CHEMISTRY

Paper 0620/12
Multiple Choice (Core)

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

General comments

Candidates found **Questions 3**, **5**, **8**, **11**, **18**, **24**, **32** and **40** to have the least challenge. **Questions 1**, **4**, **26**, **34**, **37** and **38** were most demanding. **Questions 6**, **9**, **19**, **23** and **33** showed the greatest discrimination between the most and least able candidates. Questions requiring knowledge of the reactivity series of metals or endothermic and exothermic processes were not well answered.

Comments on specific questions

Question 1

Most candidates suggested option **B**, confusing a change of state that could require heat with a process that releases heat.

Question 4

This question was not well answered. The more able candidates appeared to be guessing whilst the least able tended to give option **B**. Candidates should recall that a beaker is not used to give precise measurements and that a 25 cm^3 pipette will measure only 25 cm^3. Of the other two pieces of apparatus, only the burette is able to measure exactly 5.00 cm^3.

Question 6

This question discriminated well between the most and least able candidates. The distribution of options chosen suggests the least able candidates were guessing.

Question 7

Both options **C** and **D** were commonly chosen. The general properties of diamond and graphite should be well known but over a third of the stronger candidates did not identify the correct answer.

Question 9

This question discriminated well between the most and least able. Options **B** and **C** were more likely to be chosen by the least able showing confusion between electron gain and loss and the corresponding ions formed.

Question 15

Similar to **Question 1**, candidates confused the meanings of the terms endothermic and exothermic. Option **D** was chosen by half the candidates.

Question 17

Although most answered this question correctly, more than a third gave option **D** suggesting that only the physical states of the substances were considered. Candidates should make sure that all the information provided is used.

Question 19

This question discriminated well between the most and least able. Candidates should be reminded that the reactants are on the left hand side of the reaction arrow and that these are the substances which undergo oxidation or reduction.

Question 21

Most candidates were able to identify the presence of a calcium salt from the information given. Weaker candidates were more likely to confuse the halide identified by acidified silver nitrate and chose option **A**.

Question 26

This question was found to be demanding by all the candidates. Option **D** was the most common incorrect answer. Candidates should recall the reactivity series given in the specification and that the most reactive metals require electrolysis for extraction.

Question 33

Most candidates recalled the role of sulfur in making sulfuric acid. More than a third thought that it was also required to make NPK fertilisers and gave option **C**. Candidates should be reminded that N, P and K are chemical symbols.

Question 34

This question was not well answered. Although many candidates identified how lime is made and its chemical name, few were also able to identify a use. Option **C** was the most common answer.

Question 37

Although most candidates correctly recalled that ethene and propene are both hydrocarbons, this fact does not explain why they have the same chemical properties. Option **B** was the most common answer.

CHEMISTRY

Paper 0620/22
Multiple Choice (Extended)

Question Number	Key
1	A
2	D
3	A
4	D
5	C
6	B
7	A
8	B
9	D
10	C

Question Number	Key
11	A
12	C
13	C
14	D
15	C
16	B
17	D
18	A
19	A
20	B

Question Number	Key
21	A
22	D
23	D
24	C
25	D
26	A
27	D
28	A
29	C
30	B

Question Number	Key
31	D
32	B
33	B
34	B
35	C
36	A
37	B
38	C
39	C
40	C

General comments

The most able candidates had few difficulties with this paper. A small number answered all the questions correctly. The gap between the most and least able candidates was wide and some of the weaker candidates may have found the core paper more appropriate.

Overall, candidates found **Questions 1**, **5**, **6**, **18**, **21**, **24**, **31**, **32** and **35** to have the least challenge.

Questions 22, **30** and **38** were most demanding. **Questions 8**, **15**, **19**, **23**, **25** and **38** showed the greatest discrimination between the most and least able candidates.

Comments on specific questions

Question 2

Although most candidates answered this correctly, many of the weaker candidates were unable to apply particle theory to identify the number of particles in a fixed volume. Option **B** was a common incorrect answer.

Question 8

Few of the more able candidates gave an incorrect answer. Weaker candidates appeared to be guessing and did not recognise incorrect formulae such as Na_2 for sodium or N for molecular nitrogen.

Question 10

Option **A** was the most common incorrect answer. Candidates recognised the high melting point of the ionic compound but the least able candidates were more likely to suggest that the solid would be a conductor.

Question 11

Option **D** was the most common incorrect answer. A third of the weaker candidates chose this option. The movement of ions was correctly identified but the electron movement was confused for these candidates.

Question 14

This question discriminates well between the most and least able candidates. Only a third of the least able candidates were able to give the correct answer. All the other options were chosen equally.

Question 15

A third of the candidates overall gave option **D**. Similarly to the 0620/12 paper, candidates found it difficult to recall the difference between endothermic and exothermic processes.

Question 19

Few candidates chose options **C** or **D** showing understanding of the effect of concentration on particle collision rate. Even so, many gave option **B** suggesting that the relationship between concentration, activation energy and rate is not as well understood.

Question 22

The weaker candidates appeared to be guessing in this question. All the options were chosen.

Question 23

This question strongly discriminated between the most and least able. Option **C** was commonly chosen suggesting that the weaker candidates did not recall that the weak acids do not fully dissociate in aqueous solution.

Question 25

This question is also a strong discriminator. Weaker candidates commonly choosing option **C**. This question could be attempted using knowledge of the reactivity series or by recall of the extraction of iron.

Question 30

This was one of the few questions which all the candidates found difficult. Option **C** was commonly chosen. Candidates should recall that when written with the ‘reversible symbol’ the equation represents both a forward and a reverse reaction. In this example the H_2O acts as a base in the forward reaction and NO_3^- is a base in the reverse reaction.

Question 38

Option **D** was a common incorrect answer, with almost half of the weaker candidates choosing it. Candidates should be aware that the structures of products of organic reactions must be known.

CHEMISTRY

Paper 0620/32
Theory (Core)

Key messages

- Some candidates would benefit by improving their knowledge of specific chemical terms and processes and in writing specific answers.
- Many candidates need more practice in analysing the stem of a question.
- Many candidates need more practice in memorising chemical tests and practical procedures.
- Interpretation of data from tables and completion of chemical equations was generally well done.

General comments

Many candidates tackled this paper well, showing a good knowledge of core Chemistry. The standard of English was generally good. Very few questions were left unanswered.

Some candidates need more practice in writing answers with the correct amount of detail using or explaining specific chemical terms. For example, in **Question 3(b)(i)** some candidates wrote about compounds when defining an alloy, whilst in **Question 7(b)(ii)** many did not explain the meaning of the term 'decomposition' in sufficient detail.

In **Question 8(a)** most candidates did not explain the meaning of the term 'element' accurately.

Many candidates need more practice in memory work and understanding the meaning of general chemical terms. For example, in **Question 3(c)** some candidates did not know the order of reactivity of the metals in the reactivity series, whilst in **Question 5(a)(iv)** many candidates did not understand the meaning of the terms 'arrangement' and 'separation' in the context of particle theory.

Many candidates need further revision about pollutants, including their effects and sources (**Questions 5(b)(i)** and **(b)(ii)**). Other candidates need to revise chemical nomenclature.

The suffix ending of binary salts, -ide, was sometimes written as -ine.

Some candidates gave answers which were too vague to be given credit. For example, in **Question 2(a)(ii)** many candidates did not focus on the compounds in biogas **X** and biogas **Y** and just wrote general statements about pollutants.

In **Question 3(b)(ii)** some candidates wrote statements about general metallic properties and in **Question 3(b)(iii)** many gave inexact answers such as 'utensils' or 'in the kitchen'.

In **Question 5(a)** many candidates gave inexact answers for the effect of the pollutants, e.g. '*disease*' or '*harms you*' whilst in **Question 5(b)** many candidates wrote vague answers about the pollutant source such as '*cars*', '*factories*' or '*combustion*'.

In **Question 6(a)(ii)** many candidates did not give a detailed enough response, many just referred to either melting point alone or to the fact that '*it is liquid at that temperature*'.

Some candidates need more practice in analysing the stem of a question to pick out the essential words needed to answer the question. In **Question 1(a)(ii)** many candidates did not seem to distinguish between electrons and electron shells.

In **Question 2(a)(ii)** some candidates wrote about similarities rather than differences, whilst in **Question 2(b)** some candidates drew the symbols for carbon and hydrogen rather than drawing the electronic structure. In **Question 3(b)(iii)** some candidates gave properties of stainless steel instead of uses.

In **Question 5(a)(ii)** some candidates did not heed the word 'volume' in the stem of the question and wrote about kinetic particle theory, whilst in **Question 5(b)(ii)** some candidates did not heed the word 'other' in the stem of the question and wrote about nitrogen dioxide and compounds of lead.

The word 'observations' in **Question 6(b)** was misunderstood; most candidates giving the names of products rather than '*bubbles'* or '*bursts into flames*'. In **Question 6(c)(i)** many candidates did not note the word 'non-metal' in the stem of the question, whilst in **Question 6(d)** many candidates gave metallic properties rather than the properties of an ionic compound.

Many candidates need to revise practical procedures and qualitative tests for specific ions and molecules. In **Question 4(b)** most candidates wrote confused statements about how to prepare a dry sample of the salt zinc sulfate from zinc sulfate solution. Many did not read the question properly and started with zinc and sulfuric acid. Others did not qualify their statements and implied that they were heating to dryness.

Most candidates need more practice in answering questions about observations during chemical reaction which are stated in the syllabus. For example, in **Question 6(b)** most candidates gave answers which stated the reactants and products of the reaction rather than what you see or hear during the reaction. The answers to the questions about the test for bromide ions (**Question 8(d)(ii)**) and the identification of an organic compound which decolourises aqueous bromine (**Question 7(a)(iii)**) were not well known.

Many candidates were able to extract information from tables and graphs, balance symbol equations and undertake simple chemical calculations.

Comments on specific questions

Question 1

This was one of the best answered questions on the paper. Most candidates identified the atom in Group V of the Periodic Table in **(a)(i)** and many gained credit for **(a)(ii)**, **(a)(iii)** and **(a)(v)**. In **(b)** many candidates gave the correct number of neutrons and protons.

(a) (i) Most candidates identified **A** correctly (phosphorus atom). The commonest error was to suggest **E** (chlorine atom).

(ii) Many candidates identified **C** (oxygen atom) as having two shells of electrons. The commonest error was to suggest **B** (helium atom). In many cases this was probably due to a misreading of the question (two electrons rather than two electron shells).

(iii) Many candidates identified **C** (oxygen atom) as having an ion with a charge of 2–. The commonest error was to suggest **D** (aluminium atom). Others suggested **B** (helium atom), presumably because it had two electrons. A few suggested **C** (oxygen atom).

(iv) Few candidates were able to identify the atom of a monoatomic gas. The commonest error was to suggest **E** (chlorine atom). Other common errors were to suggest **D** (aluminium atom) or C (oxygen atom).

(v) Many candidates recognised the electronic structure of aluminium. The commonest error was to suggest **E** (chlorine atom). A significant number of candidates chose the incorrect answer **A** (phosphorus atom), which like aluminium has three unpaired electrons in the outer shell but also has two electrons which are paired.

(b) Many candidates deduced the correct number of protons and neutrons. The commonest error was to ignore the charge on the rubidium ion and suggest 37 electrons. Others suggested that Rb^+ has 38 electrons by not realising that a positive charge indicates that electrons have been removed. A few candidates suggested that the uranium isotope has 327 neutrons by adding the proton number to the mass number rather than subtracting it from the mass number. A few candidates who deduced the number of electrons in Rb^+ correctly also gave 36, rather than 37, for the number of protons.

Question 2

Some candidates gave good answers to **(a)(i)** and **(c)(i)**. In **(a)(ii)** many gave vague answers and did not compare specific gases. In **(b)** many candidates drew too many electrons in the structure of methane. In **(c)(ii)** few candidates explained the oxidation by reference to the reactant hydrogen sulfide.

(a) (i) Many candidates calculated the percentage by mass of 'other gases' correctly. The commonest error was to suggest 0.5%. Other common errors were to give answers which were incorrect by a factor of 10, e.g. 0.1% or 10%.

(ii) Some candidates did not refer to specific gases and gave vague answers such as '*there is more gas in **X** than **Y***'. Others misread the stem of the question and wrote about '*oxygen and hydrogen being the same in **X** and **Y***' or suggested that there is '*more methane in **Y***' or '*more carbon dioxide in **X***'.

(b) Some candidates drew a pair of electrons in each overlap area. Many disadvantaged themselves by adding extra electrons on either the carbon atom or the hydrogen atom. A considerable number of candidates drew eight electrons around each hydrogen atom. Others drew one or three electrons in each overlap area or misread the question and just added the symbols for carbon and hydrogen rather than completing the electronic structure.

(c) (i) Most candidates were successful in balancing the hydrogen sulfide molecule. Fewer realised that oxygen was present in both products and attempted to balance the oxygen molecules as $2O_2$ or $1O_2$.

(ii) The best answers referred to the hydrogen sulfide, hydrogen or sulfur gaining oxygen. Many did not refer to the equation and just gave a definition of oxidation. Others gave vague or incorrect statements about the products, e.g. '*the water and sulfur dioxide have gained oxygen*' or '*the oxygen is mixed with the hydrogen sulfide*'. Some candidates just paraphrased the equation by writing statements such as '*the hydrogen sulfide has reacted with oxygen to form water and sulfur dioxide*'.

Question 3

This question was well answered by some candidates. Most candidates gave at least two correct properties of metals in **(a)**. Others gave vague answers to many parts of the question about alloys in **(b)**. In **(c)** many candidates did not remember the order of reactivity of common metals. Some candidates were able to do the calculation in **(d)** correctly. Others need more practice in questions involving simple proportion.

(a) Many candidates gave three general properties common to most metals. Common errors included reference to reactivity, brittleness and/or low melting point. Others gave electrical and heat conductivity or high melting point and high boiling point. These two pairs were only given one mark per pair. When considering the general properties of <u>most</u> metals, candidates should consider a wider range of properties such as lustre, malleability and sonority.

(b) (i) The best answers included '*a mixture of metals with another element*' or '*a mixture of metals*'. Common errors included '*a mixture of elements*' or '*a combination of metals*'. Candidates should realise that the word 'mixture' is an essential part of the definition of an alloy. Many candidates did not gain credit because they wrote about '*metal compounds*' or '*metal molecules*'.

(ii) Better answers commented about the increased strength, increased hardness or increased resistance to corrosion of alloys compared with the individual metals. Many candidates gave statements which did not refer to all alloys, e.g. '*they do not rust*' or '*they are more reactive*'. Others gave vague statements such as '*they have more useful properties*'.

(iii) Some candidates gave a suitable use for stainless steel. Many others gave answers which were too vague such as '*for utensils*' or '*for machines*'. Some candidates did not read the question properly and gave properties of alloys rather than uses, even though the properties had been already dealt with in **(ii)**.

(c) Some candidates were able to remember the reactivity series of metals correctly. Others appeared to guess the order. The commonest errors were to reverse the order of copper and zinc and/or to reverse the order of magnesium and potassium.

(d) Some candidates calculated the mass of magnesium correctly showing all their working. Others confused the mass of magnesium with the mass of magnesium oxide.

Question 4

This question was well answered by some candidates. Many candidates gave at least two correct answers to the question about rates of reaction in **(c)**. In **(a)(i)** many candidates gave hydrogen as a product in place of water and in **(a)(ii)** some did not name the indicator. Very few candidates were able to describe how to prepare pure dry crystals of zinc sulfate in **(b)**.

(a) (i) Many candidates identified sodium nitrate as one of the products. The commonest errors were '*sodium nitric acid*', '*sodium nitrite*' or the very vague '*salt*'. Many candidates thought, incorrectly, that hydrogen was the other product rather than water. Others disadvantaged themselves by writing both water and hydrogen.

(ii) Many candidates who gave the name of a suitable indicator, gained credit for the correct colour in alkaline solution. The commonest errors were to suggest that litmus or methyl orange were red in sodium hydroxide. A considerable proportion of the candidates did not gain credit because they did not specify the indicator and stated that '*the named indicator turns blue*'. Others referred to measuring pH rather than referring to the colour of the indicator.

(iii) Most of the candidates gave the correct name for the salt '*sodium chloride*'. A few just suggested '*salt*' without giving a specific name or suggested '*sodium chlorine*'. The mark for ammonia was less often gained; common errors being '*ammonium*' or '*ammonium hydroxide*'. A considerable minority of the candidates gave '*nitrogen*' or '*hydrogen*' instead of ammonia.

(b) Very few candidates were able to describe how to prepare pure dry crystals of zinc sulfate starting from zinc sulfate solution. Many did not read the question properly and started with zinc and sulfuric acid. Many candidates seemed to put the filtration step in randomly. The best answers referred to '*evaporating to the crystallisation point*' or '*heating to the boiling point then leaving to crystallise*'. Most candidates implied that they were heating to dryness and many stated this, e.g. '*evaporate the zinc sulfate until it is dry*'. Few candidates gained credit for filtration of the crystals or picking out crystals. Many referred to drying the residue. A minority of the candidates referred to drying with a filter paper. Most suggested '*drying in an oven*'.

(c) The commonest error was to suggest that a lower concentration of sulfuric acid increases or has no effect on the rate of reaction. Some candidates did not refer to the rate of reaction and wrote about the effect on the time or volume of gas.

Question 5

This was one of the least-well answered question on the paper. Parts **(a)(i)** and **(a)(ii)** were generally well answered. In **(a)(iii)** few candidates gave convincing answers as to why the noble gases are unreactive. In **(a)(iv)** many did not understand the terms 'arrangement' and 'separation' and wrote about particles in motion instead. The answers to **(b)** about pollutant gases were generally too vague and many candidates confused the sources with the effects

(a) (i) A majority of the candidates gave oxygen as gas **G** and nitrogen as gas **H**. Some reversed oxygen and nitrogen. The commonest error was to suggest other gases in the air, especially '*carbon dioxide*' or '*argon*'. A considerable number of candidates suggested '*hydrogen*'.

(ii) Many candidates described the volume increasing with increase in temperature. A few suggested that the volume decreases with increase in temperature. Others did not answer the question and attempted to give an explanation in terms of kinetic particle theory rather than stating the effect on the volume. Others thought that the question was about rates of reaction rather than gas volumes.

(iii) Many candidates wrote vague statements about stability or number of electrons in the outer shell. The best answers suggested that '*the outer shell is full*' or '*there is a complete outer shell of electrons*'. Candidates who wrote about '*eight electrons in the outer shell*' did not gain credit because the question was more general; helium has two electrons in its outer shell. Other common incorrect answers included '*the electronic structure is weak*' or '*the electronic structure is not complete*'.

(iv) Most candidates gave very confused answers and often wrote about the motion of the particles rather than their arrangement or separation. Most candidates wrote vague statements about the arrangement, such as, '*it's loosely packed*' or '*they move away from each other*'. Many candidates realised that the particles in a gas are far apart but wrote answers which were too vague, such as, '*they are separated*'; this was not accepted as it just repeats the question. Others stated '*they are a little apart*'; this was not accepted as it could apply to a liquid. Others wrote about methods of separation, e.g. '*by filtration*', '*by distillation*'.

(b) (i) Many candidates need more practice in memorising the effects of pollutants on health. Many did not read the stem of the question properly and gave answers relating to acid rain rather than an effect on health. Others wrote answers which were too vague or incorrect, e.g. '*bad skin*', '*disease*', '*helps breathing*' or '*reduces haemoglobin*'. A majority of the candidates suggested that lead had an effect on respiration or gave the vague answer '*causes disease*'.

(ii) Few candidates gained full credit. Those who did usually chose carbon monoxide or sulfur dioxide as the pollutants. Many candidates did not heed the word 'other' in the stem of the question and chose nitrogen dioxide and/or lead as the pollutant. Those who chose methane often did not gain credit for the source because they suggested '*natural gas*' without any qualification. Others gave the effects of the pollutant rather than the source or were inexact in their choice of pollutant, e.g. sulfur (instead of sulfur dioxide) or carbon oxide (instead of carbon monoxide or excess carbon dioxide).

Question 6

This was one of the least-well answered questions on the paper. A majority of the candidates estimated the boiling point and relative hardness in **(a)(i)** and some identified the products of electrolysis of lithium chloride in **(c)(iii)**. In **(b)** few candidates gave suitable observations when potassium reacts with water, whilst in **(d)** most candidates appeared to guess the properties that make lithium chloride an ionic compound.

(a) (i) A majority of the candidates estimated the boiling point and relative hardness correctly. Common errors included values between 500 °C and 600 °C for the boiling point of sodium and values around 0.12 rather than 1.2 for the hardness of lithium. Very few candidates gave very high values (more than 5.0) for the relative hardness of lithium.

(ii) Many candidates recognised that lithium would be liquid at 200 °C. Few gave a suitable answer in terms of 200 °C being between the melting and boiling points. The commonest errors were to mention only the melting point or to give vague answers referring to properties or structures, such as, '*because lithium is a metal and chlorine is a non-metal*'.

(b) Most candidates gave answers relating to the products formed rather than focussing on the observations. The commonest errors were '*hydrogen is given off*', '*potassium hydroxide is formed*' and/or '*the solution turns purple*'. The commonest correct answers referred to '*bubbles*' or '*fizzing*'.

(c) (i) Some candidates correctly suggested graphite or carbon. Many candidates did not read the word 'non-metal' in the stem of the question and gave the names of metals, platinum or copper being the commonest errors. Others suggested gases such as argon.

(ii) Better performing candidates realised that the electrodes should not react with the electrolyte. Most candidates appeared to guess the property. A wide range of physical properties was seen. Common errors were '*high boiling point*', '*conducts heat*' or '*strong*'. A significant number of candidates did not appear to understand the question and gave answers such as '*negative electrode*'.

(iii) A minority of the candidates related the correct electrode products to the correct electrode. Others gave the correct products at the incorrect electrodes. The commonest errors were to suggest '*chloride*' or '*chloride ions*' instead of '*chlorine*' or '*lithium ions*' instead of lithium. A significant number of candidates thought that an aqueous solution of lithium chloride was being electrolysed and suggested '*hydrogen*' as one of the products. Others did not give the name of a product and wrote comments such as '*to plate the electrode*' or '*a gas is released*'.

(d) Hardly any candidates gained full credit. The commonest correct answer being '*high melting point*'. Most candidates appeared to guess the answer. A wide range of metallic properties were seen, common errors being '*conducts heat*' or '*has high density*'. Many candidates did not read the stem of the question properly and suggested '*conducts electricity*'. Few candidates suggested properties of both lithium and chlorine as separate elements rather than the compound lithium chloride.

Question 7

This was one of the best answered questions on the paper. Most candidates recognised the structures in **(a)(i)** and **(a)(ii)** and completed the sentence correctly in **(b)(i)**. Most candidates identified the fractions correctly in **(c)**. Fewer candidates recognised that the C=C double bond reacts with aqueous bromine (**(a)(iii)**) or gave a convincing definition of thermal decomposition (**(b)(ii)**).

(a) (i) Nearly all the candidates could identify the carboxylic acid. The commonest incorrect answers were **P** (ethanol) and **R** (propene).

(ii) Many candidates could identify propane as belonging to the same homologous series as ethane. The commonest incorrect answer was **R** (propene).

(iii) Some candidates recognised that the C=C double bond reacts with aqueous bromine. Others suggested **P** (ethanol) or **S** (propane).

(iv) Some candidates were able to deduce the molecular formula $C_4H_8O_2$. Others made simple counting errors, the commonest being C_4H_8O and $C_4H_7O_2$. A minority of the candidates wrote a formula of the type C_3H_7COOH, which is not a molecular formula. Many candidates counted the number of atoms correctly but either put + signs between the atoms ($C_4 + H_8 + O_2$) or wrote the numbers upper case. (C4H8O2 or 4C,8H,2O).

(b) (i) Most candidates identified alkenes as a product of cracking. The commonest incorrect answer was '*ethanol*'. '*Acids*' was also another incorrect answer which was often seen.

(ii) The best answers referred to '*breaking down of compounds using heat*'. Most candidates gained credit for '*in the presence of heat*' or '*thermal energy input*'. A few wrote too vaguely or suggested that thermal energy was given out. Others mentioned an input of energy but did not refer to '*thermal*' or '*heat*'. Most candidates gave vague answers when explaining the meaning of decomposition, e.g. '*the substances break*' or '*the atoms breakdown*'. Many did not explain the term decomposition at all and just used this word in their answers, e.g. '*decomposition of a compound using heat*'. Candidates should be reminded that if there are two words in a term, both of these must be explained.

(c) Most candidates linked a correct fraction with its use. The commonest errors were to link naphtha to waxes and polishes or the lubricating fraction to making chemicals.

Question 8

Some candidates answered this question well. Parts **(b)** and **(c)** were generally well answered by most candidates. Others found the halogen / halide questions in **part (d)** challenging. Very few candidates gave a suitable definition of an element in **(a)**. The calculation in **(e)** was done correctly by nearly all the candidates.

(a) Few candidates were able to give a suitable definition of the term 'element'. The best answers related to '*a substance containing only one type of atom*'. A common error was to suggest that several atoms of the same type were present, e.g. '*it contains atoms of the same type*'. This was not accepted because it could apply to compounds such as methane and ethane, both of which have carbon and hydrogen atoms. Other common errors included '*it contains a single atom*' or '*it is a compound with only one type of atom*'.

(b) Many candidates realised that chlorine is used in water purification or for killing bacteria. Others did not gain credit because their answers were too vague, e.g. '*making salt*', '*filtering water*' or '*cleaning water*'.

(c) (i) Many candidates balanced the equation correctly. The balance of phosphorus was generally correct. The commonest error was to balance the chlorine as $3Cl_2$ rather than $5Cl_2$.

(ii) Many candidates were able to state the meaning of the term exothermic correctly. The commonest error was to mention '*release of energy*' without referring to '*thermal*' or '*heat*'.

(d) (i) Some candidates identified the correct products but could only correctly name one. The commonest errors were '*bromine chloride*' as one of the products, '*bromide*' instead of bromine, '*hydrogen*' or '*water*' instead of bromine and '*sodium hydroxide*' instead of sodium chloride.

(ii) Very few candidates described the test for bromide ions correctly. Many suggested using sodium hydroxide, aqueous bromine or carrying out a flame test. Those who suggested silver nitrate sometimes disadvantaged themselves by suggesting the addition of hydrochloric acid, sulfuric acid or sodium hydroxide instead of nitric acid. Some candidates gained credit for the correct colour of the precipitate. The commonest error was to suggest '*white precipitate*'. Others omitted the word '*precipitate*' or '*solid*'.

(iii) The better responses made the correct comparison of the reactivities of chlorine and bromine. Many tried to compare the reactivity of bromine or chlorine with sodium, sodium chloride. Others compared the reactivity of one or both the halides. For example: '*chlorine is more reactive than bromide*'.

(e) A majority of the candidates gained credit for the calculation. The commonest error was to suggest 112, obtained through using the relative atomic mass of chlorine as 35 rather than 35.5 or truncating their answer from 71 to 70. Another error was to ignore the number of hydrogen atoms or chlorine atoms.

CHEMISTRY

Paper 0620/42
Theory (Extended)

Key messages

When drawing organic structures, candidates should be aware that structures will require all bonds to be drawn and thus the valency of the atoms used needs to be correct. Trivalent carbon atoms and divalent hydrogen atoms were seen in **Question 6(e)(i)**.

Candidates do need to read the question carefully. For instance in **Question 5(b)(i)** many candidates gave various values of temperatures despite being told the reaction took place at room temperature.

Candidates do need to use clear and legible handwriting. It was not always possible to be able to distinguish between the letters a, e and o. This is a particular problem in naming organic compounds such as methanol in **6(c)(ii)**.

General comments

The paper allowed most candidates to show a good understanding of the subject at this level. The general standard was very good with some candidates scoring very high marks

Where a single answer is asked for, two (or three) answers should not be given as incorrect statements may contradict correct answers.

Candidates should be encouraged to show working in calculations as this often allows error carried forward marks to be awarded.

Comments on specific questions

Question 1

Most candidates scored all or nearly all of the marks available in this question which was designed to be an easy introduction to the paper.

Common errors included argon given as the answer to **1(e)** and carbon to **1(i)**.

Question 2

(a) All candidates knew the correct state symbols for the solid $MgCO_3$ and gaseous CO_2, but many erroneously assumed it was $HCl(l)$ or $H_2O(aq)$.

(b) This question differentiated well. Most candidates gave the charges correctly – a few had the signs of the charges wrong. Many candidates did not attempt to draw the outer rings for the ions. The magnesium ion was more often correct than the chloride ions: candidates often gave the same symbol for all the electrons in the outer shell of the chloride ion. Better candidates drew non-bonding electrons as pairs.

(c) The bonding within CO_2 was well known.

(d) (i) Better candidates secured the mark with the simple comment that the gradient (or slope) of the graph decreased.

(ii) Candidates are not strong at describing changes in rate of reaction in terms of particles. The first key point was the concentration of the acid decreased ('less acid' was too vague). This leads to the second point that the frequency of collisions between acid particles decreased. Once again, 'less collisions' was insufficient.

(iii) Most candidates drew a steeper curve than the original one and ensured that it became level at an earlier time and at the same volume as the original curve.

(e) Most candidates scored all three marks, showing a good understanding of the mole concept.

Question 3

(a) Most candidates realised that nitrogen dioxide forms as a consequence of atmospheric nitrogen reacting with atmospheric oxygen although a surprising number of candidates believe nitrogen comes from the fuel. The second mark was given for stating the reaction needs a very high temperature to occur.

(b) Most candidates knew nitrogen dioxide led to acid rain but weaker candidates described it as a greenhouse gas or a cause of global warming.

(c) (i) Thermal decomposition was almost universally known.

(ii) Although a significant number of candidates were able to determine that the one other molecule formed consisted of one atom of C, H, N and O and gave the formula as CHNO (any order was accepted). Many candidates tried to give the formula of a compound they knew such as CO, CO_2, H_2O and NH_3.

(iii) The test for ammonia was well known by nearly all candidates. Weaker candidates need to be advised that 'pungent smell' is not a valid test for ammonia.

(d) (i) Candidates did well here. Some scored just one mark by giving the correct number of NO_2 molecules (6) or NH_3 molecules (8) deriving these values from $12H_2O$ seen on the right hand side. Occasionally $14N_2$ was seen on the right hand side, presumably as a result of failing to realise that nitrogen was diatomic.

(ii) Although reduction could be expressed in many different terms (e.g. electron gain), the candidates were asked to use the equation to describe the reduction. Thus loss of oxygen was the accepted answer.

(iii) Nearly all candidates scored this mark for stating the meaning of the term *redox*.

(e) Most candidates scored both marks. The M_r was occasionally miscalculated or the mass calculated was not converted from g to kg, but as most candidates showed clear working, if an error was made when calculating the M_r, then M2 could be awarded providing a correct unit conversion to kilograms was performed.

(f) (i) Although most candidates knew carbon monoxide was formed by incomplete combustion, weaker candidates gave a range of gases such as nitrogen dioxide, carbon dioxide, sulfur dioxide and even oxygen.

(ii) Carbon dioxide was well known but a variety of responses were seen for the other non-toxic gas – including nitrogen dioxide which was stated as being toxic in **part (b)**.

Question 4

(a) (i) The more able candidates knew the electrons went along the wire from the more reactive metal, zinc, to the less reactive metal copper but other candidates struggled. Many had arrows representing electrons flowing through the electrolyte and some had a pair of arrows pointing in contradictory directions.

(ii) Most candidates constructed a correctly balanced ionic half-equation. Weaker candidates had Zn^{2+} ions forming Zn atoms and others thought that the 2+ charge required 2 Zn atoms on the left hand side

(b) (i)/(ii) Most candidates used their knowledge of the Periodic table to correctly select a more reactive element than zinc (usually magnesium) for **(b)(i)** and a known less reactive element than iron (usually copper) for **(b)(ii)**.

A few candidates opted for metals not in the Periodic Table given in the syllabus such as ruthenium. Sometimes they were lucky. It should be noted that Group 1 metals were allowed as being more reactive than zinc this time but as they would also react with water, this may not be the case in future series.

(c) (i)/(ii) Most candidates knew the reactants and products of a fuel cell.

(d) (i) The term 'electrolysis' was almost universally known.

(ii) Better candidates knew that ions needed to be mobile and alternative phrases were allowed such as 'able to move' or 'able to flow'. Loose wording such as ions 'need to be free' received no credit. Weaker candidates assumed mobile or delocalised electrons were responsible for the passage of current through an electrolyte.

(e) (i)/(ii) The more able candidates could name all three products in **(e)(i)** and gave sodium as the different product in **(e)(ii)**. Weaker candidates tended to write sodium instead of sodium hydroxide in **(e)(i)** and often opted for impossible products such as hydrogen or water in **(e)(ii)**.

Question 5

(a) (i) Cracking was well known by candidates, although polymerisation was a common error.

(ii) This question differentiated well. Most candidates worked out the formula of decane. Some candidates did not read the question and often two 5 carbon compounds were given instead of ethane and ethene as the products and some lost the final mark by omitting the balancing.

(b) (i) Many candidates wrote 'hydrochloric acid' for their response. This is incorrect. In the absence of water, candidates need to appreciate that the other product in this substitution reaction is gaseous hydrogen chloride. Candidates were asked for a *name*. 'HCl' was not given credit as there was no way of determining whether the candidate meant hydrochloric acid or hydrogen chloride.

(ii) Ultra-violet radiation / light or any response which contained radiation within the ultra-violet range of the spectrum (such as sunlight) was also given credit.

(c) (i) More candidates were aware that addition reactions form a single product than last time this question was asked. There was still some confusion with polymerisation, however.

(ii) This structured question differentiated well. Error carried forward marks were able to be awarded to candidates who showed clear working.

In step 1, candidates were required to add up the energy required to break all the bonds in the reactants. Some candidates used the good practice of pencilling out bonds in the structures to ensure every bond was accounted for. Occasionally the $Cl–Cl$ bond was omitted.

In step 2 candidates were expected to realise that if the total energy change was –180 kJ / mol then the energy released in formation of product bonds must be 180 kJ / mol more than step 1. Frequently many assumed it to be 180 kJ / mol less.

In step 3, candidates had to account for the bond energy of both $C–Cl$ bonds by subtracting the bond energy of 4 × C–H bonds plus the C–C bond from the value given in step 2 followed by division by two.

Question 6

(a) (i) / (ii) / (iii) 'Homologous series', 'same functional group and 'general formula' were all well known.

(iv) Most candidates worked out that butyl propanoate contained 7 carbon atoms although many gave 4 as their answer, presumably thrown by the 'butyl' part of the name.

(b) Nearly all candidates knew that a mixture of liquids is separated by fraction distillation.

(c) (i) Candidates who understood esters had no problem identifying the name of the acid needed to produce butyl propanoate. Some candidates failed to draw all bonds in the structure, in particular the O–H bond was often missing.

(ii) Nearly all candidates identified methanol as the alcohol needed to produce a methyl ester.

(d) (i) The term 'isomer' was almost universally known.

(ii) Candidates are required to know the name of esters which can be made from unbranched alcohols and carboxylic acids, each containing up to four carbon atoms so the two expected names were ethyl butanoate and butyl ethanoate. However many candidates gave methyl pentanoate and pentyl methanoate as well as correctly named branched isomers. These were given credit.

(e) (i) There were some excellent answers to this question, but some candidates had no idea and divalent hydrogen atoms or trivalent carbon atoms were common with weaker candidates. The ester group orientation caught out those who did not look at the structures in the question properly.

A significant proportion of candidates did not attempt to draw continuation bonds or finished with complete carboxylic acid and hydroxyl groups at the ends of their structure.

(e) (i) / (ii) Condensation polymerisation was well known in **(e)(i)** as was terylene in **(e)(ii)** (including its many varied but recognisable spellings).

CHEMISTRY

Paper 0620/52
Practical Test

Key messages

- Readings recorded from a given item of apparatus should all be recorded to the same resolution (the same number of decimal places).
- Where, in a quantitative task, a reagent is added dropwise and then in excess, candidates should give observations for the dropwise addition and for the addition in excess; making it clear which observation is for dropwise addition and which for addition in excess.
- 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 credit cannot be awarded.
- Graph scales should be chosen such that the plotted data takes up over half of the available grid space. It is recommended that each major grid line should be equivalent to 1, 2, or 5 (or those numbers multiplied by 10^n) – this is indicated in the mathematical requirements in the syllabus and by the Association for Science Education (A.S.E.).
- It is strongly recommended that candidates have a 30 cm ruler with them to facilitate the drawing of graph lines.

General comments

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

Some responses might suggest that candidates have limited practical experience.

When giving a numerical answer such as in **Question 2(g)**, if candidates give a range, both the lower and upper numbers given must fall within the range of answers accepted.

Comments on specific questions

Question 1

(a) The vast majority of candidates obtained a full set of experimental results which showed the expected pattern. It should be noted that thermometer scales should be read to the nearest half division, so to the nearest 0.5 °C in this case.

(b) Many excellent graphs were seen, with the majority of candidates gaining all five marks available. Almost all candidates gained results that could have been plotted using a *y*-axis scale where each large grid square equated to 5 °C. Candidates who selected other scales made more errors in plotting than those who selected this scale. The instructions in the question were to draw a straight line of best fit and that the line should pass through (0,0); these instructions were ignored by some candidates who then drew dot-to-dot lines, which did not gain credit, or did not continue the line to (0,0). It was evident that some candidates did not have a sufficiently long ruler to use and produced lines with a clear bend in the middle or double lines where they did not position their short ruler correctly when drawing the second section of the line.

(c) Most candidates gained full credit. The working on the graph expected, and shown by the majority of candidates, was a vertical line from 3.4 g on the *x*-axis to the graph line and then a horizontal line across to the *y*-axis. A few candidates decided not to use a ruler for these construction lines while others did not draw the line to the *y*-axis carefully and so, for example, a reading of 14.5 °C on the graph line became 14 or 15 by the time the construction line reached the axis.

(d) Better performing candidates recognised the inverse ratio of ΔT and mass of water, with some giving excellent reasons based on the same energy change in the reaction being used to heat twice as much water. However, many weaker candidates thought that more water would mean more reaction and so a greater temperature change.

(e) Some excellent answers were seen. Other candidates did not read the question and gave changes that were not based on a change to the apparatus. The two expected improvements were based on increasing the accuracy of the measurement of the volume of water by using a burette and reducing heat loss by insulation or using a polystyrene cup or using a lid.

It should be noted that digital thermometers (or thermocouples) are not necessarily more accurate than liquid-in-glass thermometers; while they do have a greater resolution, they are no more accurate (and often less accurate) than liquid-in-glass thermometers. Another misconception was that using the thermometer to stir rather than a glass rod changed the accuracy of the results.

Question 2

(a) The majority of candidates were able to report a correct flame colour, however, it is evident that some candidates are not clear on what a flame test involves and reported impossible observations, such as precipitates. References to the flame being blue-green were ignored since the yellow colour due to the sodium ions in the solution should have been more evident, and may have totally masked the blue-green colour caused by the copper ions.

(b) Most candidates were able to clearly report the expected observations. Some candidates had difficulty in clearly stating their observations. As the test reagent was added dropwise and then in excess, answers should have clearly shown the observations on dropwise addition and then the observations for further addition in excess. Some candidates gave contradictory statements such as stating that a precipitate dissolves to form a deep blue precipitate. In this example, the mark for the precipitate dissolving cannot be awarded as the answer has gone on to say a precipitate is still there and so it has not dissolved.

(c) Stronger responses noted that the precipitate formed was cream. Where the colour of the solution can mask the colour of a precipitate, candidates need to look carefully; often the correct colour can be seen by letting the precipitate settle for a while or by looking at any of the precipitate that is held on the surface of the liquid.

(d) A variety of observations were seen. Any precipitates formed were ignored and credit awarded for an appropriate colour for the solution.

(e) Most candidates correctly noted the formation of bubbles as the solution reacted with the magnesium ribbon.

(f) Stronger responses correctly identified all three ions in solution **A**. An error carried forward was allowed based on the colour of the precipitate formed in **(c)**. Weaker responses often gave ions that had not been tested for or which did not match their results. A common error was to state that the solution contained Cr^{3+} ions.

(g) Most candidates were able to give a suitable pH. Some candidates gave a range (such as 9 to 11), in these cases then both the upper and lower limit given by the candidate had to lie within the acceptable range, so '*7 to 14*' did not receive credit as '*7*' is not an acceptable answer.

(h) Almost all candidates correctly stated that a white precipitate formed. Many did not make it clear that the precipitate remained when excess aqueous sodium hydroxide was added.

(i) Stronger responses correctly noted either a faint precipitate or no reaction; both answers were acceptable since the formation of a precipitate is dependent on the concentrations of the reagents.

(j) The majority of candidates correctly stated that solid **B** contained calcium ions. Far fewer correctly deduced the presence of hydroxide ions from the pH test in **(g)**. A common error was to suggest that solid **B** was calcium carbonate; this is impossible since calcium carbonate is insoluble in water.

Question 3

Many excellent answers to this planning question were seen.

The expected procedure was to place a known volume of the drink in a suitable container (such as a conical flask) which was connected to apparatus able to collect the gas and measure its volume. The drink was then heated until all the carbon dioxide was removed, and the volume of gas measured. That volume should then have been scaled up to the volume of gas in 1 dm^3 of drink.

However, some candidates did not read the question carefully and used 1 dm^3 of the drink despite being told they had a small sample which was less than 1 dm^3. Others tried to work out the volume of carbon dioxide measured in dm^3 rather than the volume of carbon dioxide dissolved in 1 dm^3 of the drink.

Other common errors made in an otherwise suitable method were:
- using a beaker to contain the drink – this is not suitable as it cannot be fitted with a bung to enable the gas to be collected via a delivery tube
- not stating how the volume of gas collected is scaled up to the volume of carbon dioxide in 1 dm^3 of the drink; statements such as '*use ratios*' or '*cross multiply*' were insufficient.

It should be noted that the term 'amount' is not an acceptable alternative for 'volume'; hence '*measure the amount of carbon dioxide collected*' did not gain credit.

Three of the most common inappropriate methods were:
- The use of mass loss to determine the mass of carbon dioxide lost. However, since the drink needs to be heated during the experiment there will be a considerable loss of water through evaporation and so most of the mass lost will be water.
- Calculating the volume of carbon dioxide lost by measuring the volume of the drink before and after heating. As the carbon dioxide is dissolved in the drink it does not have any significant effect on the volume of the drink.
- Trying to cool the carbon dioxide released into a liquid and measuring the volume of the liquid carbon dioxide.

All these methods could gain some credit for steps such as measuring the initial volume of the drink and heating the drink. However, full credit could not be awarded as the methods would not work.

Some candidates started off by writing the aim of the experiment – there is no need to do this as the aim is in the question. Some then gave lists of the apparatus used. Credit will not be given for lists of apparatus, where credit is available for the use of suitable apparatus then it needs to be clear in the experimental plan (the 'method') what that apparatus is used for. For example, while there was credit for using a suitable container in which to heat the drink, such as a conical flask, just writing 'conical flask' in a list of apparatus would not gain credit as there is no indication of what it is to be used for.

CHEMISTRY

Paper 0620/62
Alternative to Practical

Key messages

- Readings recorded from a given item of apparatus should all be recorded to the same resolution (the same number of decimal places).
- Where, in a quantitative task, a reagent is added dropwise and then in excess, candidates should give observations for the dropwise addition and for the addition in excess; making it clear which observation is for dropwise addition and which for addition in excess.
- 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 credit will not be awarded.
- Graph scales should be chosen such that the plotted data takes up over half of the available grid space. It is recommended that each major grid line should be equivalent to 1, 2, or 5 (or those numbers multiplied by 10^n)° – this is indicated in the mathematical requirements in the syllabus and by the Association for Science Education (A.S.E.).
- It is strongly recommended that candidates have a 30 cm ruler with them to facilitate the drawing of graph lines.

General comments

The vast majority of candidates successfully attempted all of the questions and the full range of marks was seen. The paper was generally well answered, with very few blank spaces.

Some responses might suggest that candidates have limited practical experience.

When giving a numerical answer such as in **Question 3(d)**, if candidates give a range, then both the lower and upper numbers must fall within the range of answers accepted.

Comments on specific questions

Question 1

(a) The majority of candidates correctly stated that the reading on the balance would decrease; fewer were able to give a correct reason for this. The explanation had to relate to the gas made leaving the flask. The most common incorrect explanations were based on the amount of calcium carbonate becoming less as it reacted or dissolved and so it weighed less; or that a gas was made and that gases are light. Some candidates thought the mass would be unchanged due to the conservation of mass. This suggested that they were not familiar with experiments based on mass loss due to loss of a gas.

(b) (i) Better responses correctly stated that a bung would prevent the gas made from leaving the flask. Some candidates incorrectly thought that a bung would let gas escape or that the bung could not absorb the gas. While it is true that a bung would not absorb the gas, it is not a correct explanation of why a bung is not used since the cotton wool, which is used, will not absorb the gas either.

(ii) While some fully correct answers were seen, many of the answers suggest a significant number of candidates were not familiar with this simple rate of reaction experiment. Many candidates thought the cotton wool would trap or absorb the carbon dioxide or would prevent air or debris falling in. Only a minority of candidates could correctly state that the cotton wool prevented the acid spraying out during the reaction.

(c) The majority of answers were correct. For others, it was evident that some candidates did not know what a reactant was and identified a product or a substance that was neither a reactant nor a product.

(d) The first step of the process should have been filtration to remove the remaining solid calcium carbonate. Many candidates did filter the reaction mixture; some thought that this gave the crystals of calcium chloride, or they then incorrectly went on to use the residue in the next stage. Once the solution of calcium chloride had been obtained, it should have then been heated until it was saturated/had reached crystallisation point. Some excellent descriptions of this, involving testing the solution with glass rods or placing the solution on a cold slide, were seen. Answers such as '*crystallise the solution*' did not gain credit since the question asked for a description of how this is done.

Question 2

(a) Most candidates were able to correctly read the thermometer diagrams and calculate the temperature changes. Candidates are expected to read thermometers to the nearest half a division (in this case to the nearest 0.5 °C). It was common for candidates to give some temperatures to a whole number and others to the nearest 0.5 °C; those candidates could gain full credit. All readings from the same item of equipment should be given to the same resolution, in this case all reading should have ended with '.5' or '.0'.

(b) Many excellent graphs were seen with the majority of candidates gaining all five marks available. The expected graph scale on the *y*-axis was each large grid square representing 5 °C. Candidates who selected other scales made more errors in plotting than those who selected the expected scale. The instructions in the question were to draw a straight line of best fit and that the line should pass through (0,0); these instructions were ignored by some candidates who then drew dot-to-dot lines, which did not gain credit for the line, or did not continue the line to (0,0). It was evident that some candidates did not have a sufficiently long ruler to use and produced lines with a clear bend in the middle or double lines where they did not position their short ruler correctly when drawing the second section of the line.

(c) Most candidates gained full credit. The working on the graph expected, and shown by the majority of candidates, was a vertical line from 3.4 g on the *x*-axis to the graph line and then a horizontal line across to the *y*-axis. A few candidates decided not to use a ruler for these construction lines while others did not draw the line to the *y*-axis carefully and so, for example, a reading of 14.5°C on the graph line became 14 or 15 by the time the construction line reached the axis.

(d) Better responses recognised the inverse ratio of ΔT and mass of water, with some giving excellent reasons based on the same energy change in the reaction being used to heat twice as much water. However, many weaker responses thought that more water would mean more reaction and so a greater temperature change.

(e) Some excellent answers were seen. For others, it was evident that some candidates did not read the question and gave changes that were not based on a change to the apparatus. The two expected improvements were based on increasing the accuracy of the measurement of the volume of water by using a burette and reducing heat loss by insulation or using a polystyrene cup or using a lid.

It should be noted that digital thermometers (or thermocouples) are not necessarily more accurate than liquid-in-glass thermometers; while they do have a greater resolution, they are no more accurate (and often less accurate) than liquid-in-glass thermometers. Another misconception was that using the thermometer to stir rather than a glass rod changed the accuracy of the results.

Question 3

(a) The flame test colour for copper(II) ions was well known. 'Blue' alone as the colour was not acceptable. It was evident that some candidates did not recognise the description of a flame test and so gave inappropriate observations.

(b) The test for copper(II) ions using aqueous ammonia was well known. Some candidates had difficulty in clearly stating the expected observations. As the test reagent was added dropwise and then in excess, answers should have clearly shown the observations on dropwise addition and then the observations for further addition in excess. Some candidates gave contradictory statements such as stating that a precipitate dissolves to form a deep blue precipitate. In this example, the mark for the precipitate dissolving cannot be awarded as the answer has gone on to say a precipitate is still there and so it has not dissolved.

(c) The formation of a cream precipitate was well known. However, some candidates incorrectly stated that the precipitate was slightly soluble – possibly thinking about the addition of aqueous ammonia to the precipitate (which is not on the syllabus). Stating the precipitate is slightly soluble in aqueous ammonia is correct and was ignored, but it is not considered slightly soluble in water.

(d) Most candidates were able to give a suitable pH. Some candidates gave a range (such as 9 to 11), in these cases both the upper and lower limit given by the candidate must lie within the acceptable range, so '*7 to 14*' did not score as '*7*' is not an acceptable answer.

(e) Most candidates correctly identified solid **B** as containing calcium ions; fewer realised that because the solution formed was alkaline, it must have contained hydroxide ions; both 'oxide' and 'hydroxide' were accepted since calcium oxide is alkaline.

Question 4

Many excellent answers to this planning question were seen.

The expected procedure was to place a known volume of the drink in a suitable container (such as a conical flask) which was connected to apparatus able to collect the gas and measure its volume. The drink was then heated until all the carbon dioxide was removed, and the volume of gas measured. That volume should then have been scaled up to the volume of gas in 1 dm^3 of drink.

However, some candidates did not read the question carefully and used 1 dm^3 of the drink despite being told they had a small sample which was less than 1 dm^3. Others tried to work out the volume of carbon dioxide measured in dm^3 rather than the volume of carbon dioxide dissolved in 1 dm^3 of the drink.

Other common errors made in an otherwise suitable method were:
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It should be noted that the term 'amount' is not an acceptable alternative for 'volume'; hence '*measure the amount of carbon dioxide collected*' did not gain credit.

Three of the most common inappropriate methods were:
- The use of mass loss to determine the mass of carbon dioxide lost. However, since the drink needs to be heated during the experiment there will be a considerable loss of water through evaporation and so most of the mass lost will be water.
- Calculating the volume of carbon dioxide lost by measuring the volume of the drink before and after heating. As the carbon dioxide is dissolved in the drink it does not have any significant effect on the volume of the drink.
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Some candidates started off by writing the aim of the experiment – there is no need to do this as the aim is in the question. Some then gave lists of the apparatus used. Credit will not be given for lists of apparatus, where credit is available for the use of suitable apparatus then it needs to be clear in the experimental plan (the 'method') what that apparatus is used for. For example, while there was credit for using a suitable container in which to heat the drink, such as a conical flask, just writing 'conical flask' in a list of apparatus would not gain credit as there is no indication of what it is to be used for.