CHEMISTRY

Paper 5070/11
Multiple Choice

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

General comments

Candidates found **Questions 7**, **19**, **21**, **22**, **24**, **28**, **36** and **37** to be straightforward.

Questions 20, 23 and **29** proved to be particularly challenging for candidates.

Comments on specific questions

The choice of distractor in the follow items revealed where some candidates had gaps in their knowledge and/or misconceptions.

Question 1

Many candidates chose **A** and **D** showing a possible lack of understanding of the appropriate method for gas collection.

Question 3

Many candidates chose the distractors **C** and **D**. This shows they had not learnt the difference in the behaviour of Cr^{3+} and Fe^{2+} in excess aqueous NaOH.

Question 10

Many candidates could not work out the stoichiometry of the reaction from the question, which was framed in terms of volumes of gases.

Question12

A significant proportion of candidates chose distractor **C**. This suggests they disregarded the mass data provided and chose the compound with the largest number of O atoms.

Question 13

Many candidates chose distractors **A** and **B**. This shows that they had not learnt the products of electrolysis as required by the syllabus.

Question 14

Distractors **C** and **D** combined were selected more than the key. This suggests these candidates thought that ionic compounds contain free electrons.

Question 17

Many candidates were not aware that paraffin showed the correct use.

Question 20

Most candidates did not appreciate that Fe^{2+} could be oxidised (by $KMnO_4$).

Question 23

Some candidates' responses indicated poor knowledge of salt preparation.

Question 29

Many candidates thought that an alloy is a compound rather than a mixture.

Question 32

Many candidates misunderstood the chemical processes in a blast furnace.

Question 34

When asked to select non-acidic gases, many candidates chose the distractors with CO_2. This showed poor knowledge of the chemistry of non-metallic oxides.

CHEMISTRY

Paper 5070/12
Multiple Choice

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

General comments

Candidates found **Questions 5**, **11**, **22** and **28** to be straight forward.

Questions 1, **9** and **29** proved to be particularly challenging for candidates.

Comments on specific questions

The choice of distractor in the follow items revealed where some candidates had gaps in their knowledge and/or misconceptions:

Question 1

Distractor **D** was chosen more than the key (**B**). Distractor **C** was also chosen by a significant number of candidates. Neither **C** or **D** had a balance to measure the mass of the calcium carbonate.

Question 4

Many candidates did not think that ammonia and hydrogen chloride gas react to form solid ammonium chloride.

Question 9

Distractor **A** was chosen more than the key (**B**). These candidates disregarded the lattice of atoms, which should be positive ions, and perhaps just focused on the 'sea of electrons'.

Question 10

Many candidates could not work out the stoichiometry of the reaction from the question, which was framed in terms of volumes of gases.

Question 13

Many candidates chose distractors **A** and **B**. This shows that they had not learnt the products of electrolysis as required by the syllabus.

Question 18

Many candidates thought that starch, rather than glucose, along with oxygen is a product of photosynthesis.

Question 20

Better performing candidates were able to work out which of the three reactions were redox. The statistics suggest weaker candidates could not and were guessing.

Question 23

Most candidates knew that distractor **B** was incorrect but found it hard to decide on the correct pair of reagents needed to prepare copper(II) chloride.

Question 29

Many candidates thought that an alloy is a compound rather than a mixture.

Question 32

Some candidates misunderstood the chemical processes in a blast furnace.

Question 37

Some candidates found it difficult to identify the key as the molecule with bromine atoms on adjacent carbon atoms.

CHEMISTRY

Paper 5070/21
Theory

Key messages

A significant proportion of the candidates showed all the relevant working out when completing calculations and this allowed error carried forward marks to be awarded. Candidates used the appropriate number of significant figures in calculations.

Candidates must distinguish between rate of reaction and position of equilibrium when answering questions. The use of collision theory is appropriate for rate of reaction but not for questions about the position of equilibrium. In terms of position of equilibrium candidates must appreciate that for a change in pressure it is the number of moles of gas on each side of an equation that is the important factor.

General comments

Most candidates answered only three questions from ***Section B***, but a small proportion of candidates answered all four.

Comments on specific questions

Section A

Question 1

This was an objective question about gases.

(a) Candidates often chose helium as the gas used to make margarine, however ethane and methane were common incorrect answers.

(b) Many candidates appreciated that sulfur dioxide is used as a food preservative, although some candidates gave sulfur trioxide instead. Carbon dioxide was also a common incorrect answer.

(c) Many candidates recognised that ethane had a molecule containing eight atoms. Neon was a common incorrect answer.

(d) Most candidates recognised that methane is formed during the bacterial decay of vegetable matter. Other candidates gave carbon dioxide which was also given credit in the mark scheme.

(e) Some candidates recognised that ozone was formed in a photochemical smog, but a significant proportion of the candidates chose carbon monoxide instead.

(f) Candidates found this question about formation of carbon dioxide challenging and rarely gave the correct response of carbon monoxide. The most common incorrect answers involved the gases that were flammable and formed carbon dioxide on combustion.

Question 2

This question focused on the chemistry of the elements in Group VII.

(a) Candidates often recognised that the elements had the same number of electrons in the outer shell, and often stated that there were seven valency electrons. Common misconceptions included the elements having the same electronic configuration or the same valency.

(b) (i) Many candidates failed to give an observation, instead they gave comments about oxidation and reduction. Other candidates described the formation of a precipitate rather than a brown solution. A significant proportion of the candidates did not attempt the question.

(ii) Many candidates appreciated that oxidation involved the increase in the oxidation number and/or the loss of electrons, however they often did not relate this to the correct chemical species. The best answers referred to the iodide ions losing electrons to form an iodine molecule or the oxidation state of iodine increasing from -1 to 0. Common misconceptions included iodine or chloride ions losing electrons.

(iii) Many candidates appreciated that reduction involved the decrease in the oxidation number and/or the gain of electrons, however they often did not relate this to the correct chemical species. The best answers referred to chlorine molecules gaining electrons to form iodide ions or the oxidation state of chlorine decreasing from 0 to –1. Common misconceptions included chloride ions losing electrons and iodine gaining electrons.

(c) Candidates could often state the chemical test for chlorine. Many candidates used moist blue litmus and stated that the paper would go red and then white. A small proportion of the candidates used starch-iodide paper going blue-black as a test and this was given full credit in the mark scheme.

(d) (i) Most candidates recognised that the rate of reaction increased. Only the best answers referred to both collision frequency and the number of particles per unit volume in their answers. Many candidates just referred to more collisions or more successful collisions and this was not sufficient to be awarded a mark. The idea of particles having more particles per unit volume was often poorly expressed.

(ii) Most candidates focused on the effect of a catalyst on the activation energy and often failed to mention that the reaction has an alternative pathway. As an alternative to mentioning the activation energy candidates often referred to the presence of a catalyst causing more successful collisions.

Question 3

This question was about the preparation of barium salts.

(a) (i) Many candidates appreciated that the barium sulfate was filtered from the reaction mixture although some candidates then crystallised the filtrate rather than washed and dried the residue. Other candidates omitted the filtration step completely and described crystallising the barium sulfate as though it was a soluble salt. Another common misconception was to describe the titration of barium chloride with dilute sulfuric acid as part of the salt preparation.

(ii) A significant proportion of the candidates gave the correct ionic equation and included the state symbols. Some candidates gave the full stoichiometric equation and if this equation included the correct state symbols it was awarded one of the two marks for this question. Candidates often gave their working out that involved crossing out of ions. These candidates should make certain that their final answer is clearly presented and all the working out is completely crossed out.

(b) A significant proportion of the candidates could correctly calculate the mass of barium chloride. Other candidates used the correct method but made minor slip-ups or omissions during the calculation. Common errors included failure to account for the 75 per cent yield, and not using the 2:1 mole ratio, or calculating the incorrect number of moles of hydrochloric acid. Most candidates gave their answer to the required three significant figures.

(c) Many candidates could give the correct numbers of subatomic particles in the barium ion. The most common errors involved the numbers of electrons and/or protons.

Question 4

This question focused on the chemistry of ethanol and ethanoic acid.

(a) Many candidates recalled that fermentation involved glucose and yeast, and often the candidates named the enzyme present in yeast responsible for fermentation. The conditions for fermentation were well known; typically candidates gave the lack of oxygen and a suitable temperature. The final marking point required a reference to distillation and this was often missing from even the best answers. Only a very small proportion of the candidates confused hydration of ethene with fermentation of glucose.

(b) Candidates found this question challenging and often did not include the formation of water in their equation. A significant misconception was to use [O] or O in the equation rather than molecular oxygen.

(c) A significant proportion of the candidates did not attempt this question. Candidates often drew an incorrect ester linkage and so were not awarded a mark. Most candidates who attempted the question drew a displayed formula (all of the atoms and all of the bonds).

(d) A significant proportion of the candidates obtained the correct answer, although some candidates did not attempt the question. The most common misconception was to use 0.240 dm^3 or 240 cm^3 as the number of moles of ethanol.

Question 5

This question focused on the chemistry of silicon.

(a) A significant proportion of the candidates calculated the correct mass of silicon. Candidates showed their working out were often able to get credit for using the wrong number of moles of silicon dioxide.

(b) Candidates could often predict at least one physical property of silicon. The most common properties given were a high melting point and a high boiling point. These two properties were only given one mark, whether one or both were given. Some candidates predicted that silicon was hard or insoluble in water. Only a very small proportion of the candidates stated that silicon was an electrical semi-conductor.

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(c) (i) Many candidates could draw the '*dot-and-cross*' diagram for silane.

(ii) Candidates often could not relate the low boiling point of silane with its structure and bonding. Most candidates did not mention that silane had a simple covalent or simple molecular structure. The most common correct answer was that silane had weak intermolecular forces, although some candidates referred to the intermolecular forces between atoms which was considered as a contradiction. A common misconception was that the covalent bonds present were weak and easy to break.

(d) (i) Candidates often gave imprecise answers about two monomers forming a polymer. A significant proportion of the candidates appreciated that a small molecule was eliminated during the formation of a condensation polymer.

(ii) Candidates were often not able to draw the repeat unit for siloxane. One misconception was to repeat the structure shown in the stem of the question but make it a slightly shorter polymer chain. Other candidates did not include the extension bonds at either end of the repeat unit. A third misconception was to include two oxygen atoms in the repeat unit.

(e) Candidates found drawing poly(butene) challenging and a significant proportion of the candidates did not attempt the question. Often a straight chain polymer resembling poly(ethene) was drawn. As in **(d)(ii)** the extension bonds were often missing.

Section B

Question 6

This question focused on the extraction of copper from copper pyrites.

(a) A significant proportion of the candidates calculated the mass of copper. Some candidates were not able to calculate the relative formula mass of copper pyrites, but if their working was clear they could have access to a mark for error carried forward.

(b) Candidates found this equation extremely challenging and many candidates gave at least one incorrect formula and so were not awarded any marks. Of the correct equations there was a mixture of those with fractions and those without.

(c) Two equations were allowed in the mark scheme one making carbon monoxide and the other carbon dioxide. Most candidates were able to give one of these equations.

(d) (i) Many candidates gave copper(II) sulfate or copper sulfate. Other soluble copper salts were allowed but only an extremely small proportion of the candidates gave answers such as copper nitrate or copper chloride.

(ii) Candidates needed to specify that the anode was impure copper to be awarded a mark. It was acceptable just to state copper for the cathode and so candidates that just stated copper for both electrodes were awarded one mark.

(iii) A significant proportion of the candidates were able to recall the two equations for the electrode reactions. Some candidates put the two equations the wrong way around and if both were correct were given one mark. A common misconception was to have an equation that had a 2 in front of the Cu in the equations, e.g. $Cu^{2+} + 2e^{-} \rightarrow 2Cu$.

Question 7

This question focused on the iron oxide with formula Fe_3O_4.

(a) Although many candidates referred to the forward and backward reactions a significant proportion did not mention about the rates of these reactions being the same.

(b) Candidates found this question challenging. Most candidates did not focus on the moles of gas on each side of the reaction and merely referred to the difference in the number of moles. As a result only a small proportion of the candidates recognised that the composition of the equilibrium mixture did not change.

(c) (i) Many candidates deduced that the enthalpy change was negative or that the reaction was exothermic. A common misconception was to refer to the enthalpy change increasing or decreasing.

(ii) Most candidates recognised that the rate of reaction increased and gave a suitable explanation. The most common answers referred to the particles moving faster or having more energy. A smaller proportion of candidates referred to more successful collisions.

(d) (i) Many candidates deduced that the liquid was water.

(ii) Candidates often gave the incorrect formula for iron(III) sulfate, and as a result these candidates could not balance the equation.

(iii) Most candidates used sodium hydroxide to test for iron(III) ions; ammonia was only used by a small proportion of the candidates. Candidates normally gave the correct positive result referring to the formation of a brown precipitate. A very small proportion of the candidates used alternative reagents e.g. potassium hexacyanoferrate(II), and often these candidates did not give the correct name for the reagent.

Question 8

This question focused on methanesulfonic acid.

(a) A significant proportion of the candidates did not write the molecular formula and gave formulae such as CH_3SO_3H rather than CH_4SO_3. Any order of the symbols in the formula was allowed in the mark scheme.

(b) Many candidates assumed that methanesulfonic acid was a strong acid and gave answers such as methanesulfonic acid completely dissociated but ethanoic acid only partially dissociates. The mark scheme just required the idea that methanesulfonic acid dissociates more than ethanoic acid. Common misconceptions were to refer to the rate of dissociation, the number of hydrogen ions and/or the pH of the solution.

(c) Most candidates understood the significance of the hydrogen ion in acids and the hydroxide ion in alkalis.

(d) A significant proportion of the candidates obtained the correct answer. Good answers were typified by clear working out involving the calculation of the moles of acid, the relative formula mass and finally the mass of methanesulfonic acid. The clear working out allowed marks to be awarded for error carried forward where candidates calculated an incorrect amount in moles or the wrong relative formula mass.

(e) A significant proportion of the candidates obtained the correct answer although some candidates did not attempt the question.

(f) (i) Many candidates recognised that magnesium and acids gave hydrogen gas.

(ii) A significant proportion of the candidates were able to use the formula of the anion to deduce the formula of the magnesium salt.

Question 9

This question focused on rate of reaction and the chemistry of hydrocarbons.

(a) (i) Some candidates gave the correct formula as $C_4H_8Cl_2$ but often candidates struggled with the structure of the compound. Many candidates did not appreciate that the carbon skeleton would remain as methylpropane and so gave structures of straight chain compounds. The mark scheme did allow for an error carried forward from an incorrect molecular formula providing that the structure given was based on methylpropane.

(ii) Many candidates gave the correct working but were not able to deduce that the formula was $C_4H_7Cl_3$ and gave answers such as CH_2Cl.

(iii) Candidates found this question very challenging and often gave formulae such as C_4Cl_{10} or $C_4H_{10}Cl_5$ rather than the correct formula $C_4H_5Cl_5$. Only an extremely small proportion of candidates gave HCl, and this would have been allowed in the mark scheme

(b) (i) Candidates were often able to state the meaning of the term *isomerism*.

(ii) Candidates were often able to state the meaning of the term *hydrocarbon*.

(iii) Candidates often appreciated that an unsaturated compound has at least one double bond, but they did not always mention that it is a carbon-carbon double bond. Candidates very rarely mentioned that a saturated compound contains only carbon-carbon single bonds.

(iv) The use of bromine water was well known, and the best answers gave the results for both a saturated and an unsaturated compound. A small proportion of the candidates referred to the reaction of aqueous potassium manganate(VII) and if the observations were correct this type of answer was given full credit.

CHEMISTRY

Paper 5070/22
Theory

Key messages

- Many candidates need more practice in interpreting the stem of a question.
- Many candidates need more practice in drawing the structures of organic compounds.
- Some candidates need more practice in writing formulae and constructing equations, especially ionic equations.

General comments

Many candidates tackled this paper well and gained good marks in both ***Section A*** and ***Section B***. Most candidates gave answers of the appropriate length to questions involving free response. Most candidates responded to most parts of each question. The exceptions were **Questions 9(e)** (the equation for the reaction of sulfamic acid with magnesium) and **Question 10(b)(ii)** (identification of butanol with reason), where a significant minority of candidates did not respond.

A significant proportion of the candidates did not always appear to read the stem of the question carefully enough. For example, in **Question 2(b)(i)** many candidates wrote about oxidation and reduction rather than giving observations; in **Question 2(c)** many candidates gave an example of a transition element rather than a compound of a transition element; in **Question 9(e)** many did not use the information in the stem of the question that there was a 1:1 mole ratio of sulfamic acid to hydrogen. Some candidates repeated what was in the stem of the question. For example, in **Question 2(d)** many candidates just repeated comments in the stem of the question about the action of catalysts increasing rate of reaction by lowering the activation energy. In **Question 10(e)(ii)** many candidates repeated the examples of ester usage given in the stem of the question.

Some candidates' knowledge of organic chemistry was good. Many others need to practise drawing organic structures such as alkenes, substituted alkanes (**Question 5(c)**, **5(d)**) and alcohols (**Question 10(b)(ii)**). Others need to practise writing isomers (**Question B10(c)(ii)**). Many candidates also need practice in distinguishing molecular formulae from other types of formulae, especially when related to organic compounds as in **Question 9(a)**. Most candidates need practice in drawing a section of the nylon polymer chain (**Question 6(a)**) and in drawing the structure of an alkene monomer when given the structure of the addition polymer formed (**Question 6(b)(ii)**).

The writing of balanced equations was not always successful. Some candidates were able to work out the correct formulae for reactants and products. Others need more practice in memorising or working out simple formulae such as ZnO, HNO_3 or $Ca(NO_3)_2$ from first principles. **Question 9(e)** caused particular problems in terms of both identifying the species involved and balancing the equation. A major area needed for some candidates to improve is the construction of ionic equations such as **Question 3(a)(ii)** and the half equations for the reactions at the electrodes (**Question 7(d)**).

Some candidates' knowledge of structure and bonding was good. In **Question 4(b)** many could not distinguish between molecular structures and giant structures or ionic and covalent bonding. Candidates should also be advised to check that their answers do not contain conflicting statements e.g., 'it is a giant ionic structure with strong intermolecular forces between the ions'.

Some candidates performed well in questions involving calculations, showing appropriate working, clear progression in each step of the calculation and clear indications about what each number refers to. Other candidates should make sure that they set out each stage of their working clearly in calculations involving several successive divisions e.g. **Question 4(a)** or calculations where moles as well as percentages are involved e.g. **Question 3(c)**. Statements in the form of moles of X = ... or mass of Y = ... always help to make clear the processes involved.

Comments on specific questions

Section A

Question 1

This was the best answered of the ***Section A*** questions. Most candidates scored the marks for parts **(a)**, **(b)**, **(d)** and **(e)**.

(a) Most candidates identified the use of hydrogen in making margarine. The commonest incorrect answers were oxygen, butane and propane.

(b) Nearly all the candidates chose the correct answer (chlorine). The commonest incorrect answer was sulfur dioxide.

(c) A majority of the candidates correctly identified propane as having eight atoms. A large range of incorrect answers were seen including butane, and the diatomic molecules oxygen and nitrogen.

(d) Nearly all the candidates identified nitrogen as the gas forming 78% of the air. The commonest incorrect answer was oxygen. A few suggested hydrogen.

(e) Many candidates gave the correct answer (ammonia). The commonest incorrect answer was nitrogen.

Question 2

This question was one of the least well answered from ***Section A***. Only a minority gave two observations in part **(b)(i)** and others wrote confused or conflicting answers in part **(b)(iii)** (explaining how the equation shows reduction). In part **(c)** many candidates selected a transition metal instead of a transition metal compound, whilst in part **(d)** the majority wrote about activation energy or rate of reaction instead of reducing energy consumption.

(a) A majority of the candidates were able to recall the correct colour of iron(III) hydroxide. The commonest errors were to suggest green, red or yellow.

(b) (i) A significant number of candidates did not give observations and described what was happening in the reaction in terms of oxidation and reduction. Candidates who did give observations often mentioned the formation of a pink solid or deposit. Many candidates appreciated that the blue solution disappears or that a green solution is formed; only a minority mentioned both. Some did not mention a solution or referred to a green precipitate. A minority of the candidates mentioned that the iron gradually disappears. Most suggested that the iron dissolves, which was not an acceptable answer. Very few mentioned that the reaction mixture gets warm.

(ii) Many candidates wrote about iron losing electrons or that iron increases in oxidation number. A few candidates illustrated their answers with a suitable half equation, which was acceptable. Some referred to copper or copper ions, rather than iron.

(iii) Many candidates referred to copper, which is on the right hand of the equation, rather than the copper ions on the left-hand side of equation. The best answers referred to decrease in oxidation number without mentioning electrons. Many who did suggest that the oxidation number of copper decreases, disadvantaged themselves by writing conflicting statements such as 'the copper gains electrons' (rather than copper ions gain electrons).

(c) Most candidates who gave vanadium(V) oxide as an answer also suggested the Contact process or gave the equation for the conversion of sulfur dioxide to sulfur trioxide. A majority of the candidates appeared not to notice the essential term *compound* in the stem of the question and gave the elements iron or nickel with an appropriate reaction.

(d) Many candidates wrote about activation energy or rate of reaction, which were both mentioned in the stem of the question. The best answers referred to a reduction in energy consumption or energy cost. A smaller number of candidates wrote about the use of lower temperatures or lower pressures.

Question 3

Some candidates gave good answers to many parts of this question but others need more practice in describing the preparation of an insoluble salt (part **(a)**) and in writing equations, especially ionic equations (parts **(a)(ii)** and **(b)(ii)**).

(a) (i) Many candidates confused the preparation of insoluble and soluble salts and many suggested a titration followed by crystallisation. Others heated the mixture at the beginning and did not mention filtration. Those candidates who did describe the correct method often included both the washing and drying stages. The washing stage was more often omitted than the drying stage. Some candidates did not obtain a mark for the drying stage because there was no qualification as to how it was dried e.g. in an oven or left in a warm place. Many candidates wrote confused accounts, some drying before washing or making it unclear whether it was the filtrate or the residue which was being taken for the second or third steps.

(ii) Some candidates wrote a correctly balanced ionic equation. Common errors included Ag^{2+} instead of Ag^+, $AgCl_2$ as the formula for silver chloride or Ag^+ and Cl^- as products. A significant number of candidates did not write ionic equations or wrote a mixture of ionic and molecular equations. Others did not include state symbols or wrote only some of the state symbols. A minority of candidates wrote (l) or (aq) as the state symbol for silver chloride.

(b) (i) Many candidates gave an example of a photochemical reaction; 'photosynthesis' being the commonest error. Some candidates knew the term *photochemical* or something close such as 'photolytic'; others suggested 'endothermic'.

(ii) Some candidates wrote a correctly balanced equation. Others gave Ag^+ and Cl^- as products or wrote Ag_2 instead of 2Ag. A significant number of candidates wrote either Cl or $2Cl$ for chlorine.

(c) Many candidates calculated the answer correctly. The commonest errors were to forget the 80% yield or to double the relative formula mass or double the number of moles of silver nitrate. Most candidates quoted the answer to three significant figures.

Question 4

This question was generally well answered by many candidates; part (c) proved the most challenging.

(a) Some candidates were able to do the calculation correctly. Others made errors either in the incorrect use of the mole ratio or in the calculation of the relative formula mass silicon dioxide. Those who gained a single mark generally obtained it for the correct number of moles of silicon dioxide. The candidates' working for this question was often muddled.

(b) Many candidates gave two suitable physical properties of phosphorus, low boiling and melting point and poor electrical conductivity being the commonest correct responses. Other correct responses such as reference to insolubility in water or low density were less often seen. Some candidates gave low melting point and low boiling as separate bullet points and so only gained a single mark. A minority of candidates thought that phosphorus has a giant structure and gave high boiling points, hard or dense as an answer.

(c) Some candidates mentioned ions but then contradicted themselves by writing about molecules or atoms of calcium or phosphate. A common error was to write about 'strong intermolecular forces between the ions'. Others wrote about covalent bonding between ions. The best answers linked a giant ionic lattice with a strong ionic attraction between positive and negative ions or strong ionic bonds. A minority of the candidates gained the first mark for mentioning a giant structure or a lattice.

(d) Candidates were more likely to get the numbers of the subatomic particles correct than the isotopic formula of the phosphide ion. The commonest error was to omit the 3– charge. A significant number of candidates gave a mass number of 30 rather than 31 or altered or omitted the proton number.

Question 5

This question was generally well answered by many candidates in all parts.

(a) Many candidates mentioned fractional distillation; a considerable minority thought that cracking was occurring. A minority of the candidates mentioned that the crude oil was heated. Many described a blast furnace and quoted temperatures which were more like that of a blast furnace. The idea that different fractions in crude oil have different boiling points was often poorly expressed and many candidates just wrote about temperatures rather than boiling points. A minority of candidates mentioned melting points rather than boiling points. Others wrote about the position where the naphtha condenses in the column without mentioning where this was or gave an incorrect position such as 'condenses at the top'.

(b) (i) The general formula of an alkane was well known. The best answers substituted n=12 to show that $C_{12}H_{26}$ was an alkane.

(ii) Many candidates who deduced the correct formula for the alkene with six carbon atoms also gained the mark for balancing the equation. The two equations most commonly seen involved C_6H_{14} or H_2. Common errors included two molecules with the incorrect formula or a misreading of the question to omit the species C_6H_{12}.

(c) Most candidates were able to draw the correct 'dot-and-cross' diagram for ethene, some using circles and others not. Candidates should be reminded that the use of dots or crosses at the end of a line e.g. x — x, is not strictly speaking accurate, since the line represents a bonding pair of electrons. The commonest errors were a single pair of electrons between the carbon atoms or a lone pair of electrons on each carbon atom.

(d) (i) Some candidates drew the correct structure of 1,2–dichloroethene. Others either drew a double bond between the carbon atoms, included only one chlorine atom or placed both chlorine atoms on the same carbon.

(ii) A minority of the candidates gave the correct molecular formula. The commonest error was to suggest $C_2H_2Cl_4$. Another common error was C_2H_5Cl. A small number of candidates just wrote an equation and did not make it clear which of the two products was organic.

Question 6

This was found to be challenging.

(a) Some candidates could draw a partial structure for nylon but many others included an extra oxygen or hydrogen in the linkage. Another common error was to draw NH_2 in the amide group instead of NH. A significant number of candidates did not include any nitrogen. Many candidates either did not draw a complete repeat unit or did not include one or both extension bonds at the ends of the chain.

(b) (i) Few candidates scored both marks for an explanation of addition polymerisation. Those candidates who scored the mark for the idea of monomers adding together rarely scored the second mark for explaining that only a single product is formed. The best answers referred to the polymer being made without the formation of other molecules such as water. A common misconception was to refer to the polymer being formed with no mass or atoms being lost. This was not accepted because it was really another description of the Law of Conservation of Mass.

(ii) Some candidates drew the correct structure of the alkene. Others drew chains of unsaturated hydrocarbon, with six or more carbon atoms in a row, with or without a double bond. Many candidates drew the structure of ethene or only drew one or two CH_3 groups. Others included bonds which were only joined to an atom at one end.

(iii) Many candidates mentioned that addition polymers are non-biodegradable. A common misconception was to suggest that these polymers produce toxic gases or greenhouse gases without being burnt.

Section B

Question 7

This question was generally well answered. Construction of equations was done better in **(d)** than in **(c)**.

(a) Many candidates calculated the mass of zinc correctly**.** Most used a method starting with the fraction of percentage of zinc in zinc sulfide. The commonest errors were to use atomic numbers instead of atomic masses or to calculate the mass of zinc sulfide incorrectly.

(b)(i) A majority of the candidates wrote the correct formulae for the reactants and the products. A significant minority did not balance the equation correctly and many left it unbalanced.

(ii) Some candidates realised that sulfur dioxide is responsible for acid rain. Others gave answers which were far too vague such as 'it causes air pollution', 'affects respiration' or 'kills you'.

(c) Some candidates wrote the correct equation. Others either tried to balance the equation with two ZnO or wrote the incorrect formulae such as ZnO_2 or Zn_2SO_4. A significant number of candidates thought that hydrogen was formed rather than water.

(d) Many candidates were able to construct the equations for both electrodes. A common error was to write the equation at the cathode as $Zn^{2+} + 2e^{-} \rightarrow 2Zn$. Some candidates reversed the half equation at the cathode. Common errors in the anode equation included putting the electrons on the wrong side of the equation, lack of charge on the hydroxide ion and incorrect balance of the products, often $2O_2$ rather than $2H_2O$.

(e) Many candidates realised that zinc is more reactive than iron and some then linked this to the idea of zinc reacting with air and water instead of iron. A small proportion of candidates disadvantaged themselves by suggesting that zinc rusts. Some candidates wrote statements which either repeated the stem of the question e.g. 'so it prevents the iron from rusting' or were too vague e.g. not mentioning a layer of zinc on the ion.

Question 8

Candidates performed strongly on this question. Most scored marks for parts **(a)**, **(c)** and **(d)(i)**. Fewer candidates knew the test for water in part **(d)(ii)** or were able to construct the equation for the reaction of nitric acid with calcium carbonate in part **(c)**. In part **(b)** only a minority of the candidates were able to predict and explain the effect of decreasing the pressure on the equilibrium.

(a) Many candidates realised that the reaction was reversible and many went on to describe that the rate of the forward reaction was equal to the rate of the backward reaction. Others missed out the essential term *rate*. A common error was to suggest that the amounts or concentrations of the reactants and products were equal.

(b) Some candidates realised that the number of moles of gas was the greater on the right-hand side of the equation but most omitted the essential term *gas*. A significant proportion of the candidates either gave the incorrect direction of change in the position of equilibrium (no effect being a common error) or focussed on the rate of the reaction.

(c) Many candidates recognised that the reaction was endothermic or that the sign of the enthalpy change was positive. The commonest error was to suggest that the enthalpy change was increasing rather than giving the sign.

(d) (i) Many candidates recognised that carbon dioxide was given off and gave the correct test. The commonest error was to suggest that the gas was hydrogen. Oxygen or ammonia were also often seen as incorrect answers. Only a few candidates suggested substances which were not gases.

(ii) Many candidates recognised that water was formed but some gave nitric acid or calcium nitrate. The full details of the chemical test for water were often omitted and many just stated that 'copper sulfate goes blue'. Many candidates who selected anhydrous cobalt chloride as the test reagent, gave the incorrect colour change, either reversing the colour change (pink to blue) or giving the colour change for copper sulfate.

(iii) Some candidates constructed the correct equation. Others either wrote the incorrect formula for calcium nitrate ($CaNO_3$ and CaNO being common) or suggested that hydrogen is formed. A significant number of candidates who did write the correct formula for calcium nitrate did not balance the equation. Some candidates wrote the formula of nitric acid as H_2NO_3.

Question 9

Parts **(b)** (strong and weak acids) and **(c)** (calculation) were well answered. In part **(a)** many candidates wrote a partial structural formula instead of a molecular formula and in part **(d)** many candidates made simple errors in the titration calculation. In part **(e)** few candidates were able to construct the equation for the reaction of sulfamic acid with magnesium.

(a) Some candidates wrote the correct molecular formula but many gave a structural formula or partial structural formula such as SOH_3NO_2 or SO_2NH_2OH. Some candidates wrote a correct molecular formula after writing a structural formula but did not state which one of these was the molecular formula.

(b) (i) Most candidates appreciated the significance of the hydrogen ion. The commonest errors were to focus on the pH or to make a vague statement about hydrogen atoms or hydrogen gas.

(ii) Most candidates understood that a strong acid is totally ionised or dissociated and that a weak acid is partially ionised or dissociated. The commonest errors were either to refer to differences in the ability of strong or weak acids to dissolve or to refer to the difference in reactivity of the acids. Other candidates confused concentration with strength and wrote incorrect answers such as 'a strong acid has a higher concentration of hydrogen ions and a weak acid has a lower concentration'.

(c) Most candidates gained at least two of the three marks available. The commonest errors involved either calculating the incorrect relative formula mass or the incorrect number of moles.

(d) Some candidates calculated the volume of sulfamic acid correctly. Others made errors associated with the conversion between dm^3 and cm^3. Working was generally shown, which made it possible to award marks for error carried forward where necessary.

(e) Many candidates were not able to deduce the formula of magnesium sulfamate correctly. Common errors included omitting hydrogen or ignoring the information in the stem of the question that the mole ratio of sulfamic acid to hydrogen was 1:1. A significant number of candidates did not respond to this question.

Question 10

Most candidates gave a good answer to part **(b)(i)** (calculation of empirical formula). Some candidates exhibited a good grasp of organic chemistry in parts **(a)** to **(d)**. Others need more practice at drawing the structures of organic molecules, especially isomers. In part **(e)(i)** some candidates could use the kinetic theory to describe the change in rate of diffusion; others wrote answers that were unnecessarily complicated.

(a) Some candidates could name the ester butyl ethanoate. A few suggested ethyl butanoate but the main errors arose from inaccuracy in naming the ethanoate, 'ethanote' and 'ethanate' being commonly seen.

(b) (i) Many candidate deduced the empirical formula correctly. Others used the correct approach but made errors in deducing the simplest ratio. A common misconception was to use the symbol S instead of Na and/or to use 32 rather than 23 for the relative atomic mass of sodium. Other candidates used the atomic number instead of the relative atomic mass.

(ii) Many candidates realised that C was butanol but the structure was not always drawn correctly. Common errors were: the carbon atom attached to the OH group with 5 bonds, H and O inverted so that the termination was CH_2–H–O or a double bond between the oxygen and the hydrogen. Candidates often gave reasoning based on the reaction with potassium manganate(VII), stating, correctly, that alcohols are oxidised to carboxylic acids. Others wrote vague statements which either mentioned reactions other than oxidation or wrote about esters. Those who went down the route of showing that the sum of the relative atomic masses for butanol is 74 sometimes made errors in their calculations. A considerable number of candidates did not respond to this question.

(c) (i) Some candidates gave a suitable definition of isomerism. Most candidates knew that isomers had different structures but many suggested that they had the same general or empirical formula rather than molecular formula. A minority of the candidates mistook isomers for isotopes and wrote about differences in numbers of neutrons.

(ii) Most candidates who gained the mark drew isomers that were esters, others drew acceptable isomers which were carboxylic acids or a contained C=O and –O– groups. Some candidates missed off one or more hydrogen atoms from the structure they drew. Others redrew butyl ethanoate by bending the chain round at the end.

(d) Those who wrote about carbon-carbon single bonds often forgot to state that all the carbon- carbon bonds were single bonds. Others did not make it clear that saturation and unsaturation refers to carbon-carbon bonds and not just to any double bond.

(e) (i) Some candidates gave good answers which referred to particles and decrease in the kinetic energy of the particles. Others either wrote about energy in general or gave answers which related to chemical reactions rather than diffusion e.g. reference to frequency of collisions, activation energy or distance between particles.

(ii) Some candidates correctly referred to flavourings or, less frequently, solvents. Others gave uses of esters without really defining the function of the ester e.g. 'in paints' rather than 'as a solvent in paints'. A significant proportion of the candidates did not heed the words 'one other use', in the question and suggested uses related to perfumes or fragrances, which appeared in the stem of the question. Others suggested uses for esters other than butyl ethanoate e.g. fuels or clothing (polyesters).

CHEMISTRY

Paper 5070/31
Practical Test

Key messages

The questions and calculations in quantitative exercises require a firm grasp of the task involved.

Candidates should aim to read the information provided in the question more carefully and thoughtfully, so they secure the necessary understanding.

In qualitative tests, candidates should be encouraged to be consistent in their performing of tests and reporting of observations. The terminology and method of reporting, given in the qualitative analysis notes on the last page of the examination paper, are a model for the successful recording of observations.

General comments

The overall standard was good and in general, candidates performed equally well in both questions.

Comments on specific questions

Question 1

(a) Nearly all candidates completed the results table correctly by recording readings to one or two decimal places, accurately subtracting them to determine the volumes of **P** used and then ticking two or more titration results that did not differ by more than $0.2\,cm^3$. Securing at least two titres within $0.2\,cm^3$ of the supervisor's value proved challenging for some. Candidates who obtain concordant titres after two or three titrations are advised not to carry out any more.

In the calculations that followed, candidates generally attempted all the parts and provided clear working.

(b) This was the most successfully completed calculation with many candidates producing the correct concentration of hydrogen ions in **P** to the required three significant figures.

(c) There were relatively few candidates who realised that 0.125, the concentration of nitric acid, should be subtracted from the answer to **(b)**, the total concentration of hydrogen ions.

(d) Recognising that each sulfuric acid produces two hydrogen ions in aqueous solution and hence the concentration of the acid was half that of **(c)** proved problematic for many.

(e) It was rare to find the correct answer, 0.25. Many candidates tried to use data involving their titration results rather than use the information supplied in the question, i.e. 'The concentration of nitric acid in **P** is $0.125\,mol/dm^3$' and '**P** was made by mixing equal volumes of the two dilute acids'.

Question 2

Almost all candidates completed this question and generally followed the test instructions. Relatively few incorrect observations were recorded; incomplete or missing observations were common.

R was dilute sulfuric acid **S** was copper(II) carbonate

Test 1 It was unusual to find a candidate who did not report blue litmus turned red. Some candidates also claimed red litmus turned blue or tested the gas produced from **R** rather than the solution.

Test 2 A white precipitate in **(a)** that remained in **(b)** was commonly recorded.

Test 3 Bubbles seen on adding magnesium to **R** led many candidates to test the gas and conclude it was hydrogen. Several candidates believed a glowing splint would ignite hydrogen and produce a pop. The distinction between a lighted or burning splint (used to test for hydrogen) and a glowing splint (used to test for oxygen) needs to be understood. There were a few candidates who reported the correct gas test and result but did not name the gas.

Test 4 Most candidates reported that the solution or the filtrate was blue; many missed the bubbling. Those who noted the gas being produced did not always go on to identify it.

Test 5 The occasional candidate did not indicate that the precipitate was insoluble in excess of the alkali.

Test 6 Many correct responses were seen for test 6. Missing the colour of the final solution, which is a dark blue, or missing the precipitate, due to rapid addition of aqueous ammonia, were common errors.

Test 7 Most responses noted that **S** changed colour when heated; many did not heat it enough and reported the solid turned darker green or brown rather than black. Relatively few detected that carbon dioxide was evolved though some of those who had missed the gas in test 4 identified it here.

Test 8 Bubbling at some stage of the test was indicated by nearly all candidates and there were a good number who went on to test the gas correctly with a glowing splint and identify it as oxygen.

There was, however, confusion evident in the observations for this test. In **(a)**, there is little or no reaction when the solid from test 7 is added to the hydrogen peroxide. Some bubbling might be seen but it is unlikely that enough oxygen is produced to relight a glowing splint. While the added solid is insoluble, there is no precipitate formed. In **(b)**, the addition of aqueous ammonia to the mixture from **(a)** causes rapid decomposition of the hydrogen peroxide and, consequently, much effervescence of oxygen. Many believed the gas evolved to be ammonia. It is important that candidates recognise that aqueous ammonia smells of ammonia and, therefore, will always give a positive test for the gas.

Conclusions

Most candidates provided sufficient evidence to justify their identification of **R** as sulfuric acid. Many realised that **S** contained copper; there were only a minority who had detected carbon dioxide and could therefore identify copper(II) carbonate.

CHEMISTRY

Paper 5070/32
Practical Test

Key messages

The questions and calculations in quantitative exercises require a firm grasp of the task involved.

Candidates should aim to read the information provided in the question more carefully and thoughtfully, so they secure the necessary understanding.

In qualitative tests, candidates should be encouraged to be consistent in their performing of tests and reporting of observations. The terminology and method of reporting, given in the qualitative analysis notes on the last page of the examination paper, are a model for the successful recording of observations.

General comments

The overall standard was good and in general, candidates performed equally well in both questions.

Comments on specific questions

Question 1

(a) Nearly all candidates completed the results table correctly by recording readings to one or two decimal places, accurately subtracting them to determine the volumes of **P** used and then ticking two or more titration results that did not differ by more than 0.2 cm^3. Securing at least two titres within 0.2 cm^3 of the supervisor's value proved challenging for some. Candidates who obtain concordant titres after two or three titrations are advised not to carry out any more.

In the calculations that followed, candidates generally attempted all the parts and provided clear working.

(b) This was the most successfully completed calculation with many candidates producing the correct concentration of hydrogen ions in **P** to the required three significant figures.

(c) There were relatively few candidates who realised that 0.125, the concentration of nitric acid, should be subtracted from the answer to **(b)**, the total concentration of hydrogen ions.

(d) Recognising that each sulfuric acid produces two hydrogen ions in aqueous solution and hence the concentration of the acid was half that of **(c)** proved problematic for many.

(e) It was rare to find the correct answer, 0.25. Many candidates tried to use data involving their titration results rather than use the information supplied in the question, i.e. 'The concentration of nitric acid in **P** is 0.125 mol / dm^3' and '**P** was made by mixing equal volumes of the two dilute acids'.

Question 2

Almost all candidates completed this question and generally followed the test instructions. Relatively few incorrect observations were recorded; incomplete or missing observations were common.

R was dilute sulfuric acid **S** was copper(II) carbonate

Test 1 It was unusual to find a candidate who did not report blue litmus turned red. Some candidates also claimed red litmus turned blue or tested the gas produced from **R** rather than the solution.

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Test 3 Bubbles seen on adding magnesium to **R** led many candidates to test the gas and conclude it was hydrogen. Several candidates believed a glowing splint would ignite hydrogen and produce a pop. The distinction between a lighted or burning splint (used to test for hydrogen) and a glowing splint (used to test for oxygen) needs to be understood. There were a few candidates who reported the correct gas test and result but did not name the gas.

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Test 5 The occasional candidate did not indicate that the precipitate was insoluble in excess of the alkali.

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Test 8 Bubbling at some stage of the test was indicated by nearly all candidates and there were a good number who went on to test the gas correctly with a glowing splint and identify it as oxygen.

There was, however, confusion evident in the observations for this test. In **(a)**, there is little or no reaction when the solid from test 7 is added to the hydrogen peroxide. Some bubbling might be seen but it is unlikely that enough oxygen is produced to relight a glowing splint. While the added solid is insoluble, there is no precipitate formed. In **(b)**, the addition of aqueous ammonia to the mixture from **(a)** causes rapid decomposition of the hydrogen peroxide and, consequently, much effervescence of oxygen. Many believed the gas evolved to be ammonia. It is important that candidates recognise that aqueous ammonia smells of ammonia and, therefore, will always give a positive test for the gas.

Conclusions

Most candidates provided sufficient evidence to justify their identification of **R** as sulfuric acid. Many realised that **S** contained copper; there were only a minority who had detected carbon dioxide and could therefore identify copper(II) carbonate.

CHEMISTRY

Paper 5070/41
Alternative to Practical

Key messages

Questions that require a candidate to plan an experiment contain detailed information that is designed to help the candidate include all the relevant information needed. Candidates are advised to read this information carefully.

Candidates need to be able to select suitable equipment for specific practical tasks. They should also understand why one piece of equipment is more suitable for a task than another. For example, they should understand that a pipette generally gives a more accurate value for volume than a measuring cylinder.

General comments

The alternative to the practical paper is designed to test candidates' knowledge and understanding of the skills required in practical work. This includes the ability to make observations and take measurements.

Observations may include:

- colour changes (requiring initial and final colours)
- effervescence (in the case of gas production)
- solids dissolving or disappearing
- precipitates forming (with their colours)
- heat changes
- smells and colours of gases.

Where a candidate is asked to record observations, credit is not usually given for conclusions if the observation is not also given.

Comments on specific questions

Question 1

(a) Candidates were usually able to identify a burette and a conical flask. The volumetric flask shown has a clear mark on the neck indicating that it is not a round bottom flask.

(b) (i) Most candidates were able to take readings from the diagrams of the burette. Care needs to be taken to ensure that the scale is read from the top downwards. For example, some candidates recorded 1.4 rather than 0.6 for the initial burette reading.

(ii) Candidates were generally able to make the correct subtractions.

(iii) Candidates usually calculated a correct average value. It is important that candidates also know which values to tick in order to indicate the values they have used in calculating the average.

(iv) The question required the candidate to suggest an improvement and to explain why it makes the result more accurate. There are a range of allowable answers (as an alternative to selecting a pipette instead of a measuring cylinder and explaining why a pipette is more accurate by reference to a lower apparatus error or greater precision) which candidates could have given, including:

- washing the burette with solution to prevent dilution
- rinsing the measuring cylinder to ensure all the acid is transferred
- using a white tile to ensure a clear end-point.

Few candidates were able to come up with a suitable suggestion for improvement. Many of those who did, simply stated that it would make it more accurate, as given in the question.

No credit was given for repeating the experiment as it had already been done four times.

(c) (i) and **(ii)**
Some candidates who answered parts **(i)** and **(ii)** correctly found parts **(iii)** and **(iv)** a little more challenging.

(iii) $25\,cm^3$ had been taken from a total volume of $250\,cm^3$ so candidates needed to multiply their answer from part **(ii)** by ten.

(iv) The volume of $5\,cm^3$ needed to be converted to $0.005\,dm^3$ before it was used in the calculation.

Question 2

(a) The question clearly asks candidates to describe the observation and to include the identity of the gas, the test for it and the result of the test. Some answers were incomplete.

When a gas is produced the observation is effervescence or bubbling.

(b) Most candidates identify the sulfate ion. Some thought the test was for a chloride.

(c) Candidates needed to record the colour of the initial precipitate, the fact that it dissolved in excess aqueous ammonia and the colour of the solution. Candidates needed to indicate that the colour of the solution was darker than the precipitate.

Question 3

(a) Many candidates correctly identified the fact that if ink is used, it can dissolve and separate into its different colours.

(b) Most candidates drew a line below the spot.

(c) The term, *locating agent*, was generally well known. Some candidates described the role of a locating agent if they did not know the term or named a suitable locating agent such as ninhydrin. Knowledge of the name of a specific locating agent was not essential.

(d) Many were not able to deduce that hydrolysis broke the molecule down into smaller soluble units (amino acids).

(e) Candidates often found it difficult to express their answers to this question even though they had some idea of what was happening. The simple idea that two of the amino acids in the molecule were the same was not often stated. A variety of alternative valid explanations were accepted.

(f) (i) Most candidates showed a good understanding of an R_f value. Some candidates referred to the distance to the top of the paper rather than the distance to the solvent front. A few candidates reversed the division by putting the distance to the solvent front over the distance to the centre of the spot.

(ii) When calculating an R_f value it is important that the measurement is taken from the initial line to the centre of the spot. Some candidates measured to the top or the bottom of the spot.

Question 4

(a) This question required candidates to describe observations. These could include the formation of a pink/brown solid, the change in colour of the solution, the piece of zinc becoming smaller and the possibility of effervescence. No credit was available for conclusions drawn from the data.

(b) (i) Most candidates were able to work out the correct order of reactivity.

(ii) The question asks candidates to refer to the results in their answer. Totally theoretical answers in relation to the reactivity series did not gain credit. Candidates could refer to specific reactions or the number of reactions shown by each metal. Many candidates explained the position of magnesium and copper. Candidates also needed to explain how zinc and tin were placed in order.

(c) This question required candidates to plan an experiment. Detailed bullet points were provided in the question and full marks could only be obtained when candidates had addressed all of these bullet points. Candidates need to make sure that they read the question carefully.

Candidates needed to refer to initial and final temperatures being measured rather than stating that a temperature change is measured. Temperature change is calculated from the initial and final temperatures and is not an actual observation.

A number of candidates were confused between the rate of the reaction and the amount of heat produced in an exothermic reaction when explaining how the order of reactivity is deduced. The order is determined by the amount of heat produced.

Question 5

(a) (i) Most candidates knew that this method depends on the fact that oxygen is only very slightly soluble in water. A statement that it is insoluble was also acceptable. A general statement that the method depends on solubility was not sufficient.

Some candidates referred to density instead of, or as well as, insolubility.

(ii) Most candidates correctly suggested a gas syringe. Use of a burette was also acceptable.

(iii) Most candidates knew the test for oxygen. Some candidates were confused between the test for oxygen and for hydrogen.

(b) (i) Most candidates could plot the points correctly.

(ii) Most candidates could identify the anomaly correctly.

(iii) Many candidates found it difficult to draw a smooth curve. When drawing a smooth curve, points should not be joined by a series of straight lines. Some candidates incorrectly draw the curve through the anomalous point.

(iv) It is important that candidates read the question carefully. A number of candidates omitted a second curve even when they had written about it.

Most candidates drew a steeper line and correctly related this to the fact that the reaction is faster at a higher temperature.

Many candidates thought that more gas was produced and drew the line levelling off at double the volume of oxygen.

When candidates did draw the line at the correct height, few of them went on to relate this to the fact that the same amount of hydrogen peroxide had been used.

Question 6

As in **Question 4(c)** candidates needed to refer to all aspects mentioned in the question, in order access full marks. In particular, they needed to ensure that the products were pure.

(a) Most candidates knew that the process involved filtration.

Few candidates heated or stirred the mixture to ensure that all the salt dissolved.

Few candidates referred to ensuring that the sand was pure by washing the residue with water after filtering to remove any solution of the sodium chloride adhering to the sand.

Most candidates knew to evaporate or crystallise the sodium chloride solution.

(b) Many candidates realised that fractional distillation was required to separate the liquids.

Many candidates knew that distillation involves condensation.

Despite the flammability of the liquids, few candidates chose to use indirect heating rather than a Bunsen burner.

Some candidates referred to the fact that the first liquid to be collected has the lower boiling point and that the second liquid remains in the flask or can be collected in a separate flask by heating to the higher boiling point.

CHEMISTRY

Paper 5070/42
Alternative to Practical

Key messages

- Candidates were asked to give names of ions and salts in various questions on this paper. Many candidates chose to give formulae instead of, or as well, as names. These candidates were not obeying the rubric of the question. Some candidates disadvantaged themselves by giving correct names but incorrect formulae.
- Names such as exothermic (as opposed to endothermic) and ammonium (as opposed to ammonia) must be written clearly so there is no doubt which word the candidate has written.
- 'Parallax error' was frequently given as an incorrect reason for experimental inaccuracies. Candidates should familiarise themselves with other types of experimental error.

General comments

If questions ask for observations, answers should refer to some, or all, of the following:
colour changes (requiring initial and final colours)
effervescence
solids dissolving or disappearing
precipitates forming (with their colours)
heat changes
smells and colours of gases.

If questions ask for observations it is unnecessary to refer to:
names of products
theoretical explanations
details of types of reactions.

Comments on specific questions

Question 1

(a) This was answered perfectly by the majority of candidates.

(b) Heat loss to the surroundings was not very commonly stated. Despite the question stating 'other than candidate error', candidate error was often mentioned. Parallax error was an example of candidate error that was frequently mentioned as well as incorrect positioning of the thermometer. There was no suggestion in the question that the hexane and/or octane could have been impure, although several candidates suggested this.

(c) (i) Most candidates chose octane as the answer. A statement of the temperature increase being larger when octane was used was less common.

(ii) Some candidates did not write sufficiently clearly to distinguish between the correct response 'exothermic' and the incorrect response 'endothermic'.

Question 2

(a) (i) Pipette was well known, but often spelt incorrectly.

(ii) Pipette was often seen as the answer, as was biurette or biuret, instead of burette.

(b) (i) Burettes are calibrated to read to the nearest 0.1 cm^3, which means the volume of **R** used in titration 3 should have been calculated as 15.0 cm^3 as opposed to 15 cm^3.

(ii) The explanation required a comparison. Candidates often answered by saying their chosen values were the ones that were close together. However, candidates should have made it clear that their chosen values were closer together than the other value of 15.6 cm^3, or that the difference between the two chosen values was the smallest. This can be expressed best by saying that two concordant values were chosen. A small but significant number of candidates suggested that the smallest values should be chosen.

(iii) The average volume of **R** used was usually correctly calculated from the values selected in **(ii)**.

(c) This was answered extremely well. There were no common errors and the value was usually correctly given to three significant figures.

(d) This was answered extremely well. There were no common errors and the value was usually correctly given to three significant figures.

(e) This was answered quite well. The value was usually given to three significant figures.

(f) (i) The lemon juice was diluted by making 10 cm^3 up to 100 cm^3 by dilution with water, so the original lemon juice was ten times more concentrated than the dilute solution. Therefore, the answer to **(f)(i)** should have been achieved by multiplying the answer to **(e)** by ten.

Some candidates calculated that the original lemon juice was less concentrated than the diluted lemon juice.

Common incorrect answers to **(f)(i)** were 0.0755 (0.000755 ÷ 0.01) and 0.1208 (0.0302 × 4).

(ii) The most likely source of error was using a measuring cylinder rather than a more accurate piece of apparatus such as a burette or a pipette. Parallax error was commonly given as the most likely source of error.

Question 3

There were some excellent diagrams to assist with candidates' description of their experimental method as well as some excellent descriptions.

Candidates were required to include the collection of carbon dioxide gas in their method; it was a common error to allow the gas to escape and measure the loss in mass.

Many candidates referred to measuring the amount of carbon dioxide or simply measuring the carbon dioxide. Candidates were told that the carbon dioxide had to be collected, it was therefore expected that measuring the volume of carbon dioxide would be mentioned.

Measurement of time is an essential part of any experimental work to determine rate of reaction.

Many candidates referred to plotting a graph of volume of carbon dioxide against time. Fewer described how to use their graphs to determine rate of reaction.

A conical flask is the most appropriate apparatus in which to carry out the reaction rather than a beaker or test tube.

Question 4

(a) It was very common for candidates to attempt a description of filtration of a mixture of solids. Only a small number of candidates described the addition of water for the purposes of dissolving **L**.

(b) Formulae were often seen instead of, or as well as, names. Ammonia or ammoniam were seen regularly instead of ammonium. NH_3^+ was also commonly seen. Nitrate was a common alternative to ammonium.

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

(ii) Formulae were often seen instead of, or as well as, names. A wide variety of names and formulae was seen.

(d) If candidates described the formation of a white precipitate, it is insufficient to say that the precipitate is insoluble. All precipitates are insoluble by definition. The precipitate dissolves ***in excess*** was required for the third mark.

Question 5

(a) (i) A large majority of candidates correctly plotted all the points and drew a smooth curve of best fit. The point at 0,0 was the one least likely to be plotted. Some curves went through all the points except the origin. Some 'curves' went through the anomalous point.

(ii) The majority of candidates identified the anomalous point.

(iii) This was not answered particularly well. '15' was commonly given as the answer.

(b) This was answered extremely well.

(c) This was answered extremely well.

(d) This was answered quite well. There were no common errors, although a small number of candidates gave a range of values rather than one value.

Question 6

(a) Candidates found this question challenging.

The completion of the table requires observations as opposed to names of substances (unless names of gases are specifically asked for in the question) and types of reactions. 'A gas is given off' is not an observation as is impossible to see a colourless gas – the observations that can be made are effervescence, bubbles or fizzing. The disappearance of **Z** when added to hydrochloric acid was the answer that scored least marks.

'The solution changes colour from purple to colourless' is preferable to 'it is purple to colourless', which could mean that the colour of the solution is somewhere in between purple and colourless.

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

(ii) This was answered well. The preferred test for hydrogen is that a burning splint 'pops' or a lighted splint 'pops'. Glowing splints were occasionally mentioned.

Question 7

(a) A number of suggestions made were not potassium compounds.

(b) Many candidates did not attempt this question. Those that did often extended the curve to 0,0.

(c) This was answered very well. '80.5' and '88' were occasionally seen as well as correct answers.

(d) (i) This was answered very well.

(ii) This was answered quite well. Some candidates disadvantaged themselves by not showing how they achieved their final answer, which meant that no error carried forward could be applied if this value was incorrect.

Question 8

(a) Many candidates knew that the loose-fitting lid allowed carbon dioxide to escape. Some suggested that the purpose was to ***prevent*** the escape of carbon dioxide. To prevent loss of solid was very rarely given as an answer.

(b) '2.5' was commonly seen, but '0.9' was seen less often.

(c) Some candidates gave the impression that heat has mass and therefore loss of mass was due to heat loss. Many answers to this question were badly expressed.

(d) This was answered extremely well.

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

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