

# CHEMISTRY

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<p><b>Paper 5070/01</b> <b>Multiple Choice</b></p>
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<i>Question Number</i>	<i>Key</i>	<i>Question Number</i>	<i>Key</i>
1	D	21	C
2	C	22	B
3	C	23	C
4	C	24	B
5	B	25	A
6	A	26	D
7	B	27	A
8	B	28	C
9	D	29	D
10	C	30	A
11	B	31	D
12	B	32	B
13	B	33	B
14	B	34	A
15	D	35	B
16	D	36	D
17	A	37	C
18	C	38	B
19	A	39	D
20	A	40	A

## General Comments

Questions 14 and 15 were the only questions to which over 80% of the entry gave the correct answer, with very few exceptions the other questions on the paper produced answers which made it possible to discriminate between the candidates.

## Comments on Individual Questions

### Question 4

This was essentially a question of recalling the test for a chloride. Almost as popular as the correct answer was the incorrect option sodium hydroxide which did not give an observable result with either of the acids. For a chemical reaction to distinguish between two compounds the test must give very different observable results with the two compounds.

**Question 7**

A covalent compound usually has a low melting point and does not conduct electricity when solid or molten. Therefore **B** was a typical example of a covalent compound.

**Question 8**

The distribution of the answers to this question suggested that the candidates had not read the question carefully. Each option contained either positive ions or mobile electrons but only the copper wire, a metal, contained both positive ions and mobile electrons.

**Question 19**

Metals below hydrogen in the reactivity series do not react with dilute sulphuric acid, thus copper does not react with sulphuric acid.

**Question 24**

The correct answer was the third most popular answer despite caesium being the only substance, in the question, which actually reacted with water.

**Question 30**

Sodium was a very popular incorrect answer to this question although all sodium salts are soluble.

**Question 34**

The only oxide in the alternatives which was not an acidic oxide was carbon monoxide, the answer.

**Question 40**

*Terylene*, a popular response, is a polyester and prepared from an acid and an alcohol. Since the stem of this question contained an amine, *Terylene* was an incorrect response.

For addition polymerisation to be possible the monomer must contain a carbon-carbon double bond.

Starch is a carbohydrate and does not contain the element nitrogen.

After the above facts have been considered the only option remaining is **A**, the answer.

# CHEMISTRY

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Paper 5070/02

Theory

## General comments

Many candidates tackled the paper well and good answers were seen in **Question 1, 4 and 7**. However few candidates scored full marks on the other questions, generally losing marks on those parts which required a degree of explanation and continuous prose. The rubric was generally well interpreted but a few candidates failed to read the instruction in **Question A3(c)** about drawing the graph on the grid provided and merely drew a single line graph (often without relevant figures at the bottom of page 5). Most candidates attempted all parts of each question and most attempted three questions in part **B**. Several candidates wrote the answers to part **A** in a separate answer booklet rather than on the question paper itself. This should be discouraged, since they are more likely to lose marks by (i) not using the full information provided by the questions, (ii) wasting time turning backwards and forwards and (iii) failing to show relevant information on graphs, diagrams etc. Those candidates who wrote all their answers in a separate answer booklet failed to draw the graph in part **A3(c)**.

A considerable number of candidates who scored well on **Section A** were unable to maintain this standard in **Section B**. In **Section B** many candidates gave unnecessarily lengthy answers to some questions e.g. **Question B7(e), B8(d) and B10(d)**. In extended questions, some candidates disadvantaged themselves by careless and non-specific writing. 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 points specified by the number of marks. Candidates would be advised to look at the detail put in the mark schemes to satisfy themselves of the amount of detail required. The standard of English was generally good and the word 'marine' used incorrectly to mean 'water' was less frequently seen this year compared with last summer's examination.

Most candidates' knowledge of atomic structure and the properties of elements related to the Periodic Table was good but many were found to have a poor knowledge of general organic reactions and formulae. It is encouraging to note that many candidates performed well on the calculations and many candidates acquitted themselves well when calculating the empirical formula of a compound or the percentage of an element present in a compound.

## Comments on specific questions

### **Section A**

#### **Question A1**

Most candidates scored well on this question, four or five marks of the six available being not uncommon. It was encouraging to note that fewer than usual wrote the names of the compounds rather than letters. However, credit was given for those who wrote the names. It should be pointed out to candidates that following the latter course of action is more likely to lead to errors.

- (a) (i) Most candidates were able to identify the compound associated with acid rain, the most common error being to suggest **E** (zinc oxide).
- (ii) This section provided more variable answers. Many candidates did not seem to be able to identify an amphoteric oxide, with **A** often being given in place of **E**.
- (iii) This was probably the least well done of this section with **D** or **F** being incorrectly offered as an answer. The concept of a giant structure is apparently not clear to all candidates.

- (iv) The most common error here was to suggest **F** through not realising that electrolysis requires the structure to be ionic.
- (b) This part was often correct. The most common error was to write down the molecular formula,  $C_2H_4Br_2$ , rather than the empirical formula. A minority of candidates omitted the carbon atom and wrote HBr. This can only be explained by a total misunderstanding of what the question was asking.
- (c) Most candidates realised the origin of the carbon monoxide but the answers were not always expressed concisely. It is not sufficient to write that a fuel is burnt – that fuel could be hydrogen. The correct answer had to imply a carbon containing fuel. Similarly, it is not sufficient to write 'from cars' or 'from factories'. That is far too vague.

### Question A2

Most candidates scored at least half the marks available, the main errors arising from parts **(a)(i)** and **(b)(i)** where candidates often expressed themselves badly. Nearly all candidates were able to balance the 'cracking' equation and state at least one of the conditions needed for this reaction.

- (a)(i) This was the least well done part of this question, usually through the misconception that magnesium is the most reactive of the elements. Other common errors were (i) to relate the decomposition temperature to the position in the Group rather than to the reactivity and (ii) write about boiling points of the carbonates rather than the decomposition temperatures.
- (ii) The equation was rather disappointingly done by many candidates. Common errors were (i) to put oxygen on the left hand side, (ii) to suggest that Mg was formed instead of MgO and (iii) to suggest that the formula for magnesium carbonate was MgCO or  $MgCO_2$  (or that MgCO is formed).
- (b)(i) Many candidates gave imprecise answers for the reasons why oil companies crack petroleum fractions. Many were content to write about what cracking is (breaking larger molecules into smaller ones/into petrol) rather than focussing on why it is done. Many failed to gain the mark because they implied distillation of petroleum rather than cracking e.g. 'to make petrol from the oil' or because they added other fractions to the petrol.
- (ii) Most candidates scored at least one of the two marks available. Many disadvantaged themselves by writing the incorrect catalyst e.g. nickel or temperatures outside the appropriate range, sometimes in the thousands of degrees Celsius. The answer high temperature was sufficient. Heat is not a sufficiently good substitute for temperature.
- (iii) Nearly all candidates scored the mark for balancing the equation.

### Question A3

Few candidates scored more than half marks for this question. Although the graph was usually drawn correctly, the calculation was more often incorrect and very few obtained both marks for part **(d)**, indicating a poor understanding of kinetic theory by many candidates.

- (a) Nearly all candidates gained the mark for reading the graph correctly although a few candidates left this blank.
- (b) The most common error in the calculation was not to convert the  $cm^3$  to  $dm^3$  resulting in the incorrect answer 3.75, so often seen. Many candidates, however, failed to use the pattern that 1 mole of gas occupies  $24 dm^3$  at room temperature in the correct form and did rather complicated mole to gram calculations. Answer =  $3.75 \times 10^{-3}$  (moles)
- (c) Many candidates correctly identified the correct form of the graph and scored two marks. There were only a few instances where candidates showed the graph steeper at first but levelling off lower than the line given. Most candidates realised that the line would reach the  $90 cm^3$  of gas, even if they showed in error that the initial rate was slower.

- (d) A significant number of candidates failed to gain any marks because they wrote about increasing kinetic energy of particles or about increasing the surface area of the acid/carbonate. That candidates often have difficulty in using the correct information and do not understand kinetic theory is also evidenced by statements such as 'the particles move faster because the increased the temperature is increased'. The point here is that the temperature is being fixed (as stated in the question) and that some candidates seem to read too much into the question. Many candidates merely stated that the temperature was higher or that the particles were moving about quicker. The mark for increased frequency of collision was given more often than the mark for closer proximity of particles per unit volume. Candidates should be advised that when dealing with the effect of increased concentration, a time factor should be included i.e. increased collision frequency/collide more often per second.

#### Question A4

Most candidates scored at least half marks on this question but there were many vague statements in answer to part (b) and part (f). The isotopic composition in part (c) was usually correct.

- (a) There was a wide range of incorrect answers for this part ranging from balloons (a very common answer) to pencils, batteries, parachutes, fertilisers and planes. The incorrect use as balloons is due to a muddling with helium. Candidates often seem to think that what does for one noble gas, does for another and fail to recognise the density differences – and this despite the diagram in part (f). Candidates should be encouraged to be specific when they are writing answers to uses. It is far better to write 'light bulb' or 'electric bulb' than to merely put the word 'bulb' which could apply to any round glass vessel.
- (b) Most candidates had a reasonable idea about the reason why the noble gases are unreactive. However, this was often badly or vaguely expressed. A comment such as 'because it has 8 electrons in its outer shell' excludes helium and the statement 'has eight and two electrons in its outer shell' implies that magnesium, for example, should be inert. It is far better to stick to a general statement that the outer shell has the maximum number of electrons that it can hold. Many candidates failed to gain the mark by merely stating that the atoms have the stable number of electrons. This is too close to the stem of the question, which states that the noble gases are unreactive.
- (c) Most candidates obtained two marks here. Those candidates who did not score, generally made several errors in the number of proton and electron columns. Candidates scoring one mark, generally made a mistake in the number of electrons and neutrons columns for the argon-40 isotope.
- (d) Most candidates had an idea that the arrangement of elements in the Periodic Table was related to the number of protons. Common errors included trying to relate the positions to the number of electrons, to the position of the Groups or to the atomic masses (thinking that atomic mass was significantly different to relative atomic mass).
- (e) The correct balanced equation was the exception rather than the rule. Common errors included (i) 4F on the left, (ii) making argon diatomic and (iii) writing FI instead of F
- (f) Although many candidates gained the mark here, many answers were rather vague e.g. 'on the floor', 'below the bar'. A significant number of candidates thought that the balloon would explode or 'float away'. Many candidates gained the mark by drawing the balloon on the bar. This is quite acceptable. A good diagram, especially if correctly labelled, will always gain credit.

#### Question A5

Many candidates scored well on this question. Marks were most often lost for part (a)(ii), where many candidates appear not to revise the tests for ions, and part (d)(i) where the equation was often incorrectly balanced.

- (a)(i) Most candidates realised that the percentage of oxygen on the air was approximately 20%, although a few strayed out side the limits set by the examiners e.g. 25%. A small proportion of the candidates gave the figures for nitrogen i.e. 80%.

- (ii) The percentage of candidates giving the correct test for iron(III) ions was encouragingly higher than in previous years for similar qualitative analysis questions. Incorrect answers seemed to be Centre-specific. The most common errors leading to the loss of the second mark were to fail to mention the precipitate and to confuse iron(III) with iron(II) and suggest the formation of a green precipitate. A significant number of candidates disadvantaged themselves by suggesting that acid should first be added. This would neutralise any subsequent alkali added and was not therefore accepted unless it was made clear that the alkali is in excess of the acid. Candidates should be advised not to use addition of acid unless it is clearly indicated that the substance needs to be made soluble in the first place.
- (b)(i) This was generally correct. Candidates who did not gain the mark generally failed to relate the question to what happens in a water treatment plant and suggested how to separate water from a solid in a laboratory situation e.g. distillation, decanting.
- (ii) Most candidates gained the mark for the correct formula for aluminium sulphate. The most common incorrect formulae were given as  $Al_2SO_3$  or  $Al(SO_4)_3$ , the latter presumably arising through non-realisation that the sulphate ion has a 2-charge.
- (c)(i) Fewer than half the candidates realised that carbon removed odours and taste or removed colour from the water. Many candidates gave vague answers such as 'removed contaminating substances' or 'purification'. A number of candidates confused the use of carbon with the use of chlorine.
- (ii) The use of chlorine to kill bacteria was well known but some candidates failed to gain the mark by writing too vaguely e.g. 'to clean the solution'.
- (d)(i) The equation for the reaction of calcium hydroxide with hydrochloric acid was done less well than expected. Common errors included, incorrect formulae for calcium hydroxide (often  $CaOH$  or  $CaOH_2$ ) and lack of balance in the equation. Good candidates very often lost the latter mark because they failed to balance the water, even when they realised that two moles of acid react with one mole of the alkali.
- (ii) Those candidates who recognised the typical ionic equation for any acid reacting with any alkali gained this mark. Those candidates who tried to work out the equation from first principles invariably failed through lack of correct charge on the calcium or splitting up the water on the right hand side of the equation into hydrogen and oxide or hydroxide ions.

### Question A6

This question provided many candidates with a reasonable number of marks. All but the weakest candidates managed to get at least two of the three marks for the energy profile diagram even if they failed to score on the other parts of the question. Scores of 9 were not uncommon.

- (a) The structure of methane was generally correct. The most common error was to give carbon six electrons in the outer shell so that two non-bonding electrons were present. The other error, infrequently seen was to try to give carbon 12 electrons and so give incorrect numbers of electrons in the inner shell – which was not, in any case, required.
- (b)(i) Many candidates spoilt their answers by suggesting that the atoms in the solid not only vibrate, but they rotate and move from place to place as well. The mark for the arrangement of the particles was generally given, some credit also being given for the proximity of the particles, although strictly speaking this is not the arrangement, the arrangement being 'regular'. Candidates writing 'in fixed positions' did not get any credit – atoms can be in fixed positions but irregularly arranged as in glass or proteins.
- (ii) Many candidates failed to gain the marks here by writing too vaguely. An answer such as 'the temperature and pressure changes' is not sufficient. Some reference has to be made to the fact that the temperature is higher on the surface of the Earth and the pressure lower. Many candidates failed to gain the 'pressure' mark because they thought that the pressure at the Earth's surface was higher than the pressure stated in the stem of the question.

- (iii) Most candidates referred to global warming or the greenhouse effect but some disadvantaged themselves by going on to state that the methane affected the ozone layer or caused acid rain. This follows the general pattern commented on in previous Principal Examiner Reports that candidates tend to muddle up the greenhouse effect, acid rain and ozone depletion. The contribution to smog was only accepted as an answer if there was qualifying information given e.g. presence of ultraviolet radiation/photochemical reactions etc.
- (c) Over half the candidates were able to give a suitable source of methane but a small proportion gave vague answers or tried to relate it to the nitrogen cycle.
- (d) Most candidates scored a mark for a suitable use for methane. The use as a fuel (natural gas) in cooking was the most common response.
- (e) Many candidates scored all three marks for this part. The most common errors were to (i) to miss out the enthalpy change (ii) to show the activation energy for the back reaction and (iii) to show the enthalpy change going from the base line to the product energy level.

### Section B

#### Question B7

This question was attempted by nearly all the candidates. It proved to be a good source of marks for even the weakest candidates and many average candidates scored at least 6 marks.

- (a) Although many candidates based their answers on the gain of electrons, a large minority failed to gain the mark because they indicated that hydrogen was added. Candidates should recognise that the definition of reduction as the addition of hydrogen depends on molecular hydrogen (oxidation number 0) changing to hydrogen combined in a compound (oxidation number +1). In this equation there is no change in the oxidation number of the hydrogen so this cannot be accepted as an answer. Candidates should be encouraged to give answers which relate to the question, which specifies the particular equation. A considerable number of candidates thought, incorrectly, that reduction is the loss of electrons.
- (b) Very few candidates wrote the correct ionic equation for the reaction. A minority of candidates got close and balanced the species but most of these forgot to balance the charges by adding electrons.
- (c) (i) Many candidates remembered the correct sources of nitrogen and hydrogen for the Haber Process but quite a number thought that the hydrogen came from the air. Some candidates correctly stated that hydrogen was obtained from the cracking of hydrocarbons but others disadvantaged themselves by either suggesting that methane was cracked or petroleum/crude oil is cracked.
- (ii) Most candidates gained two marks for stating the correct conditions for the Haber Process. Some candidates failed to gain the mark because the temperature or pressure was not quoted. The syllabus statement for the Haber Process states that candidates have to know the essential conditions for the manufacture of ammonia. This indicates that conditions of temperature and pressure should be known.
- (d) The calculation of the percentage of nitrogen was usually well done, most candidates obtaining at least 3 of the three marks available. The most common errors were to use atomic masses rather than formula masses or to calculate the formula masses incorrectly. Some candidates used up time by calculating the percentages of each element present rather than just the nitrogen. (Answer: N in ammonium nitrate = 35%; N in ammonium hydrogen phosphate = 21%)
- (e) Most candidates gained the mark here by mentioning eutrophication. Some described the whole process in detail and even though only one mark was available. Candidates who wrote extensively also left themselves open to losing the mark through incorrect science. Examples of this included 'algae use up the oxygen' and 'marine life is killed'.

**Question B8**

Of the questions in part **B**, this one was the least well done, with few candidates scoring more than 5 of the 10 marks available. Many candidates had difficulty with the concept of equilibrium and even the simple preparation of iron(II) sulphate provided problems for many. As with other questions in part **B**, candidates tended to write too much rather than sticking to the basic facts.

- (a) Only about half the candidates gained the mark for balancing the equation. The most common error was to put a 2 in front of the oxygen rather than a 3.
- (b)(i) Very few candidates gave the correct answer by referring to the number of moles of gas on each side of the equation. Most wrote about vague equilibrium shifts or tried to relate it to kinetic theory.
- (ii) The most common correct answer related to economic factors. Very few candidates appeared to understand other equilibrium aspects of the question.
- (iii) This was probably the best answered of the three equilibrium questions. Although about one-fifth of the candidates attempting this question obtained the mark for the recognition that the reaction was exothermic, very few were able to explain the effect of temperature on equilibrium. The most common error was to try to answer the question in terms of rates. Many tried to relate the cooling to incorrect ideas about protecting the catalyst from damage.
- (c) Most candidates gained one of the two marks available. The mark for filtering off the excess iron was, however, rarely obtained. Many candidates suggested filtering, but their filtering referred to the iron(II) sulphate crystals. A large minority of candidates wrote very vague statements, often suggesting that the solution should be evaporated to dryness. A large number of candidates wrote too much, including information about how the reaction was carried out.
- (d) Many candidates scored most of their marks for **Questions 8** on this part. It appears that this type of standard calculation is well practised. Most candidates recognised the 2:1 ratio of sodium hydroxide to sulphuric acid and many could calculate the number of moles of potassium hydroxide. Fewer could rearrange the equation to calculate the concentration of sulphuric acid. Answer =  $0.125 \text{ mol/dm}^3$

**Question B9**

This question was reasonably well done and the empirical formula calculation provided many candidates with the bulk of their marks. As previously commented, basic organic chemical structure and equations are not particularly well known.

- (a) About half the candidates obtained the mark for the correct structure of butanoic acid. Incorrect structures included: (i) pentanoic acid (care needs to be taken to count the number of carbon atoms) (ii) writing the formula for butanol (iii) putting an aldehyde group at the end of the chain through lack of appreciation that there are two oxygen atoms in a carboxylic acid group.
- (b)(i) Most candidates understood the concept of a weak acid, although many wrote vaguely about the fact that there were not many hydrogen ions when it dissolved without reference to the proportion of ions formed.
- (ii) Many candidates understood how to show that an acid is weak but a significant minority thought that litmus paper could be used or tried to use ideas about rates of reaction without mentioning any comparison with a strong acid. Fewer obtained the second mark relating to the results through suggesting that the pH would be in the range 4 to 7, thus including 7 which is incorrect.
- (c) Even the weakest candidates gained some marks for the calculation of empirical formula, the idea of dividing by atomic mass and then by the lowest number being well known. The empirical formula was generally correct. Fewer calculated the molecular formula correctly, many being content to just write x2 or  $(\text{C}_3\text{H}_6\text{O})_2$ .
- (d)(i) Many candidates did not know the equation for fermentation. The most common errors were (i) to leave the ethanol and carbon dioxide unbalanced (ii) to add water or oxygen to the right hand side.



- (ii) Few candidates gave the correct reagents and conditions for the oxidation of ethanol to ethanoic acid. When potassium dichromate or potassium permanganate was given, the sulphuric acid was often missing. The answers were often written as if an industrial process for producing ethanol was being asked for e.g. references to very high temperatures, high pressures and catalysts. The idea of refluxing or even heating moderately was rarely seen. Many candidates confused this reaction up with fermentation using yeast, perhaps thinking about the previous reaction.

### Question B10

This question was generally well answered, many candidates scoring at least half the marks. In part (b) many candidates had difficulty in disentangling the role of electrons and ions in electrical conduction. This has been commented on in previous Principal Examiner Reports. It is encouraging to note that many candidates had a fairly good understanding of electrode processes and how malleability depends on metallic structure.

- (a) Most candidates scored at least 2 marks for this section. Some candidates, however, confused the electrodes when writing their equations or put the electrons on the wrong side of the equations. The latter usually occurred when the equations were written with 'minus electrons' on one side. The use of this form should be discouraged since it often leads to errors. A significant minority of candidates confused this electrolysis with that which occurs with graphite electrodes, suggesting, incorrectly that gases were given off at the electrodes.
- (b)(i) Most candidates realised that mobile electrons are responsible for electrical conductivity in metals although a few disadvantaged themselves by talking about ions moving as well.
- (ii) Many candidates answered this part correctly but a significant number thought that electrical conductivity was due to the movement of electrons rather than ions. This is a common error seen year after year.
- (c) This part was not particularly well answered. The anode and cathode were often confused and the electrolyte was often not mentioned or stated to be copper sulphate or iron sulphate.
- (d) Although many candidates appeared to understand how malleability depends on the metallic structure, there was often much rather vague writing. The idea of the layers of atoms sliding over each other was often omitted but some good diagrams often made up for this. Common errors were (i) to mention the lower malleability of bronze without stating why copper was more malleable (ii) failure to mention that the tin atoms in bronze were a different size (iii) describing malleability differences in terms of differences in numbers of electrons.

# CHEMISTRY

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<p>Paper 5070/03 Paper 3 Practical Test</p>
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## General comments

The overall standard was very variable and although many candidates were able to demonstrate significant practical skills a significant minority appeared to have had very little experience of the type of exercises they were required to attempt.

## Comments on specific questions

### Question 1

- (a) The hydrogen peroxide potassium manganate(VII) titration was generally well done. Many candidates scored full, or nearly full marks. Full marks were awarded for recording 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  $0.2 \text{ cm}^3$ .

Teacher are asked to continue to emphasise that in any titration exercise, candidates should repeat the titration as many times as necessary, until they have obtained consistent results, and then to average these **consistent** results, having first 'ticked' them to indicate that these are their most accurate values. Although many candidates do carry out this procedure carefully, a substantial number still tick only one result. Similarly a number of candidates average all their results, irrespective of how consistent they are. Deciding whether to disregard some results is an important skill, and teacher are asked to reinforce this message.

- (b) Most candidates were able to calculate the correct concentration of the hydrogen peroxide in **P**. Although there were a few examples of candidates inverting either the mole ratio or the volume ratio.

### Question 2

This was a relatively difficult exercise with many colour changes and marks were somewhat disappointing. Marks were usually lost for failing to describe the changes sufficiently accurately. Most candidates used the correct terminology to describe the formation of precipitates although there is still some confusion between clear and colourless and a small number of candidates do not appear to know that the term precipitate only relates to a solid. In reactions in which a gas is produced, candidates are expected to note the observation, effervesces etc., give the test for the gas and then name it. A surprising number lose marks unnecessarily by omitting one or more of these statements. It was apparent that in a few Centres, candidates were provided with sodium nitrate rather than sodium nitrite. In these cases the mark scheme was adjusted so that the candidates would not be penalised. If Centres are unable to obtain any of the required chemicals they are advised to contact CIE Customer services as far in advance of the examination as possible for advice. If alternative chemicals or apparatus are used, Centres are encouraged to record details on the Supervisor's Report.

- Test 1** The addition of concentrated hydrochloric acid to solution **R** (sodium nitrite) produces immediate effervesces of a brown gas which turns litmus red. The gas is nitrogen dioxide although candidates were not expected to know this. The gas is produced several times in **Tests 1 – 4** and candidates could score marks in later tests if they failed to score the marks in **Test 1**. At the end of the reaction, the solution is pale blue although very few candidates noted this. A number of candidates thought chlorine was evolved and claimed that the gas bleached litmus, although nitrogen dioxide does not do this.

- Test 2** The addition of **R** to potassium manganate(VII) causes the solution to be decolourised, most candidates scored this mark.
- Test 3** When **R** is added to potassium iodide there is no initial reaction, however the subsequent addition of hydrochloric acid cause strong effervescence and the formation of a black precipitate. Although many candidates noted the initial lack of reaction, relatively few scored both the latter marks.
- Test 4** With iron(II) chloride solution **R** produces a very dark coloured solution but not a precipitate. A range of 'dark' colours was acceptable but not black itself. On standing the colour fades and any reasonable 'paler' colour scored the mark. When aqueous sodium hydroxide is then added a brown precipitate of iron(III) hydroxide is produced.
- Test 5** When **R** is warmed with aqueous sodium hydroxide and aluminium foil, there is effervescence and the gas produced turns litmus blue, proving that it is ammonia. All three statements were required.
- Test 6** The addition of **S** (sodium sulphite) to potassium manganate(VII) causes the solution to be decolourised.
- Test 7** There is no reaction between **S** and potassium iodide and most candidates recognised this.
- Test 8** The addition of **S** to barium nitrate produces a white precipitate of barium sulphite which should dissolve, at least partially, on the addition of dilute hydrochloric acid. Although most candidates scored a mark for the original precipitate, very few noticed that it dissolved in acid.
- Test 9** With iron(III) chloride **S** produces a deep red solution. Shades or combinations of red were allowed. When this solution is heated a brown precipitate is formed. The addition of hydrochloric acid followed by warming the mixture causes the colour to fade and sulphur dioxide to be given off. Candidates were expected to confirm the presence of sulphur dioxide by testing with potassium dichromate(VI), which turns green. When aqueous sodium hydroxide is added the precipitate is now iron(II) hydroxide and it should be green.

### Conclusion

The tests show that **R** is both an oxidising agent, reacting with potassium iodide, and a reducing agent, decolourising potassium manganate(VII). **S** is just a reducing agent as it does not react with potassium iodide but does react with potassium manganate(VII). The production of ammonia in **Test 5** show that an element present in the anion of **R** is nitrogen. A disappointingly large number of candidates detected ammonia and failed to give the element as nitrogen, often identifying the anion as nitrate, which was not required.

# CHEMISTRY

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**Paper 5070/04**  
**Alternative to Practical**

## General comments

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

Skills 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 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 pipette.

### Question 2

(a) (i) and (ii) The colour of the litmus solution is blue in ammonia solution and red in hydrogen chloride solution.

(iii) Aqueous hydrogen chloride is more commonly known as hydrochloric acid.

(b) (i) The correct answer is position **C**. This is the consequence of ammonia having a smaller molecular mass or density than hydrogen chloride allowing it to travel faster.

Answers which involve aqueous ammonia and aqueous hydrogen chloride lost both marks. The suggestion that ammonia travels further without reference to time also lost a mark.

(ii) The process is diffusion, (iii) the white solid being ammonium chloride,  $\text{NH}_4\text{Cl}$ .

(c) Ammonia is collected by upward delivery (**Y**) and hydrogen chloride by downward delivery (**X**). **Z** is not acceptable as both gases are soluble in water. Answers need to relate the density of each gas to that of air not to each other in supporting the choice of collection.

### Question 3

(a) The diagram shows the direction of water in and out of the condenser incorrectly.

(b) The apparatus (**E**) is a condenser. Its purpose includes condensing vapours back to liquids, preventing reactants from escaping and returning reactants to the flask. A common error is stating its use is to condense vapours without any explanation as to the purpose of condensing.

- (c) Many candidates found difficulty in drawing the structures of the two alcohols and of those who made attempts very few were correct.
- (i) Structures of propan-1-ol and propan-2-ol in (d) were required with all bonds and atoms shown.
- (ii) Suitable oxidising agents are acidified potassium manganate(VII) giving a colour change of purple to colourless and acidified potassium dichromate(VI), orange to green. Many candidates lost the first mark by omitting the acid from the oxidising agent.

### Questions 4 to 8

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

### Question 9

#### Part A.

The first part of this question involves the analysis of the fertiliser L. Test 1 gives a coloured solution indicating that L contains a transition metal.

Tests 2 (b) and (c) confirm the presence of the  $\text{Fe}^{2+}$  ion.

The solution from 2(b) should be warmed to produce a gas or ammonia which turns litmus blue. Any mention of initially adding ammonia to the solution from 2(b) loses the first two marks. Many candidates confused this reaction with the test for the nitrate ion by initially adding aluminium foil.

Test 3. The test for the sulphate ion was generally correct. It is necessary to specify the acid used. Acidified only loses the first mark. The use of sulphuric acid loses the first two marks.

#### Part B

- (a) The mass of L used in the experiment is 4.73 g.
- (b) The colour change on titration is yellow to orange, pink or red.
- (c) Most candidates read the burette diagrams correctly and deduced the correct mean value to be used in the subsequent calculations. Candidates who incorrectly read the burette diagrams should choose the closest two volumes to calculate the mean volume not necessarily the second and third. Failure to do so is penalised. The correct mean value is  $24.6 \text{ cm}^3$ .

The correct answers to the calculations are:

- (d) 0.00246, (e) 0.00246, (f) 0.0246, (g) 0.05, (h) 0.0254, (i) 0.432 g (j) 91.3%

Any incorrect answer may be used in subsequent parts of the calculation and gain marks accordingly.

### Question 10

- (a) A correct test for oxygen is the relighting of a glowing splint.
- (b) The correct volumes of oxygen as shown on the syringe diagrams are 32, 52, 64 and  $70 \text{ cm}^3$ .
- (c) These volumes together with the volumes shown in the table should be plotted on the grid, the points being connected by two smooth curves both of which should be extended to pass through the origin. The plotting of all points and the subsequent observations using the graphs should all be to the nearest half small square.

- (d)(i)** The correct answer is  $32 \text{ cm}^3$ .
- (ii)** Candidates should read the volume of oxygen on each curve at 75 seconds and subtract the two, giving an answer of  $12 \text{ cm}^3$ .

In parts **(d)(i)** and **(ii)** the candidate's graphs are read to obtain the answers.

Many candidates incorrectly read the positions of 45 and 75 seconds on the time axis in assessing the volumes of oxygen produced.

- (e)** Copper(II) oxide is used as a catalyst in the experiment or to speed up the reaction. Any suggestion that it reacts in some way loses the mark.

- (f)(i)** The last two readings were the same because the reaction was completed or finished.

As has been mentioned in previous reports, the statement that the reaction had stopped was not acceptable. This would imply that the reaction could start again.

- (ii)** The answer to the calculation was 0.245 g. The equation should be used to determine the mass of  $\text{KClO}_3$  required to produce  $72 \text{ cm}^3$  of oxygen.