

CHEMISTRY

Paper 5070/11
Multiple Choice

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

General Comments

Two questions in particular, numbers 12 and 16, proved to be difficult and were not answered well. The two questions mentioned highlighted the importance of reading the question carefully before attempting to answer. In general the questions involving applications of chemistry in industry and every day life were the ones least successfully answered.

Comments on Individual Questions

Question 6

The incorrect answer **C** was almost as popular as the correct answer **B**. The most likely reason being a failure to appreciate the importance of the charges on each of the hydrogen ions.

Question 7

The key word in the stem of the question was gaseous and of the elements mentioned in the question only graphite, carbon, forms a gaseous oxide.

Question 13

Almost fifty percent of the entry chose the incorrect alternative **C**. The significance of the word reverse in the stem of the question having been missed by the candidates.

Question 15

The most common questions on the reaction between calcium carbonate and hydrochloric acid involve how the volume of carbon dioxide given off varies with respect to time. Over sixty percent of the entry answered the question from the perspective of the volume change and not, as required, from the perspective of rate change.

Question 27

The three incorrect alternatives attracted in total over sixty percent of the candidates with each alternative being equally popular. This emphasises once again the importance of reading the stem of the question with great care.

Question 29

All of the properties of aluminium given in the question were correct properties of aluminium. The key to the correct answer was that only alternative A referred to an alloy of aluminium.

Question 31

This question involved simple recall of a quote in the syllabus. Bacterial decay of plants was given as the answer by many candidates. Unfortunately whilst compounds of nitrogen are given off by bacterial decay of plants the oxides of nitrogen are not included in these compounds.

CHEMISTRY

Paper 5070/12
Multiple Choice

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

General Comments

Two questions in particular, numbers 12 and 16, proved to be difficult and were not answered well. The two questions mentioned highlighted the importance of reading the question carefully before attempting to answer. In general the questions involving applications of chemistry in industry and every day life were the ones least successfully answered.

Comments on Individual Questions

Question 5

The incorrect answer **C** was almost as popular as the correct answer **B**. The most likely reason being a failure to appreciate the importance of the charges on each of the hydrogen ions.

Question 7

The key word in the stem of the question was gaseous and of the elements mentioned in the question only graphite, carbon, forms a gaseous oxide.

Question 12

Almost fifty percent of the entry chose the incorrect alternative **C**. The significance of the word reverse in the stem of the question having been missed by the candidates.

Question 16

The most common questions on the reaction between calcium carbonate and hydrochloric acid involve how the volume of carbon dioxide given off varies with respect to time. Over sixty percent of the entry answered the question from the perspective of the volume change and not, as required, from the perspective of rate change.

Question 28

The three incorrect alternatives attracted in total over sixty percent of the candidates with each alternative being equally popular. This emphasises once again the importance of reading the stem of the question with great care.

Question 29

All of the properties of aluminium given in the question were correct properties of aluminium. The key to the correct answer was that only alternative A referred to an alloy of aluminium.

Question 30

This question involved simple recall of a quote in the syllabus. Bacterial decay of plants was given as the answer by many candidates. Unfortunately whilst compounds of nitrogen are given off by bacterial decay of plants the oxides of nitrogen are not included in these compounds.

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Paper 5070/21

Theory

General comments

Most candidates followed the rubric of the question paper and attempted just three questions from **Section B**. A small proportion of candidates attempted all four questions from **Section B** and then crossed out their answers to one of these questions.

Candidates often found the short answer questions less challenging than those which required extended answers. Good answers used the correct chemical terms and/or illustrated answers with clear labelled diagrams. Some candidates gave imprecise and vague extended answers. These candidates could be advised to use bullet points rather than writing in paragraphs.

Good answers to quantitative questions included clear working out so that credit could be awarded for error carried forward. In contrast other candidates either gave just an answer. In these cases it was impossible to award credit for an error carried forward if the answer was incorrect.

Comments on Specific Questions

Section A

Question A1

- (a)
- (i) Many candidates were able to identify the chlorofluorocarbon, **D**. The two most common incorrect answers were carbon dioxide, **F**, and carbon monoxide, **A**.
 - (ii) Carbon monoxide was well known by many candidates.
 - (iii) Many candidates correctly identified **E** as the unsaturated hydrocarbon. A small proportion of the candidates ignored the unsaturated part and gave the hydrocarbon **C**.
 - (iv) Most candidates correctly recognised alcohol **B**.
 - (v) A large proportion of candidates recognised carbon dioxide as a product of respiration.
 - (vi) Many candidates correctly identified the hydrocarbon **C** as an isomer of butane. A small proportion of the candidates gave the alkene **E** instead
- (b) A significant proportion of the candidates identified the alcohol as propan-2-ol, although credit was also awarded for propanol since the use of position numbers is not part of the O-Level specification.

Question A2

Many candidates found (e), the question on alloys, much more difficult than the earlier part questions on atomic structure.

- (a) Most candidates identified the gallium atom as the particle with the most number of protons.
- (b) Many candidates were able to identify the manganese ion and the nickel atom as having the same number of neutrons. There was no need to give the full symbols for the particles providing that manganese and nickel were identified.

- (c) Many candidates gave the correct answer of 23 electrons. Other candidates gave 25, only a very small proportion gave 30 electrons.
- (d) Good answers gave the electronic configuration as 2,8,8. Other candidates went beyond the scope of the specification and gave the answer as $1s^22s^22p^63s^23p^6$. The most common misconception was to give the electronic configuration of calcium rather than the calcium ion.
- (e)
- (i) The best answers to this question drew a close packing arrangement that had atoms of two different sizes. Only a very small proportion of the candidates were able to complete this diagram. Many candidates drew two different sized atoms but did not have them close-packed. Other candidates tried to draw a sort of *dot-and-cross* diagram in an attempt to show the bonding in a metal rather than its structure.
 - (ii) The question asked for a specific use of nickel and so the mark scheme required not just that nickel was used as a catalyst but the industrial reaction that was catalysed. As a result only a small proportion of candidates were awarded credit for their answers.
 - (iii) Credit was most often awarded here for reference to the ions being different sizes. Many candidates did not link the idea of strength with the lack of ions sliding.

Question A3

A significant proportion of the candidates found this question very challenging.

- (a) Even the most able candidates were not able to score full credit for this question. Candidates did not use the term Le Chatelier's principle and as a result were not able to predict what happens to the position of the equilibrium. Candidates did not link the change in pressure with the number of moles of gas or the change in temperature with the exothermic nature of the forward reaction.
- (b) The candidates that could recall the formula for ammonium chloride were generally able to balance the equation. A significant proportion of the candidates could not recall NH_4Cl as ammonium chloride.
- (c)
- (i) Only a small proportion of candidates mentioned the presence of nitrogen in a fertiliser and made a link to protein and growth. It was not sufficient to refer to fertilisers containing plant nutrients.
 - (ii) A significant proportion of the candidates could recall at least two of the conditions required for the Haber process. The mark scheme allowed a range of temperatures and pressures but only iron as the catalyst.

Question A4

- (a) Many candidates could list differences between potassium and iron. The most common differences referred to potassium being soft, having a low melting point, being weak and very reactive whereas iron was hard, having a high melting point, strong and not very reactive. A common misconception was to give chemical properties when physical properties were needed and vice versa.
- (b) Some candidates gave excellent answers with the working out clearly shown. Other candidates were able to work out the molar ratio but could not show how the correct formula could be obtained. These candidates ended up with a ratio of carbon : hydrogen : oxygen of 1.4 : 1.2 : 1.0 but did not show that if these numbers were all multiplied by five that the correct ratio of 7 : 6 : 5 is obtained.



- (c)
- (i) Some candidates were able to give the correct equation. Other candidates tried to show the inclusion of gallic acid.
 - (ii) Candidates were allowed to use either the change in oxidation number or the gain in electrons to explain why the process was reduction. Most candidates chose to use the change in oxidation number stating that it had changed from +1 to 0. Error carried forward was allowed for candidates who had the wrong formula for a silver ion.
- (d) Good answers used aqueous sodium hydroxide forming a red-brown precipitate. A small proportion were confused by the context and tried to use the gallic acid in the answer. Candidates were only allowed to use red-brown as a colour for the precipitate.

Question A5

- (a) Most candidates were able to draw the apparatus needed to electrolyse aqueous potassium bromide.
- (b)
- (i) This was a very challenging question and only a very few candidates were able to describe the appearance of an orange colour. Two common misconceptions were that oxygen was made at the anode or that the product was hydrogen. Only a small proportion of candidates realised bromine was produced.
 - (ii) A significant proportion of candidates realised that hydrogen burns with a squeaky pop. Other candidates gave the test for oxygen instead, referring to a glowing splint rather than a burning splint.
 - (iii) Only a small proportion of candidates realised that hydrogen ions made hydrogen gas at the cathode. The correct equation had to make H_2 rather than H.
 - (iv) Many candidates stated that potassium was more reactive than hydrogen and this was given credit in the mark scheme.

Section B

Question B6

- (a) Many candidates appreciated that the elements were in atomic number order. A common misconception was that it depended on the group or period.
- (b) Many candidates recognised that the element was in Group 3.
- (c) Some candidates recognised that some elements were missing and the groups and periods were reversed. Other candidates were not able to express the differences with sufficient clarity to be awarded credit.
- (d)
- (i) Many candidates recognised that the elements were part of the d – block.
 - (ii) Good answers appreciated that the rate of reaction increases because there are more successful collisions. Other candidates just referred to particles having more energy or having more collisions but this was not sufficient to be awarded credit. A small but significant proportion of candidates approached the question in terms of equilibrium rather than rate of reaction.
- (e)
- (i) Many candidates realised how the metals reacted with water. Some of these candidates did not really describe a trend in terms of increasing reactivity down the group.
 - (ii) Only the most able candidates wrote the correct equation. Some candidates were not able to recall the required equations while others gave the incorrect products such as Na_2O .

- (iii) Many candidates could predict the melting point of rubidium. Any value between 20 and 55 °C was allowed in the mark scheme.

Question B7

- (a) Many candidates could give two characteristics of an homologous series. The most common answers included having the same chemical properties, a general formula and each member varying by CH₂.
- (b)
- (i) Many candidates could give the formula of pentane as C₅H₁₂.
- (ii) Many candidates could predict the boiling point of pentane. Any value between 23 and 47 °C was allowed in the mark scheme.
- (c)
- (i) Most candidates recognised that it was the enthalpy change of combustion that indicated that the reaction was exothermic. Some candidates did not specifically state that it was the negative sign that was the key to the identification of an exothermic reaction.
- (ii) Most candidates were unable to explain why combustion is exothermic. Typically candidates referred to the energy needed to form bonds rather than the energy released. Candidates would be advised to answer the question as three bullet points;
- bond breaking takes in energy,
 - bond forming releases energy,
 - more energy is released than taken in.
- (iii) Some candidates appreciated that the key to the answer was the difference of a CH₂ from one alkane to another. Candidates did not mention that as a result the same extra bonds were broken or made.
- (d) Many candidates gave a correct source of methane as a pollutant normally referring to rotting plant material. Some candidates gave natural gas as the answer, this was not given credit.

Question B8

Candidates found this the most challenging question in **Section B**.

- (a)
- (i) Only a very small proportion of candidates could define a macromolecule. Many candidates referred to a giant molecule but that was not considered sufficient. Candidates had to refer to the covalent bonding as well.
- (ii) Some candidates gave carbohydrates as examples of natural macromolecules. A common misconception was to give diamond.
- (b) Some candidates gave hot dilute hydrochloric acid and others gave protease at room temperature. Many candidates were not able to give a suitable reagent and often gave more industrial conditions (high temperature and high pressure).
- (c) Candidates often received partial credit for describing paper chromatography and this was normally awarded for a labelled diagram. Only a small number of candidates referred to either comparing R_f values or the use of a locating agent. Candidates needed to ensure that their diagrams are labelled and drawn to show the important features. Often diagrams did not indicate the level of the solvent or the dots on the chromatography paper.

- (d)
- (i) Some candidates recognised that both polymers had an amide bond. Other candidates did not clearly describe a similarity.
 - (ii) Good answers referred to the different repeat units or the order of the atoms in the amide link. Many candidates were not able to express with sufficient clarity these differences and as a result were not awarded credit.

Question B9

- (a) Many candidates were able to draw the 'dot and cross' diagram for phosphine. Only a small proportion of the candidates drew an ionic structure.
- (b)
- (i) Some candidates obtained the correct answer of 0.51 g by calculating the moles of phosphorus, using the mole ratio and then calculating the mass of phosphine. Although an error carried forward was applied, only a small number of candidates were awarded such credit. A common misconception was to divide the mass of phosphorus by four and ignore the mole concept.
 - (ii) More candidates were able to calculate the volume of phosphine as 0.36 dm³ even when some of the candidates had not been able to calculate the mass in (i). A common misconception was to multiply the mass in (i) by the molar volume.
- (c) Some candidates were able to write the correct equation. A common misconception was to have the wrong formula for H₂ sometimes even H₃ was quoted.
- (d)
- (i) Some candidates were able to write the balanced equation. Many candidates were unable to deduce that phosphine was a product of the reaction.
 - (ii) Many candidates appreciated that a gas was produced with the best answers referring to the smell of garlic. A common misconception was the formation of a precipitate, often yellow.
- (e)
- (i) Some candidates were able to state that the formula of the ion is P³⁻.
 - (ii) Any property of an ionic compound was allowed in this question. Many candidates were able to score credit with the most common correct answers being a high melting point or soluble in water. It was not sufficient to state that calcium phosphide was a solid.

CHEMISTRY

Paper 5070/22

Theory

General comments

Many candidates tackled the paper well and good answers were seen in many parts of the paper especially in most parts of **Questions A1, A2, A4 and B6**. Weaker candidates found some parts of **Questions A3, A5 and B8** demanding, especially where reasoned explanations and extended prose were involved.

In general, the rubric was well interpreted and most candidates attempted all parts of each question. Some candidates did not respond to some straightforward questions. For example, in **Question A3(a)**, the second line on the graph was not drawn. It was encouraging to note that many candidates had a good grasp of the tests for iodide ions and zinc ions. Many candidates had difficulty explaining the differences in the structures of diamond and graphite (**Question A5(a)**) and drawing a metallic structure (**Question A1(b)**). Many candidates made a good attempt at writing full symbol equations and drawing the structure of specific organic compounds. Fewer were able to write balanced ionic equations. A few candidates wrote word equations in place of symbol equations. Candidates should realise that the instruction 'write an equation' in this examination always refers to a symbol equation. Many candidates need to improve their arguments with regard to questions on reaction rates (**Question A3**) and rates of decomposition (**Question B8(d)(ii)**). As in previous sessions, many candidates need to explain convincingly how to prepare pure dry crystals from a given compound (**Question B8(b)**). There were only a few instances where candidates disadvantaged themselves by giving multiple answers.

Many candidates performed well in the calculations in **Questions A4(e)** and **B7(e)** and fewer candidates than in previous sessions seemed to round up figures in the middle of their calculations. Most candidates scored equally well in **Sections A** and **B**, with **Question B6** proving to be the most popular choice from **Section B**.

Most candidates wrote to the point and it is encouraging to note that many concentrated on the main requirements of the question and did not put in too much extra material. The standard of English was generally good and there were few instances of misused words. It should be noted that it is acceptable to write in note form or in bullet points. This may help those who are less confident in the English language to reduce the incidence of unintentional errors when writing more extended answers.

Comments on Specific Questions

Section A

Question A1

This question was generally well answered. Some candidates drew very good labelled diagrams of metallic structure in **(b)** though many drew diagrams which were not sufficiently accurate.

(a)

- (i)** This was generally correctly answered, although some candidates incorrectly suggested magnesium.
- (ii)** Most candidates gained credit here. The commonest incorrect answers were either magnesium or potassium. Although both these metals will form an oxide layer on their surfaces, the oxides are reactive and so not protective.
- (iii)** Many candidates chose iron, the correct catalyst for the synthesis of ammonia. The commonest incorrect answer was vanadium, undoubtedly chosen because its oxide is the catalyst for the contact process (rather than the Haber process).

- (iv) Many candidates recognised the sacrificial protective properties of magnesium. The commonest incorrect answers were potassium (not allowed because it is reactive with water) and aluminium (not allowed because the formation of an oxide layer prevents close contact of the metal with the iron).
 - (v) A common incorrect answer was lead. Many candidates forget that the first period in the Periodic Table contains only hydrogen and helium and tend to think erroneously that the first period starts with lithium.
- (b) Many candidates scored at least partial credit. Candidates should realise that it is important to draw regular rows of ions and not try to construct three dimensional diagrams. Many candidates who drew a regular arrangement of particles were only awarded partial credit because they either only drew the electrons around the outside of the structure or drew electrons as if they were negative ions i.e. in circles the same size as the metal ions. Some candidates disadvantaged themselves by stating that the positive metal ions were protons. A minority of candidates did not answer the question.

Question A2

Many candidates scored well on this question with (b) and (d) being particularly well done.

- (a)
- (i) Only a minority of candidates realised that glucose or another suitable sugar was the organic compound required for fermentation. The commonest incorrect answer was to suggest yeast. Ethanol was also often erroneously suggested through a misunderstanding of the difference between 'requirement' and 'product'. Ethene was also occasionally seen.
 - (ii) Many candidates realised that a relatively low temperature was required for fermentation as well as absence of oxygen. The commonest error was to mistake the process of fermentation with that of the industrial production by addition of steam to ethene. In consequence of this, many candidates included high temperatures and pressures as well as a wide range of inorganic catalysts in their answers. A number of candidates also gave rather vague answers such as 'low temperature' or 'enzymes' which were not considered to be sufficiently good answers.
- (b) Most candidates could construct a suitable equation for the reaction of steam with ethene. The commonest error was to suggest that water or hydrogen is formed as well. A small number of candidates wrote word equations and so could not be awarded credit.
- (c)
- (i) Many correct answers were seen. Candidates who wrote incorrect answers usually gave at least one of the parts of the name correctly e.g. methyl ethanoate or ethyl methanoate. The generality 'ester' was often seen but was not awarded credit because it is not a specific enough name. When candidates did not refer to esters, they either suggested alcohols, often butanol.
 - (ii) This was well answered; as many candidates referring to a reversible reaction as those referring to esterification. The answer 'ester', which was often seen, was too vague to warrant credit. A significant number of candidates referred to exothermic or endothermic. There is nothing in the equation to suggest the sign of the enthalpy change and so such answers cannot be awarded credit.
- (d)
- (i) Most candidates gained credit here, butanol being a common incorrect response.
 - (ii) Many candidates who did not gain credit in (d)(i) were awarded credit here for the correct structure of propanol. Some candidates wrote out a full electronic structure, which is not necessary but were awarded credit when correct. Candidates should be encouraged to write the simplest structure so as not to disadvantage themselves timewise.

Question A3

This question proved to be a good discriminator. A few responses were excellent although the majority of answers lacked essential detail, especially in **(c)(ii)**, **(d)** and **(e)**. Candidates should also be advised to pay special detail with regard to units, which was an essential requirement for obtaining credit in **(a)**.

- (a)** Many candidates were able to do the calculation, the commonest mathematical error being not to divide by 2. A considerable proportion of candidates wrote down the incorrect unit for the rate and so were not awarded credit. In this respect the commonest errors were to suggest s as a unit rather than min and to write min as m (m is metres) – this was actually written on rare occasions as the actual word 'metres'. If candidates are unsure about the units, it is advisable that they look at the units on the graph itself and write them out in full e.g. cubic centimetres per minute.
- (b)** A few candidates gave well reasoned answers highlighting the fact that the zinc was the limiting reagent and was used up. Most candidates were content just to refer to the 'reactants being used up', 'the zinc had stopped reacting' or 'the reaction has finished'. These are too vague to be awarded credit. A common misconception was to refer to the products rather than the reactants e.g. 'the hydrogen has run out'.
- (c)**
- (i)** Many candidates were awarded credit for a steeper line at the start and levelling off at the same level. The commonest error was to draw the line less steep at the start. Most candidates realised that the same volume of hydrogen would be produced. A number of candidates did not respond to the instruction in this question.
- (ii)** The candidates who gained credit here often wrote about the lowering of activation energy. The meaning of the word 'how' in the stem of this question was misinterpreted by many candidates. Many just gave a definition of the word catalyst rather than suggesting the method by which a catalyst exerts its effect. Some referred to an increased surface area of the catalyst. This is insufficient and cannot explain catalysis in general.
- (d)** Most candidates obtained credit for 'increased rate'. Only a few could explain this increase in rate in terms of colliding particles. Most were content to refer to 'more collisions'. A consideration of time is also required i.e. more collisions per second, more frequent collisions.
- (e)** There were many good answers to this question and many candidates were awarded full credit. Most realised that the particles had more energy as the temperature increased.

Question A4

Some candidates gave very good answers to this question and many candidates demonstrated a good mathematical understanding in the calculation in **(e)**. It is also encouraging to note that a greater number of candidates than in previous November sessions were able to select a correct qualitative test for halide ions. The parts requiring more precision in the answers were **(a)** and **(c)(iii)**.

- (a)** Many candidates wrote about either elements being diatomic or compounds being diatomic. Unfortunately, these two words prevented candidates from gaining credit, since both elements and compounds can be diatomic. Some candidates suggested that a diatomic compound was an atom. In forming definitions, candidates should take care to ensure that they write accurately.
- (b)**
- (i)** There were many good answers to this question, most candidates realising that down Group VII, the colours get darker. A common error was to suggest that the colour increases down the Group without reference to the nature of the colour. Many gave the correct colours of the halogens, although a few suggested incorrectly that iodine (solid) is brown or purple.
- (ii)** Many candidates were unsure of the states of the halogens. Bromine was often held, incorrectly, to be a gas and iodine a liquid. A few candidates referred to the aqueous state rather than the natural state of the element.

- (c)
- (i) A few candidates gave a properly balanced equation showing the correct charges. The majority of candidates either gave the bromine and iodine molecules charges as well or wrote the molecules as 2Br and 2I .
 - (ii) Many candidates gave good answers to this part. Lead nitrate was equally popular as a choice of test reagent as silver nitrate and many demonstrated precision by suggesting the addition of nitric acid as well. Common errors were to suggest sodium hydroxide as a test reagent, to suggest starch or chlorine as a test reagent and to suggest that the precipitate is white in colour.
 - (iii) About half the candidates realised that chlorine is more reactive than bromine. Common errors included a comparison of the position in the Group rather than reactivity, a comparison of the halides or a halide with a halogen or that bromine is less reactive than potassium.
- (d) Most candidates gave good answers. Many answers included the OH^- ion (which was acceptable as long as hydrogen and chloride ions were present).
- (e) Many candidates set out their calculations in a clearly-presented manner. Most candidates gained at least partial credit, this usually being for the correct 2:1 ratio of hydrochloric acid to calcium hydroxide. Some candidates used a standard formula to calculate the concentration of calcium hydroxide. Although this is perfectly acceptable, candidates need to realise that this method more often leads to errors than the standard method of calculating the moles of the acid followed by calculation of the concentration of the alkali. A common error in the latter method was to multiply the moles from step 2 by 20/1000 rather than by 1000/20.

Question A5

Although most candidates gave good answers to (b)(i), (c)(i) and (c)(iii), many parts of this question provided a challenge. In (a) candidates could improve their answers by comparing similar structural features of graphite and diamond rather than selecting different structural features. As has been noted in previous Examiner Reports, candidates need to write less vague answers in response to questions on environmental effects of compounds such as carbon monoxide.

- (a)
- (i) Most candidates scored at least partial credit for comparing a correct structural feature of diamond and graphite. Candidates can improve their answers by ensuring that like for like is being compared. For example one should compare the tetrahedral structure of diamond with the layered structure of graphite rather than with the presence of delocalised electrons in graphite. Some candidates wrote about graphite as if it were diamond and vice versa. Candidates should always make sure that they use the diagrams when given to help them with their answers. Other common errors were to write about properties rather than structure or to use the word molecule instead of atom e.g. 'there is space between the graphite molecules' (rather than referring to the distance between the graphite layers).
 - (ii) Few candidates gained full credit for this part because they only referred to graphite in their answers. The word layer was often missed out in the first marking point, many candidates simply implying that all the atoms in graphite have weak forces between them.
- (b)
- (i) Most candidates gained credit for this part, 'loss of oxygen' being the commonest correct answer. Common errors included not making clear that it is the tin which changes its oxidation number, rather than the tin oxide (or oxygen) or making vague statements about electron loss or gain. A few candidates contradicted themselves by stating both loss of oxygen and loss of electrons.
 - (ii) Few candidates gave sufficiently accurate answers to gain credit here. As in previous sessions, the Examiners require the answer toxic or poisonous, rather than the vague 'it causes breathing difficulties', 'pollutant' or 'harmful'. A significant minority of candidates tried to relate the carbon monoxide to reducing action and problems with the industrial process rather than with the effect on health.



- (c)
- (i) Many candidates were able to construct the correct balanced equation for the reaction of carbon dioxide with carbon. The commonest error was to try to balance the equation by putting 2C on the left hand side.
 - (ii) Many candidates gained at least partial credit for this question, usually for the three pairs of electrons bonding the carbon and oxygen atoms. Candidates need to read the stem of the question carefully in order to extract the essential information about the number of electron pairs. Further credit was awarded less often because candidates put three non-bonding electrons on one atom thus making the number of electrons around each atom incorrect. Candidates need to realise that the octet rule still applies in less familiar compounds. Many candidates constructed a dot and cross diagram based on CO₂ or CO₃, despite the fact that the formula of carbon monoxide had been given in the equation in (b).
 - (iii) There were many good answers to this part of the question. The commonest errors were to forget that there is only 1 Cr atom and try to reduce the formula still further to CrCO and to multiply the O atoms by 3 thus obtaining the incorrect formula CrCO₁₈.

Section B

Question B6

This was the most popular of the **Section B** questions to be chosen and many candidates performed well. Parts (a) and (c) were particularly well done. In (b)(i) many candidates focused on the science of global warming rather than on the resultant effects, whilst in (b)(iii) many candidates were apparently unaware of the reaction of chlorine with alkanes in the presence of sunlight.

- (a) This was generally well answered with most candidates realising the correct gas exchange during respiration and photosynthesis. Few candidates mentioned the balance between the amount of carbon dioxide released in respiration and absorbed in photosynthesis. Many were content to just repeat or paraphrase the stem of the question e.g. 'so the amount of carbon dioxide is kept the same'.
- (b)
- (i) Most candidates who were awarded full credit concentrated on polar ice melting and sea level rising or flooding. Many candidates wrote, incorrectly, about global warming, the ozone layer and industrial pollution. In order to improve their answers, many candidates need to disentangle the various environmental aspects mentioned in the syllabus.
 - (ii) There were a significant number of good responses to this question. Common errors were to write a word equation, to write the incorrect formula for methane, CH₂ or CH₃ being particularly common and an incomplete balance of the equation.
 - (iii) Few candidates realised that the reaction was a substitution reaction or that chlorine reacts with methane (in the presence of ultraviolet light). The commonest errors were to suggest fermentation, cracking and addition reactions.
- (c)
- (i) This part was generally well answered although poor English describing the trend sometimes meant that credit could not be awarded. Candidates should be advised to read the question carefully and see whether or not the direction of the trend has been given. In this case, there was no indication about how the size of the molecules changes. Therefore both the trend in the size of the molecules and the trend in the boiling point are needed in order to gain the credit. For example, the answer 'the boiling point increases as the molecules get larger' will get credit but 'the boiling points depend on the size of the molecules' is not sufficient.
 - (ii) The candidates who were awarded full credit for this part generally wrote about high temperature and high pressure or catalyst. Candidates should be advised that if they give specific temperatures, pressures and specific catalysts these must be correct. Many candidates gave rather wild conditions of temperature and pressure such as 1000 atmospheres and 20 °C or 2000 °C. A considerable number disadvantaged themselves by giving incorrect catalysts such as nickel or silicon (rather than silicon dioxide).

Question B7

This was a fairly popular choice of question for **Section B**. There were many excellent answers describing the test for zinc ions and it is encouraging to note that fewer candidates than in previous sessions referred to electrons in **(a)**. The calculation in **(e)** posed some problems for many candidates and some left this part blank.

- (a)** Most candidates could explain why molten zinc chloride conducts electricity but fewer referred to the lack of conduction in the solid. A few candidates disadvantaged themselves by writing about electrons being responsible for conduction in the melt.
- (b)** This was generally well done. The commonest errors were either to put the chloride at the anode or to put the products the wrong way round.
- (c)** There were more good answers in this session compared with similar questions in previous November sessions. High-scoring candidates often got the equation correct. Lower-scoring candidates tended to focus on zinc ions and chloride ions rather than on hydroxide ions, water and oxygen. Other common errors included 2O_2 on the right hand side of the equation, H_2 rather than H_2O on the right hand side and incorrect charges on the ions or putting charges on the atoms.
- (d)** The test for zinc ions was well known, the main error being to suggest that the precipitate was insoluble.
- (e)** Many of those candidates attempting this question obtained at least partial credit. The commonest errors were to miscalculate one or both formula masses or to use the formula masses of the wrong compound. A significant minority of candidates tried to do percentage yield calculations. Candidates need to be able to make the distinction between theoretical yield calculations and percentage yield calculations.

Question B8

This was the least popular and generally lowest-scoring question in **Section B**. Although **(c)** and **(d)(i)** were generally well answered, each of the other parts provided the candidates with individual challenges.

- (a)**
- (i)** This was generally well done. The main errors were to suggest magnesium hydroxide as a product rather than magnesium oxide or to give water as a product rather than hydrogen.
- (ii)** Few candidates gained credit for the equation. The main errors were to suggest that the formula of magnesium ethanoate is CH_3COOMg , to put extra hydrogen atoms or molecules on either side of the equation and to write MgO in place of magnesium ethanoate as a product.
- (b)** A few good responses were seen from candidates who clearly understood the different methods of salt formation and the process of crystallisation. Other candidates need to distinguish between the different methods of salt formation and to give more detailed methods of how dry crystals are obtained from a solution by;
- forming a saturated solution at first,
 - leaving the solution to form crystals,
 - separating the crystals from the mother liquor,
 - drying the crystals on filter paper.

Common errors were to suggest a titration, add incorrect acid, add chlorine or a solid chloride, suggest evaporation or complete evaporation of the solution rather than evaporation to the crystallisation point and no reference to how the crystals were dried. Many candidates also need to realise that it is a solution which is to be evaporated and not a mixture of solids

- (c)** Most candidates recognised a decomposition reaction. The commonest errors were to suggest combustion or redox.

- (d)
- (i) Nearly all candidates identified correctly a factor which must be kept constant. The commonest answers referred to the amount of carbonate or the temperature of the Bunsen flame.
 - (ii) Only a few candidates gained full credit here. Candidates often confused the rate of decomposition of the compound with the reactivity of the metal. This left too many incorrect answers relating the more reactive metals to faster decomposition. Many candidates only wrote about two of the metals or metal carbonates and so the exact order of decomposition was unclear.

Question B9

Some candidates gave very good answers to most parts of this question. Parts (a) and (d) presented particular problems to some candidates. The former reflects the need for candidates to develop a better understanding of environmental Chemistry (see comments about **A5(b)(ii)** above) and the latter highlights a difficult area of the syllabus, where candidates often confuse the position of equilibrium with rates of reaction.

- (a)
- (i) The best answers referred to volcanic eruptions or burning fossil fuels. Other candidates gave rather vague answers, often just referring to industrial waste, fumes from chimneys or car exhausts. A good answer must refer to fossil fuels or a named fossil fuel rather than just fuels because fuels such as hydrogen do not cause acid rain.
 - (ii) This question was generally answered well. Some candidates wrote about global warming or gave vague answers such as 'erosion' without mentioning what it was that was being eroded. Candidates should also be advised to avoid statements that are too dramatic and which imply complete destruction of objects.
- (b)
- (i) There were many examples of good equation writing. The main errors usually involved state symbols - calcium carbonate was often given the state symbol (aq) and sulfuric acid given the state symbol (l). Other errors included lack of water in the equation, hydrogen released instead of water and incorrect formula of calcium sulfate.
 - (ii) The commonest correct response usually referred to car batteries. A wide range of incorrect answers were seen many involving laboratory processes.
 - (iii) This question was generally well answered. Most candidates realised that strong acids are completely ionised. The usual errors were to suggest that they have a lot of hydrogen ions or that they have a low pH.
- (c)
- About a third of the candidates realised that both sulfur and air are raw materials. Common errors included sulfur dioxide (the product rather than the raw material), vanadium pentoxide or only choosing one of the raw materials.
- (d)
- (i) Fewer than half the candidates could identify an enthalpy or energy change. Many just concentrated on temperature or energy or referred to the amount of energy released. The latter did not gain credit because 'energy released' refers to the sign of the enthalpy change as well and not the symbol for enthalpy change itself.
 - (ii) A few candidates gave excellent responses showing a clear understanding of the position of equilibrium in relation to temperature change and sign of enthalpy change. There were also some very clear answers in terms of Le Chatelier's Principle. Many candidates needed to give more detailed arguments based on equilibrium rather than on rates of reaction and kinetic theory.

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Paper 5070/31
Practical Test

General comments

While the exam proved more challenging than last year's, there were nevertheless candidates who proved to be very proficient in meeting its demands. Many candidates demonstrated capable practical skills in completing the quantitative exercise involving a titration. However, they were less assured in dealing with the qualitative tasks. Supervisors are thanked for providing the required experimental data to enable assessment of their candidates' work.

Comments on Specific Questions

Question 1

- (a) Many candidates performed well with the acid/alkali titration. There were a few Centres where the necessary volumetric skills were not sufficiently developed and who would do well to act upon the comments that follow regarding the securing and processing of results.

Full credit was awarded for obtaining two results within 0.2 cm^3 of the Supervisor's value, and then for averaging two or more results that did not differ by more than 0.2 cm^3 .

Teachers should continue to emphasise that, in all titration exercises, candidates should repeat the titration as many times as necessary, until they have obtained **consistent** results. These titres i.e. best titration results, should be ticked and then averaged.

Although only the more able candidates scored full credit in the calculations that followed, it was encouraging to find that most attempted the examples.

- (b) While there were a number of candidates who were able to calculate the correct concentration of hydrogen ions in **P**, the most common error was due to using a mole ratio of 2:1. Answers were required to three significant figures and there were few examples of candidates over-approximating.
- (c) Many candidates scored credit here but some made the mistake of dividing the answer from **(b)** by 10000 or multiplying it by 10000/24.
- (d) Many correctly multiplied the answer from **(c)** by 100 but there were relatively few who recognised the need to use the proportions provided in the equation on page 2 and divide by 2.

Question 2

There were a number of candidates who successfully followed the instructions, carefully carried out the various test-tube reactions and accurately recorded the observations. Unfortunately there were numerous candidates who gave not only incomplete answers, but also incorrect ones. Teachers should continue to encourage candidates to make full use of the qualitative analysis notes supplied on the last page of the exam paper. The terminology and method of reporting provided are a model for the successful recording of observations. It is also important that the conclusions made by a candidate are supported by the observations recorded. It was not necessary to make all the observations to obtain full marks for this question.

- Test 1** There were many candidates who correctly noted the bubbling, some who recorded that the gas 'pops' with a lighted splint but not all of the latter named the gas as hydrogen. A number of alternative gases were erroneously identified including ammonia.
- Test 2** When a white precipitate was reported, it was generally found to dissolve in excess alkali and some noted that the final solution was colourless. However, there were many who stated there was no reaction, presumably because they added insufficient sodium hydroxide solution or added it too quickly.
- Test 3** Those who obtained a white precipitate in **Test 2** usually found one here as well and recorded that it was insoluble in excess ammonia. There were many who once again stated there was no reaction.
- Test 4** Very few candidates were awarded full credit in this test. Most commonly bubbling in **(a)** or the white precipitate with the addition of acid in **(b)** was noted. As with **Test 1** the testing of the gas was not generally undertaken but for those who did, a few more were successful in identifying hydrogen.
- Test 5** No reaction took place when **R** was added to the aqueous copper(II) sulfate but a red or brown solid, copper, was produced when sodium chloride was dissolved in the mixture. Many made both these observations but in **(b)** few noted the bubbling and even fewer the fading of the colour of the solution.
- Test 6** In **(a)** the reduction of the iron(III) ions was accompanied by a change in colour of the solution and when aqueous sodium hydroxide was added in **(b)** a green (or black) precipitate, insoluble in excess alkali, was obtained. Few candidates noted the colour change of the solution but nevertheless many obtained a green precipitate. Credit for the insolubility of the precipitate in excess alkali was awarded regardless of the solid's colour but was still infrequently awarded.
- Test 7** A significant number of candidates stated that ammonia was evolved but did not provide any evidence and consequently were awarded no credit. There were also those who scored only partial credit because they noted that a gas was produced, which turned litmus blue but then did not identify the gas.

Conclusions

Although many candidates gave the 'correct' answers here, far fewer were awarded credit because they did not have the evidence to support their conclusions.

This was particularly the case with **R** which was frequently stated to be aluminium but without the necessary observations in **Tests 2** and **3**. Candidates were generally more successful in identifying **R** as a reducing agent and, when an alkaline gas had been recorded in **Test 7**, **S** as a nitrate.

CHEMISTRY

Paper 5070/32

Practical Test

General comments

While the exam proved more challenging than last year's, there were nevertheless candidates who proved to be very proficient in meeting its demands. Many candidates demonstrated capable practical skills in completing the quantitative exercise involving a titration. However, they were less assured in dealing with the qualitative tasks. Supervisors are thanked for providing the required experimental data to enable assessment of their candidates' work.

Comments on Specific Questions

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There were a number of candidates who successfully followed the instructions, carefully carried out the various test-tube reactions and accurately recorded the observations. Unfortunately there were numerous candidates who gave not only incomplete answers, but also incorrect ones. Teachers should continue to encourage candidates to make full use of the qualitative analysis notes supplied on the last page of the exam paper. The terminology and method of reporting provided are a model for the successful recording of observations. It is also important that the conclusions made by a candidate are supported by the observations recorded. It was not necessary to make all the observations to obtain full marks for this question.

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- Test 2** When a white precipitate was reported, it was generally found to dissolve in excess alkali and some noted that the final solution was colourless. However, there were many who stated there was no reaction, presumably because they added insufficient sodium hydroxide solution or added it too quickly.
- Test 3** Those who obtained a white precipitate in **Test 2** usually found one here as well and recorded that it was insoluble in excess ammonia. There were many who once again stated there was no reaction.
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Conclusions

Although many candidates gave the 'correct' answers here, far fewer were awarded credit because they did not have the evidence to support their conclusions.

This was particularly the case with **R** which was frequently stated to be aluminium but without the necessary observations in **Tests 2** and **3**. Candidates were generally more successful in identifying **R** as a reducing agent and, when an alkaline gas had been recorded in **Test 7**, **S** as a nitrate.

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Paper 5070/41
Alternative to Practical

General comments

The Alternative to Practical Chemistry paper is designed to test the candidate's knowledge and experience of practical chemistry. Skills examined include recognition and calibration of chemical apparatus and their uses, recall of experimental procedures, handling and interpretation of data, drawing of graphs, analysis of unknown salts and calculations. The standard continues to be maintained and the majority of candidates show evidence of possessing many of the aforementioned skills.

Most candidates show competency of plotting points accurately on graphs and joining the points as instructed.

Calculations are generally completed accurately using the appropriate significant figures.

Comments on Specific Questions

Question 1

The question is about the reaction of sodium with water. Most candidates showed good knowledge of this reaction and scored well.

- (a) Candidates were asked to read the thermometers. The temperatures were 31.9 and 25.6 giving a rise of 6.3.
- (b) The temperature increase shows that the reaction is exothermic.
- (c) The gas produced is hydrogen which pops in the presence of a flame.
- (d) The solution remaining was sodium hydroxide which turns litmus blue.
- (e) Two observations other than a temperature rise were needed. These include a violent or vigorous reaction, the sodium moving around the surface and melting, dissolving or disappearing.

Question 2

The question involves the separation of miscible liquids by fractional distillation.

- (a) Two errors were that the water in apparatus **B** is flowing in the wrong direction and that the collection vessel **C** should be open.
- (b) Apparatus **A** is a fractionating column and is used to separate the vapours. Apparatus **B** is a condenser and is used to change vapour into liquid. The explanation for the use of **B** should not include the word condense.
- (c) The first liquid to collect will be hexane which has a lower boiling point. When all this liquid had distilled over, the temperature would rise.
- (d) An electric heater was used as both liquids are flammable.
- (e) 0.47 moles of hexane and 0.60 moles of heptane were collected which is 44% of hexane. Errors in calculation of the moles could be carried forward.

Question 3

The answer is **(a)**. In this electrolysis the ratio of hydrogen: oxygen is 2:1.

Question 4

The answer is **(a)**.

Question 5

The answer is **(b)**. **X** is more reactive than copper but less reactive than zinc.

Question 6

The answer is **(c)**.

Question 7

The answer is **(a)**. This is because ethanoic acid cannot be oxidised.

Question 8

- (a)** The mass of iron(II) sulfate used in the experiment was 6.24 g.
- (b)** The colour change was from colourless or green to purple or pink.
- (c)** The three titres are 22.8, 22.2, and 22.4. As usual, when errors occur in reading the burette diagrams or subtracting the volumes the mean must be taken from the closest two titres.

Answers to the calculations are:-

- (d)** 0.000446
- (e)** 0.00223
- (f)** 0.0223
- (g)** 3.39
- (h)** 2.85
- (i)** 0.158
- (j)** 7.09
- (k)** **x** must be given as a whole number.

Errors may be carried forward throughout this question and if used correctly further credit may be awarded.

- (l)** A redox reaction involves simultaneous oxidation and reduction. In this reaction manganate(VII) ions are reduced and iron(II) ions are oxidised.
- (m)** A similar titration could not be used for iron(III) chloride as this cannot be oxidised.



Question 9

This question involves the analysis of calcium iodide.

- (a) A colourless solution indicates that a transition metal ion is not present in compound **P**. Candidates who state that **P** is not a transition metal were not awarded credit.
- (b) When sodium hydroxide solution is added, a white precipitate is formed that is insoluble in excess.
- (c) When aqueous ammonia is added, there is no precipitate or a slight white precipitate. The answer 'no reaction' is insufficient for credit to be awarded.
- (d) The test for iodide ions is to add dilute nitric acid followed by lead nitrate solution or silver nitrate solution. A yellow precipitate is observed. When the acid was not specified in acidified silver/lead nitrate, credit could not be awarded. If hydrochloric acid or an iodide was added in the test, only partial credit for the yellow precipitate could be given.

Candidates in general showed good knowledge of these tests and scored highly on this question.

Question 10

- (a) The mass of the flask decreased as a gas, carbon dioxide, was given off.
- (b) Candidates were asked to complete the table by calculating the total loss in mass.

In experiment 1 the answers are 0.63, 0.73, 0.80 and 0.80.
In experiment 2 the answers are 0.76, 0.80, 0.80 and 0.80.
- (c) The results are plotted on the graph. Candidates are given credit for plotting the points accurately and joining them with two smooth curves passing through zero. Most candidates scored well.
- (d) The results are the same because the reaction is complete.
- (e) The answers are obtained from the candidates' graphs. Most candidates correctly answered 0.56 g in (i) and also correctly read the graph in (ii) as 0.60 g. The question in (ii) however, asks for the mass of the flask and not the loss in mass, making the answer 90.30 g.
- (f) Most candidates knew that the effect of using powdered marble was to increase the rate of reaction.



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Paper 5070/42

Alternative to Practical

General Comments

The Alternative to Practical Chemistry paper is designed to test the candidates' knowledge and experience of practical chemistry. Skills examined include recognition and calibration of chemical apparatus and their uses, recall of experimental procedures, handling and interpretation of data, drawing of graphs, analysis of unknown salts and calculations. The standard continues to be maintained and the majority of candidates show evidence of possessing many of the aforementioned skills.

Most candidates show competency of plotting points accurately on graphs and joining the points as instructed.

Calculations are generally completed successfully using the appropriate significant figures.

Comments on Individual Questions

Question 1

- (a) The diagram shows a measuring cylinder, which contains 44 cm^3 of 0.100 mol/dm^3 of sulfuric acid or 0.0044 moles.
- (b) 0.12 g or 0.005 moles of magnesium is added to sulfuric acid. Candidates must give a reason for their choice of excess reagent in (iii), e.g. there are more moles of magnesium than sulfuric acid. In the event of a candidate giving an incorrect equation, a case for sulfuric acid being the excess reagent may be supported.
- (c) Hydrogen produces a 'pop' when a flame is applied. Many candidates confused this test with that of oxygen for which a glowing splint is used.

Question 2

- (a)
- (i) Most candidates read the thermometer diagrams accurately and used the temperatures to complete the table.
 - (ii) Candidates should note that these temperature rises show that all the reactions are exothermic. An explanation based on a definition of an exothermic reaction is not acceptable.
- (b) Using the molar masses of each alcohol and the temperature rises, most candidates deduced that alcohol **X** is butanol, **Y** is ethanol and **Z** is propanol.
- (c)
- (i) Propanoic acid may be prepared by oxidising propanol, alcohol **Z**.
 - (ii) Acidified potassium dichromate(VI) (colour change orange to green) or acidified potassium manganate(VII) (colour change purple to colourless) could have been used.

- (d) The ester $C_2H_5CO_2C_4H_9$ may be prepared by reacting alcohol **X**, butanol with propanoic acid.

Questions 3 to 7

Most candidates gave correct responses to some or all of the multiple choice questions.

Question 8

- (a) 3.12 g of the acid **V** was weighed out.
- (b) Having been given the colours of phenolphthalein in acid and alkali solutions most candidates gave the correct colour change at the end-point.
- (c) The three correct titres are: 25.2, 24.3 and 24.5 cm³, the mean of which is 24.4 cm³, the mean of the second and third titres. In cases where one or more of the titres is incorrect, candidates must indicate their choice of the two titres which are used to calculate the mean. An inappropriate choice, such as choosing two titres that are not the most similar, means that credit cannot be awarded.

Candidates in general scored well on this question and, in particular, it is encouraging to see so many candidates who were able to complete the whole question without an error, producing a correct value for *n* and the consequential formula for **V**.

Question 9

- (a) Since **H** is a compound of a transition metal, a coloured solution is observed. A coloured precipitate or solid is not acceptable.
- (b) On addition of aqueous sodium hydroxide a blue precipitate, insoluble in excess, is seen.
- (c) On addition of aqueous ammonia a blue precipitate is produced which dissolves in excess to form a dark blue solution. Candidates must state that the colour is dark blue to gain credit.
- (d) The presence of the nitrate ion is confirmed by the addition of aqueous sodium hydroxide and aluminium. The solution is warmed and ammonia gas, which turns litmus blue, is produced. Candidates who use nitric acid in this test cannot be awarded credit.

Credit is awarded for the correct formula of compound **H**.

Question 10

- (a) Candidates are required to complete a table of results by calculating the increase in mass in each case.
- (b) Most candidates plotted the points accurately on the grid. On connecting the points, a straight line is produced for experiment 1, and two intersecting straight lines for experiment 2. Credit was not awarded for incorrect plotting of one or more points, either line not passing through zero and if only one straight line is drawn for experiment 2.
- (c) A common mistake here is not realising that one small square on the *y*-axis is equal to 0.02 g rather than 0.01 g.
- (d) The mass of silver deposited in 35 minutes in experiments 1 and 2 are 1.04 g and 1.40 g respectively, giving a difference of 0.36 g.
- (e) All the silver is deposited in experiment 1 after 54 minutes. Candidates needed to extend both lines on their graph to show how they had worked this out in order for credit to be awarded.
- (f) The mass of silver deposited can be increased by increasing the volume or concentration of the silver nitrate. In the latter case answers must infer that an increase in concentration is required. The use of a silver anode is also acceptable.