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FOREWORD

This booklet contains reports written by Examiners on the work of candidates in certain papers. **Its contents are primarily for the information of the subject teachers concerned**.

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CHEMISTRY

GCE Ordinary Level

Paper 5070/01
Multiple Choice

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

General comments

All the questions proved straightforward with the exception of **Question 34** which had a very strong distracter in alternative **C**. Two questions, namely **Questions 15** and **17**, proved to be very easy and **Questions 4**, **15**, **26** and **40** had low discrimination.

In general the Paper discriminated well between the candidates and proved to be a good test of knowledge and understanding.

Comments on specific questions

Question 2

The responses to this question suggested that many of the candidates were guessing. The question involved little if any chemical knowledge and simply the ability to interpret the information given by a graph. An ability required by all chemists.

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Question 4

An aqueous solution of barium ions on the addition of sulphate ions always forms a white prec barium sulphate. This is the basis of the test for sulphate ions. Thus the state symbol aq after *M*SO the key to obtaining the correct answer.

Question 8

Atom Y (2.8.1..) was the atom of a metal and atom Z (2.8.7.) was the atom of a non-metal and could be expected to bond ionically making alternative **D**, which was popular, incorrect.

Question 19

Alternative **D** had more candidates choosing it than had the correct answer **A**. The change from Zn^{2+} in $Z^{2+}S^{2-}$ to Zn is reduction, making **D** incorrect.

Question 24

Compounds of transition metals are usually coloured and the choice of answer for this question could be quickly reduced to a choice between alternatives **A** and **B**.

Question 26

Industry has to take into account many considerations when deciding upon a particular method of preparation for a chemical and cost is almost always a major consideration. Iron could be manufactured by electrolysis but the reduction of haematite by coke is cheaper.

Question 29

This question proved to be difficult but a good discriminator. Carbon dioxide is the gas to which all carbon compounds in the exhaust gases are converted and hence the answer to the question.

Question 34

The statement on the Question Paper in alternative **A** was almost a direct quote from the syllabus and the question was intended to be a matter of simple recall. Unfortunately alternative **C** was too strong a distracter and proved to be favoured by a large number of the entry.

Question 40

This question from an Examiner's point of view had by far the worst statistics of any on the Paper. This was surprising since it had been used quite successfully on previous occasions, although these occasions were quite a number of years ago.

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Paper 5070/02

Theory

General comments

A full range of performance was seen from candidates. Some exceptional candidates achieved almost full marks. The candidates appeared to use their time well. Candidates answered longer questions well. Most candidates showed skills in answering longer questions by attempting to write separate answer points to match the number of marks for longer part questions.

The Paper revealed very good understanding of syllabus chemistry in some areas. Candidates showed a very good grasp of areas such as organic chemistry, rates of reaction and in factual recall. Candidates showed exemplary skills in the setting out of calculations and the inclusion of the relevant units. More able candidates should be encouraged to work out calculations involving industrial quantities i.e. tonnes, using reacting ratios, rather than always converting all masses to grams and then back to tonnes. Such working is unnecessary and leads to arithmetic errors.

New syllabus areas were well attempted. Energy level diagrams were problematic for some candidates. Where understanding of environmental issues is tested, candidates need to ensure that they make clear, scientific points. Vague answers that mention ‘pollution’ will not score.

Some Examiners again commented on the need for using the lined pages provided for answering ***Section B*** questions. Some candidates are including part answers on pages where the questions are printed. This should be discouraged, because answers not on the lined pages may be mistaken for rough work.

Comments on specific questions

Section A

Question 1

Fewer candidates than usual scored full marks for the introductory question, although most scored at least four of the possible six marks. Common errors were naming hydrogen as the gas used to make ammonia for **(a)(ii)**, which did not score, as it was not one of the gases available for selection from the table. The diagram of the gas particles for part **(v)** was well answered, but many candidates drew the gas particles at spacings not much greater than those of the solid. Some candidates misread or misunderstood the meaning of the word ‘higher’ in part **(b)**, and wrongly gave ‘nitrogen’ as the answer to **(ii)** i.e. the gas present in the *highest* percentage, rather than carbon dioxide, the gas whose percentage becomes *higher*.

Question 2

The candidates showed good understanding of the new area of the syllabus tested in this question. For **(a)** most knew that UV caused harm to humans, but many scored only one from the possible two marks. Some answers did not make it clear that ozone depletion allows more UV through to the surface of the earth, some showed only partial understanding of the harmful nature of UV e.g. ‘causes cancer’. Better answers clearly stated skin cancer or cataracts as resulting from increased UV exposure. The dot and cross diagram was well done by more able candidates. Common errors were to omit the six non-bonding electrons from the fluorine atoms or to add an additional electron to each hydrogen. For part **(c)** too many gave the formula ‘HF’ when the question clearly asked for the name of the product. Some gave the name as ‘hydrofluorine’. For **(iii)** a surprising number of candidates thought that the rate of reaction depended on the mass of bromine compared to fluorine, sometimes discussing diffusion rates, rather than the relative reactivity of the two halogens.

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Question 3

This question was very well answered. Only very weak candidates failed to score the marks for kn of sub-atomic particles in **(a)**. Some candidates unfortunately used a dash '-' to show the charge neutron. This was ambiguous, as it could have been a negative sign, or could imply no charge, and so answer did not score. Candidates found **(b)** challenging. T^+ and T^{2+} were very common answers. Marks were lost in **(c)** due to vague answers e.g. 'tritium has similar properties to hydrogen'. This repeated the question and so did not score – a clear link to the state of water or 'hydrogen oxide' was needed. Some answered by discussing tritium as an element, and hence said that it was a gas, like hydrogen.

Question 4

This question asked for *similarity* and a *difference* between two *structures*. Candidates did not always use ideas about structures, but gave vague answers which did not score. When a *difference* is asked for, it is important that the answer makes a comparison e.g. 'Propene contains a double bond, propane does not.' scores 1, but 'Propene contains a double bond.' is not enough to score.

Part **(a)** was well answered, most candidates correctly stating that both structures contain 3 carbon atoms or are hydrocarbons. Some believed that propane contained four carbons. The difference between the molecules was not so well answered, with too many failing to give a *structural* difference, as stressed in the question. Hence, answers which used the terms 'saturated' and 'unsaturated' only, did not score; a mention of the double bond was needed.

Parts **(b)** and **(c)** were mostly correct, although some candidates tried to display the C_6H_5 part of the molecule – this was not necessary. Nearly all knew that carbon dioxide is produced by complete combustion, but surprisingly, many gave hydrogen as the second product. In discussing environmental issues, such as the advantages of disposing of polystyrene by burning, it is important that the candidates make clear, scientific points. Vague responses e.g. 'no air pollution' 'no land pollution' etc. did not score here. Better answers included 'the energy produced can be used to generate electricity', or 'less space needed for landfill sites'. A wide range of answers was given credit.

Question 5

This question tested a new syllabus area, and a wide spread of achievement and understanding was shown by the candidates. Many candidates showed only partial understanding of the conventions used in energy level diagrams. Most knew that the peak was related to the activation energy, some drawing a label which pointed to the top of the curve. Many did not correctly draw a vertical line from the level of the products to the level of the top of the curve. (Candidates were not penalised for double headed arrows or lines with no arrows, but by convention, the arrowhead should point upwards). In drawing a catalysed reaction profile, many candidates moved the curve to the left or the right, rather than drawing a lower curve. Weaker answers moved one or both of the reactant and product lines to a lower level.

A great deal of confusion was revealed by candidate's answers to **(iii)** about exothermic reactions and bonds. Many discussed energy needed for breaking bonds (correct) compared to energy needed (incorrect) for making bonds. Some believed that it was the number of bonds made and broken that was important. Only very good candidates scored all three marks here. Part **(b)** was well answered, although a surprising number of answers gave 'lead' and explained that this is a 'transition metal'.

Question 6

Answers to this question showed that candidates have a good understanding of redox and can discuss redox reactions in a number of ways; by oxygen or electron transfer, and by using oxidation numbers. Some lost marks in **(a)(ii)** by discussing how iron oxide had been reduced, which did not answer the question, rather than how carbon monoxide acts as a reducer i.e. by acting as an oxygen acceptor/electron donor. Part **(b)** scored poorly. Again, if environmental issues are tested it is important that answers show some scientific content to score. 'Saves waste' 'reduces land pollution' etc are too vague. Better answers included 'Saves finite iron resources', and 'Energy for recycling metals is less than extraction'. The calculation was well done, but some candidates could not convert the ratio 0.9:1.2 into the formula Fe_3O_4, hence scoring only two marks.

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Section B

Question 7

This question was well answered, with most candidates scoring at least 8 marks. For **(a)** some failed to identify carbon monoxide as the hazardous gas. Most gave excellent accounts of the formation of carboxyhaemoglobin. In **(b)** some candidates gave confused responses which lacked focus and clarity and so failed to score e.g. 'sodium carbonate is too reactive to decompose', 'the bonds are too strong'. To score full marks it was necessary to discuss why each reaction in turn would not occur for sodium compounds.

Part **(c)** was very well answered. Candidates clearly know this new syllabus area very well. A very few weak candidates confused global warming with acid rain or ozone depletion. In part **(d)** it was necessary to organise information about two experiments sequentially to gain five marks. Some candidates did not manage to address all the points and so did not score fully e.g. equations or gas tests were omitted, despite being asked for in the question. Many candidates gave incorrect observations here e.g. formation of brown/dirty green precipitates. Predicting observations is an area where candidates are less well skilled. Where equations were given they were usually correct, the commonest error being using the formula '$ZnCl$' for zinc chloride.

Question 8

This question was extremely well answered, many scored full marks, despite the question containing several marks for graph interpretation and calculations in an unfamiliar context. All knew the ions present in aqueous copper(II) sulphate, although a very few gave O^{2-} rather than OH^-. Similarly **(b)** was answered very well. Common equation errors were to reverse the equation or to give a wrongly balanced equation. Candidates should note that Examiners accept 'e' or 'e-' or 'electron' to represent electrons in an equation. Other abbreviations such as 'ele' or 'ele-' are not acceptable and will not score. A very few named and tested hydrogen, rather than oxygen, as the anode product. Some candidates tested for oxygen using a lighted rather than a glowing spill. The graph and calculation for **(c)** was very well done by all candidates, with exemplary care in presentation of working and use of units.

Question 9

This question was the least popular choice, although candidates scored well if they attempted it. In **(a)**, all suggested correctly that the rate would increase, but many gave only a partial explanation that this was due to more collisions, rather than the fully correct 'more frequent collisions.' Some candidates believed that increasing pressure increases energy. Part **(ii)** was poorly answered, with almost all candidates wrongly stating an increase in yield would result. The effect of pressure on equilibrium reactions involving gases is not well understood.

Part **(b)** was straightforward for all – the effect of surface area on rate is very well known. For **(c)** the calculation was well done, but many candidates carried out the working by very laboriously converting to grams. Few used direct reacting ratios. Some stopped at the first stage giving 720/24 = 30 g as the full answer. The equation proved difficult – candidates found adding the equations difficult. Multiples of the correct equation were allowed to score. Very few correctly cancelled the numbers down correctly i.e. '$4NH_3 + 8O_2 \rightarrow$ …' was seen more often than '$NH_3 + 2O_2 \rightarrow$ …'

Question 10

Candidates tended to score very high marks here – the manufacture of sulphuric acid is very well known. Surprisingly, many did not know that calcium carbonate comes from limestone. 'Lime' '$Ca(OH)_2$' and 'Calcium oxide' were very commonly seen. The equation was given by all but the weakest candidates. Again, most converted quantities to grams and back again when carrying out the calculation. Although correct, this is unnecessary. More able candidates should be encouraged to work using reacting ratios.

The sulphuric acid manufacture was very well known, with many scoring all six available marks. Errors included failing to identify at which stage the catalyst was used – some implied that vanadium(V) oxide was involved when sulphur trioxide reacts to form oleum. Some did not mention the need for reacting sulphur trioxide with concentrated sulphuric acid. The equations were very well done. Please note that where a description of a process is tested, candidates should not use formulae as abbreviations in their written description. Formulae should be used in the equations, but the compounds should be named in their main answer.

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Paper 5070/03

Paper 3 - Practical Test

General comments

The overall standard was very high and candidates are to be congratulated on the way they tackled the examination. Only a minority of candidates were unable to demonstrate significant practical skills.

Comments on specific question

Question 1

(a) The titration was exceptionally well done, with most candidates scoring full, or nearly full marks. Although redox titrations, using potassium manganate(VII), are relatively straightforward, the overall standard was very pleasing. Full marks were awarded for recording two results within 0.2 cm^3 of the Supervisor's value and then for averaging two or more results which did not differ by more than 0.2 cm^3.

Teachers 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 the majority of candidates do carry out this procedure carefully, a small 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 Teachers are asked to reinforce this message.

It is clear that a few candidates 'alter' their results at a late stage to 'improve' them. This often leads to candidates losing marks. It is always advisable to record results as soon as possible and to have confidence in their accuracy.

(b) Most candidates were able to calculate the correct concentration of the solution **Q** which was iron(II) sulphate. Only a few inverted the volume ratio and even fewer used anything other than the correct 5:1 mole ratio. The answer was required to three significant figures and fewer candidates than usual over approximated.

(c) This part of the question asked candidates to use their answer to part **(b)** to calculate the percentage of iron(II) that had been oxidised by the air. To do this candidates were required to subtract their answer to **(b)** from the original concentration (0.125 mol/dm^3) and to express their answer as a percentage. The majority were able to do this successfully, the most common error was to simply give the answer to (**b**) as a percentage of the original concentration. There was a suggestion that some candidates might have thought that they were required to calculate the percentage of the iron(II) sulphate which had been oxidised by the potassium manganate (VII) in the titration, but in most cases, this did not seem to be the case.

Question 2

Candidates found this a demanding exercise, and the overall marks were lower than usual. Marks were usually lost for incomplete rather than incorrect observations. Most candidates used the correct terminology to describe colour changes and the formation of precipitates. When a reaction produces a number of changes, candidates are expected to record them all, not just the final result.

Test 1

When dilute hydrochloric acid is added to **R** (sodium thiosulphate), there is no initial reaction and the solution remains colourless. A white precipitate forms gradually and this slowly becomes yellow. All three of these observations were required. Warming the solution produces sulphur dioxide, which turns potassium dichromate (VI) green. The fact that the gas turned litmus red also gained some credit. A surprising number of candidates thought chlorine was evolved, possibly linked to the reactions with aqueous silver nitrate which appear later in the question. Ammonia and carbon dioxide were also claimed by a significant number of candidates.

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Test 2

Addition of **R** to acidified potassium manganate (VII) causes that solution to be decolourised. Wh stand a precipitate of sulphur also forms. Clear is not an acceptable alternative to colourless, but in th any indication of a white or yellow solid did score.

Test 3

Addition of an equal volume of aqueous silver nitrate causes the formation of a white precipitate which rapidly begins to darken in colour, turning yellow then red and finally black. All these changes were required, but a range of colours were acceptable for the intermediate colours.

Test 4

When excess silver nitrate is added rapidly, the white precipitate which still forms initially, dissolves to produce a colourless solution. As this is a difficult test to carry out, candidates whose precipitate did not dissolve completely or who obtained pale yellow/brown solutions also scored the marks.

Test 5

When an excess of **R** is added to iron(III) chloride the solution becomes very dark red or purple in colour. Black is not an acceptable colour for a solution and there is no precipitate formed at this stage. The dark red solution rapidly becomes paler, finally becoming virtually colourless. Any 'paler' colour was acceptable, provided it was linked to a solution and not a solid. When aqueous sodium hydroxide is now added a green precipitate of iron(II) hydroxide is formed. Candidates who failed to use the correct ratio of **R** to iron(III) chloride initially either obtained a red/brown precipitate of iron(III) hydroxide, or a black precipitate which contains a mixture of iron(II) and iron(III) hydroxides. Candidates should be encouraged to read the instructions carefully and to use the stated quantities.

Test 6

When **R** is added to aqueous copper(II) sulphate the solution changes colour from blue to green and there is no precipitate. Addition of aqueous sodium hydroxide now produces a precipitate which is blue for a very short time before becoming green. A small number of candidates saw this change in colour and should be congratulated on their powers of chemical observation. When dilute sulphuric acid is added the precipitate dissolves to form a pale yellow solution. A range of colours were allowed throughout this test.

Conclusions

The formation of sulphur dioxide in *Test 1*, allows the conclusion that the anion in **R** contains the element sulphur. A number of sulphur containing anions were also suggested but these did not score. It is important that candidates read the question carefully before committing themselves to an answer. The formation of a green or black precipitate in *Test 4* confirms that **R** has acted as a reducing agent, converting the original iron(III) chloride into a compound containing iron(II).

Paper 5070/04
Alternative to Practical

General comments

This 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, analysis of unknown salts and calculations.

The standard in general is being maintained and the majority of candidates show evidence of possessing many of the aforementioned skills.

Most candidates show competency of plotting points on a graph although a common error is not to use a ruler to connect points, which are in a straight line, although instructed to do so.

It is also of concern that a large number of candidates confuse the tests for Oxygen and Hydrogen. A glowing splint is not a test for Hydrogen, the gas requiring a flame to produce the characteristic 'pop'.

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Comments on specific questions

Question 1

This experiment determines the percentage composition of Nitrogen in air, this being the gas, which does react with the copper.

(a)(i) The gas is Nitrogen and **(ii)** the volume remaining in the syringe is 72 cm^3.

(iii) This gives a percentage of Nitrogen as 80%.

(iv) The copper compound is copper(II) oxide, of formula CuO which is black. Candidates who omitted the oxidation state of copper in its name lost a mark.

(b)(i) The two products were copper and water. The question asks for names. Candidates who gave formulae were penalised a mark.

(ii) The purpose of the hydrogen is to reduce the copper(II) oxide.

(iii) A test for hydrogen is the production of a 'pop' with a flame. A large number of candidates continue to give the oxygen test using a glowing splint.

Question 2

This question proved to be the most difficult on the Paper for many candidates.

(a)(i) Following the reaction a yellow precipitate was produced which is removed by filtration.

(b)(i) To answer this part of the question it is necessary to calculate the number of moles of each of the reagents i.e. 0.05 and 0.06 moles of potassium iodide and silver nitrate respectively. This means that silver nitrate is the excess reagent.

(ii) To calculate the mass of silver iodide requires the use of the limiting reagent which is potassium iodide. By multiplying the molar mass of silver iodide, 235g by 0.05 = 11.75g.

(c)(i) Silver chloride is a white precipitate, which darkens on standing.

(ii) The mass of silver iodide produced will be more than silver chloride as the molar mass of silver iodide is greater than that of silver chloride.

Questions 3 – 6

The correct answers are **(c)**, **(d)**, **(a)**, **(b)**.

Question 7

(a) The mass of fertiliser weighed out is 1.76 g.

(b) Any correct test for ammonia scores the mark. The two most commonly given are litmus turning blue and white fumes produced from exposing ammonia to hydrogen chloride gas or acid fumes. For the latter test it is not acceptable to add hydrochloric acid, an answer seen on a number of scripts.

(c) The colour change at the end-point is either red, pink or purple to colourless.

(d) The volumes of hydrochloric acid produced from the titrations were 27.6, 27.1and 27.3 giving a mean value of 27.2 cm^3. Candidates are asked to tick their best titration results. This is very important where a candidate incorrectly reads the burettes giving volumes of acid not always obvious as to which have been used to calculate the mean. The correct calculations are : (e) 0.00272, (f) 0.00272, (g) 0.0272, (h) 0.05, (i) 0.0228, (j)(i) 0.387 g, (ii) 22.0 g.

Candidates should maintain three significant figures throughout the calculations. Failure to do so is penalised once only. Any incorrect answer may be consequentially used to gain the remaining marks.

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Question 8

This question involves the analysis of the salt zinc chloride, $ZnCl_2$.

Test 1 - A colourless solution is obtained. Answers stating a colourless compound would lose the ma *Tests 2* and *3* produce a white precipitate, which is soluble in excess. Candidates should not use solid, deposit or compound instead of precipitate. *Test 4* - The test for a chloride is the addition of nitric acid and silver nitrate to produce a white precipitate. Care should always be taken to ensure that the acid is the correct one. Many otherwise good answers are spoilt by the use of hydrochloric acid or in many cases by the unspecific use of the word acidify.

Question 9

(a) The precipitate is barium sulphate of formula $BaSO_4$.

(b) The correct masses of precipitate are 0.93, 1.20, 1.86, 2.33, and 2.33g.

(c) When plotted on the graph candidates are instructed to join the points with two straight lines. The first four points fall on an angled straight line, which then becomes a horizontal line with the final two points.

(d) The point 1.20 is obviously the incorrect point as it is below the line, the correct value taken from the line is 1.40. Candidates whose line followed all the points including the incorrect one lost a mark.

(e) The volume of **K** producing 1.60 g of precipitate is 6.8 cm^3.

(f) The masses of precipitate were the same in the last two experiments because the experiment had finished. Other better answers included that all the barium chloride had been used but a similar statement involving sulphuric acid was incorrect.

(g) The last part of the question requires the candidate to recognise that whatever the volume of **K**, the volume of **J** is the limiting factor, hence the mass of precipitate is 0.47 g in all three cases.