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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**.

CHEMISTRY

GCE Ordinary Level

Paper 5070/01
Multiple Choice

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

General comments

Only one question, **Question 18**, was found to be easy by almost all the entry. **Question 28** produced a great deal of guessing. Except for the two questions already referred to the Paper discriminated well between the candidates and proved to be a good test of knowledge and understanding.

Comments on specific questions

Question 5

This was one of the few questions where an incorrect alternative was more popular than the correct answer. Candidates had to realise that sulphuric acid was a diprotic acid.

$$H_2SO_4(aq) \rightarrow 2H^+(aq) + SO_4^{2-}(aq)$$

Question 9

The diagrams of diamond and graphite were very well known and for most of the entry the question was a choice between alternatives **A** and **C**. Metals are a lattice of positive ions in a "sea of electrons" which was alternative **C**. Alternative **A** was a lattice of positive and negative ions which is the structure of an ionic compound such as sodium chloride.

Question 10

Alternative **A** was a strong distractor since the correct combination of X and Y produced $CaCl_2$ a well-known compound. However, ionic compounds have high melting and boiling points and calcium chloride would not be expected to be gaseous.

Question 15

A sound knowledge of the electrolysis of concentrated aqueous sodium chloride is required by the syllabus. Hence changing sodium chloride to rubidium chloride, another Group I chloride, would not change the products of electrolysis.

Question 24

A high proportion of the candidates incorrectly thought that the melting point of the elements increases down Group I, possibly because the relative atomic mass of the elements increases down the Group. The melting point of the elements decreases down Group I because the strengths of the metallic bonding decreases.

Question 32

A great deal of guessing occurred in this question. This question was intended to test the simple recall of a statement in the syllabus concerning the manufacture of hydrogen by the cracking of oil.

Paper 5070/02

Theory

General comments

This Question Paper generated a wide range of marks, from single figures to close to the maximum. Some very good scripts were seen and the majority of the candidates must be congratulated on the clarity of the presentation of their answers.

This year, ***Section A*** proved to be more difficult than usual and high marks were rare. Conversely, ***Section B*** resulted in higher marks than in previous years.

Many of the questions in both sections contained points that even the strongest candidates found testing. There was no evidence of candidates having problems in completing the Paper in the time allocated.

As in previous examinations, a common fault was the failure to respond to the precise wording of the question. Candidates should be advised to read and think before they begin to write. Note that when the question asks for the name of a material, then the formula may not be accepted.

Comments on specific questions

Section A

Candidates found this section to be rather difficult and marks over 35 were rare. Fewer than 20 was a frequent score. All seven questions contained something that caused problems, even for the better candidates.

Question 1

Just three or four was a common score and all five marks was rare.

(a) Both bromine and sulphur were given as forming a basic oxide.

(b) Bromine was the most common answer, but iodine was a popular incorrect suggestion.

(c) Hydrogen as reacting with aqueous copper(II) sulphate was a frequent error.

(d) The correct answer, hydrogen, was the mark scored most frequently in this question.

(e) Ignoring 'giant' in the question, bromine and sulphur were common answers.

Question 2

As for **Question 1** it was unusual for all eight marks to be scored.

(a) Although the mark allocation for this section was shown as four, many answers did not contain four points. Any three from fermentation, yeast, using glucose solution and a temperature in the range 20° to 40° C were allowed. The fourth mark for the equation was rarely scored. Either the equation was unbalanced or there was no attempt at the equation.

(b) The displayed formula in **(i)** was usually correct, as was the name, water or steam, in **(ii)**. In **(iii)**, phosphoric acid as the catalyst was well known. For the temperature and pressure, specific figures were required. Temperatures in the range 300° to 400° C and pressures of 40 to 80 atmos were allowed. No credit was given for generalised statements such as high temperature or high pressure.

Question 3

A generally high scoring question with many candidates gaining all eight marks.

(a) Well known. Some indication that carbon and hydrogen are the only elements present was required.

(b) With the wide range of acceptable answers available, incorrect suggestions were rare.

(c) All four marks in this section were frequently gained. One type of error seen in **(i)** and **(ii)** was a result of not reading the question. Two formulae of specific compounds were required. Names and general formulae were not accepted. The tests in **(iii)** were very well known.

Question 4

Most candidates scored some marks on this question but full marks were rare.

(a) Either the phrase 'global warming' or a specific example of this effect was accepted.

(b) A source of methane was not well known. Car exhausts was a common misconception.

(c) In order to score, the candidates were required to refer to the greenhouse factor given in the table. Many irrelevant accounts of the removal of carbon dioxide in photosynthesis were seen.

(d) Only about half of the candidates mentioned ozone depletion. Skin cancers and some effect on plant growth are examples of unacceptable answers.

Question 5

There was a wide range in the quality of the answers to this question.

(a) Almost every candidate scored this point. Some thought that the water evaporated.

(b) Either reference to the balance readings or to the effervescence ceasing was accepted. Some suggested that the marble had completely reacted.

(c) The two calculations in **(i)** and **(ii)** were very well answered and figures other than 0.10 moles of acid and 0.02 moles of carbonate were rare.

In **(iii)**, not many candidates could use these two figures to show that an excess of the acid was present. An excess of the acid because 0.10 is greater than 0.02 was a frequent suggestion. Others ignored the equation given in the question and worked with a 1:1 mole ratio.

(d) That the rate would increase was well known. Reference to an increase in the frequency of collisions was often omitted.

Question 6

This was the question in this section most likely to lead to a zero score for the weaker candidates. Stronger candidates could score all six marks.

(a) Failure to mention pH at all by stating that the change was from acid to alkali was the most frequent error.

(b) This ionic equation was not often correct. Many candidates gave a molecular equation.

(c) The meaning of 'acid' in **(i)** was well known but the response to **(ii)** was poor. Confusion between strength and concentration was frequent. That a strong acid gave more hydrogen ions than a weak acid was a typical attempt.

(d) Again, the ionic equation was not well done. Many had an Mg^{2+} ion on the left-hand side or only one H^+.

Question 7

The candidates found this to be the most difficult question in this section.

(a) That the ions cannot move was the only possible answer. Movement of electrons and movement of molecules were very frequent errors.

(b) Very few candidates could score on this section. There were many lengthy accounts of the transfer of electrons between the atoms of the elements. Melting points, determined by the attractive forces between the ions was not understood.

(c) Many good diagrams were given and for some candidates this was the only section in this question to score. Common errors were to omit the inner electron pair and failure to show any charges on the ions.

Section B

Many candidates scored highly on this section and, with the exception of **Question 8**, full marks were often awarded.

Question 8

This was by far the least popular question and also the one leading to the lowest scores.

(a) The source of oxygen was better known than that of hydrogen. Electrolysis of water was not accepted as a source of either gas.

(b) The name of the electrolyte was well known.

(c) Ignoring the equations given in the question, oxidation was a more popular choice than the correct response of reduction. With just one mark available, only the reason for the selection of reduction gained credit.

(d) This calculation caused problems for many candidates. Although the question specifically asked for the volume of oxygen needed, this figure was missing from many answers. An incorrect connection between the volume of oxygen and the mass of water formed resulted in many answers of either half or double the correct figure of 180 g of water.

(e) About the only valid advantage seen with any frequency was that water as the only product causes no pollution problems. Vague references to cost were not accepted, expensive electrodes were allowed. Although the question showed that the fuel cell was for use in a space shuttle, difficulty in transporting the cell was a commonly quoted disadvantage.

Question 9

A popular and generally high scoring question.

(a) Both sections of this question were well answered. Some candidates gave their answer on page 11 of the Question Paper.

(b) Failure to read the question resulted in structures for pentanoic acid rather than propanoic acid. Candidates should be advised that a displayed formula requires inclusion of the bond between O and H in an acid.

(c) Many correct calculations were given. Since the question asked for an empirical formula, the answer, HCO_2H, was not accepted.

(d) The names of the products were scored more often than the equation. An incorrect formula for magnesium ethanoate was the main problem. Again, failure to read the question was the reason for the answers using magnesium rather than magnesium oxide.

(e) The reaction with ethanol was usually scored but the use of concentrated sulphuric acid in this reaction was often omitted. Many candidates included a correct equation in their answer. In that this equation was not required by the question, additional credit could not be allowed.

Question 10

A popular and high scoring question.

(a) This tended to be a three or zero section. Energy required to make bonds was a common error. Disregarding the structural equation given in the question, many stated that more bonds are formed than are broken.

(b) Many candidates could arrive at 222.5 kJ. The Examiners allowed –222.5 kJ but the unit kJ/mol was not correct here.

(c) These diagrams varied widely in quality. A common error was the failure to indicate where the reactants and the products were on the diagram. The question asked for labels for both the activation energy and the enthalpy change. Although the activation energy was usually shown, an indication of the enthalpy change was often missing.

(d) This diagram was almost always correct.

Question 11

The most popular and also the highest scoring question in this section.

(a) Many equations were correct. N for N_2 was the most frequent error.

(b) Answers to **(i)** and **(ii)** were usually correct. In **(iii)**, calcium oxide was the common error.

(c) Both an oxidising agent and a catalyst were acceptable answers. For those choosing an oxidising agent, the reason had to include some explanation of oxidation. Mere repetition of the words oxidation and reduction was insufficient.

(d) Many correct statements were seen. Some lengthy descriptions of this process were given but they usually included the key facts of a temperature in the range 450° to 600° C and vanadium(V) oxide as the catalyst. With reluctance, the Examiners allowed the name vanadium oxide for the catalyst. Referring to the question, a formula was not accepted.

Paper 5070/03
Paper 3 – Practical Test

General comments

The overall standard was pleasing with many candidates demonstrating a sound understanding of both qualitative and quantitative techniques.

Comments on specific questions

Question 1

(a) *Reactions of hydrogen peroxide*

This proved to be the most difficult part of the Paper. Many candidates lost marks for incomplete, incorrect, observations and the 'chemical' language used was often contradictory, e.g. many candidates recorded the formation of "soluble precipitates".

Test 1

The addition of potassium dichromate(VI) to an acidified solution of hydrogen peroxide produces a very dark blue or purple solution, which rapidly begins to effervesce and turn green. As is always the case, candidates were expected to make the observation (effervesces or bubbles), test for the gas (relights a glowing splint) and then to name the gas (oxygen). A large number of candidates lost marks by failing to include all three pieces of information. There was the usual confusion with hydrogen which 'pops' with a *lit* splint and oxygen which relights a *glowing* splint, often with a 'pop'. A range of colours was allowed, but not black or dark and marks were lost for reporting coloured precipitates rather than solutions.

Test 2

With equal volumes of hydrogen peroxide and potassium iodide a *solution* of iodine is produced, the colour of this solution will lie between yellow and brown depending on the precise concentrations used. Candidates who reported a black precipitate (or similar) had used too much hydrogen peroxide and did not score.

Test 3

When hydrogen peroxide is added to aqueous iron(II) sulphate, oxidation takes place and the solution becomes noticeably more yellow, there is no precipitate at this stage. Subsequent addition of aqueous sodium hydroxide produces the usual red/brown precipitate of iron(III) hydroxide. This was often accompanied by the decomposition of any excess hydrogen peroxide and the evolution of oxygen gas.

Test 4

The addition of **S** (manganese (IV) oxide) to the hydrogen peroxide catalyses the decomposition and vigorous effervescence is seen. Candidates were again expected to report the observation and test for and name the gas. Leaving the mixture to stand should have enabled candidates to see that **S** settles and has not changed its state, allowing the later conclusion that it had not been used up and had acted as a catalyst. There are no additional precipitates formed and the solution remains colourless, once **S** has settled and the effervescence has slowed.

Conclusions

The formation of a brown precipitate of iron(III) hydroxide with sodium hydroxide in Test 3 indicates that the original iron(II) sulphate has been oxidised and that the hydrogen peroxide had acted as an oxidising agent.

Similarly **S** remains unchanged in Test 4 and has therefore acted as a catalyst.

Many candidates had great difficulty with these conclusions with many guessing and changing their minds several times. It is always the case that conclusions come from the experimental observations and candidates are not expected to know the theoretical answer.

(b) *Determination of the concentration of hydrogen peroxide*

Although most candidates coped well with the relatively difficult manganate (VII) titration, there were a number who appeared to have never carried out a titration before and therefore failed to score many marks. Full marks were awarded for 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 all 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' 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 results (or none at all) and often use another value in the summary. Another common fault is for candidates to average all their results even if they had 'ticked' only one result. When carrying out titrations, candidates are expected to use their chemical judgement and sometimes reject some of their values.

(c) The calculation of the concentration of hydrogen peroxide was not well done, with many candidates making no attempt at this part of the Paper.

Most candidates who scored the marks in part **(c)** did so by using the basic equation:

$$\frac{\text{Conc. } H_2O_2 \times \text{Vol. } H_2O_2}{5} = \frac{0.02 \times \text{Vol. } KMnO_4}{2}$$

Any equivalent method involving calculating the number of moles of hydrogen peroxide in 25 cm^3 (or 20 cm^3) of solution, as the first step, was equally acceptable. Answers were required to three significant figures. It is an important skill to recognise that titrations are an accurate method for determining concentrations and using the correct number of significant figures is a way of recording this.

Question 2

It was intended that this part of the Paper would be relatively straightforward to balance a difficult **Question 1**. This did not appear to be the case and answers were, in many cases, disappointing.

Tests on Solution **T** (zinc sulphate)

Tests 1 and 2

Addition of either aqueous sodium hydroxide or aqueous ammonia to zinc sulphate produces a white precipitate which dissolves in excess to give a colourless solution. Whilst many candidates scored full marks in these two tests, many lost marks by failing to describe the colourless nature of the final solution. Clear and colourless are not the same. More worryingly many simply described the initial reaction as turning the mixture 'milky or cloudy' neither of which are acceptable terms.

Test 3

There is no reaction with silver nitrate or when nitric acid is subsequently added. Candidates often tried quite hard to describe some sort of chemical change but they should recognise that there will occasionally be Tests which do not have any positive observations to report.

Test 4

With barium nitrate, zinc sulphate produces a white precipitate which does not dissolve on the addition of nitric acid. As in Tests 1 and 2 many candidates lost marks by using imprecise descriptions, 'turns milky' was again very common.

Conclusions

In the introduction, **T** was described as a "simple salt" and the intention was that this would indicate that it contained one positive and one negative ion. Surprisingly many candidates gave either two positive ions (often aluminium and zinc) or two negative ions (chloride and sulphate). Candidates could use either names or correct formulae for the ions and as always conclusions required correct observations to score.

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 apparatus and their uses, recall of experimental procedures, handling and interpretation of data including the drawing and interpretation of graphs, analysis of unknown salts and calculations are to be tested. The standard in general continues to be maintained and the majority of candidates show evidence of possessing many of the aforementioned skills. Most candidates show competence of accurately plotting points on graphs although the connecting of these points freehand, rather than using a ruler to draw a straight line occurs too frequently. A large number of candidates continue to confuse the tests for oxygen and hydrogen. This has been mentioned in previous reports. The rounding up and down of answers to calculations should be discouraged and the appropriate number of significant figures should be carried through all calculations.

Comments on specific questions

Question 2

(a) Aqueous ammonia turns litmus blue.

(b) The gas evolved is ammonia, which is confirmed by litmus turning blue or any other correct test such as the formation of white fumes with a stopper from a bottle of concentrated hydrochloric acid, not dilute hydrochloric acid. Several candidates stated that the gas is oxygen or hydrogen. These answers are incorrect but for these two gases, only, a correct test for either gas, could score the last two marks.

(c)(i) The other essential element is nitrogen.

(ii) The molar mass for ammonium phosphate is 149, which gives an answer of 208 g of phosphorus produced from 1 kg of the salt. Several candidates lost the second mark by not stating the unit of mass with the answer, i.e. 208 g or 0.208 kg. The second mark may be obtained, if an incorrect molar mass is correctly used to calculate a mass of phosphorus. Candidates must show all their working, as an incorrect answer alone, scores no marks.

Question 3

(a) Although the correct answer is 5.80 g many candidates wrote it as 5.8. All candidates should maintain the number of significant figures with any calculation answer.

(b) The correct acid is nitric acid.

(c)(i) The heating is done in the fume cupboard to ensure that students are not exposed to the poisonous gas, nitrogen dioxide. The toxicity of the gas is the point to mention.

(ii) The dish was reweighed to ensure that constant mass was obtained, indicating that decomposition is complete. Answers suggesting that it is to check that the first weight was accurate, were not acceptable.

(iii) The mass of magnesium oxide was 5.50 g giving a percentage yield of ....

(d) 94.8%.

(e) This question allows candidates to think of any possible errors that may have occurred during the experiment. Answers included: "the initial sample of magnesium oxide was impure", or "a small amount of the powder was lost or solution was spilled when carrying the dish". It was pleasing to see a large number of candidates thinking about the question and producing some appropriate answers.

Questions 4 - 8

The correct answers are **a**, **d**, **b**, **d** and **a** respectively.

Question 9

(a) The correct apparatus is a pipette.

(b) The colour change is yellow to orange, pink or red.

(c) The reading of the burettes was generally excellent. However, many candidates do not indicate which titres have been used to calculate the average volume to be used in the calculation. Candidates should always indicate the titres to be used with a tick in each case.

(d) The correct answer is 0.003 moles.

(e) The candidate's average volume is used to calculate the answer which is 0.001 moles, if 22.3 cm^3 was used as the average.

(f) This answer is the result of dividing answer **(d)** by answer **(e)**. Candidates are expected to give an accurate answer to this calculation which is then rounded up or down for the answer to part **(g)**.

(g) The value for *x* is 3, which should then be used to produce a balanced equation for **(h)**. Any other calculated value for *x* may be appropriately used in an alternative equation.

Question 10

(a) Any inert electrode is acceptable, the most popular choice being carbon or graphite.

(b) Copper is deposited at electrode E. Although the answer 'cathode' is correct, the letter of the electrode must be stated as requested in the question.

(c) A gas or effervescence is seen at the other electrode. It was not necessary to state which gas, as unless tested, its identity cannot be confirmed.

(d)(i) The total increases at 30, 40, 50 and 60 minutes are 1.35, 1.80, 2.25 and 2.25 g respectively.

(ii) These masses should be plotted on the graph and connected by two straight lines using a ruler. Any incorrect increase in mass in **(d)(i)** could obtain marks subsequently, providing that these incorrect points are accurately plotted and connected on the graph.

(iii) A correctly plotted graph will give an answer of 35.5 minutes for the time taken to deposit 1.60 g of copper.

(iv) The last two readings are identical, as there is no more copper or copper ions remaining in the solution. Alternative answers, suggesting that the electrolysis was finished or complete, were acceptable.

(e) The colour is blue at the start of the experiment and colourless at the end. Many candidates use the word clear instead of colourless or give answers such as bluish or lighter blue, all of which are incorrect.

(f) To gain the mark, candidates must draw a straight line on the existing angled line and extend it further to give one straight line only.

(g) The final colour is blue.

Question 11

(a) The test will give a white precipitate to confirm the presence of sulphate ions.

(b) Effervescence is seen producing a gas, which turns lime-water milky.

(c) The test for iodide ions requires the addition of nitric acid followed by aqueous lead(II) nitrate. There is a mark for the word aqueous to describe the state of lead(II) nitrate. The large majority of candidates scored well on this question indicating a sound knowledge of experimental inorganic analysis.

Question 12

(a)(i) Apparatus **M** is a fractionating tube or column and is used to,

(ii) Separate liquids or vapours, separate being the important word.

(iii) Apparatus **N** is a condenser and is used to,

(iv) Cool or change vapours to liquids. An answer stating that it is used to condense vapours was insufficient as it does not explain the meaning of the word, condense.

(b) The hydrocarbon mixture is very flammable thus a water bath is used, for safety reasons, rather than a flame to heat the mixture.

(c) The reading on the thermometer was 69°C when the first few drops distillate were seen.

(d) The candidates knew that all the first alkane had distilled over when the thermometer showed an increase in temperature.