CHEMISTRY

Paper 5070/11
Multiple Choice

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

General Comments

A small number of questions were found to be particularly challenging by the candidates. Rationale for these is given below. Candidates are advised to read each question and all the options carefully to avoid some of the difficulties highlighted.

Comments on Specific Questions

Question 8

The correct answer to the question was the only formula containing six hydrogen atoms, six being the number of hydrogen atoms that two molecules of ammonia would provide.

Question 13

Aqueous copper(II)sulfate was the choice of many of the candidates despite the question stating that a gas was produced at each of the electrodes`.

Question 18

The hydroxide ion does combine with hydrogen ions but not with hydrogen, thus option **A** is incorrect.

Question 22

The strongest distractor in this question was **B**, Group III. Atoms in Group III lose three electrons when they form ions and atoms in Group V gain three electrons when they form ions. Thus X in the ion X^{3-} was a member of Group V.

Question 29

Calcium oxide is a basic oxide, silica is an acidic oxide, and the reaction is an acid-base reaction.

Question 34

Carbon dioxide is responsible for global warming and not carbon monoxide. Thus option **A** was incorrect.

Question 35

The structures of two compounds were given and were very different. Therefore alternative **D**, structural formula, was incorrect. The two compounds each had the molecular formula C_4H_{10} and therefore the same composition by mass.

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Paper 5070/12
Multiple Choice

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

General Comments

A small number of questions were found to be particularly challenging by the candidates. Rationale for these is given below. Candidates are advised to read each question and all the options carefully to avoid some of the difficulties highlighted.

Comments on Individual Questions

Question 8

The most common error made in this question was to think of both ions in the compound as being positive, leading to option **A**. One ion must be negative and so either X or Y must be in Group V, i.e. a 3- ion. The stoichiometry determines that Y is the Group V element, and X is therefore in Group **II**.

Question 11

There was some difficulty with regard to the colour change taking place in the manganate(VII) solution, with the most popular distractor involving a colour change from colourless to pink rather than the reverse.

Question 13

The question caused some difficulty. Some candidates were unable to work out the volume of hydrochloric acid required to neutralise the sodium hydroxide. Others omitted to add the volume of acid to the volume of alkali to find the total volume.

Question 14

Many candidates used the reactants in the first reaction and and the products of the last, concluding that two moles of NO could produce four moles of nitric acid. They did not take into account that the first equation produces two moles of NO_2 while the second reaction uses four moles of NO_2, therefore the first reaction must be doubled before concluding the ratio of nitric acid to NO.

Question 29

Candidates were confident about deciding whether molten iodine conducts, but less certain of its state at room temperature. The melting points of the halogens increase from fluorine to iodine. Fluorine is a gas and iodine is a solid at room temperature.

Question 35

The polymer poly(ethene) is made from ethene which is one of the products of the cracking of naphtha. Thus naphtha is the raw material required.

Question 39

The oxidation of an alcohol involves the loss of hydrogen and the gain of oxygen with the number carbon atoms remaining unchanged. Thus the acid containing four carbon atoms, **B**, was the answer to the question.

CHEMISTRY

Paper 5070/21
Theory

Key Message

Candidates may improve their performance by giving more precise and better organised answers. The use of bullet points may help with extended answers, and candidates are advised to show their working for quantitative questions.

Candidates are advised to learn key definitions carefully and thoroughly.

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. All the questions from ***section B*** were popular.

Candidates found the short answer questions less challenging than those which required extended answers. Good answers to the longer questions used the correct chemical terms but many candidates gave imprecise and vague extended answers. Candidates may have gained more credit by using bullet points rather than using sentences and paragraphs.

Candidates also found some questions that involved the recall of key definitions very difficult e.g. definition of relative atomic mass. Candidates were able to construct balanced symbol equations but had much more difficulty when these involved charge.

Candidates often did not organise their answers to quantitative questions which made it difficult to award marks for errors carried forward. Candidates should be advised to show all the steps in a calculation so that Examiners can easily credit the working out.

Comments on specific questions

Section A

Question A1

This question was about elements.

(a) Candidates found this question very challenging and often gave definitions more closely linked to an atom rather than an element. Good answers referred to a substance containing only one type of atom or a substance that could not be broken down chemically into simpler substances. A common misconception was to refer to a substance with just one atom rather than one type of atom.

(b) (i) Many candidates were able to deduce that the element was gallium although a common error was aluminium.

(ii) Candidates often recognised argon as the element with eight electrons in its outer shell. Some candidates were confused between a total of eight electrons and eight electrons in the outer shell and as a result oxygen was a common incorrect answer.

(iii) Many candidates recognised that bromine was a liquid at room temperature.

(iv) Although many candidates recognised hydrogen, significant numbers gave other elements such as oxygen.

(v) Many candidates deduced that the ionic chloride was magnesium chloride but sodium chloride was a common error.

(vi) Candidates often chose argon as the element used in light bulbs but helium, nitrogen and aluminium were common incorrect answers.

(c) Candidates often wrote the electronic structure of aluminium and also drew the structure. A common error was to draw the electronic structure of an aluminium ion, including the charge on the ion.

Question A2

This question focused on the corrosion of iron.

(a) The conditions for the corrosion of iron were well known with many candidates giving oxygen and water. Full credit was also given to candidates who gave answers such as moist air.

(b) Good answers referred to the greater reactivity of magnesium and that as a result magnesium would corrode instead of the hull. The use of the term sacrificial protection was not sufficient on its own to gain credit, candidates needed to explain what this term meant. Common misconceptions included the formation of a protective layer of magnesium oxide or that magnesium was unreactive and would not corrode.

(c) Many candidates appreciated that an alloy contained at least one metal but many implied that it was a compound and did not use the term mixture in their answer.

(d) Candidates often referred to acidity and alkalinity rather than the pH values. Candidates needed to clearly state that as the pH decreased the rate of corrosion increased. Most candidates did not refer to the pH range where the rate of corrosion did not change and as a result only got partial credit for this question.

Question A3

This question focused on the homologous series of alcohols.

(a) (i) Candidates were able to deduce the formula as $C_6H_{13}OH$ and only a very small number of candidates gave the molecular formula $C_6H_{14}O$ instead.

(ii) Candidates were often not able to use the pattern of the boiling points to get the expected boiling point value of 157 to 160 ^{o}C.

(b) Good answers gave a balanced equation in addition to the conditions needed, however many candidates did not mention that ethene was needed and just referred to the hydration of an alkene. The use of phosphoric acid as a catalyst for the hydration of ethene was well known.

(c) (i) The most popular correct oxidising agent given was potassium dichromate. Candidates should be advised to ensure that they give the correct oxidation states when naming chemicals. As an example, credit was not given for potassium manganate(V) because it should have been potassium manganate(VII). Many incorrect answers were seen including water and sulfuric acid.

(ii) Most candidates drew structures showing all the atoms and all the bonds however the structure for propanoic acid was not well known with propanol and butanoic acid being common incorrect answers.

Question A4

This question focused on chemicals dissolved in water and water pollution.

(a) Candidates often gave dissolved gases rather than solids. Nitrogen, carbon dioxide and oxygen were common correct answers however hydrogen was not given credit in the mark scheme. Candidates that gave the names of specific salts often gave insoluble salts rather than soluble ones.

(b) (i) Most candidates gave names of ions as requested in the question. Common correct answers included potassium, phosphate, ammonium and nitrate ions. A common misconception was to refer to nitrogen ions.

(ii) Only the most able candidates could give a coherent description of eutrophication. Many candidates did not mention an algal bloom or that the bloom stops sunlight reaching plants beneath the surface. Common misconceptions included the fertiliser or the algae providing a barrier to oxygen entering the water or that the algal bloom used up the oxygen in the water.

Question A5

Candidates found this question on fuel cells very challenging.

(a) Even though most of the reactants and products were given candidates still found this question difficult. Candidates often included sodium atoms or ions in the equation or could not balance the charge.

(b) (i) Candidates could not explain the direction of flow of electrons. Candidates did not refer to their answer in **(a)** which involved the formation of electrons to help them in their answer.

(ii) Most candidates gave the ionic equation for neutralisation using hydrogen ions rather than hydrogen molecules in their equations. Candidates did not appreciate the need to use electrons to balance the charge in the equation.

(c) (i) Candidates often gave very vague answers rather than giving specific advantages of a fuel cell, for example mentioning less pollution rather than referring to water as the only product from the fuel cell. The idea that fuel cells are more energy efficient was not well known by candidates

(ii) Cost was often given as the disadvantage of a fuel cell rather than focusing on the difficulties of storing hydrogen.

Question A6

This question focused on the manufacture of sulfuric acid.

(a) Candidates could construct the correct equation but often gave the wrong state symbol for sulfur or did not include state symbols at all.

(b) (i) Most candidates gave the name of the catalyst but it is important that candidates give the exact name e.g. vanadium(V) oxide or vanadium pentoxide rather than just vanadium oxide.

(ii) Candidates did not often use le Chatelier's principle to explain that the position of equilibrium moves to the right as pressure increases because there are less moles of gas on the right hand side. Candidates often focused on rate rather than equilibrium or gave explanations based on exothermic reactions.

(iii) Candidates did not appreciate that the position of equilibrium was already on the right hand side and often mentioned that this was the best pressure to use or that it was to ensure that the equilibrium was established.

(iv) Candidates did not often refer to rate and position of equilibrium in their answers. Good answers explained that if the temperature was higher the position of equilibrium moved to the right since the reaction was exothermic. The answers went on to explain that if the temperature was lower the reaction was too slow.

(c) Candidates often constructed the correct equation but the use of $H_4S_2O_8$ or the formation of hydrogen was quite common.

(d) Good candidates organised their answers and gave the correct answer of 0.147 mol/dm^3. Candidates need to show their working clearly to allow credit to be given for error carried forward. A good approach to use would be to calculate moles of sodium hydroxide, deduce the moles of sulfuric acid using the mole ratio followed by calculation of the concentration. The most common error took place in the use of the molar ratio. Some candidates used 1:1 and others 2:1 (acid: alkali).

Section B

Question B7

This question focused on the chemistry of tin.

(a) Candidates often drew diagrams that included delocalised electrons but did not show the close packing nature of the positive ions. A common misconception was to refer to protons or atoms in a sea of delocalised electrons.

(b) Candidates were more likely to explain why metals conduct electricity than to explain malleability. The idea of moving electrons was well known but the ability of layers of positive ions to slide easily was not well known.

(c) (i) Candidates often identified the missing product and were able to construct the equation but many candidates wrote an arrow rather than the reversible symbol and so were not given credit in the mark scheme.

(ii) The meaning of amphoteric was well known.

(d) (i) Candidates found constructing the equation for the reaction between tin and nitric acid much more demanding than other equations in this examination paper.

(ii) Most candidates tried to give answers that involves a reduction with aluminium to get ammonia. Only a small number of candidates used the ‘brown-ring test’. A common misconception was to confuse ammonium with aluminium. Other candidates did not mention the need to warm the reaction mixture or to add aqueous sodium hydroxide.

Question B8

This question focused on the processing of petroleum by fractional distillation and cracking.

(a) Candidates found this question challenging and rarely gained full credit for this question. Although the use of boiling point was well known, the idea of a temperature gradient within the fractionating column was not.

(b) (i) The term *homologous series* was well understood but a common error was to refer to a group of elements rather than compounds. The idea of similar chemical properties as well as having a general formula was well known.

(ii) Most candidates drew structures showing all the atoms and bonds rather than condensed structures involving the use of CH_3 for example. A common error was to draw the same structure twice.

(c) Candidates gave balanced equations involving both fractions and integers. The products of complete combustion were well known even if candidates made slip ups with the balancing of the equation.

(d) (i) Good answers referred to the demand for petrol or alkenes but candidates need to be careful not to just repeat the information in the stem of the question.

(ii) The chemical test for alkenes was well known. Only a small number of candidates used potassium manganate(VII) instead of bromine.

Question B9

This focused on the chemistry of magnesium.

(a) Candidates often gave a definition for the mass number rather than the relative atomic mass. Even answers that referred to carbon-12 did not clearly indicate that it was the mass of one atom and often candidates referred to the mass of an element.

(b) Credit was only given for the working out. Good answers were exemplified by a logical calculation. This calculation involved calculating amount in moles of hydrogen from the volume and then use of the mass to work out the molar mass.

(c) (i) The most common misconceptions were to calculate 75% of 12 or to work out what 100% would be if 75% was 12. Good answers calculated the mass with 100% to be 20 kg and only then applied the 75% percentage yield to get 15 kg.

(ii) Candidates did not often deduce the correct formula for magnesium nitride and often gave formulae involving oxysalts rather than using the nitride ion.

(d) (i) Many candidates could construct the correct equation.

(ii) Candidates had very little difficulty with the 'dot-and-cross' diagram for silane abut sometimes labelled it as methane.

(iii) Many candidates could construct the correct equation.

Question B10

This question was about Group II carbonates.

(a) Candidates did not clearly describe the use of limestone in the blast furnace. The equation for the decomposition of calcium carbonate was often correct but candidates had much more difficulty in writing the equation for the reaction between silicon dioxide and calcium oxide. Candidates often gave an overall equation involving the reaction of calcium carbonate with silicon dioxide to make calcium silicate and carbon dioxide. Many candidates did not recall that slag was calcium silicate.

(b) (i) Candidates often recognised that barium carbonate was the most thermally stable.

(ii) Good answers clearly linked greater reactivity of the metal with greater thermal stability.

(c) (i) The use of either a gas syringe or displacement of water into a measuring cylinder was well known but many of the diagrams had set ups that would not work. The set-ups were either not gas tight or they would push water/acid, rather than air, into a gas syringe.

(ii) Many candidates thought this question was about rate of reaction and they gave answers based upon collision theory rather than kinetic theory. The relationship between gas volume with pressure and with temperature was not well known.

CHEMISTRY

Paper 5070/22

Theory

Key Messages

- Candidates could improve their performance by giving more precise and better organised answers and paying attention to detail. More care is needed when reading questions in order to interpret what is exactly being asked.
- Calculations were generally done well, though some candidates need to ensure that they know the difference between amount in moles and concentration in moles per decimetre cubed. Candidates are advised to show their working clearly for quantitative questions.
- The basic knowledge of simple inorganic chemistry was good though more practice is required in writing formulae of simple inorganic compounds and in writing ionic equations.
- Some candidates need more practice at answering questions about practical aspects of chemistry, for example, salt preparation, measurement of reaction rates and electroplating.

General comments

The standard of written work was generally good and many candidates tackled this paper well in both ***sections A*** and ***B***. However, while some candidates gave answers of the appropriate length to questions involving free response, others wrote only one or two sentences where 3 or 4 separate points were required for an answer. Some candidates disadvantaged themselves by writing answers that were not sufficiently specific or by repeating themselves in questions requiring a specific number of answers. This was especially apparent in questions on reaction rate, **A3(a)**, and structure, **B7(a)**. Some answers to extended questions were written in a confused manner or with the points in an incorrect sequence, for example **Questions A3(a)(i)** and **(ii)** and **B8(c)(ii)**.

The instructions given in questions were not always followed correctly. For example in **Question B9(c)(i)** many candidates did not heed the instruction to draw all atoms and bonds. In **Question A3(a)(iii)** many wrote about ways to increase the rate reaction rather than how to monitor the reaction. In **Question A5(d)** many candidates did not appreciate that the physical properties had to be those of all metals and so often listed properties more suitable to transition elements alone. In **Question B6(b)** some candidates just wrote the letters down without giving a reason as requested in the question.

The majority of candidates attempted most parts of each question. The main exceptions were **A4(c)(i)** (completing the formula of ethyl ethanoate), **B6(d)(ii)** (calculation), part **(c)(ii)** of **Question B8** (salt formation) and parts **(c)** and **(d)** of **Question B9** (ionic equations and formulae).

Aspects of inorganic chemistry were often well answered. The writing of balanced equations was not always successful, a major obstacle for some candidates being to work out the formula of simple species such as chlorine, ammonia and the ammonium ion. Many candidates did not know how to write ionic equations. Most candidates' knowledge of structure and properties in terms of atoms, ions and electrons was fairly good. Many candidates were able to explain the lack of electrical conduction in silicon dioxide and many could write electronic structures of ions (Na_2O) and molecules (water).

Practical aspects of chemistry e.g. **Questions A3(a)(iii)** (following the course of a reaction) and **B8(c)(ii)** (preparation of a salt) posed challenges for many candidates. Candidates fared better in the question about nickel electroplating, **A5(c)**, where they had to draw a labelled diagram of the apparatus.

Many candidates performed well in questions involving calculations. Many showed appropriate working and clear indications about what each number referred to. Others did not always draw the distinction between amount of substance in moles and the concentration of a substance in moles per decimetre cubed. This was especially apparent in **Question B6(d)(ii)** where many omitted the first stage in the calculation, that of calculating amount in moles from the relevant concentration obtained from part **(i)**. In order to gain as many marks as possible, candidates should make it clear why they are performing certain steps of calculations and organise their answers logically so that it is possible to award marks for working out even if an error has been made (error carried forward).

Comments on specific questions

Section A

Question A1

This question was reasonably well answered well answered, many candidates scoring over half marks. The definition of the term compound was not well known. Most candidates could draw the correct dot-and-cross diagram for water. Few gave multiple answers to the questions in part **(b)**. Many candidates appeared not to read parts **(b)(iii)** and **(b)(iv)** carefully enough and mistook products for reagents or vice versa.

(a) Some candidates gave a good definition of a compound involving both bonding and different atoms. Others disadvantaged themselves by using the word 'mixture'. The majority of answers referred to elements rather than atoms or molecules. Many definitions tended not to use chemical terms. For example many focused on two or more elements being joined rather than using the word 'bonded'.

(b) (i) Many candidates appeared to misread the question and gave an answer relating to a reactant involved in fermentation and not the product. Glucose or sucrose was commonly seen as an incorrect answer. Many candidates also suggested water, perhaps by confusing the process with aerobic respiration.

(ii) Many candidates recognised that zinc oxide is amphoteric. Common errors were to suggest calcium carbonate, sodium oxide or, less commonly, water.

(iii) The majority of candidates recognised that calcium carbonate reacts with hydrochloric acid to turn limewater milky. Most of the others did not read question carefully and suggested carbon dioxide, the product, rather than the reactant.

(iv) Many candidates did not read the question carefully enough and gave calcium carbonate as an answer instead of carbon dioxide.

(v) The majority of candidates recognised that methane is formed by the decay of organic matter. Common errors were to suggest other organic molecules such as propane, glucose or sucrose.

(vi) Most candidates recognised that carbon monoxide was a product of the incomplete combustion of a hydrocarbon. The commonest errors were to suggest carbon dioxide or methane.

(c) Most candidates drew a suitable dot-and-cross diagram for the structure of water. Only a small proportion gave ionic dot and cross diagrams. A small number drew the structure as HO_2 rather than H_2O or put extra electrons around the hydrogen atoms.

Question A2

Many candidates scored reasonably well in this question. Parts **(a)(i)**, **(a)(ii)** and **(b)(iii)** were best done. Other candidates need more practice at identifying the correct formulae for species used in writing balanced equations. In part **(b)(i)**, few candidates scored the second mark because the answers were not sufficiently specific. In part **(b)(ii)**, many candidates were penalised because they did not use the correct scientific term, 'density'.

(a) (i) Over half the candidates deduced the correct order of reactivity. A few missed out one metal or included and extra metal not in question. The commonest errors were to place iron and lead in the incorrect positions and to write the list in reverse.

(ii) Many candidates were successful in writing an equation for the reaction between iron oxide and zinc. The commonest error was to balance the iron atoms by writing Fe_2 rather than 2Fe. A small proportion of candidates wrote the equation as a multiple, which was given credit. Others did not balance the equation at all.

(b) (i) The presence of oxide layer was well known but most candidates gave answers that were too vague to score second mark. Very few mentioned that the oxide layer is firmly fixed to the surface of the aluminium. A greater number indicated that the oxide layer is unreactive. Most did not gain this mark because they wrote statements such as 'the layer makes the aluminium unreactive' instead of 'the oxide layer is unreactive'. The former could not be awarded because it just repeats the information already in the stem of the question.

(ii) Most candidates did not refer to the correct scientific term, 'density' and so did not obtain the mark. Most focused on aluminium being 'light' or on iron being 'heavy'. A common error was to suggest that aluminium is not corrosive or is strong. Many muddled the properties of aluminium with the properties of iron.

(iii) Many candidates appreciated that the number of protons was 13 but a large variety of neutron numbers was given other than correct value of 14.

Question A3

This question proved to be the most difficult on the paper with many candidates scoring only just over one third of the marks available. Explanations as to why the speed of reaction changes with concentration and temperature did not always include the necessary scientific ideas. Parts **(a)(iii)** and **(b)(i)** were left unanswered by a significant minority of candidates. Few could suggest a suitable alternative method for measuring the speed of the reaction in part **(a)(iii)**, while in part **(b)(i)** many did not appear to know how to construct an ionic equation. Most candidates scored one or two marks for the enthalpy profile diagram in part **(b)(ii)**. Few scored all three marks.

(a) (i) A significant number of candidates did not describe how the speed of reaction changes. Many referred to particles in their answers but a large minority did not. Many candidates did not gain the second mark because they did not refer to collision frequency. Common errors were **(i)** to suggest that the particles move faster **(ii)** there are more effective collisions **(iii)** not mentioning particles of any kind. The best answers referred to more molecules per unit volume leading to more frequent collisions. Many just suggested 'there are more collisions' instead of 'more frequent collisions'.

(ii) Some candidates made a similar error to part **(i)** by not always linking the increase of speed of reaction with the temperature increase. A significant proportion of the candidates did not mention particles in this question and just referred to an increase in kinetic energy. Many referred, incorrectly, to collision frequency rather than to more successful or more effective collisions. Very few candidates referred to activation energy in their answers.

(iii) Many candidates misinterpreted the question and gave ways to increase the rate of reaction rather than how to monitor the reaction. The most common correct answer was to write about a change in bromine concentration. Many referred, incorrectly, to measuring the volume of gas given off. Others repeated the method already given by measuring the decrease in the mass of the iron. A considerable number of candidates suggested the addition of a catalyst or increasing the surface area of the iron.

(b) (i) Few candidates were able to write balanced half equations for the reaction between iron and bromine. Many wrote a type of molecular equation instead. Common errors were: lack of balance in terms of charge; writing the equations the wrong way round; not balancing with electrons; writing the bromide ion as Br^{2-}; writing 2Fe on the left but only Fe^{2+} on the right. Candidates were more likely to get a mark for the oxidation half-equation rather than the reduction half-equation.

(ii) This was the best answered part of **Question A3**, though candidates rarely got all 3 marks. This was usually because the arrow for the enthalpy change was either double-headed or pointing the wrong way. A small number of candidates drew diagrams for an endothermic rather than an exothermic reaction. Other common errors were: drawing the activation energy for the back reaction; muddling the enthalpy change with the activation energy; writing the enthalpy change in words near the top of the diagram rather than drawing an arrow.

Question A4

Many candidates scored well on the calculation in part **(b)(iii)**. Part **(c)(i)** was not attempted by a considerable number of candidates.

(a) Many candidates scored at least one mark but fewer obtained all 3. Some good answers were seen especially by those who gave the equation for photosynthesis with chlorophyll or sunlight over the arrow. Water often omitted. A common error was to confuse the process of respiration with that of photosynthesis, many suggesting that glucose was a reactant and carbon dioxide a product.

(b) (i) Under half the candidates named calcium ethanoate as the salt. 'Calcium carbonate' was the commonest error. A significant minority suggested 'water'.

(ii) Just under half the candidates mentioned boiling point. A considerable number suggested melting point as well and so did not gain the mark. Other common errors were suggesting density or temperature without any qualification.

(iii) In general, the calculation was well set out and well organised showing relevant working. Common errors were: the use of masses and not the mole ratios to work out the empirical formula; dividing relative atomic mass by percentage; simplifying the formula to CH_2O.

(c) (i) A significant number of candidates did not complete the partly-written formula. Others gave answers that corresponded to acids, ketones or hydroxyketones. Almost all drew all atoms and bonds.

(ii) Over half the candidates gave general uses of esters consistent with the syllabus e.g. solvent, flavourings and so gained the mark. Others gave rather specific uses which referred to particular articles. Many of these were too vague to allow a mark to be awarded, for example: plastics, clothes, washing powders.

Question A5

Many candidates gave good answers to parts **(b)** and **(c)**. Fewer were able to extract the information from the stem of the question to answer parts **(a)(ii)** and **(a)(iii)**. The electrolysis diagram in part **(c)** was not attempted by some candidates.

(a) (i) Many candidates did not recognise the term volatile or did not refer to evaporation at all. The main errors were to suggest that volatile means 'reactive' or 'it is a liquid or gas'.

(ii) About one third of the candidates suggested that nickel carbonyl can be decomposed by heating. Common errors included 'electrolysis' or 'adding carbon monoxide'.

(iii) Most candidates did not use the information in the stem of the question. Candidates were most likely to gain a mark if they focused on the carbon monoxide. Ideas of filtration or evaporation of the solid impurities were commonest errors.

(b) This calculation was generally well answered. A range of answers was seen, the commonest incorrect answer being '2'. Another common incorrect answer was '3'. Some fractional answers were also seen.

(c) Most candidates obtained at least 1 or 2 marks, generally for the electrodes dipping into liquid and the electrolyte. Candidates who appreciated that the electrodes were pure nickel and impure nickel usually correctly identified which was anode and which was cathode. Common errors included: the suggestion that the electrodes were copper or carbon; stating that one of the electrodes is nickel and the other is an electrodes which is either inert or made of another metal. Common misconceptions regarding the electrolyte were that it was nickel solution or nickel carbonyl, or the word 'electrolyte' was given without further qualification.

(d) Many candidates obtained 2 or 3 marks. Others did not appreciate that the physical properties had to be those of all metals and so often listed properties more suitable to transition elements alone. As a result, many candidates referred to metals being strong with high boiling points rather than focusing on general metallic properties such as malleability, ductility and conduction.

Section B

Question B6

The relative reactivity of iodine and bromine were well known and many candidates were able to interpret the information from the table in part **(b)**. The explanation of oxidation and reduction in part **(a)** was not always accompanied by reference to the equation. Some candidates set out the calculation in part **(d)(ii)** in a logical way. Others did not use their answer to part **(i)** for the calculation, used gas volumes or muddled amount in moles with concentration. A considerable number did not attempt the calculation.

(a) (i) Some candidates gave a good explanation of oxidation and reduction by referring electron transfer to the correct species. Others did not link comments to oxidation or reduction. Others just mentioned electrons gained and lost without stating which species were involved. Although correct answers normally referred to electron transfer, a significant number of candidates referred to oxidation states. Many did not gain a mark because electron transfer referred to bromine rather than the bromide ion.

(ii) Most candidates appreciated that universal indicator had to be used but did not explain that the colour obtained should be matched against a colour chart. A significant number of candidates gained the mark for reference to the use of a pH meter.

(iii) The relative reactivity of iodine and bromine was well known. Common errors included: comparison with sodium bromide; comparison with chlorine; reference to the position of the two elements in the group rather than to reactivity.

(b) This question was generally well done. Many candidates identified C and D but not all gave a reason for this choice as instructed in the stem of the question.

(c) Nearly half the candidates were able to balance the equation from the information given. Others often made simple errors in writing the formulae. For example, chlorine was often written Cl and sodium chloride sometimes written $NaCl_2$. Incorrect products were also written by many candidates, the commonest of these being hydrogen.

(d) (i) About a quarter of the candidates calculated the concentration of sodium thiosulfate correctly. The commonest incorrect answers were 12.4 or 0.124 mol/dm^3 for thiosulfate concentration. Some multiplied by 24 whilst others made errors in the calculation of the relative molecular mass of the hydrated sodium thiosulfate, the $5H_2O$ posing a particular problem.

(ii) Many candidates did not show their working out in logical manner. Some did not use the correct molar ratio or confused amount in moles with concentration. Many did not calculate the first step and started by assuming that the concentration of thiosulfate calculated in part **(i)** was the number of moles of thiosulfate. Others did not use the results from part **(i)** at all.

Question B7

This question proved to be the most popular of the part **B** questions, over 90% of the candidates choosing it. The answers requiring comparison of the structures of diamond and silicon dioxide in part **(a)** were not always well thought out, incorrect comparisons often being made. Many candidates could draw good dot and cross diagrams of the ionic structure of sodium oxide and explain diffusion of the ions in glass.

(a) (i) Candidates often referred to the number of atoms bonded to other atoms but did not appreciate the difference in structure of silicon dioxide and diamond in this respect. For example, the answer 'all the atoms are bonded to four others in silicon dioxide and diamond' is not correct because the oxygen atoms in silicon dioxide are only bonded to two others. Many referred to diamond as having oxygen atoms and silicon dioxide having carbon atoms. The idea of a tetrahedral arrangement was the point most often scored. Some candidates referred to properties instead of structure. Typical examples are 'they have a high boiling point' and 'they both conduct electricity'. In respect of the last statement, it seems that some candidates muddle the structure of diamond with that of graphite. Fewer candidates gained the mark for referring to giant structure than for the mark referring to arrangement of atoms relative to each other.

(ii) This was less well done than part **(i)**. Candidates often referred to strong bonds but were less likely to refer to giant structure or many bonds. A considerable number disadvantaged themselves by writing that there were 'strong intermolecular forces' or 'strong forces between the molecules'.

(iii) Many candidates gave good explanations by referring to the lack of free or mobile electrons. A few suggested, incorrectly, that the atoms did not move or that the electrons did move. A few wrote vague statements such as 'because it is not a metal'.

(b) (i) Most candidates correctly referred to the movement of particles from high to low concentration. Some did not refer to particles and so did not get mark.

(ii) About half the candidates gained the mark by referring to differences in density of mass. A considerable number of candidates referred to different relative molecular mass rather than atomic mass. This was not given credit because neither of the particles is a molecule. Correct terms should be used. Another common error was to refer to relative reactivity rather than to mass or density.

(c) Many candidates drew good dot-and-cross diagrams for the sodium and oxide ions. Only a small proportion of candidates drew the electrons being involved twice i.e. an arrow showing transfer of electrons from sodium to oxygen but showing the electrons in both species. The formula for Na_2O was well known and candidates tended to get this wrong only if their dot-and-cross diagram was incorrect. Other common errors were **(i)** showing a sodium ions as Na^- **(ii)** showing an oxide ions as O^- **(iii)** drawing a covalent structure instead of an ionic one **(iv)** showing the sodium ion with a single electron in its outer shell.

Question B8

Many candidates were successful in calculating the percentage of nitrogen by mass in ammonium nitrate. Fewer could explain succinctly why fertilisers are added to the soil or why they should be soluble in water. Explanations of how crystals of ammonium sulfate can be prepared lacked detail, especially of the titration procedure. Parts **(c)(ii)** and **(d)** were not attempted by a considerable minority of candidates.

(a) Many candidates gave vague answers such as 'increasing the fertility of the soil' or 'for healthy growth' rather than writing about an improvement in growth or yield. A small number of candidates confused fertilisers with insecticides.

(b) Many candidates appreciated that the fertilisers have to be soluble to pass through into the plant. Others gave answers which were not sufficiently specific such as 'fertilisers move through the soil'.

(c) (i) This question was well done by the majority of candidates and relevant working was shown. Many of the candidates were able to calculate the correct formula mass of ammonium nitrate. Others did not use all the available nitrogen to work out the percentage and so got the answer 17.5% rather than 35%. Many calculated the percentage of nitrogen in ammonium sulfate rather than in ammonium nitrate. Others added the atomic masses incorrectly.

(ii) A minority of candidates gave good answers to this question giving full descriptions of a titration with, then without, the indicator. The other candidates did not appear to know how to make ammonium sulfate from ammonia. Titration was seldom mentioned and sulfur was a common incorrect reagent added to ammonia. Many candidates just focused on the crystallisation part. Candidates often evaporated to dryness or implied that the ammonium sulfate was a precipitate.

(d) This was generally well answered. Candidates gave the correct answer in variety of ways e.g. PO_4^{3-} or just -3. Others gave incorrect answers such as 2- and 3+.

Question B9

This was the least popular of the part **B** questions. Many candidates did not attempt parts **(c)** and **(d)**. Parts **(a)** and **(b)** were generally well done. Many candidates were not sure how to construct ionic equations but many could write the correct formula for a polymer from a given monomer.

(a) (i) Fewer than half the candidates realised that sulfur dioxide is a good bleaching agent for wood pulp. The commonest errors were to suggest fluorine, sulfuric acid or bromine. A large number of candidates repeated the stem of the question and chose chlorine.

(ii) Most candidates gave the correct use for chlorine in the water purification process. The commonest error was the rather vague 'cleaning water'. Many wrote detail relating to other stages in the water purification process which was not relevant. Other common errors included reference to making the insoluble material soluble.

(b) (i) Many candidates drew the polymer structure accurately either as a number of repeating units or as the basic structure in brackets and an 'n'. Very few candidates included a double bond in their structure. Common errors included: omission of the extension bonds at the end of each section of the polymer; missing 'n' in the condensed structure; missing off of one of more hydrogen atoms; closing the chain at one end or both with a hydrogen or chlorine atom.

(ii) The test for unsaturation was well known. A few used potassium permanganate as a reagent, which was acceptable. Common errors included: use of litmus; use of sodium hydroxide; colour change from colourless to brown with an alkene.

(c) (i) Only the highest scoring candidates could write the formula for the ethanoate ion correctly. Many did not follow the instructions to draw all atoms and bonds and drew condensed structures such as CH_3COO^-. Many did not show a charge or drew the molecule of ethanoic acid. A few candidates drew the charge twice, once on the correct oxygen and once again outside square brackets which had been added.

(ii) This was better done than part **(i)**. Those who used the equation $H^+ + OH^- \rightarrow H_2O$ scored the mark, whereas most of those who tried to write fuller versions did not. Many candidates wrote molecular rather than ionic equations.

(d) (i) Many candidates realised that ammonia gas is released into the atmosphere. Others did not appreciate that ammonia given off and suggested nitrogen gas. A minority thought that the ammonia was neutralising the soil.

(ii) Many candidates wrote molecular rather than ionic equation. Others did not know the formulae for the ions involved. Equations often included oxides of nitrogen or ammonium hydroxide. Other errors were: NH_4 without charge; NH^+ instead of NH_4^+ as a reactant; H_2 as a product; N_2 as a product.

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Paper 5070/31
Practical Test

Key Message

Candidates are encouraged to persist through to the end of calculations, showing clear working. It is important that candidates realise that even if an answer to one part is wrong, credit can still be gained in subsequent parts providing the chemistry is correct.

General comments

A good number of candidates demonstrated capable practical skills in carrying out the titration and recorded and processed the data appropriately. However, candidates were generally less successful in dealing with the demands of the qualitative tests and, consequently, scored fewer marks in **Question 2** than in **Question 1**. Supervisors are thanked for providing the required experimental data to enable assessment of their candidates' work.

Comments on specific questions

Question 1

(a) Candidates obtained full marks for their titration results by recording initial and final burette readings to 1 or 2 d.p., obtaining at least two titres within 0.2 cm^3 of the Supervisor's value and then correctly averaging two or more ticked results that did not differ by more than 0.2 cm^3.

While there were a considerable number who scored full or nearly full marks, there were some whose titres were considerably different from the Supervisor's value. Nevertheless, many of the candidates obtained and selected concordant titres, which they correctly averaged. Once concordant titres have been obtained there is no benefit in repeating the titration further – time spent producing extra data would be better spent on the rest of the paper.

Candidates generally found the questions that followed difficult to deal with. It is important that candidates realise that even if an answer to one part is wrong, credit can still be gained in subsequent questions providing the chemistry is correct.

(b) This was the most successfully completed calculation. There were some who obtained partial credit because they precisely assembled the information in a mathematical equation but could not evaluate the answer correctly. Answers were required to three significant figures and there were a number of examples of over approximation.

(c) Many candidates did not appreciate the acid in **P** was that remaining after the reaction with the metal oxide and, as a result, few subtracted their answer in **(b)** from 0.2. Some were distracted by the mass of the metal oxide provided and felt that it must be used in this part. Others missed the word calculate and simply wrote the answer to **(b)** again.

(d) Despite the previous problem, more candidates scored a mark in this calculation than in **(c)** or **(e)** by using the equation provided and dividing the number of moles of acid from **(c)** by 2.

(e) There were a number who divided the mass of metal oxide by the answer from **(d)** but, unfortunately, not all of these subtracted 16 from the answer.

Question 2

All the points noted in the mark scheme were awarded in the assessment of the examination scripts with some candidates addressing more than enough marking points to gain full credit. While marks were frequently lost for incomplete, rather than incorrect, answers, there were also examples of poor use of terminology and contradictory observations. It is important that instructions are carefully followed and terms such as precipitate and solution are used precisely. Teachers should continue to encourage candidates to make full use of the Qualitative Analysis Notes supplied on the last page of the exam paper. These notes are a model for the successful recording of observations.

Test 1 ‘Sublimes’ or a description of the process of sublimation was expected but rarely seen.

Test 2 Many candidates reported that ammonia was produced because litmus turned blue. However, some provided the correct test but did not name the gas. There were also a number of candidates who mistakenly recorded effervescence.

Test 3 While many noted the formation of a white precipitate or solid on addition of aqueous silver nitrate, there were a significant number who did not score a mark because the description was flawed e.g. milky, white or cloudy solution.

Test 4 In general candidates who reported a precipitate in **Test 3** found that it remained when the acid was added.

Test 5 There was more variation in the descriptions arising from the addition of aqueous ammonia to the precipitate from **Test 3**. While a good number noted the solid disappeared, not all of these pointed out that the final solution was colourless. Contradictory observations, such as ‘the precipitate dissolves and white solid remains’, were presumably the product of not mixing the solutions.

Test 6 A green solid was formed as a result of adding aqueous sodium hydroxide. While most reported this, a lot fewer stated the precipitate was insoluble in excess and hardly any that the precipitate turned brown (at the surface) on standing.

Test 7 The addition of aqueous hydrogen peroxide caused solution **S** to turn yellow and when aqueous sodium hydroxide was added to the mixture, there was effervescence and a red brown precipitate formed, which was insoluble in excess of the alkali. While the descriptions were at times unclear, many recorded the solid and the bubbling. Some tested for the gas, reporting it relit a glowing splint, but fewer than carried out the identification of ammonia in **Test 2**. Once again, not everyone who recorded the correct test named the gas as oxygen.

Test 8 Most candidates provided a description, which indicated that there was a white precipitate formed in **(a)** and the solid remained when acid was added in **(b)**.

Test 9 Many reported that the purple colour was lost when **S** was added but there were a number who used the word clear when they meant colourless.

<u>**Conclusions**</u>

Providing there was some indication of ammonia gas in **Test 2** and that the white precipitate in **Test 3** remained in dilute nitric acid, NH_4^+ and Cl^- each scored a mark when identifying **R**. Nevertheless, despite the correct observations, there were alternatives suggested – most commonly NO_3^- and Zn^{2+}.

In the case of **S**, success in **Test 8** led many to conclude SO_4^{2-}, but there were a significant number who chose Fe^{3+} rather than Fe^{2+} and a few who gave the formulae of both iron ions and ignored the sulfate ion.

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Paper 5070/32

Practical Test

Key message

In order to score high marks in the qualitative analysis, candidates must take care over the execution of the more demanding tests and ensure that they provided all the observations required. Marks for conclusions cannot be given unless the supporting evidence is present. Candidates should use the terminology and method of expression found in the Qualitative Analysis notes as a model for writing observations.

General comments

Most of the candidates demonstrated capable practical skills in carrying out the titration and recorded and processed the data appropriately. However, they found the calculations which followed challenging. In general the qualitative test instructions were followed but the observations made were incomplete rather than incorrect. Supervisors are thanked for providing the required experimental data to enable assessment of their candidates' work.

Comments on specific questions

Question 1

(a) Candidates obtained full marks for their results by recording initial and final burette readings to 1 or 2 d.p., obtaining at least two titres within 0.2 cm^3 of the Supervisor's value and then correctly averaging two or more ticked results that did not differ by more than 0.2 cm^3.

While the Table of Results was usually completed correctly, there were a few candidates who needlessly lost marks - causes included not ticking at least two of their 'best' results, determining the average of all the titres obtained not just those ticked, using integer values throughout for volume readings and recording 50.0 for the initial reading in the table.

Despite the problems candidates faced with the calculations that followed, it was good to find a good number persisted and attempted all the parts. Credit was obtained, providing the working demonstrated correct use of the chemistry involved.

(b) This was the most successful of the calculations undertaken. A number of candidates lost one of the marks because they over approximated the final answer – the concentration value should be given to 3 significant figures. Other mistakes varied from the careless e.g. using 0.8 rather than 0.08, to those where the volumes or the mole ratios were inverted.

(c) It was evident that most candidates did not realise the acid titrated in **P** was that remaining after reaction with the metal carbonate. There were very few who subtracted their answer for **(b)** from 0.1. Many missed the word 'calculate' in the instruction and simply wrote down the answer to **(b)** again.

(d) The equation provided showed that equal numbers of moles of acid and carbonate react together and so the answer to **(d)** was the same as that to **(c)**. More candidates scored this mark than that in **(c)**.

(e) As long as the answer or the working indicated that 5.04 was divided by the answer from **(d)** and then 60 was subtracted from it, credit was given. There were some who determined the relative formula mass of the metal carbonate but then either stopped or divided its value by 60.

Question 2

Many of the candidates followed the test instructions, but those who scored highly executed the more demanding tests more carefully and ensured that they provided all the observations required.

Candidates should use the terminology and method of expression found in the Qualitative Analysis notes, as a model for writing observations.

R was ammonium aluminium sulfate solution which had been further acidified with a little sulfuric acid

Test 1 Virtually all the candidates reported a white precipitate with the aqueous sodium hydroxide and most correctly noticed that it dissolved in excess. Fewer, however, described the resulting solution as colourless.

Test 2 The observations in this test were identical to those from **Test 1** but in order to secure them the acid has to be added carefully and with thorough mixing. There were numerous candidates who reported no change. For those whose precipitate in **Test 1** had not dissolved, there was the opportunity to score two marks here providing they noted the disappearance of the solid to form a colourless solution.

Test 3 On warming the mixture from **Test 1**, there were a lot who initially reported no reaction but then went on to correctly test and identify ammonia as the gas evolved. Many claimed the mixture effervesced, although it only boils, and there were some who identified other gases, such as carbon dioxide, as being produced.

Test 4 Although many noted the white precipitate on addition of aqueous ammonia to **R**, fewer commented on its insolubility in excess.

Test 5 Most reported that **R** turned litmus red (or pink) but orange and peach were not uncommon and precipitates sometimes accompanied the colour.

Tests 6 & 7 Bubbling was recorded in both of these tests by most candidates. While the carbon dioxide in **Test 6** was generally correctly tested for and identified, the testing of hydrogen was not so secure. The Qualitative Analysis notes state 'pops with a lighted splint'. Popping gas, gas pops, pops with a splint, pops with a *glowing* splint are not acceptable descriptions for the identification of hydrogen.

Test 8 Virtually all candidates obtained a white precipitate on addition of aqueous barium chloride but surprisingly, given the correct descriptions in earlier tests, there were a number who reported the formation of a cloudy/milky liquid or a white solution. Despite this, most made it clear that the precipitate did not dissolve in acid.

Conclusions

SO_4^{2-} was the most commonly identified ion followed by NH_4^+ and Al^{3+}. There were candidates who suggested one or both of the latter ions but did not provide the evidence required, e.g. simply stating ammonia gas was produced in **Test 3** is insufficient and to identify Al^{3+}, there must be a white solid formed in **Tests 1** and **4**, which is soluble in aqueous alkali but does not dissolve in aqueous ammonia. Despite there being plenty of evidence available, H^+ was rarely suggested. While CO_3^{2-} was the most frequently seen wrong answer, a whole variety of others were offered including NO_3^- and Fe^{3+}.

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Paper 5070/33

Practical Test

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(d) The equation provided showed that equal numbers of moles of acid and carbonate react together and so the answer to **(d)** was the same as that to **(c)**. More candidates scored this mark than that in **(c)**.

(e) As long as the answer or the working indicated that 5.04 was divided by the answer from **(d)** and then 60 was subtracted from it, credit was given. There were some who determined the relative formula mass of the metal carbonate but then either stopped or divided its value by 60.

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Many of the candidates followed the test instructions, but those who scored highly executed the more demanding tests more carefully and ensured that they provided all the observations required.

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Conclusions

SO_4^{2-} was the most commonly identified ion followed by NH_4^+ and Al^{3+}. There were candidates who suggested one or both of the latter ions but did not provide the evidence required, e.g. simply stating ammonia gas was produced in **Test 3** is insufficient and to identify Al^{3+}, there must be a white solid formed in **Tests 1** and **4**, which is soluble in aqueous alkali but does not dissolve in aqueous ammonia. Despite there being plenty of evidence available, H^+ was rarely suggested. While CO_3^{2-} was the most frequently seen wrong answer, a whole variety of others were offered including NO_3^- and Fe^{3+}.

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Paper 5070/41
Alternative to Practical

Key Messages

Questions involving the drawing of a graph:
When candidates are asked to draw a curve through a set of points, the curve should be extended, where appropriate, to pass through zero. It should be noted that this is only required when the curve, on extension, would naturally pass though zero.

Questions involving one or more calculations:
In answering calculations candidates should always show all of their working. When the number of marks allocated to a calculation is greater than one, one or more of the marks will be for the working. If no working is shown and the answer is incorrect then all the allocated marks for that calculation are lost. If the working is shown, marks can be awarded for the correct parts of the working.

General comments

The Alternative to Practical Chemistry paper is designed to test the candidates' knowledge and experience of practical chemistry.

Skills including 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 drawing curves as instructed.

Calculations are generally completed successfully using the appropriate significant figures, but candidates should be encouraged to show all their working.

Comments on specific questions

Question 1

The question concerns the use of items of laboratory apparatus and was well answered.

Question 2

The question is about the chemistry of magnesium.

(a) (i) and **(ii)** The colour alone was insufficient to score the mark.

(b) (i) Most candidates correctly identified the gas as hydrogen.

(ii) Some candidates confused the test for hydrogen, using a lighted splint, with that for oxygen when a glowing splint is used.

(iii) Many candidates produced an equation with an incorrect formula of $MgCl$ for magnesium chloride.

(c) (i) Magnesium is converted into magnesium oxide by *burning* or *heating* in oxygen or air. *Reacting* with oxygen/air was insufficient.

(ii) The equation was well known.

Question 3

(a) The chemical test for water is to use anhydrous copper(II) sulfate (colour change white to blue) or anhydrous cobalt(II) chloride or cobalt chloride paper (colour change blue to pink). These colour changes were sometimes confused.

(b) The test for pure water is to measure the boiling point which is 100 ºC. A common error was to measure the pH.

Question 4

(a) The test for carbon dioxide was well known.

(b) When the reaction has stopped, effervescence or fizzing will stop. If this mark had not been awarded in **(i)**, it could be scored in **(ii)**.

(c) Most candidates answered correctly.

(d) The number of moles was generally correctly calculated.

(e) (i) Errors in **(d)** are carried forward and if working is shown, partial credit can be gained by correctly calculating the relative molecular mass or by multiplying an incorrect relative molecular mass by the number of moles.

(ii) A common error was to multiply the number of moles by 24.

Questions 5

In this reaction copper(II) sulfate is reduced to copper and zinc is oxidised.

Question 6

Reaction 4 uses a higher volume of hydrochloric acid. This indicates that some alkali was already in the flask.

Question 7

A more reactive halogen displaces a less reactive halogen from its salt. The halogens become less reactive down the group.

Question 8

The water level will not change if the gas is insoluble in water. The only insoluble gas is nitrogen.

Question 9

(a) Most candidates gave the correct colour change from pink to colourless.

(b) As usual, when errors occur in reading the burette diagrams or subtracting the volumes, the mean must be taken from the closest two titres. A common error is to use all three titres in calculating the mean.

(c) The number of moles was generally correctly calculated. A minority of candidates calculated the number of moles in the average volume of **R**.

(d) – (g) As usual, errors are carried forward so that candidates are given credit for correct chemistry even if an error has been made in an earlier part. Partial credit can be given in parts with more than one mark, provided the working is shown.

(h) (i) A common error was ethanol.

(ii) When oxidation states are given, they must be correct.

Question 10

This question involves the analysis of zinc iodide. The reactions were generally well known. Candidates must be careful to talk about the ions in the compound rather than the compound itself.

The correct formula for **T** was usually given.

Question 11

(a) – (c) Most candidates scored well although a minority did not extend the lines to zero when drawing the graph. Marks in **(c)** are given for the candidate reading their own graph correctly. The concentration is deduced by comparing the volume of gas produced in the two experiments at any time. If final volumes are compared the concentration is 0.15 mol/dm^3 as 50% more hydrogen is produced in experiment 2.

(d) Many candidates scored the first mark by recognising that the curve would have a greater slope as powdered marble increases the rate of reaction but only a minority scored the second mark for showing that the final volume would be the same as in experiment 1.

CHEMISTRY

Paper 5070/42
Alternative to Practical

Key Messages

Questions involving the drawing of a graph:
When candidates are asked to draw a curve through a set of points, the curve should be extended, where appropriate, to pass through zero. It should be noted that this is only required when the curve, on extension, would naturally pass though zero.

Questions involving one or more calculations:
In answering calculations candidates should always show all of their working. When the number of marks allocated to a calculation is greater than one, one or more of the marks will be for the working. If no working is shown and the answer is incorrect then all the allocated marks for that calculation are lost. If the working is shown, marks can be awarded for the correct parts of the working.

General Comments

The Alternative to Practical Chemistry paper is designed to test the candidates' knowledge and experience of practical chemistry.

Skills including 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 drawing curves as instructed.

Calculations are generally completed successfully using the appropriate significant figures, but candidates should be encouraged to show all their working.

More care should be taken in the spelling of chemicals, apparatus and techniques.

Comments on specific questions

Question 1

(a) The volume of aqueous silver nitrate in the measuring cylinder is 25 cm^3. Several candidates misread the volume as 20.5 cm^3. Although losing this mark, parts **(d)**, **(e)**, and **(f)** of the question may be completed using 20.5 cm^3 and marks can be gained providing that the calculations are correct.

(b) Silver iodide is a yellow precipitate. This mark is lost for any ambiguous answer such as yellowish white or creamy yellow.

(c) The precipitate may be separated by filtration. Rarely seen but allowable alternatives include decantation and the use of a centrifuge.

Question 2

(a) Copper(II) oxide has the formula CuO and is black in colour. Most candidates gave the correct formula but several confused the colour with that of copper(I) oxide which is red.

(b) Most candidates were able to construct the correct equation for the reaction between copper(II) oxide and dilute sulfuric acid.

(c) The coloured compound is copper(II) sulfate which is blue.

Candidates who gave the formula rather than the name lost the mark.

It should be noted that when a name is asked for in a question the formula is not acceptable.

(d) Candidates are asked to give three of four possible observations when zinc is added to aqueous copper(II) sulfate.

- zinc dissolves or disappears (not reacts),
- the blue colour of the solution reduces, fades or is lost,
- a pink, red-brown, orange or copper deposit, powder, solid etc. (not red)
- a gas is evolved, fizzing or effervescence.

Any answer involving heat is not acceptable.

Most candidates answered this question well and obtained at least two marks out of the possible three.

(e) Several possibilities were available to candidates: silver, gold, platinum, mercury or even copper itself will not give a reaction with aqueous copper(II) sulfate.

Question 3

(a) In part **(i)** propanol may be used to prepare propanoic acid. Candidates should be advised to ensure, that in naming alcohols or any other organic compound, their handwriting is sufficiently clear to distinguish between, for example, propanal and propanol. In situations, where it is not clear, a mark is not awarded.

In part **(ii)** apparatus A is used to return any unreacted propanol to the flask for further reaction. Answers suggesting that it is used to change a vapour into a liquid, although correct, were not sufficient in answering this question.

(b) In part **(ii)** approximate answers such as ‘near to 140’ or ‘approaching 140’ or ‘just past 140’ were not acceptable.

In part **(iii)** any answer relating to the apparatus exploding, breaking, pressure build up, to explain why the receiver flask should remain open was awarded the mark.

Questions 4 to 7

Candidates, in general, gave correct responses to most of the questions.

Question 8

In part **(c)** **c**andidates are asked to read the burette diagrams and complete the table. If a candidate misreads any of the burette diagrams giving different titres, the mean value must reflect the two closest titres.

In part **(k)** the answer **(a)** 1.61 g should be divided by the answer **(j)** to obtain the relative molecular mass of G which is 132. Any error or approximation loses the individual mark but the answer may be used in subsequent calculations and, if correct, the appropriate marks are awarded.

The majority of candidates were able to read the burette diagrams correctly and complete most parts of the calculation. Any errors carried through the calculation may give different values of **x** and **y**, which if correctly deduced will gain marks.

Question 9

(a) A coloured solution suggests the presence of a transition metal or transition metal ions in the solution of compound **M**.

Candidates who suggested that **M** or 'it' is a transition metal were not given the mark.

(b) In part **(iii)** it is important to state that it is the gas evolved which turns litmus blue as the solution is alkaline and would also turn litmus blue.

(c) The presence of a sulfate is confirmed by the addition of either barium chloride or nitrate together with hydrochloric or nitric acid which giving a white precipitate. Several candidates lost the marks by acidifying the solution with sulfuric acid.

Question 10

(a) Most candidates were able to plot all the points accurately and to draw a smooth curve through the points. The point at pH 4.2, volume 28.0 cm^3 appeared to cause the most problem, a significant number of candidates plotting the point at 29.0 cm^3.

(b) (i) Most candidates gave a correct pH value when 15.0 cm^3 of acid had been added.

(ii) The only correct answer to this question is pH 7. Candidates who gave alternative answers lost the mark and also the mark for **(iii)**. Candidates who gave the correct answer could then read the volume of acid from their graph corresponding to pH 7.

(c) (i) The equation between sulfuric acid and sodium hydroxide gives a mole ratio of 1:2 which is used in calculating the concentration of sulfuric acid from **(b)(iii)**.

(ii) The correct answer based on a volume of acid of 27.5 cm^3 is 0.455 mol/dm^3, but marks are awarded according to the candidate correctly reading their own graph.

(d) Three marks are awarded for the method producing good quality crystals of sodium sulfate. Most candidates made good attempts at an acceptable answer, many gaining all three marks.