CHEMISTRY

Paper 0620/12
Multiple Choice (Core)

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

General comments

Candidates found **Questions 1**, **7**, **11**, **37** and **40** to have the least demand. Candidates found **Questions 2**, **12**, **25** and **35** the most demanding. Candidates should be reminded that they are provided with a Periodic Table to aid questions which require calculation or to identify the position of an element. Examples of these questions include **Questions 6** and **10**.

Questions which required candidates to recall the colours of chemicals were not well answered by some of the candidates. Examples of these include **Questions 17** and **20**.

Comments on specific questions

Question 2

This was a demanding question requiring both an understanding of the term ‘monoatomic’ and interpretation of data. In general, all options were chosen equally suggesting many candidates guessed.

Question 3

Most candidates recalled that the boiling point of a substance will increase when impurities are added. The decrease in melting point was not so well recalled. Many candidates incorrectly chose option **A**.

Question 6

Candidates who performed less well were more likely to choose option **B**. A significant proportion of all candidates confused the terms 'mixture' and 'compound'.

Question 8

Some candidates struggled to recall the bonding in molecules listed in the syllabus and many incorrectly chose option **B**.

Question 10

Candidates who performed less well ignored the formula and chose option **A**, picking out the element with the closest relative mass to the compound shown.

Question 12

This question was the least well answered on this paper. Nearly all candidates recognised that dilute hydrochloric acid could be electrolysed to produce hydrogen. Few recalled the electrolysis products of concentrated aqueous sodium chloride. Option **C** and option **B** were more likely to be suggested as answers.

Question 17

The colours of hydrated and anhydrous salts were not well recalled. All options were chosen equally, suggesting some guessing.

Question 24

The correct option, **A**, was the most common. However, option **D** was chosen by many candidates. Candidates should take care to recall that elements which are higher in the reactivity series will react with acids but that the oxides of these elements will not react with carbon.

Question 25

Candidates who were unclear about the meanings of the terms 'compound' and 'mixture' were likely to choose the incorrect option. Either option **A** or option **D** were chosen.

Question 26

A large number of candidates did not recognise that magnesium as a metal would be a good conductor of electricity. Option **B** was a commonly chosen incorrect answer.

Question 31

Some candidates chose option **C**.

Question 35

This question was not well answered. The correct option was rarely selected and option **A** was as likely to be chosen as the correct answer. Candidates may be confusing the terms 'natural gas' and 'clean air'.

Question 40

Candidates had little trouble with this question and it was correctly answered by all candidates.

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Paper 0620/22
Multiple Choice (Extended)

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

General comments

As a group, the candidates found this paper accessible. They showed good understanding of the syllabus. Candidates found **Questions 8**, **24**, **25**, **27** and **35** to be more demanding. Questions with the least demand were **Questions 4**, **11**, **16**, **26**, **28**, **31**, **37** and **39**.

Comments on specific questions

Question 1

Most candidates answered this correctly. A significant minority chose distractor **A**, suggesting a confusion of heat movement during melting.

Question 2

There was a distribution of choices between options for candidates who performed less well, which suggests guessing.

Question 3

Some candidates were less likely to be able to determine the R_f value and so tended to choose option **A** more frequently than the correct option, **C**.

Question 7

Candidates who performed less well chose any of the options, other than the correct answer. Option **B** was the most popular incorrect choice.

Question 8

Options **B** and **C** were popular incorrect answers to this question. Many candidates found it difficult to distinguish between the type of particles in ionic and covalent compounds and attractions between particles.

Question 10

Most candidates answered this question correctly; a significant minority ignored the formula given and chose the element with the closest relative mass, option **A**.

Question 17

Option **D** was commonly chosen for candidates who performed less well.

Question 24

Options **B** and **C** were commonly chosen, particularly by lower performing candidates. Candidates should take care to recall that elements which are higher in the reactivity series will react with acids but that the oxides of these elements will not react with carbon.

Question 25

A small minority chose the correct answer; a significant number chose option **A**, confusing the role of cryolite in the extraction of aluminium from its ore.

Question 26

A large majority of candidates answered this correctly, showing understanding in the properties and uses of metallic elements.

Question 27

Very few candidates chose option **D**, options **A** and **C** were commonly chosen by lower performing candidates, suggesting confusion in the reactivity of metal oxides and carbon.

Question 35

This question was not well answered by candidates who performed less well. Option **A** was more likely to be chosen as the correct answer. Candidates may be confusing the terms ‘natural gas’ and ‘clean air’.

Question 38

Some candidates selected option **C**.

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Paper 0620/32
Theory (Core)

Key messages

- Many candidates need more practice in reading and analysing the stem of each question.
- Some candidates need more practice in writing with precision.
- Many candidates would benefit by improving their knowledge of specific chemical terms and processes.
- Interpretation of data from tables and completion of chemical equations was well done by many candidates. Others need more practice in these areas.

General comments

Many candidates tackled this paper well, showing a good knowledge of core chemistry. Nearly all candidates were entered at the appropriate level. The standard of English was generally good. Few of the questions were left unanswered.

Many candidates need practice in reading the stem of the question carefully to determine exactly what is being asked. Many errors arose from not heeding essential words in the stem. For example, in **Question 1(c)** some candidates chose elements that were not shown in the diagram. In **Question 2(a)(i)** some candidates ignored the word 'negative' in reference to the ions whilst in **Question 2(a)(ii)** some candidates gave names rather than the formulae of the ions. In **Question 3(b)(i)** some candidates wrote the formula instead of the electronic structure and in **Question 4(d)** many wrote names rather than giving an observation. In **Question 5(c)(ii)** some candidates did not use the information in the diagram, whilst in **Question 5(f)(ii)** many gave the same use as given in the stem of the question rather than one other use. In **Question 7(d)(ii)** some candidates wrote about chemical properties rather than physical properties, whilst in **Question 7(e)(i)** many candidates wrote the name of products other than sodium hydride despite the fact that sodium hydride had been given in the stem of the question. In **Question 7(e)(iii)** many candidates did not refer to the equation and just wrote a definition of reduction. In **Question 8(c)** most candidates did not heed the words 'acidified solution' in the stem of the question and just gave the orange colour of methyl orange.

Many candidates could improve their marks by writing with greater specificity. For example, in **Question 3(a)(iii)** some candidates wrote vague answers about the melting point without mentioning the boiling point or the stated temperature. In **Question 5(d)** (degree of separation of particles in a liquid) many candidates wrote confusing statements such as 'a little far from each other' or 'the particles are apart but not quite as much in a gas' rather than sticking to the simpler 'close together' or 'most are touching each other'. In **Question 5(e)** many candidates did not write about particles or molecules and just mentioned hydrogen sulfide going towards and reacting with the filter paper. In **Question 6(c)(i)** many candidates just mentioned 'breaking molecules' or 'breaking bonds' instead of the idea of decomposing large molecules to small molecules by heating. In **Question 6(c)(ii)** some candidates just wrote 'temperature' instead of 'high temperature' and in **Question 6(e)** many wrote vague answers such as 'land pollution' or 'water pollution'. In **Question 7(d)** some candidates wrote about the malleability of sodium, as if iron was not malleable at all.

Some candidates need more practice in writing answers with the correct amount of detail using specific chemical terms. For example, in **Question 5(e)** few candidates used the term diffusion, whilst in **Question 5(f)(i)** many did not use the terms erosion or (chemical) weathering.

Some candidates would benefit from further revision of specific topic areas such as electrolysis (**Questions 7(a)**, **(b)** and **(c)**), especially in terms of naming the products at each electrode and the observations at each electrode. Other candidates need to revise qualitative tests and colours of specific ions and molecules. The answers to the questions about Fe^{3+} ions (**Question 1(d)**), the test for bromide ions (**Question 2(a)(iv)**) and the colour of chlorine (**Question 7(c)**) were not well known. In contrast, many candidates knew the colour produced by the flame test for sodium (**Question 7(f)**).

Many candidates were able to extract information from tables, balance symbol equations and undertake simple chemical calculations. Others need more practice in dealing with negative numbers (**Question 3(a)(i)**) and doing calculations involving simple proportion (**Question 2(a)(iii)**) and (**Question 3(c)**). A few candidates need more practice in analysing and drawing graphs. In **Question 4(b)** a number of candidates did not start the line at the 0,0 point or drew lines which were wavy.

Comments on specific questions

Question 1

Many candidates identified the correct elements in **(a)**, **(b)** and **(e)**. Few candidates identified iron(III) ions from the information given in **(d)**. In **(c)** some did not heed the instruction to choose only the symbols given in the table.

(a) The majority of the candidates knew that aluminium is extracted from bauxite. The commonest incorrect answer was to suggest iron. A few candidates chose other metals or non-metals. A small number of candidates chose non-metals; bromine and nitrogen being the commonest.

(b) The majority of the candidates correctly identified oxygen. The commonest error was to suggest nitrogen. A few chose carbon.

(c) Some candidates recognised that oxides of nitrogen are responsible for acid rain. Others did not heed the instruction to use only the elements shown in the diagram and chose sulfur. Another common error was to choose carbon. Students should realise that although carbon dioxide is an acidic oxide, it is not acidic enough to be classed as a contributor to acid rain. A considerable number of candidates suggested chlorine or iodine.

(d) Some candidates knew the test for iron(III) ions. A wide variety of incorrect answers were seen, the commonest being Al, K, Zn or Mg. A considerable number of candidates suggested bromine, presumably because they recognised that it has a red-brown colour.

(e) Most candidates recognised that argon has a complete outer shell of electrons. A wide variety of incorrect answers were seen; the commonest being Fe, Zn, Cu and Cl.

Question 2

Many candidates gave good answers to **(a)(i)**, **(b)**, **(c)** and **(d)(i)**. In **(a)(ii)** some candidates wrote the names of the ions rather than the formulae and in **(a)(iv)** many only gave the formula of the chloride ion rather than naming the compound. Some candidates did the calculation in **(a)(iii)** correctly. Others need more practice at simple proportion.

(a) (i) A majority of the candidates recognised metaborate as the negative ion with the lowest mass. The commonest error was to ignore the essential word 'negative' in the question and therefore to choose strontium.

(ii) Some candidates gave the correct formulae by using the information in the table. Others wrote the names rather than the formulae. Many candidates did not use the information in the table and wrote SO_4, S or S^{2-} instead of SO_4^{2-}. The formula for the potassium ion was nearly always correct.

(iii) Some candidates were able to apply simple proportion to get the correct answer. Others made simple errors in division, giving differences to the power of ten, e.g. 8 or 800 rather 80. Another common error was 500 obtained by $200 \times 1000 \div 400$. A few candidates tried to do mole calculations or used the molar gas volume in expressions such as $0.2 \div 24$.

(iv) Some candidates recognised the compound sodium chloride. Many others just named the chloride ion or gave its formula. A significant number of candidates suggested carbon dioxide. A few did not heed the word evaporation in the question and suggested 'water'.

(v) Very few candidates recognised that bromide ions give a cream precipitate with aqueous silver nitrate. Some were not accurate enough and wrote bromine instead of bromide. Chloride, potassium and magnesium were the commonest incorrect answers.

(b) The commonest errors were to write $2(H_2O)$ and/or $2(HCl)$ or to attempt to balance with multiples of 2 or 3 such as 4, 6 or 9.

(c) Many candidates deduced the correct numbers of protons and neutrons. The commonest errors were to suggest 38 electrons (ignoring the charge on the ion) or 38 neutrons (by not subtracting proton number from mass number). Others suggested 87 electrons or neutrons (the mass number).

(d) (i) A majority of the candidates recognised that the treatment of cancer is an important medical use of radioactive isotopes. The commonest errors were to suggest X-rays or scanners. A considerable number of candidates suggested chemotherapy rather than radiotherapy. Some answered vaguely with responses such as 'making medicines'.

(ii) A minority of the candidates referred to energy production, electricity or power. Some candidates gave subsidiary uses such as 'detecting leaks in pipelines'. Many gave answers which were too vague to be credited, e.g. 'in factories' or 'nuclear reactors'. A considerable number of candidates referred to 'bombs', which is not an acceptable use.

Question 3

Some candidates performed well on many parts of this question but many made simple errors in interpreting the information in the table in **(a)(i)** and **(a)(iii)** or wrote vague statements in **(a)(iii)** and **(b)(ii)**. Some candidates were able to do the calculation in **(c)**. Others need more practice with this type of question.

(a) (i) Some candidates predicted both the boiling point and density correctly. The commonest errors related to the negative numbers in the boiling points. Some candidates gave values more negative than −188°C. Others gave a value for the boiling point as between −101°C and −188°C, not realising that the boiling point cannot be less than the melting point. A considerable number of candidates gave positive values well above 10°C, e.g. 186°C. The prediction of the density was more successful, many candidates giving values within an acceptable range. A significant minority either gave values well above 1.56 or gave negative values, presumably because the melting and boiling points were negative values.

(ii) Most candidates recognised the trend of increasing melting point down the group. A few candidates did not heed the negative values and suggested that the trend was decreasing. Others did not refer to the trend and just stated that 'fluorine has a lower melting point than iodine' or 'iodine has the highest melting point'.

(iii) Many candidates recognised that iodine is a liquid at 130°C. Fewer gave a convincing explanation. The best answers referred to 130°C being between the melting and boiling points. The commonest incorrect answer was to refer only to the melting point. Others wrote answers which were vague or referred to iodine subliming.

(b) (i) Many candidates gave the correct electronic structure of fluorine. The commonest errors were 2.8.1, 2.8.8.1 or 9. A considerable minority of the candidates did not understand the term *electronic structure* and gave the formula of the ion or the formula of the atom showing the mass number and proton number.

(ii) Very few candidates referred to the number of protons and electrons. Most referred to 'it gains an electron' or 'it needs an electron for a full outer shell'. The 'it' in these answers would refer to the fluoride ion, which does not gain an electron.

(c) Some candidates were able to do the calculation. Others need more practice with simple proportion. The commonest incorrect answer was 3.2 obtained by $1.24 \times 6.2 \div 2.4$.

Question 4

Parts **(a)** and **(c)** were generally well answered. In **(d)**, some candidates named the correct products but few gave correct observations.

(a) Many candidates deduced the correct time taken for the reaction to finish. The commonest errors were 26 s or 140 s; the latter being the end of the horizontal line, rather than the point at which the horizontal line starts.

(b) The best answers showed the initial gradient less steep and starting at 0,0 with the reaction finishing below 25 cm^3. Many candidates did not appreciate that the same volume of lower concentration of hydrochloric acid produces a lower volume of hydrogen and drew the line finishing at 25 cm^3 or greater. Some candidates did not start their line either at the origin or only deviated from the line for the more concentrated acid later on in the reaction.

(c) Many candidates realised that rate of reaction increases when temperature increases and decreases when magnesium ribbon is used instead of magnesium powder. Some candidates wrote about the time taken for the reaction to finish or the volume of gas rather than rate of reaction. Others gave unnecessary information about the reaction in terms of colliding particles.

(d) The best answers gave calcium chloride, carbon dioxide and water as the correct products as well as describing an observation such as 'effervescence'. The commonest errors in naming the products were hydrogen instead of water and carbon instead of carbon dioxide. Many candidates recognised calcium chloride. Others wrote the incorrect formula rather than the name or gave the generic answer 'salt'. Calcium carbonate was often seen as an incorrect answer. A majority of the candidates did not give a relevant observation. Many either stated the name of the gas or gave tests such as 'limewater turns milky' or 'gives a pop sound with a lighted splint'. Candidates should be aware that they should answer the direct question and not assume that other equipment is available. The commonest incorrect answer for the observations was 'white precipitate'.

Question 5

Most candidates were able to describe at least two physical properties of non-metals in **(a)** and complete the energy level diagram in **(c)(i)**. Some candidates answered the other parts of this question well. Others wrote vague statements in **(c)(ii)** and **(f)(i)**. In **(d)** many candidates confused the separation of the particles with their arrangement or motion. In **(e)** many candidates did not refer to the kinetic particle model or muddled diffusion with Brownian motion.

(a) Most candidates were able to describe at least two physical properties of non-metals. A common error was to refer to lack of magnetism, which was not acceptable since many metals are not ferromagnetic. Others assumed that all non-metals are liquids or gases.

(b) The best answers related to sulfur deposits being found underground or in specific places. The commonest errors were to suggest sources such as 'air', 'acid rain', 'fossil fuels', 'sulfur dioxide' or 'bleach'.

(c) (i) Most candidates completed the energy level diagram correctly. The commonest errors were to write 2S on the arrow, reverse the reactants and products or to add additional arrows.

(ii) Many candidates did respond to the request in the stem of the question to use information from the diagram. Many just gave a definition of an endothermic reaction or gave vague answers such as 'the energy of the reaction is increasing'. The best answers stated that 'the energy level of the product is higher than the energy level of the reactants'.

(d) Few candidates gained full credit and many either muddled motion with separation or wrote about the arrangement of the particles. Others wrote about the bulk properties of a liquid rather than referring to the particles. Many candidates ignored the important word 'particles' in the stem of the question and gave separation techniques such as distillation or filtration. Many others gave vague statements such as 'the particles are a little far apart'. The best answers suggested that the particles are 'close to each other'. More candidates were able to describe the motion of the particles. The commonest errors were to write statements relating to the separation of the particles or to suggest that the particles 'only vibrate'.

(e) Many candidates referred to hydrogen sulfide moving and then reacting with lead(II) ethanoate but without any mention of particles or molecules. Some confused diffusion with Brownian motion. Others wrote confused statements which had the cotton wool moving in the tube as well as the hydrogen sulfide gas. The best answers referred to evaporation, diffusion and an explanation of diffusion (the random movement or random collisions of the particles).

(f) (i) Many candidates gave vague answers such as 'the building is damaged', 'the paint goes yellow', 'the building becomes dull' or the more drastic 'the building collapses'. The best answers referred to 'chemical weathering', 'chemical erosion' or 'corrosion of iron'.

(ii) Many candidates did not heed the essential word 'other' in the stem of the question and suggested 'bleaching wood pulp' or 'bleaching clothes'. Few candidates gave a suitable alternative use for sulfur dioxide. The commonest incorrect answers were 'neutralising acidic soil', 'making fertilisers', 'making pesticides' or 'for cleaning'.

Question 6

Many candidates identified the carboxylic acid group in **(a)(i)** and identified poly(ethene) and addition in **(d)**. Some were able to deduce the molecular formula in **(a)(iii)** and to give the conditions required for cracking in **(c)(ii)**. Fewer were able to state the name of the carboxylic acid with two carbon atoms in **(a)(ii)**, draw the structure of ethene in **(b)** or describe a pollution problem caused by plastics in **(e)**.

(a) (i) Many candidates identified the COOH group. The commonest errors were to circle the C=C group or the C=O group or to include the carbon and hydrogen adjacent to the COOH group. A few candidates circled the OH group or larger parts of the molecule containing 2 or 3 carbon atoms.

(ii) The commonest errors were to suggest ethanol or ethene instead of ethanoic acid. A significant number of candidates suggested inorganic compounds such as hydrogen, carbon dioxide, hydrochloric acid or carbonate.

(iii) Many candidates deduced the correct molecular formula. The commonest errors in counting were six carbon atoms or four oxygen atoms. Other candidates wrote a formula such as 5C + 8H + 3O or HOC_4H_6COOH rather than $C_5H_8O_3$.

(iv) The best answers referred to the presence of the C=C double bond. Many candidates gave answers which were too vague to be credited, e.g. 'it has double bonds', 'it can't absorb anything else' or 'it doesn't contain enough hydrogen'.

(b) Many candidates drew a structure containing two carbon atoms but most added extra hydrogen atoms or an OH group. Others drew structures with three carbon atoms.

(c) (i) Many candidates did not refer to hydrocarbons or alkanes and just referred to 'breaking down', 'breaking down elements' or referred to 'the sound made when substances are heated'. Others wrote vague statements about 'breaking bond' or 'breaking substances to make another substance'.

(ii) Most candidates gave one correct condition; the commonest being 'high temperature'. Many disadvantaged themselves by just writing 'temperature', which could refer to high or low temperatures. Others gave temperatures which were out of range, e.g. 100°C or 2000°C. The term *catalyst* was less frequently mentioned, many suggesting 'pressure' instead of catalyst.

(d) Most candidates identified poly(ethene). The commonest error was to suggest poly(ethane). Fewer candidates recognised that the reaction is an addition reaction. The commonest incorrect answer was 'decomposition' and a few suggested 'reduction'.

(e) The best answers referred to animals getting trapped or choking on plastics. Many candidates wrote answers which were too vague such as 'land pollution', 'water pollution' or referred to events related to global warming such as 'glaciers melt'. Others gave the meaning of non-biodegradable rather than defining a specific problem. Some suggested that toxic gases were released but omitted the important words 'when plastics are burned'.

Question 7

Most candidates could interpret the information in the diagram for **(b)(iii)** and knew the result of the flame test for sodium in **(f)**. Some were able to explain why sodium is extracted by electrolysis in **(a)** and give a suitable substance that can be used as an anode in **(b)(i)**. Many candidates gave one difference in the physical properties of sodium and transition elements in **(d)** but few gave two differences. Many candidates need more practice in determining the products of electrolysis and the observations to be made (**(c)**). Others need more practice in interpreting equations (**(e)(i)** and **(e)(iii)**).

(a) Some candidates realised that sodium is very reactive. The best answers stated that 'sodium is above carbon in the reactivity series' or that 'sodium is very high in the reactivity series'. Common incorrect answers included 'because sodium reacts with carbon', 'the result isn't good enough' or 'sodium has a higher melting point'.

(b) (i) Some candidates suggested graphite, carbon or platinum electrodes. Others gave metals such as copper or lead. A wide variety of other elements or compounds were seen; the commonest being 'sodium chloride' or 'chlorine'. Gases such as hydrogen or argon were also suggested.

(ii) Some candidates identified the anode correctly. Others either labelled the cathode (shown as the wall of the cell), the wires attached to the power supply or the hood over the anode.

(iii) Most candidates realised that the sodium was floating above the sodium chloride. Incorrect answers were rarely related to density, e.g. 'the amount of sodium is less' or 'there are more atoms of sodium'.

(c) A few candidates correctly identified both hydrogen and chlorine. The commonest errors were to suggest sodium at the negative electrode and hydrogen at the positive electrode. Other incorrect metals or gases frequently suggested at the negative electrode were magnesium or carbon dioxide.

Carbon dioxide was also a common error for the products at the positive electrode. Few candidates gave suitable observations at the electrodes. A common error at the negative electrode was to suggest 'sodium particles form'. A common error at the positive electrode was to suggest 'white precipitate'. 'A gas is formed' was not credited because this is not considered an observation. Correct observations included 'bubbles are seen at the negative electrode' or 'a <u>green</u> gas is formed at the positive electrode'. A few candidates wrote about electron loss or gain rather than giving observations.

(d) Many candidates gave one correct difference in the physical properties of sodium and transition elements. Few gave two correct differences and a significant minority gave chemical rather than physical properties. Another common error was to mention malleability and ductility of sodium without the essential qualification 'more' (malleable or ductile). Other candidates suggested differences in conductivity, not realising that both conduct.

(e) (i) Some candidates wrote the correct word equation. Others did not heed the name 'sodium hydride' in the stem of the question and gave the name of the product as sodium hydroxide or sodium hydrate. A few included a number in the word equation, e.g. two sodium.

(ii) Very few candidates referred to the fact that the presence of water would cause a reaction or produce a hydroxide or hydrogen. Many suggested that the product would be water or that the sodium will react with the air. Others suggested that the sodium must be dry for a complete reaction. This is too vague an answer.

(iii) The best answers referred to the oxygen being removed from the iron(III) oxide. Many answers were too vague, either referring to the oxygen being removed from the iron on the right of the equation or added to the sodium hydride. Others just gave a definition of reduction without referring to the equation. Some candidates suggested, incorrectly, that the oxygen is reduced.

(f) A majority of the candidates gave the correct flame colour. The commonest incorrect colours were red, blue or green.

Question 8

Many candidates were awarded some credit for the dot-and-cross diagram in **(a)**. The calculation of relative molecular mass in **(d)** was generally well done. Some candidates completed the word equation in **(b)** correctly; others made simple errors in naming the salt. A minority of the candidates gained credit for the colour change in **(c)** and for the use of fertilisers in **(d)**. Others did not heed the words 'acidified solution' in **(c)** or gave answers to **(d)** which were too vague.

(a) Some candidates drew neat dots and crosses. Others crossed out some of their work so that it was difficult to determine if there were two or three dots or crosses. If candidates make too many errors, they would be advised to redraw the diagram elsewhere on the page or in another suitable blank space. Many responses included the three bonding pairs of electrons, although a significant number of candidates added extra non-bonding electrons on the hydrogen atoms. Other candidates put three electrons in the overlap areas between the hydrogen and nitrogen atoms. A significant number of candidates drew only one non-bonded electron on the nitrogen atom.

(b) Many candidates correctly identified the salt as ammonium chloride; some incorrectly included water or hydrogen in the equation, sometimes by adding an extra box. Common errors in naming the salt included 'ammonia chloride', 'ammoniam chloride', 'ammonium hydrochloride' or 'ammonium chloric acid'. A few suggested sodium chloride, perhaps muddling N and Na.

(c) Few candidates described the correct colour change. Most did not heed the important words in the stem of the question 'acidified solution' and suggested that the initial colour of the methyl orange was orange rather than red. Many of those who suggested red muddled the indicator with litmus and suggested that the colour goes blue in alkaline solution.

(d) A majority of the candidates calculated the relative molecular mass correctly. A few candidates made simple errors in addition which lead to values such as 148, rather than 168. A significant number of candidates did not use the formula in the stem of the question and wrote 8 oxygen atoms in the second column instead of 2 (8 being the proton number of oxygen).

(e) The best answers referred to <u>increasing</u> the growth of plants or the replacement of nitrogen in the soil, which is lost after plants have taken the nutrients. Some answers were too vague, e.g. 'for growth', 'to fertilise the soil' or 'to add nutrients to the soil'. Many answers were unrelated to plant growth, e.g 'insecticide', 'to maintain the pH of the soil' or 'to kill bacteria'.

CHEMISTRY

Paper 0620/42
Theory (Extended)

Key messages

- In extended questions, such as **Question 3(a)(v)** and **Question 3(b)(vi)**, candidates are advised to present their answers in short, sharp sentences or use bullet points. Otherwise, long rambling sentences lead to repetition of some facts, which often show contradictions to earlier comments.
- 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 and pentavalent carbon atoms were seen in **Question 5(g)(ii)** and divalent hydrogen atoms and/or monovalent oxygen and nitrogen atoms were often seen in the linkages given in **Question 6(c)(ii)**.
- When temperature or pressure values are asked for, such as those in **Question 3(a)(iii)**, candidates are advised to give specific values and not to give a range of temperature or pressure values as any chosen number extending beyond the acceptable range would nullify credit.
- Candidates should be advised to avoid leaving blanks in questions, such as **Question 1**, where the responses were chosen from structures **A** to **H**.

General comments

Most candidates seemed very well prepared for this paper and there were some excellent scripts seen.

If candidates need to change their answer, then the original answer should be crossed through and the new answer written. New answers should not be written over the top of the original answer as it can be impossible to tell what the answer is supposed to be.

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

Candidates are advised to take care with handwriting so that the answer given is legible.

Comments on specific questions

Question 1

(a) Parts **(i)** to **(vi)** and **(viii)** were generally well known. Candidates found **(vii)** more challenging. Some candidates left questions unanswered. Instead of leaving a blank answer space, they should have written an answer from letter **A** to letter **H** based upon an educated guess.

(b) This was well answered.

Question 2

(a) Most candidates knew the green gas was chorine.

(b) Many candidates misinterpreted the instructions and chose elements from the list given in the question.

(c) (i) Most candidates attempted to write what the net result of diffusion was rather than describe how gases diffuse. Very few gave the idea of both particles and their random movement. Both 'random movement of gases' and 'particles move' were insufficient. Some candidates confused diffusion with Brownian motion.

(ii) Hydrogen was almost always correctly identified but relatively few gave a suitable explanation. Instead of 'hydrogen has the lowest M_r', the meaningless statement that 'hydrogen was the lightest gas' was seen frequently.

(d) (i) The majority of candidates were able to state that nitrogen constituted 78 per cent of the atmosphere. 79 per cent was the most common incorrect answer (presumably based upon the assumption that if oxygen is 21 per cent then nitrogen must be 79 per cent). There were also many other values between 71–78 per cent given.

(ii) Most candidates identified argon as another element present in the atmosphere, but credit was awarded for any noble gas, including helium. Hydrogen was a common incorrect answer.

(iii) Many candidates did not pick up that the question referred to *clean, dry air* so 'water vapour' or gaseous pollutants such as 'methane' or 'nitrogen dioxide' received no credit.

(iv) Fractional distillation was almost universally known.

Question 3

(a) (i) The name of the process was well known. Haber was often spelt incorrectly.

(ii) The symbol for a reversible reaction was well known.

(iii) Most candidates correctly stated the essential conditions. Occasionally units were omitted, rendering the numerical value meaningless. Some candidates gave a range of values, with some of the range being outside acceptable values. Candidates should be advised to give single values only.

Occasionally, values associated with the Contact process were seen.

(iv) Iron was very well known as the catalyst.

(v) Some well-expressed answers were seen. Many other responses did not address the key focus of the question about *equilibrium*. Candidates were required to know that it is the *equilibrium* which shifts and not the reaction. The reason for the shift in equilibrium was then expected. Many candidates struggled with their words and gave very unclear answers. There was clearly some confusion of left and right with some candidates.

In this particular question, more candidates gained credit for the explanation than for describing what happened to the equilibrium.

(vi) Nearly all candidates had the idea of particles having more energy. When writing about collisions, candidates should note that they must have a time aspect in their statement, such as 'more collisions per second' rather than just 'more collisions'. 'The frequency of collisions increases' is a suitable alternative. The explanation must also refer to an increased percentage or proportion of collisions having sufficient energy to react (activation energy); this was rarely seen. The simple comment 'more collisions are successful' is insufficient since, if there are more collisions per second it follows that more collisions are successful. The important point is that not only are there more frequent collisions but also that a greater percentage of the collisions are successful. This is why a small increase in temperature can cause a large increase in rate.

(b) The formula of ammonium sulfate was usually incorrect. Common errors were $(NH_3)_2SO_4$ and $NH_4(SO_4)_2$. Some candidates gave other products such as H_2 in addition to ammonium sulfate.

Question 4

(a) Most candidates gave the correct formula for hydrogen or zinc chloride. Many equations were left unbalanced and relatively few candidates gave the correct state symbols. $HCl(l)$ was the commonest error. Some candidates ignored the instruction regarding state symbols or gave some but not others.

(b) Most candidates appreciated why excess zinc was used.

(c) Filtration was almost universally known.

(d) Many candidates had clearly learnt the description of a saturated solution. The temperature dependency part was occasionally omitted and weaker responses confused the terms solute and solvent.

(e) This was very poorly answered with only a small minority realising that solubility decreased as temperature decreased. A very common incorrect explanation was based on evaporation of water.

(f) The names of two zinc compounds were known by most, although a significant minority gave three (or more) compounds often losing credit as a result.

(g) Candidates found this question difficult. It was common for candidates to claim calcium did not react with acids or was not soluble. Some talked of an unreactive coating of calcium oxide. Very few realised that after reacting with HCl to form the chloride, calcium would go on to also react with water to form the hydroxide.

(h) (i) Nearly all correctly circled neutralisation.

(ii) Many candidates were able to get as far as determining the concentration of NaOH in mol/dm^3, but only the better performing candidates converted this value into g/dm^3.

For the last part of the calculation, even if the M_r was incorrectly calculated a continuation mark could be awarded. However, many candidates did not make it clear they were trying to calculate an *Mr* and multiplied by an unrelated number and consequently the continuation mark could not be awarded. Conversely, some candidates showed correct working (23 + 16 + 1) without providing the value of the M_r.

Question 5

(a) Most candidates recognised that the unsaturated hydrocarbons were **R** and **U**, but many opted to **include Q** (propanoic acid) and **T** (methyl butanoate) presumably as they too have a double bond.

(b) This was well known, with most candidates giving the test as ‘bromine’ or ‘bromine water’ and stating the bromine would be decolourised. Candidates should be advised that ‘bromination’ is insufficient for a description of the test.

(c) (i) The expected answer of but-2-ene was seldom seen. The most common incorrect answer was ‘butene’.

(ii) The expected structure, methylpropene, was seldom seen. Most candidates drew but-1-ene or but-2-ene but placed the terminal carbon atom at ninety degrees to the penultimate carbon atom.

Of those who attempted to draw methylpropene, many had diagrams with incorrect valencies.

(d) (i) The application of the general formula of alkanes to a molecule with 12 carbon atoms was well done.

(ii) Most candidates gave the correct response of the alkane (**P**) and any alkenes (**R** and **U**) as products of cracking.

(e) For the reagent, candidates often incorrectly wrote water rather than steam; although, many rescued this by stating a temperature above 100°C. Most candidates knew the typical temperature and pressure values, but incorrect names of catalysts were often seen.

(f) (i) Many candidates worked out that the type of chemical change was oxidation. Decomposition was a common incorrect answer.

(ii) Most candidates knew the acidified reagent but often did not give the correct oxidation state or placed it in the wrong position such as potassium(VII) manganate.

(g) (i) Most candidates knew substance **T**, methyl butanoate, was an ester.

(ii) Better performing candidates showed a strong understanding of names for organic compounds and their structures. The lack of a bond drawn between the oxygen and hydrogen in the OH group meant credit was lost in otherwise accurate structures. Weaker responses were able to name one or both compounds but were not able to draw their structures.

(iii) Many candidates did not understand the definition of a molecular formula and gave condensed structural formulae such as $C_3H_7COOCH_3$.

Question 6

(a) The correct answer, monomers, was almost universally known.

(b) (i) The structure of the monomer (but-2-ene) was correctly drawn by most candidates. Some erroneously drew the displayed formula of the repeating unit and some candidates gave five valent carbon atoms.

(ii) Nearly all candidates correctly identified this as addition polymerisation. 'Additional' polymerisation was considered incorrect.

(c) (i) Although various ways of spelling 'protein' were seen, most candidates gained credit here.

(ii) Many weaker responses did not draw a recognisable amide link and others did not show all atoms and all bonds in the link. Relatively frequently, the orientation of the second link was incorrect and continuation bonds were often omitted.

(iii) Although the majority of candidates gained credit, there was some confusion between 'hydrolysis' and 'hydration'.

CHEMISTRY

Paper 0620/52
Practical Test

Key messages

- When recording results from an experiment, all data obtained from the same measuring device should be recorded to the same resolution (the same number of decimal places). In **Question 1(a)** all burette readings and calculated volumes should have been given to one decimal place (or to the nearest 0.05).
- In a quantitative task, where 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 is for addition in excess.
- In a quantitative task, where the question tells candidates to test and identify a gas, candidates should describe the test and positive result for the gas produced; they should not list all of the negative tests and results.
- Observations are those which you can see. For example, 'fizzing' is an observation but 'hydrogen gas is produced' is not an observation as you cannot see that the gas is hydrogen.

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.

Centres should ensure that solutions used in the practical tasks are of the concentrations specified in the confidential instructions. This is particularly important in the quantitative task as solutions of an incorrect concentration could give results very different from those expected or even no results at all.

Comments on specific questions

Question 1

(a) Almost all candidates correctly recorded results for both titrations. The most common errors were not recording all values to one decimal place (or better) and switching over their initial and final readings. When recording their results, candidates should know that the final burette reading will always be greater than the initial reading.

(b) Most candidates were able to correctly state the colour change in Experiment 2. However, it should be noted that 'clear' or 'transparent' does not mean the same as 'colourless'. A colourless solution will be clear and have no colour, while a clear or transparent solution can have a colour.

(c) The correct colour change at the end-point in this titration is from yellow (alkaline colour of methyl orange) to orange. A colour change of yellow to red was allowed (despite the red colour indicating that the solution is now acidic and the end-point has been overshot). A starting colour of orange was not allowed.

(d) (i) Nearly all candidates knew that rinsing the conical flask with distilled water was to remove the solutions remaining from Experiment 1.

(ii) Better performing candidates realised that rinsing with aqueous potassium hydroxide would result in a small amount of potassium hydroxide remaining in the flask and so the volume of solution **B** required to reach the end-point would increase. Some candidates incorrectly thought that the concentration or pH of the aqueous potassium hydroxide would change or gave answers that suggested they thought the burette was being rinsed with aqueous potassium hydroxide.

(e) (i) This was generally well answered with most candidates correctly stating that as a smaller volume of hydrochloric acid **A** was required then it must be the more concentrated.

(ii) The vast majority of candidates gained credit, with some showing their working of the second titre divided by the first. Weaker responses sometimes subtracted the titres rather than divided.

(f) The reason for repeating experiments was not well known. The most common error was to state that repeating made the results more accurate – it does not; random errors will occur in the repetition as much as in the first run. There were also many answers which stated that repeating the experiment makes the results reliable – it does not, results do not become reliable simply because the experiment has been repeated; if the method is flawed then it will remain flawed. The advantage of repeating is that results can be compared, anomalous results excluded and then the mean found of the remaining results. It is the process of finding the mean that will increase accuracy by minimising the effect of random errors.

(g) This was generally well answered; some candidates omitted the expected units. A small number of candidates gave the wrong numerical answer despite showing correct working, suggesting they had not used a calculator. A small number of candidates rounded 39.6 to 40, which is not appropriate for a burette reading.

(h) Most candidates correctly stated that a pipette could be used in place of the measuring cylinder or to measure the volume of the aqueous potassium hydroxide. Some did not state specifically what the pipette would be used for; some incorrectly suggested using a pipette in place of the burette.

(i) Candidates found this part difficult. Since the conical flask was merely the container in which the reaction happened, it would not have changed the results. It was a common error to state that the reaction would be faster (due to a larger surface area) or inaccurate.

Question 2

(a) Almost all candidates were able to correctly describe the appearance of solid **C**

(b) The majority of candidates were able to conduct a flame test successfully and report a red colour. However, it is evident that some candidates are not clear on what a flame test is and reported results that suggested they had tested using a lighted splint.

(c) Most candidates correctly reported that there was no change on addition of aqueous sodium hydroxide; a small number reported that fizzing was seen.

(d) Most candidates correctly noted that fizzing occurred and that the gas produced turned damp red litmus paper to blue. A small number of candidates reported the impossible result of the litmus paper bleaching.

(e) Many fully correct identifications of solid **C** were seen. The most common errors were to state that the metal ion was calcium or that the salt contained ammonium ions (presumably because ammonia was given off in **(d)**).

(f) (i) Most candidates gave fully correct answers. Observations on adding aqueous sodium hydroxide dropwise and on adding it in excess were expected. Candidates should have given an observation for each stage, making it clear which observation was for which stage. A minority of candidates gave only one observation (such as 'white precipitate') or gave contradictory observations such as 'soluble white precipitate'; a precipitate is not soluble, if it was then it would not be a precipitate.

(ii) Most candidates gave fully correct answers. Observations on adding the reagent dropwise and in excess were expected.

(iii) Almost all candidates noted the formation of a white precipitate; fewer noted the effervescence.

(iv) The majority of candidates correctly stated that there would be no change. Some reported a white precipitate. However, none that reported a white precipitate concluded that solid **D** contained chloride ions in **(g)**.

(v) The vast majority of candidates noted the formation of a white precipitate.

(g) Many correct conclusions were seen.

Question 3

The planning task involved devising an investigation to find which of two samples of concrete contained the larger percentage of calcium carbonate. Some excellent and well planned out answers were seen. Some candidates were not thinking things through before they started and so found the need to insert missed out steps.

There were a number of suitable routes through the problem. The most common approaches were:

- trying to measure a reduction in mass of solid based on calcium carbonate forming a solution of calcium chloride
- trying to find the mass of calcium chloride formed
- trying to find the volume of carbon dioxide gas formed.

All three of these approaches required the mass of the concrete to be measured, the concrete to be ground to a powder (to speed up the reaction) and then an excess of dilute hydrochloric acid to be added. The acid had to be in excess to ensure all of the calcium carbonate in the concrete sample reacted. Errors which were common (and were not credited) included measuring the volume of the concrete rather than the mass, using calcium carbonate rather than concrete or trying separation using fractional distillation.

Approaches that tried to measure the mass of solid left sometimes missed out the important filtering and then washing and drying of the residue prior to weighing. Candidates that tried to find the mass of calcium chloride formed often did not evaporate the filtrate to dryness, instead just warmed to the crystallisation point and so left much of the calcium chloride formed in solution. Answers based on gas volume were often the most successful. However, in all methods there were instances of candidates just saying they would ‘compare the results’ rather than saying how the results would tell you which sample contained the most calcium carbonate.

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). For example, all burette readings and calculated volumes should be recorded (at GCSE) to one decimal place (or to the nearest 0.05).
- In a quantitative task, where 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.
- In a quantitative task, where the question states the gas was tested, candidates should describe the positive test and result for the gas produced; they should not list all of the negative tests and results.
- Observations are those which you can see. For example, 'fizzing' is an observation but 'hydrogen gas is produced' is not an observation as you cannot see that the gas is hydrogen.

General comments

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

Candidates need to ensure they do not inadvertently miss a question part out. This most commonly occurs when candidates are required to add something to a diagram rather than complete a table or write on a response line.

Comments on specific questions

Question 1

(a) Almost all candidates were able draw an arrow in the appropriate place, showing heat being applied to the bottom of the side-arm tube. A small number of candidates decided to heat the rubber connector on the side arm or even the power supply.

(b) Candidates were expected to use the information in the question to be able to devise a method of collecting **and** measuring the volume of the chlorine gas produced. Many fully correct answers, showing well drawn and labelled gas syringes, were seen; errors were common. Candidates were told in the stem to **Question 1** that chlorine is soluble in water; this ruled out collecting the gas over water in a measuring cylinder as some of the chlorine will dissolve. Collection by downward delivery will not work as the volume of the gas collected cannot be measured. The most common non-creditworthy answers seen involved trying to condense the gas into a liquid or passing the gas into a closed vessel, which would result in a pressure increase and breakage of the apparatus.

(c) While some excellent answers to what proved to be a demanding question part were seen, many candidates did not give genuine observations. Simply repeating the information from the stem of the question and stating that chlorine and silver would be made did not gain any credit as these are not observations. The chlorine gas would be seen as bubbles in the electrolyte or as a green gas; the silver would be seen as a shiny / grey solid.

(d) Stronger answers correctly identified the use of a fume cupboard or well-ventilated space because of the toxic nature of chlorine. Many candidates stated that a face mask should be worn, this did not receive credit as chlorine molecules will not be stopped by a face mask. Respirators or gas masks were not accepted as they are not items of equipment normally encountered in a laboratory. Two common errors were to raise concerns with the possibility of electrocution (electrolysis in a laboratory will normally use a low d.c. voltage and there is no risk of electrocution), or to comment on the risk of burns from the hot apparatus (since apparatus is routinely heated in experiments it should be standard procedure not to pick up items that have just come out of a Bunsen flame).

(e) Most candidates correctly stated that zinc was not inert or even went on to correctly describe the reaction of zinc with silver chloride or chlorine. However, answers stating zinc did not conduct electricity or that it was not a metal were common.

(f) Stronger answers realised that if chlorine is passed into sodium bromide solution then a displacement reaction would occur due to chlorine having a greater reactivity than bromine. One of the more common errors was to identify the salt as sodium hydroxide or even methyl orange.

Question 2

(a) The vast majority of candidates were able to correctly read and record the readings from the burette diagrams. The most common error was to record the initial reading in Experiment 1 as '8' rather than '8.0'. Some candidates read the scales in the wrong direction, so rather than '27.3' they recorded '28.7'.

(b) The correct colour change at the end-point in this titration is from yellow (alkaline colour of methyl orange) to orange. A colour change of yellow to red was allowed (despite the red colour indicating that the solution is now acidic and the end-point has been overshot). A starting colour of orange was not allowed.

(c) (i) Nearly all candidates knew that rinsing the conical flask with distilled water was to remove the solutions remaining from Experiment 1.

(ii) The strongest answers realised that rinsing with aqueous potassium hydroxide would result in a small amount of potassium hydroxide remaining in the flask and so the volume of solution **B** required to reach the end-point would increase. Some candidates incorrectly thought that the concentration or pH of the aqueous potassium hydroxide would change or gave answers that suggested they thought the burette was being rinsed with aqueous potassium hydroxide.

(d) (i) This was generally well answered with most candidates correctly stating that as a smaller volume of hydrochloric acid **A** was required then it must be the more concentrated.

(ii) The vast majority of candidates gained credit, with some showing their working of the second titre divided by the first. Weaker responses sometimes subtracted the titres rather than divided and ended up with an answer of 9.9.

(e) The reason for repeating experiments was not well known. The most common error was to state that repeating made the results more accurate – it does not; random errors will occur in the repetition as much as in the first run. There were also many answers which stated that repeating the experiment makes the results reliable – it does not, results do not become reliable simply because the experiment has been repeated, if the method is flawed then it will remain flawed. The advantage of repeating is it means that results can be compared, anomalous results excluded and then the mean found of the remaining results. It is the process of finding the mean that will increase accuracy by minimising the effect of random errors.

(f) This was generally well answered; some candidates omitted the expected units. A small number of candidates gave the wrong numerical answer despite showing correct working, suggesting they had not used a calculator. A small number of candidates rounded 39.6 to 40, which is not appropriate for a burette reading.

(g) Most candidates correctly stated that a pipette could be used in place of the measuring cylinder or to measure the volume of the aqueous potassium hydroxide. Some did not gain credit because they did not state specifically what the pipette would be used for; some incorrectly suggested using a pipette in place of the burette.

(h) Candidates found this part difficult. Since the conical flask was merely the container in which the reaction happened, it would not have changed the results. It was a common error to state that the reaction would be faster (due to a larger surface area) or inaccurate.

Question 3

(a) The vast majority of candidates were able to correctly identify the gas as ammonia.

(b) Many fully correct identifications of solid **C** were seen. The most common errors were to state that the metal ion was calcium (with some candidates stating that calcium gives a brick red or orange-red flame colour, which was not the colour stated in the table) or that the salt contained ammonium ions (presumably because ammonia was given off in **test 3**).

(c) Most candidates gave fully correct answers. Observations on adding aqueous sodium hydroxide dropwise and on adding it in excess were expected. Candidates should have given an observation for each stage, making it clear which observation was for which stage. A minority of candidates gave only one observation (such as ‘white precipitate’) or gave contradictory observations such as ‘soluble white precipitate’; a precipitate is not soluble, if it was then it would not be a precipitate.

(d) Most candidates gave fully correct answers. Observations on adding the reagent dropwise and in excess were expected.

(e) Many correct answers were seen. It was evident that some candidates saw that this was the test for a halide ion and so gave a positive result for a halide ion despite being told solid **D** was aluminium sulfate.

(f) The vast majority of candidates correctly stated that a white precipitate would be formed.

Question 4

The planning task involved devising an investigation to find which of two samples of concrete contained the larger percentage of calcium carbonate. Some excellent and well planned out answers were seen. Some candidates were not thinking things through before they started and so found the need to insert missed out steps.

There were a number of suitable routes through the problem. The most common approaches were:
- trying to measure a reduction in mass of solid based on calcium carbonate forming a solution of calcium chloride
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- trying to find the volume of carbon dioxide gas formed.

All three of these approaches required the mass of the concrete to be measured, the concrete to be ground to a powder (to speed up the reaction) and then an excess of dilute hydrochloric acid to be added. The acid had to be in excess to ensure all of the calcium carbonate in the concrete sample reacted. Errors which were common (and were not credited) included measuring the volume of the concrete rather than the mass, using calcium carbonate rather than concrete or trying separation using fractional distillation.

Approaches that tried to measure the mass of solid left, sometimes missed out the important filtering and then washing and drying of the residue prior to weighing. Candidates that tried to find the mass of calcium chloride formed often did not evaporate the filtrate to dryness, instead just warmed to the crystallisation point and so left much of the calcium chloride formed in solution. Answers based on gas volume were often the most successful. However, in all methods there were instances of candidates just saying they would ‘compare the results’ rather than saying how the results would tell you which sample contained the most calcium carbonate.