

# CHEMISTRY

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Paper 5070/01

Multiple Choice

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

## General comments

In general the questions discriminated well between the candidates with only **Question 33** proving an exception.

## Comments on Individual Questions

### Question 5

The incorrect answer, carbon dioxide, was very popular due to candidates failing to pay attention to the first piece of information given in the question.

**Question 7**

Essentially this question tested the realisation that the structures of diamond and graphite are different due to the carbon atoms in them having different numbers of covalent bonds. The carbon atoms in graphite each have only three covalent bonds attached and the fourth outer electron of each carbon atom is delocalised, allowing graphite to conduct electricity.

**Question 15**

The contents of the flask could not increase during the reaction and consequently alternative **B**, the second most popular answer, had to be incorrect.

After the reactants had been mixed together the mass of the flask and contents could only remain the same or decrease due to the loss of a gas and never increase because mass is never created during a reaction.

**Question 29**

This question proved to be difficult and relied upon two pieces of chemical knowledge being known and understood. First that copper(II) ions and silver ions have a different charge and secondly that the overall positive charge due to metallic ions in the solution would be unchanged.

**Question 33**

This question did not discriminate well between the candidates and the alternatives **A**, **B** and **C** were almost equally popular.

**Question 36**

The key to this question was the realisation that alternative **C** was the only compound that didn't contain the  $\text{COO}^-$  group.

**Question 37**

Approximately one quarter of the entry chose alternative **B** as their answer, ignoring the fact that the number of carbon atoms in ethanol and alternative **B** were different. In the oxidation of most organic compounds the compound undergoes a loss of hydrogen or a gain of oxygen or both and nothing else.

**Question 39**

Ethanoic acid has the molecular formula  $\text{C}_2\text{H}_4\text{O}_2$  and the empirical formula  $\text{CH}_2\text{O}$ . Candidates choosing alternative **D**,  $\text{C}_2\text{H}_4\text{O}_2$ , probably missed the word 'empirical' which was the most significant word in the stem of the question.

# CHEMISTRY

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Paper 5070/02

Theory

## General comments

Many candidates tackled the paper well and good answers were seen in many parts of the paper especially in **Questions A1, A3, A5 and A8**. In general, the rubric was well interpreted and most candidates attempted all parts of each question. Although some candidates who scored well on **Section A** failed to maintain this standard in **Section B**, many performed equally well in both parts of the paper. In **Section B** many candidates gave unnecessarily lengthy answers to some questions e.g. **Question B10(b)** and **B12(c)(i)**. Candidates should be reminded that although some of these questions involve free response, the examiners are only looking for a few essential points, and the number of these is specified by the number of marks. The standard of English was generally good and there were few instances of misused words. In **Section B** there did not appear to be any one question which was unpopular, although candidates tended to start at **Question B9** then proceed to **B10** or **B11** rather than doing them in random order. As has been commented on in previous Principal Examiner Reports, many candidates have a poor knowledge of colour changes specific to certain reactions e.g. **Question A2 (b)(c)**. The reactivity of the halogens and the colour changes involved seemed lost on all but the best candidates (**Question A6**), incorrect nomenclature e.g. writing iodide instead of iodine being a common error. Ideas about oxidation and reduction and reducing agents in terms of oxidation number changes and addition or removal of electrons were poorly known and many candidates contradicted themselves in questions involving these concepts. Many candidates' knowledge of ionic structure was poor and many could not explain the differences between covalent and ionic compounds. A considerable number of candidates had difficulty in writing quite simple symbol equations and writing formulae for specific organic compounds. The relationship between structure and properties remains a problem area for many candidates. This was exemplified in this paper by the poor marks obtained in **Questions B9(e)** and **B12(b)**. A considerable number of candidates confused ionic and covalent structures. There were only a few instances where candidates disadvantaged themselves by giving multiple answers. It was encouraging to note, that most candidates gained at least half the marks available for the calculations questions although **A8(c)** was a stumbling block for many. Candidates should be advised, however, not to round up in the middle of their calculations, only at the end – this resulted in some incorrect answers. Another general point that should be noted by candidates is that they should not write oxidation numbers above the symbols. This leads to ambiguity when examiners come to mark an equation. For example,  $\text{O}_2^{2-}$  clearly implies an oxygen molecule ion. Oxidation numbers should be written below the symbols/ formulae in such a way that it is clear that it is not part of that symbol/ formula.

## Comments on specific questions

### **Section A**

#### **Question A1**

This question was usually well answered with most candidates gaining at least three of the five marks available. Parts **(d)** and **(e)** were generally least well answered.

- (a)** This was generally correctly answered, although some suggested calcium or copper oxides.
- (b)** Most candidates chose correctly the answer carbon monoxide. There were very few incorrect answers.
- (c)** Most candidates realised that copper ions in solution are a blue colour.
- (d)** A good proportion of candidates gave the incorrect answer sulphur trioxide, perhaps through not reading the question carefully enough.

- (e) This was the least well-known, aluminium oxide often being suggested incorrectly as a addition to the blast furnace which forms a slag.

### Question A2

This question provided many candidates with their first challenges in the paper. Although many gained a single mark for the calculation, problems with addition abounded. Part (b) was often answered well but was very Centre dependent. Part (c) was poorly done by most candidates and the concept of oxidation numbers was not well-known at all.

- (a) Although many candidates gained both marks for the calculation (answer 21/ 21.2) many gained only a single mark through not realising that there were two moles of nitrogen atoms in a mole of ammonium sulphate. Some poor addition led to incorrect calculations for the formula mass of ammonium sulphate.
- (b) Many candidates knew the correct colours for the precipitates but some lost a mark through not mentioning the word precipitate. A considerable number of candidates mentioned the addition of excess sodium hydroxide, which is not necessary in this context. A minority of candidates put the colours the wrong way round.
- (c) (i) A considerable number of candidates confused this reaction with the colour change for another oxidising agent - potassium dichromate, with the result that a colour change from orange to green was seen almost as often as the correct purple to colourless. Some candidates put the colour change the wrong way round. A colour change of brown to green or green to brown was also seen, through the candidates focusing on the iron ions rather than the manganate(VII).
- (ii) Although candidates from specific Centres gave good answers to this question, many candidates were unclear about the concept of oxidation number and answered in terms of electrons or oxygen. Many candidates did not make it clear which species (the reducing agent or the substance being reduced) had a gain or loss in oxidation number.
- (d) (i) The calculation was generally well answered. Most candidates appear to be well-trained in this sort of calculation. A minority of candidates failed to use their calculator correctly and gave the incorrect number of zeros after the decimal point if they wrote it in non-standard form. (answer  $4.5 \times 10^{-4}$  mol)
- (ii) This part was less well done than part (i). Although many candidates realised that they should multiply the answer to part (i) by 5, a significant number failed to do this. Another common error was to use 58 as the atomic mass of iron rather than 56. (answer 0.126 g)

### Question A3

This question was less well answered than expected. Although the majority of candidates were able to calculate the number of protons and electrons in the calcium-40 ion, fewer were successful in calculating the number of electrons in the chloride-37 ion. A surprisingly large number of candidates seemed to add numbers for the neutrons to come up with e.g. 54 neutrons for the chloride-37 ion (obtained by adding 37 to the atomic number of 17). A number of 37 neutrons for the chloride-37 ion was not infrequently seen. The number of electrons for this ion was also often incorrectly put at 17, through not taking note of the negative charge.

### Question A4

Most candidates scored at least three of the four marks available, parts (a) and (d) usually causing the loss of the mark.

- (a) A not uncommon incorrect response was to put **F** in place of **B**. This presumably arose through a lack of appreciation that there will be more hydrogen atoms if there is no double bond or through just counting up the carbon atoms in a row.
- (b) Nearly all candidates correctly identified butanoic acid.

- (c) Most candidates could identify the chlorofluorocarbon as being responsible for ozone depletion. The commonest error was to suggest compound **C**, and this despite compound **D** also being a carboxylic acid.
- (d) This part of the question most frequently resulted in an error. Incorrect answers included (i) propene (through not counting the end carbon), (ii) butane and (iii) propanoic acid (even when the answer to **B** was correct).

### Question A5

Although many candidates scored fairly well on this question, few scored full marks in part (b) or knew the correct electrode products in the electrolysis of aqueous sodium chloride.

- (a) (i) Practically all candidates could give the correct formulae for sodium and chloride ions.
- (ii) Only about half the candidates were able to correctly identify the anode and cathode products from the electrolysis of aqueous sodium chloride. Although some were able to retrieve a single mark through putting two correct products at the incorrect electrodes, many thought that sodium was given off at the cathode. Most errors, however, arose from the mistaken notion that oxygen (from the water) would be given off at the anode. Those candidates who insisted on writing a formula for the reaction often disadvantaged themselves by writing the symbols for the atoms rather than the formula of the molecules. A significant minority of candidates wrote equations – these were not asked for and candidates should be advised to stick to exactly what is requested by the question.
- (b) Most candidates scored one or two of the marks available. Most obtained the mark for the correct apparatus but a minority of candidates failed to draw any liquid in the beaker. The second mark was often not scored because candidates did not label the electrodes in enough detail. The commonest reasons for the loss of this mark were (i) failure to imply that the cathode was made of copper, (ii) use of graphite electrodes, (iii) muddling up the anode and cathode. The third mark for the correct electrolyte was often not obtained because candidates failed to imply an (aqueous) solution. Some candidates even went as far as to suggest that copper sulphate liquid should be used or even 'copper solution'. Many candidates also chose sulphuric acid as their preferred electrolyte.
- (c) (i) Although most candidates selected bauxite as the ore of aluminium, a significant number named the compound in the ore (aluminium oxide) which was not acceptable. Alumina is, however, acceptable because the word is also used as a general term for bauxite type ores. A considerable number of candidates also suggested, incorrectly, that haematite was an ore of aluminium.
- (ii) Although about two-thirds of the candidates gave the answer carbon (or graphite) a wide variety of other answers were also seen. Incorrect responses included (i) aluminium, (ii) platinum, (iii) steel (from the steel casing so often labelled in diagrams). Non-conductors such as solid aluminium oxide and diamond and even oxygen were also seen.

### Question A6

Many candidates found this question the most challenging in **Section A**. Marks for parts (a), (b) and (d) were rarely scored. Candidates had particular difficulty in balancing equations involving the reaction of halogens and halides and there was a lot of confusion in terminology, iodine and iodide being used interchangeably.

- (a) A minority of candidates appreciated that a solution of iodine is brown in colour. Many assumed that iodine solid alone would be formed with the result that there were many answers stating merely 'black precipitate' without mentioning the colour of the solution (which tends to obscure the colour of the precipitate if there is one – if a high concentration of chlorine is present). Many candidates suggested that a purple vapour is formed, ignoring the fact that the reaction is taking place at room temperature. Many wrote the colour change the wrong way round, thinking that the iodide was coloured brown and that this decolourises. A significant number of candidates suggested, incorrectly, that there would be a 'white precipitate'.
- (b) Only a minority of candidates constructed the equation successfully. Common errors included (i)  $2Cl$  on the left (even if  $I_2$  was on the right) (ii) incorrect formula for the halides such as  $K_2Cl$  or  $KI_2$ .

- (c) Many candidates gained the mark for this question although a significant minority lost the mark through lack of accuracy in their descriptions. For example (i) 'iodine loses electrons' (rather than iodide), (ii) iodine ions (rather than iodide ions). Some candidates wrote the back reaction.
- (d)(i) About two thirds of the candidates gained the mark here. Those who failed to gain the mark did not make clear what species were being compared, compared the wrong species (stated potassium chloride) or suggested that astatine did (or did not) react due to the fact that it is radioactive.
- (ii) Few candidates were able to write the correct balanced equation. Common errors included (i) writing At instead of At<sub>2</sub>, (ii) writing the formula of sodium astatide as Na<sub>2</sub>At, (iii) writing ionic formulae for sodium and astatine, (iv) writing word equations in place of symbol equations (in O Level examinations, 'equation' always means symbol equation). A considerable number of candidates suggested that there was no reaction despite the fact that the stem states that an equation has to be written. This error may arise from the fact that the candidates are still thinking of the reaction of halides with halogens.

### Question A7

Few candidates gained full marks for this question although most were able to score over half the marks available. Parts (c) and (d) proved to be most challenging.

- (a) Most candidates knew the test for carbon dioxide and scored both marks. A number disadvantaged themselves by suggesting, incorrectly, that hydrogen is formed (or less commonly oxygen).
- (b) The equation was usually well constructed. The commonest errors were (i) to put oxygen as a product in place of carbon dioxide (even when the first part had been answered correctly), (ii) putting water as an additional product (probably thinking of the reaction of acids with carbonates), (iii) incorrect balancing (usually as  $2\text{CaCO}_3 \rightarrow 2\text{CaO} + \text{CO}_2$ ).
- (c) Just under 20 percent of the candidates were able to write the correct order of decomposition. More candidates, however, wrote the reverse order and were awarded one mark for suggesting that there was at least some relationship with the reactivity series. A significant number of candidates disregarded the fact that the order was muddled up and either just put down the order of the reactivity series without considering the letters, or put in elements which were not in the list, for example potassium and aluminium. The commonest response for an explanation of the order was the incorrect one that 'the higher the metal in the reactivity series, the quicker the carbonate decomposes'. A significant number of candidates, however, correctly related the rate of decomposition to the inverse of the reactivity series, even when they had placed the metals incorrectly in the table.
- (d) Fewer than half the candidates scored this mark, largely because they did not take into account that there were two species of gas on the right hand side of the equation. A common error was to just concentrate on the oxygen and use the relationship that 0.01 moles of calcium nitrate gives 0.005 moles of oxygen. The incorrect answer (0.02 moles) was often seen. (answer 0.025 moles)

### Question A8

Few candidates scored full marks for this question and all parts proved challenging. As has been commented upon above, some candidates had difficulty in writing the correct displayed formula of an organic compound.

- (a) Although many candidates wrote the correct displayed formula for ethanoic acid a significant minority drew the formula for propanoic acid, drew the formula for an alcohol, missed out the alcohol oxygen atom or put only a single bond in the C=O group. A number of candidates failed to obtain the mark because they wrote out the carboxylic acid group as CO<sub>2</sub>H or COOH.
- (b) This was poorly answered. Few candidates scored the mark for balancing. Common errors included (i) putting Cu<sup>2+</sup> on both sides of the equation, (ii) putting O<sup>2-</sup> as a reactant, (iii) failing to put one or other of the reactants or products in the equation (often hydrogen ions). Many candidates failed to balance the charges or left the copper on the left unbalanced.

- (c) Many candidates made an error in the calculation of the non-water part of the 'verdigris molecule'. A considerable number calculated this incorrectly as 480 and merely wrote the answer 72 without dividing by 18. (answer 5)

## Section B

### Question B9

Many candidates started with this question but few scored more than seven marks. The electronic structures of the sodium and oxide ions were often written incorrectly and few candidates recognised the difference between chemical and physical properties.

- (a) Most candidates scored two marks for this part. Many candidates suggested that magnesium only reacted with steam or that magnesium oxide was the product formed with water. Most candidates scored the mark for either suggesting that hydrogen is given off in both reactions or implying that sodium is more reactive than magnesium.
- (b) Although most candidates deduced the formula for sodium oxide correctly, only a few were able to draw the correct electronic structures for the sodium and oxide ions. Common errors included (i) lack of inner shells, (ii) lack of charges on the ions, (iii) maintaining an outer electron on the sodium, (iv) incomplete outer electron shell of oxygen. It was encouraging to note that very few candidates put the charges on the ions in the nucleus as has often happened in previous examinations.
- (c) Many candidates failed to write the correct formula for aluminium oxide and so could not gain the mark. Even when the formulae were correct, many candidates lost the mark by balancing the left with  $2Al$  rather than  $4Al$ .
- (d) Many candidates were able to state two physical properties of silicon dioxide, usually mentioning high melting or boiling points and (less common) lack of electrical conductivity.
- (e) Few candidates gained both marks here. Many did not seem to know the difference between chemical and physical properties. The most successful candidates were those who realised that the oxide was acidic. A common misconception was to suggest that the melting point of chlorine heptoxide was high, through lack of realisation that this would be a small molecule.

### Question B10

Candidates who had a good grasp of the enthalpy changes involved in bond making and breaking did well on this question, but many of the explanations to parts (b)(ii) and (c)(i) were unconvincing. The calculations were, on the whole, well done and provided lower scoring candidates with most of their marks for this question.

- (a) Most candidates correctly identified the activation energy but fewer were able to identify the enthalpy change, many just stating that **Z** was an energy change. A considerable minority of candidates wrote about bond breaking and bond making here, where it was not required. Some candidates disadvantaged themselves by not making clear which energy change they were writing about, **X** or **Z**.
- (b)(i) Many candidates tackled this in terms of bond breaking and bond making rather than simply referring to the diagram. The commonest correct answers referred to the energy level of the product being above that of the reactants.
- (ii) As in previous years, this type of question often seems to make the candidate write excessive amounts, going over the same ground time and time again. This often leads to candidates contradicting themselves. Many mixed up endothermic and exothermic in terms of bond breaking/making. A considerable number of candidates did not mention whether energy was being absorbed or released and just stated 'the energy involved in bond breaking....'. Some candidates referred to the number of bonds changing rather than bond energies.

- (c) (i) This part was not well answered, many candidates merely defining catalysis or simply writing everything they knew about catalysis. The best answers involved either lowering of activation energy or providing a surface for the molecules to come together to react.
- (ii) Most candidates were successful in completing this calculation, although many went about it in a very round-about way with many lines of working rather than taking a short route. Many worked out the answer in  $\text{cm}^3$  but a few failed to gain the mark because of an incorrect unit. (answer  $1.2 \text{ dm}^3$ )
- (iii) Fewer candidates were successful in this part of the calculation. Again a number of very complicated calculations were seen and although many of these resulted in the correct answer, a common mistake was to either not account for the moles of nitrogen(II) oxide or account for this but then divide by 2 in another step in the calculation. Taking rounding up into consideration, this resulted in the incorrect answer 42% being seen quite often. (answer = 83/ 83.3%)

### Question B11

Few candidates gained full marks for this question, parts (c)(iii) and (d) being particularly challenging. Many candidates gained all three marks for the calculation in part (c)(ii). Part (b) received a considerable number of incorrect answers. This was surprising for such a standard type of question.

- (a) Most candidates could deduce the general formula for an alcohol. Common errors included (i)  $\text{C}_n\text{H}_{2n+2}\text{O}$  (not showing clearly the  $-\text{OH}$  group) and (ii)  $\text{C}_n\text{H}_{2n+1}\text{O}$
- (b) Although many candidates could identify the combustion products of methanol, a large number suggested that hydrogen was formed instead of water. The mysterious 'methane oxide' also appeared as well as carbon monoxide (in addition to carbon dioxide).
- (c) (i) Most candidates wrote a correct equation for the formation of ethanol from ethene although a few spoiled this by putting either oxygen on the left or water on the right. Although many candidates could quote the correct conditions for this reaction, some disadvantaged themselves by either stating only one condition or giving numerical pressures which were far too high, rather than sticking to just 'high pressure'.
- (ii) Most candidates obtained at least two marks for the calculation, most of them going through the lengthier route of calculating moles. This method sometimes led to errors in the number of decimal places being made especially when candidates calculated their answers in grams. Very few candidates omitted the correct unit. (answer 18.4 tonnes)
- (iii) This was poorly answered by the majority of candidates. Many candidates mistook the word 'renewable' for 'reversible'. Many also claimed that renewable meant that 'it could be used over and over again' and did not take note of the word 'resource' whilst others failed to realise the origins of ethene as being crude oil or glucose being a product from plants.
- (d) Just over half the candidates gave the correct name (propanoic acid) but many thought, incorrectly, that an ester was formed.

### Question B12

This was the lowest scoring question in **Section B**, few candidates scoring more than five marks. Most of these marks came from part (c)(ii). Few candidates could describe adequately the pollution problems related to the non-biodegradable nature of plastics and the parts (a) and (b), which relate to structure were poorly done.

- (a) Only about half the candidates were able to draw the correct monomer structure. Common errors included (i) a single bond between the carbon atoms, (ii) a double bond between the carbon atoms but with additional bonds as 'arms' sticking out the end.

- (b)(i)** Very few candidates obtained this mark because they merely referred to electrons being shared without mentioning the numbers i.e. 'two' or 'a pair'. This a question directly based on the syllabus statement that 'a covalent bond is formed by the sharing of a pair of electrons'.
- (ii)** Many candidates failed to gain the mark for this question because they did not state that the electrons are not mobile. As commented on in previous Examiner Reports, it is not sufficient to write about 'free electrons'. After being told in the stem of the question that the compound is covalent, many candidates suggested, incorrectly, that the ions present did not move.
- (c)(i)** Few candidates were able to describe the pollution problems related to the non-biodegradable nature of plastics. The majority of candidates either described what biodegradable means or referred to pollution problems when plastics are burnt. The latter was not accepted since the question clearly refers back to the problems of the plastics being non-biodegradable and not what could be done with them. Answers related to littering were often too vague.
- (ii)** Many candidates gained at least two of the three marks for this part. A significant minority of candidates suggested that hydrogen was formed instead of water or that chlorine was given off, perhaps through thinking still of the burning of the polymer (with incorrect products) rather than concentrating on the reaction of a carbonate with an acid. Hydrogen carbonate was not infrequently seen as an incorrect product of the reaction.
- (d)(i)** Few candidates scored both marks for the electronic structure of ethene, many losing the mark for not including the inner shell of electrons of the carbon atom despite being instructed to 'draw all the electrons' in the stem of the question. A considerable number of candidates drew the structure of methane rather than ethene. Some candidates were very inaccurate in pairing the electrons and so lost a mark, whilst others put either three pairs of bonding C=C electrons or five electrons bonded.
- (ii)** Many candidates did not realise that this question was about conservation of mass rather than a calculation question. A considerable number of candidates wasted time in doing calculations which did not always lead to the correct answer, 28 tonnes.

# CHEMISTRY

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Paper 5070/03

Practical Test

## General comments

The overall standard was encouraging with many candidates demonstrating good practical skills in both the quantitative and qualitative questions.

## Comments on specific questions

### *Section A*

#### Question 1

- (a) Potassium manganate(VII)/iron(II) titrations are slightly more difficult than standard acid/base titrations and most candidates completed this part of the exercise satisfactorily.

Full marks were awarded for two results within  $0.2 \text{ cm}^3$  of the Supervisor's value and then for averaging two or more results which did not differ by more than  $0.2 \text{ cm}^3$ .

Teachers are asked to continue to emphasise that, in all titration exercises, candidates should repeat the titration as many times as necessary, until they have obtained consistent results. They should then average these consistent results, having first 'ticked' **all** of them to indicate that these are their most accurate values. Although many candidates do carry out this procedure carefully, a significant number still tick only one result (or none at all) and often use another value in the summary. When carrying out titrations, candidates are expected to use their chemical judgement and sometimes reject some of their values.

- (b) The majority of candidates correctly calculated the concentration of iron(II) sulphate in solution **P**, although a significant number of candidates made no attempt at this, or subsequent calculations. There were relatively few examples of candidates inverting either the volume ratio or mole ratio, but a number did use  $0.2 \text{ mol/dm}^3$  as the concentration of the potassium manganate(VII) in **Q** rather than  $0.02 \text{ mol/dm}^3$ . This produced problems later on in the calculations. Answers were required to three significant figures and only a small number over-approximated.

- (c),(d) These parts of the exercise proved more difficult than expected. Candidates had to calculate the mass of iron in  $1.0 \text{ dm}^3$  of **P**, by multiplying their answer to (a) by 56. A substantial number multiplied by 152 (the  $M_r$  of  $\text{FeSO}_4$ ). Candidates were then required to calculate the percentage of iron in the  $6.00 \text{ g}$  of **M** that had been used to prepare **P**. Again this proved to be surprisingly difficult. The calculations were marked consequentially throughout, even when this led to impossible answers.

#### Question 2

Marks for this question were generally high. Marks were usually lost for incomplete rather than incorrect answers. It was not necessary to make all the observations to obtain full marks for this question.

**R** was calcium chloride, **S** was zinc sulphate and **T** was lead nitrate.

**Test 1**

All three salts give a white precipitate with aqueous sodium hydroxide. Although most candidates used the correct term, 'precipitate', a number still talked of the 'mixture turning milky' or a 'white solution being formed'. The precipitate formed does not dissolve in excess sodium hydroxide with **R** but it does with both **S** and **T**. When solutions are formed candidates are expected to describe the colour of the solution, in these cases the solution is colourless. Clear is not acceptable as a description of a colour.

**Test 2**

When sulphuric acid is added to **R** there is no initial reaction, however, on standing, a white precipitate slowly forms. It was acceptable to refer to this solid as crystals.

With **S** there is no reaction either initially or on standing. Candidates should be aware that not all tests will produce a definite reaction. A number of candidates thought a gas was evolved, often on heating, and candidates are never expected to extend the test in this way.

With **T** a white precipitate is formed immediately.

**Test 3**

The addition of ammonium ethanedioate to **R** or **T** produces a white precipitate. The precipitates dissolve, producing colourless solutions, when dilute nitric acid is added. Although most candidates observed the initial precipitate, only a small number noticed that they dissolved in acid.

With **S**, there is no reaction with the ammonium ethanedioate or the nitric acid.

**Test 4**

With **R**, silver nitrate produces a white precipitate and this was recorded by most candidates. It was not necessary to carry out **Test 4** on **S** or **T**.

**Test 5**

In a similar way **S** produces a white precipitate when reacted with aqueous barium nitrate. Again, most candidates made this observation.

**Conclusion**

The white precipitates formed when **R** reacted with silver nitrate and **S** reacted with barium nitrate, confirmed that the anions in **R** and **S** were  $Cl^-$  and  $SO_4^{2-}$  respectively. Formulae were required, rather than names, and most candidates scored these marks.

**R** is confirmed as containing the  $Ca^{2+}$  ion by the formation of a white precipitate with sodium hydroxide which did not dissolve in excess. Based on its reaction with sodium hydroxide, **S** could have been either  $Zn^{2+}$  or  $Al^{3+}$ . Although many candidates did scores these marks, many inverted their answers and gave **R** as  $Zn^{2+}$  and **S** as  $Ca^{2+}$ .

# CHEMISTRY

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| <p><b>Paper 5070/04</b></p> <p><b>Alternative to Practical</b></p> |
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## 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 are included.

The standard continues to be maintained and the majority of candidates show evidence of possessing many of the aforementioned skills.

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

Calculations are generally completed accurately using the appropriate significant figures.

## Comments on individual questions

### Question 1

The diagram is that of a syringe, and the volume of liquid in the syringe is  $72 \text{ cm}^3$ .

### Question 2

- (a) The presence of carbon dioxide may be confirmed by lime water turning 'milky' when the gas is passed through it.
- (b) These two questions require the candidate to state what would be seen during the experiment and to accurately describe these observations.
  - (i) When the acid was in excess, effervescence would cease and all the zinc carbonate would have reacted (not dissolved).
  - (ii) When the acid was in excess, effervescence would cease and there would be unreacted zinc carbonate or a white solid remaining at the bottom of the beaker (not undissolved or a formation of a precipitate). The observation relating to effervescence could only be used once as stated in the question.
- (c) The unreacted zinc carbonate may be removed by filtration.
- (d) Technique (iii) would produce the largest crystals.

The answers to (e), (f) and (g) are 0.025 moles, 4.025 g and  $0.6 \text{ dm}^3$  respectively.

### Question 3

- (a) The candidate should state that the bromine or brown gas moves into the upper jar, filling both jars. Many answers were too vague, it being uncertain as to whether the candidate realised that both jars would fill with bromine. The process is diffusion.

- (b) The colour of aqueous bromine changes from brown (or orange or red) to colourless. This suggests that the hydrocarbon is unsaturated or contains a multiple bond. The question asks for the structure, hence an answer 'alkene' is incorrect.
- (iii) This reaction is an addition reaction.
- (iv) A correct calculation gives the hydrocarbon, propene,  $C_3H_6$ .

#### Questions 4 to 7

The correct answers are (a), (c), (c) and (d) respectively.

#### Question 8

- (a) The mass of acid used in the experiment was 1.51 g.
- (b) A pipette is used to measure a volume of the solution.
- (c) The colour change in the flask is pink or purple to colourless.
- (d) Most of the candidates read the burettes correctly and deduced the correct mean to be used in the subsequent calculations. Candidates who read the burettes incorrectly should choose the nearest two volumes, not necessarily the second and third, and all candidates should tick the two readings that are being used. Failure to do so is penalised. The correct mean value is  $24.4 \text{ cm}^3$ .
- (e) The correct answers to the calculations are:  
0.00244 moles, (f) 0.00244, (g) 0.0244, (h) 0.05, (i) 0.0256, (j) 0.0128
- (k) 118
- (l) Given the formula for **T** candidates should subtract 90, ( $2 \times 45$  per COOH group), from their answer in (k). The values for **x** and **y** can then be deduced i.e. **x** = 2, **y** = 4.
- (m) Candidates must show that both acid groups have been esterified, to get the mark.
- Throughout the question any incorrect calculated answer may be used in subsequent calculations and gain marks accordingly.

#### Question 9

Candidates are asked to complete the table inserting tests, observations and conclusions where appropriate.

- (a) The conclusion to this test is that there are no transition metal ions present in **V**. Answers suggesting that it, or **V**, is not a transition metal do not get the mark.
- (b) The correct observations to this test are that a white precipitate is formed which is soluble in excess.
- (c) This test requires aqueous ammonia to be added, which produces a white precipitate which dissolves on addition of excess. Use of ammonia without aqueous or ammonium loses the first mark.
- (d) The presence of the chloride ion is confirmed by the addition of dilute nitric acid and aqueous silver nitrate which produces a white precipitate.

**Question 10**

Candidates are asked to read four diagrams of a thermometer showing the temperatures when four different masses of zinc are added to the copper(II) sulphate solution, and then complete the table of results. The temperatures should then be added to the table and the increases calculated, (2.5, 4.9, 7.4, and 8.0 °C) added to the table. Each increase is taken from the original temperature of 25 °C.

Candidates were instructed to complete two graphs and to join each set of points by two intersecting straight lines. Many candidates connected each set of points by three lines or, more commonly, by two straight lines joined by a small curve. In these cases one of the two marks allocated for the graphs was lost. The lines should also pass through the zero. The graphs are then used to answer parts **(c)**, **(d)** and **(e)**, for which the candidate's graphs were used. The points of intersection produce the answers to **(e)**.

As usual, accuracy of plotting and reading must be to the nearest half small square, however, many marks are lost by not doing this.

Many candidates, in completing the original table, worked out the increases from the previous addition i.e. 2.5, 2.4, 2.5 and 0.6 °C.

A mark was lost, but providing that these incorrect increases were plotted accurately on the graph, the plotting mark could still be obtained.

- (f)** There would be no reaction or temperature increase on using silver, as silver is below copper and iron in the reactivity series. Any suggestion of a reaction or a temperature change, however small, taking place lost both marks.