the start of the answer. Any apparatus used should be referred to in the description of the experiment so that it is clear for what purpose that apparatus has been used.

General comments

There was a low number of candidates for this component. The majority of candidates attempted all of the questions. The full range of marks was seen. The paper discriminated successfully between candidates of different abilities but was accessible to all.

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

The majority of candidates were able to complete the table of results from readings on diagrams and plot points successfully on a grid, as in **Question 2**.

Comments on specific questions

Question 1

(a) Many candidates were able to state that the lid prevented loss of the solvent. Common errors included stating that it prevented the loss of water (the solvent was not water); that it provided insulation or that it held the paper/clips up.

(b) (i) The majority of candidates correctly identified that the spots of colouring should not be in the solvent. Vague answers, such as 'the depth of the solvent is wrong' were not credited nor were answers which stated that the spots of dye should be at the same level as the solvent.

(ii) Many candidates correctly stated that the dyes would wash off the paper or dissolve into the solvent. A common incorrect answer was to state that the dye would not rise up the paper. If the dye dissolves into the solvent and the solvent rises up the paper, then the dye will also rise up the paper.

(c) Stronger responses suggested a suitable solvent. The question stated the dyes were not soluble in water and so water or any aqueous solution was not given credit. A number of candidates suggested substances which were either solids or gases as the solvent.

(d) Many candidates were able to state three correct conclusions. There was some common misunderstandings of the process of paper chromatography. Two of the most common were that the distance a colour moves depends on how dark the colour is or how much of it there is.

Question 2

(a)(b)(c) Almost all candidates were able to read the thermometer diagrams correctly. Candidates should always check their work through as some errors were seen.

(d) Many of the graphs were fully correct. A number of candidates incorrectly joined the points with a series of straight lines rather than curves. Despite the instruction to 'clearly label your lines' some candidates did not.

(e) The majority of candidates clearly showed their working on the grid and correctly read the temperature from the *y*-axis scale. Other candidates showed no working on the grid or made their working very unclear. It is strongly recommended that candidates should draw tie-lines from both axes to the line. A number of candidates read the temperature from the graph line for an incorrect experiment.

(f) (i) The vast majority of candidates were able to identify *Experiment 2* as being the most exothermic and linked this to it having the larger temperature change. Other candidates incorrectly identified *Experiment 3*, giving the fact it had the lowest temperature change as the reason.

(ii) The majority of candidates linked *Experiment 1* being faster to the powder having a greater surface area. However, despite the question clearly asking for a comparison in the rates of reaction in *Experiments 1* and *3*, some candidates included *Experiment 2* in their answer. A common error was for candidates to claim the powder had a smaller surface area and so reacted faster.

(g) Most candidates realised that the reaction would have been over after 2 hours and that the temperature would return to room temperature. A few candidates were unsure and stated 'the temperature would be room temperature or even lower' – in doing this they have given two different answers for the temperature and so that mark cannot be awarded as one of them is incorrect (the temperature cannot drop below room temperature). A small minority of candidates thought the temperature would continue to increase or decrease and gave improbably high or low temperatures.

(h) A very common misconception was that taking more readings increases the accuracy. Taking lots of readings only increases accuracy if the mean is then found, which would not be appropriate in this case as each reading is taken at a different time. More frequent readings would mean that you have more data to plot on the graph and so are able to draw better graph lines – in this experiment this is particularly useful between 60 and 90 seconds where there is a rapid temperature change.

(i) Better responses correctly stated that copper is a good conductor of heat and so there would be greater heat loss to the surroundings. Stating copper would 'absorb the heat' was insufficient. The most common incorrect answer was to state that copper would take part in the reaction.

Question 3

(a) Many incorrect answers were seen. As aluminium is not a transition metal, an aluminium salt would not be expected to be coloured. Despite the question referring to solid **N**, some candidates stated it would be a liquid or a solution. It should be noted that a precipitate is a solid formed when two solutions (or a solution and a gas) react together to form an insoluble solid. A sample of solid provided cannot be described as a precipitate as there is no evidence it has been formed in this way.

(b) Many responses were fully correct and included clear descriptions of what would be seen. It was evident that the use of cobalt(II) chloride paper as a test for water was not well known by other candidates. Incorrect colour changes were common. The formation of steam or condensation was often not mentioned. As the salt was stated to be hydrated, candidates should be aware that heating it would cause the water to be lost.

(c) (i) Most candidates correctly stated that a white precipitate would form.

(ii) Most candidates correctly states the precipitate re-dissolved; others gave incorrect additional observations, such as fizzing or stated that the precipitate would remain.

(d) Most candidates correctly stated that a white precipitate would form.

(e) Stronger responses correctly identified the solid as potassium chloride; some just gave the metal and did not identify the anion.

Question 4

Some excellent and well-planned answers to this question were seen.

The expected responses either involved mixing together a known volume of acid with a known mass of each calcium compound and then comparing the pH of the resulting mixtures or adding one reactant gradually to the other in the presence of an indicator and comparing how much needed to be added in order for the indicator to change colour.

Common errors and omissions included:

- using the word ‘amount’ rather than ‘volume’ for describing controlling how much hydrochloric acid was used
- stating that the calcium compounds were liquids and so candidates measured their volume or even tried to put them in a burette
- not stirring or mixing the reactants
- using samples of soil, despite the fact that the question stated that they were provided with dilute hydrochloric acid and common laboratory chemicals.

Candidates should plan out their answers before starting to write them. This would avoid the need for lots of changes, insertions and footnotes.