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

General comments

All the questions, with perhaps the exception of **Question 35**, discriminated well between the levels of ability of the candidates.

Comments on specific questions

Question 2

The syllabus stresses the need to use locating agents in the chromatography of colourless compounds. Thus, the very popular alternative **D**, which stated that the mixture undergoing chromatography must contain substances that are coloured, was incorrect.

Question 9

Sand has a giant molecular structure in which each silicon atom is covalently bonded to four oxygen atoms and each oxygen atom is covalently bonded to two silicon atoms. Therefore alternative **B**, a simple molecular structure, and alternative **C**, showing oxygen only forming one covalent bond were both incorrect. Thus the choice was between alternatives **A** and **D** with only **A** showing a structure stretching in every direction and dimension.

Question 10

Sodium chloride is one of the examples given in the syllabus of ionic bonding. Thus alternatives **A** and **D**, both of which were related to properties concerning covalent bonding could be ignored. Although the idea that sodium chloride consisted of molecules was very popular.

Question 16

An aqueous solution always contains H^+ and OH^- ions from the water present. Also in this question the aqueous solution contains K^+ and Cl^- ions from the potassium chloride. Hence the positive ions H^+ and K^+ move towards the cathode and the negative ions OH^- and Cl^- ions move towards the anode.

Question 17

Metals, e.g. mercury conduct electricity without decomposition. Ionic compounds when aqueous or molten conduct electricity with the formation of decomposition products making alternatives **A** and **C** incorrect.

Question 22

The colour change from purple to colourless for the potassium manganate(VII) shows the presence of a reducing agent and not an oxidising agent. Consequently alternative **C** the strongest distractor was incorrect.

Question 35

Eutrophication is due to excessive plant growth which kills animal life due to a lack of oxygen. Nitrates, phosphates and sewage all promote plant growth hence **C** was the correct answer.

Question 37

The boiling points of the alkanes increases as the size of the molecules increases. Therefore, the boiling point of C_2H_6 would be greater than that of CH_4 and not less than, as was the common misconception. A common error is to assume that –185 is a larger number than –161.

Question 38

Oxygen gas is an excellent supporter of combustion although the gas itself does not burn. So a lighted splint burns brighter in oxygen but the oxygen does not burn.

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 somewhat more difficult than usual and marks above 40 were rare. Conversely, ***Section B***, other than **Question 10**, resulted in some high scores.

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 the question and think before they begin to write. Specific examples of this type of error are noted below.

Comments on specific questions

Section A

Question 1

Expected to be an 'easy' starter, not that many candidates scored all 4 marks.

(a) Responding only to the words 'greenhouse gas', sulphur dioxide was a common error.

(b) Calcium phosphate was a common incorrect response.

(c) This was well known.

(d) This was well known.

Question 2

A generally high scoring question. Only **(c)(iv)** gave problems.

(a) It was unusual to find any errors in completing this table.

(b) Many candidates could give two, or more, of the many possible observations. Failure to read the question resulted in unacceptable answers such as hydrogen gas and an alkaline solution as capable of being seen.

(c)(i) Giving just the answer 0.195/39 as the number of moles of hydroxide ion was a fairly common error. Mention of the connection between potassium and the hydroxide ion, as shown in the equation, was required.

(ii) The correct answer of 0.010 was scored by the majority.

(iv) This was badly answered. The majority simply ignored their figures in **(i)** and **(ii)** and gave pH7, because it was a neutralisation.

(d) Many clear and accurate diagrams were seen. If there was an error, it was more likely to be with the oxide ion rather than with the potassium ion. Oxide electrons shown as 2. 8. 8 and an incorrect charge were the faults.

Question 3

This question generated a wide range of marks.

(a) The majority correctly chose poly(propene) and gave two supportive reasons.

(b) Plastic bags and cling film were the popular suggestions. The Examiners did not allow the too general answer of 'making plastics'.

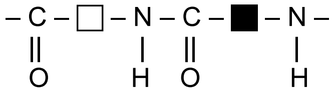
(c) The failure of bacteria to decompose plastics was well known. Finding a second reason was difficult for many candidates. The need for landfill sites was rarely mentioned.

(d) There were few correct structures for poly(propene). Recognising the presence of three carbon atoms, produced many answers of the type: $–(CH_2 – CH_2 – CH_2)_n–$.

(e)(i) Many correct answers were seen. For the name of the linkage, polyester was not accepted.

(ii) This was not so well known with nylon, starch and oil often given.

(f) Given the general pattern at the top of the page, few correct structures were seen. The correct continuations at each end were the main problems for the candidates. The following structure of nylon 6 contains all the required information.



Question 4

This was the highest scoring question in ***Section A*** with many candidates gaining full marks.

(a)(i) Other than a few candidates who showed monatomic nitrogen, errors were rare.

(ii) The increase in the number of collisions was well known.

(iii) The increase in kinetic energy was well known. However, 'more collisions', is not a rate statement. It must be more *frequent* collisions or more collisions *per second.*

(b) Again, incomplete combustion of the fuel was well known. Some candidates spoiled their answer by referring to the combustion of carbon.

(c)(i) Candidates tended either to have a correct equation giving nitrogen and carbon dioxide or an incorrect equation with the wrong products.

(ii) The mark for the increased surface area was scored by most candidates. Not continuing to state that this would lead to an increase in reaction rate was the common omission.

Question 5

Full marks for this question were rarely scored and zero was quite common.

(a)(i) A frequent approach was to say that copper was discharged in preference to hydrogen. This answer cannot score since it is merely rephrasing the question. Some reference to either the reactivity series or the electrochemical series was required.

(ii) Descriptions of oxidation in terms of oxygen/hydrogen gain/loss were not relevant here. Loss of electrons by the hydroxide ion or an increase from – 2 to 0 in the oxidation state of oxygen were necessary. The too brief answers, 'loss of electrons' and 'increase in oxidation number', were not accepted.

(iii) Many incorrect equations were seen. Electrons on the wrong side and an incorrect charge on copper(II) were frequent. In fact, all that was required was a reversal of the anode equation given in the stem.

(b)(i) Some candidates still think that ions are *formed* when a solid melts. Even greater numbers attribute the conductivity to movement of electrons. There can be no alternatives to the concept of static versus mobile ions here.

(ii) These two equations were not well done. The lead(II) equation often had Pb^{2+} on the right hand side. The bromide ion equation was rarely correct. Incorrect charges and monatomic bromine were frequent. Given the question, where did some candidates find either the chloride or the iodide ions?

Question 6

This proved to be the most difficult question in the section with many candidates giving answers that were only partially correct.

(a) The majority correctly gave covalent, although both ionic and metallic were seen.

(b)(i) About the only answer given was that the bonds were strong. This was not the point. It was the large number of bonds which was the cause of the high melting points.

(ii) To compare the two, mention of both diamond and graphite was required. That graphite 'has weak bonds' is not true, as the diagram shows. The Examiners required the answer that graphite has *some* weak bonds but diamond has *only* strong bonds.

(c) A clear statement that graphite does conduct but diamond does not conduct was required. A common failing was to explain the conductivity of graphite as due to the sliding of atoms or even moving ions.

Section B

Question 7 was only just the most popular of the four. The other three questions attracted roughly equal numbers of candidates.

Question 7

This question often resulted in full marks being scored.

(a) Many accurate statements were made. The most frequent error was to give 'exothermic because ΔH is negative'. This answer ignores the question which required ideas on bond breaking and bond making. Candidates should be advised to avoid the word 'involved'. The sentence 'The energy involved in bond breaking/making..' is ambiguous.

(b) Although there were many very good, clear diagrams, others were poor. Use of a ruler to draw a rectangular diagram is not recommended. Two errors of omission were common. The failure to label the horizontal reactant and product lines; just E_r and E_p were acceptable. Also the ΔH arrow was often omitted.

(c)(i) This time was usually correct. The Examiners accepted 35 $\pm$ 1 seconds. Occasionally either 40 or 60 seconds was given. Failure to read the question and giving 35 minutes was penalised.

(ii) The calculation leading to 0.00250 mol of oxygen was well done.

(iii) Conversely, this was not well done. A frequent error in calculating the concentration of the hydrogen peroxide was to divide the number of moles of oxygen from **(ii)** by the volume of the solution.

Question 8

Careless errors rather than chemical errors were the main cause of mark loss.

(a)(i) Many correct equations were seen. An incorrect formula for nickel(II) sulphide, even though the formula was given in the stem, was the main cause of an incorrect equation.

(ii) Most calculations were numerically correct but giving the wrong unit, g for the kg given in the question, was a frequent cause of mark loss.

(b) The presence of covalent bonding was usually recognised. Too many candidates quoted a melting point when the question only mentioned a boiling point.

(c) Any one of sulphur dioxide, carbon dioxide, carbon monoxide, nickel ions, produced with the correct environmental consequence was acceptable.

(d) The use of a nickel catalyst in the production of margarine was very well known.

(e) The 'no reaction' between nickel and zinc nitrate was usually scored. Although the correct colour of nickel(II) nitrate was given in the table, a large majority stated that the blue solution would turn colourless. Any one of the three possible ionic equations defeated all but the strongest candidates.

Question 9

A popular question often leading to scores of 8 or 9.

(a) Any of the many balanced equations leading to ethene, or both ethene and hydrogen, were accepted. Failure to read the question and hence using $C_{10}H_{22}$ as the formula for dodecane was the most frequent cause of mark loss.

(b) This diagram was not as well drawn as in the past. The formula of ethene as CH_4 and showing only two electrons shared between the two carbon atoms in ethene were typical errors.

(c) This calculation was well done with most candidates giving an easy to follow method. Using the relative atomic mass of carbon as 6 and/or of hydrogen as 2 were errors seen. These candidates always 'arranged' their arithmetic to arrive at the formula given in the question.

(d) This process was well known and nearly every candidate gave acceptable numerical values for the temperature and pressure and named the catalyst used in the process. Fermentation was occasionally given

(e)(i) This colour change was well known with just the occasional purple to colourless being given. Failure to read the question led to too many candidates not attempting to give a structure for ethanoic acid.

(ii) The candidates found this to be by far the most difficult section on the whole paper. There were far more blanks than attempts at a structure. Of the few correct attempts made, ethanedioic acid was the most popular with 2-hydroxyethanoic acid an alternative correct choice. In fact, there were five theoretically possible oxidation products here.

Question 10

This was easily the lowest scoring question in ***Section B*** with no more than one mark being a frequent score.

(a) The Examiners expected to find three fractions leading to three percentages of iron. Many candidates gave only one fraction and one percentage. Others gave two or three percentages with no supporting fractions. Both the fraction and the percentage were required in order to score. The Examiners did accept the integer values, 70%, 72% and 48% since these figures were sufficient in order to choose the highest value.

(b) This was very badly answered with hardly a single candidate scoring more than 2 from 4. There were six possible redox reactions occurring in the extraction of iron. Candidates tended to give only one equation, usually either burning carbon or one of the possible reductions of iron(III) oxide. The latter equation was frequently unbalanced. The second half the question, asking for which substance was oxidised and which reduced, was frequently ignored. Since the question asked for both, both were required for one mark. Very, very few candidates gave both.

(c) The question asked for an explanation in terms of structure. That the structure of a metal contains cations in a sea of electrons was very rarely mentioned. That malleability is due to the slippage of particles was quite well known. Too many candidates did no more than explain that malleable means that it can be beaten into sheets.

Paper 5070/03

Paper 3 – Practical Test

General comments

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

Comments on specific questions

Question 1

(a) Candidates were required to investigate the temperature changes produced when different volumes of solutions **P** (hydrochloric acid) and **Q** (aqueous sodium hydroxide) were mixed. 3 marks were given for a temperature change within 1°C of the increase reported by the Supervisor. Values within 2°C scored 1 mark. Many candidates scored all 12 marks for this part of the question and the majority of candidates scored over half marks.

The small number of candidates who made subtraction errors were penalised but the accuracy marks were given on their corrected result.

(b) Most candidates plotted the points correctly and this scored one mark. Although most candidates did draw two intersecting straight lines, very few recognised that both straight lines must pass through the corresponding 'origins' and therefore failed to score more than 1 mark for the graphs. It is always important when deciding on the position of a straight line to consider whether the origin is, itself, a genuine point. In this case using 50 cm^3 of either **P** or **Q** and no other solution will produce zero temperature change. There were very few curves.

(c)(d) Candidates were expected to take the point of intersection as the maximum temperature change and many did. As would be expected many drew their graphs in such a way that one of the plotted points was the point of intersection and thus the highest temperature change. This was acceptable provided that both lines were drawn close to the plotted points. Where candidates simply gave the highest temperature rise from the table and not from the graph, this did not score but candidates could score the mark for giving the correct corresponding volumes.

Reading the volume of **Q** caused some problems and there were a number of cases where the candidate gave the volume of **P** as 26 cm^3 (for example) and then gave 34 (or 36) cm^3 as the volume of **Q** rather than 24 cm^3.

(e) The calculation was well done with most candidates obtaining the correct answer. There were very few cases of candidates using a mole ratio of anything other than 1:1 or inverting the volume ratio. Answers were expected to two significant figures, but those that gave more were not penalised.

Question 2

This was a relatively difficult exercise and candidates found it difficult to make all the relevant observations. Marks were usually lost for incomplete rather than inaccurate observations. It was not necessary to make all the observations to score full marks for this part of the exercise. In general candidates used the correct chemical terms, with 'precipitates dissolving to form solutions' rather than 'cloudy mixtures turning clear'.

Solution **S** was prepared by adding aqueous ammonia to a solution of copper(II) sulphate until the precipitate just dissolves.

Test 1

When **S** is warmed gently, ammonia is evolved, and this can be confirmed by turning red litmus blue. As always candidates were expected to test and name the gas and many lost marks by making only one of the points. The solution also produces a blue precipitate when warmed and this slowly turns darker in colour until it is virtually black.

Surprisingly a number of candidates thought sulphur dioxide was evolved.

Test 2

The slow, careful addition of hydrochloric acid produces a blue precipitate which dissolves when more acid is added to produce pale blue solution. Colourless was an acceptable colour for the final solution as was pale green. Many candidates added the acid too quickly and only saw the final paler solution.

Test 3

When aqueous barium nitrate is added a precipitate is formed and when this is allowed to settle it is clearly a white precipitate in a blue solution rather than a blue precipitate. Allowing a precipitate to settle is often a good way of confirming its colour. When dilute nitric acid is added the precipitate does not dissolve but the dark blue solution becomes much paler. Candidates who recorded that a blue precipitate turned to a white precipitate scored half of the available marks, having missed that the precipitate itself does not change colour but the solution does.

Test 4

When aqueous silver nitrate is added to a diluted solution of **S** a small amount of blue precipitate is formed, this dissolves when acid is added to produce the usual pale blue/colourless solution.

Test 5

This was the most difficult part of the analysis and marks were given where candidates had made a creditable attempt to describe what are difficult observations.

There is no initial change when aqueous potassium iodide is added, however the addition of hydrochloric acid allows the potassium iodide to be oxidised to iodine and the copper(II) ion to be reduced to copper(I). When allowed to stand the mixture can be recognised a white precipitate (CuI) in a brown solution of iodine. The separation can be slow and so credit was given for describing both the formation of a precipitate and the colour change.

When sodium thiosulphate is now added, a number of changes take place and candidates were only expected to make some of the possible observations. Initially the brown solution is decolourised allowing the white precipitate to be seen more clearly. With more sodium thiosulphate the white precipitate dissolves forming a colourless solution which then starts to turn cloudy after a few minutes as the thiosulphate reacts with the acid to produce a new precipitate of sulphur.

Conclusions

Candidates were required to give the formulae of two of the ions present, Cu^{2+}, NH_4^+ and SO_4^{2-} were expected. For the ammonium ion and the sulphate ion experimental evidence was required. A few candidates gave the names of the ions rather than formula and this attracted a small penalty. Chloride was a popular incorrect answer, based on the use of silver nitrate in *Test 4*.

Paper 5070/04

Alternative to Practical

General comments

This paper is designed to test the candidate's knowledge and experience of practical chemistry.

Skills include recognition and calibration of chemical apparatus and their uses, recall of experimental procedures, handling and interpretation of data, drawing and interpretation 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 in plotting points accurately on graphs and the improvement in the drawing of appropriate smooth curves, as shown in recent examinations, continues to be evident.

As mentioned in previous reports there continues to be confusion between the tests for hydrogen and oxygen. Hydrogen cannot be tested with a glowing splint.

Comments on specific questions

Question 1

(a) The diagram shows a pipette.

(b) The pipette requires the use of a Safety Bulb so that the liquid is not sucked by mouth, and removing the possibility of the solution entering the mouth. A correct name for this piece of apparatus was required. Names such as sucker and plastic tube were not awarded the mark.

Question 2

(a) It was important that candidates stated Sodium's reactivity in air as the reason for storing under oil not just that sodium is very reactive.

(b) The gas is Hydrogen and its presence should be confirmed by a 'pop' being produced with a flame. Many candidates continue to confuse this test with the test for oxygen. The use of a glowing splint making a pop is incorrect.

(c) Acceptable observations included sodium moving fast around the surface, dissolving, fast reacting, flame being produced, gas bubbles, but theoretical observations such as an exothermic reaction were not allowed.

(d) As with **(b)** the question asked for the name of the product, which was sodium hydroxide. The formula was insufficient to gain the mark. The litmus was blue and a correctly balanced equation gained the final mark.

Question 3

(a) A syringe or gas syringe should be attached to the flask.

(b) Carbon Dioxide should be confirmed by limewater becoming white or 'milky'.

(c) This question tested the candidate's ability to calculate the number of moles of each reagent taking part in the chemical reaction and subsequently to state the reagent that was in excess. The subsequent calculations were dependent on the correct conclusion.

(i) 0.005 moles of calcium carbonate reacted with **(ii)** 0.01 moles of hydrochloric acid. The equation showed that one mole of calcium carbonate required two moles of hydrochloric acid, hence **(iii)** as the ratio of 0.005 to 0.01 corresponded to this ratio, neither reagent was in excess. Many candidates concluded that since the ratio was not 1:1 hydrochloric acid was in excess.

(d) Again using the equation, 1 mole of calcium carbonate gave 1 mole of carbon dioxide, hence the volume of carbon dioxide produced was 0.005 x 24 = 0.12 dm^3.

(e) 0.5 g of magnesium carbonate is 0.0059 moles of magnesium carbonate and is now the excess reagent. Hence the volume of carbon dioxide was the same, 0.12 dm^3. This proved to be the most difficult question on the paper but it was encouraging to see that a large number of candidates scored full marks. It should be stated that the answers to **(c)(iii)** and **(e)** required the correct explanation to obtain the marks.

Questions 4 - 8

The correct answers were: **(b)**, **(a)**, **(c)**, **(b)**, **(d)**, respectively.

Question 9

(a) The correct mass of iron(II) sulphate crystals was 6.96 g.

(b) Many candidates know the correct colour change produced at the end-point by aqueous potassium manganate(VII) but state it the wrong way round. Candidates should be aware that the initial colour of the solution is green or colourless before the potassium manganate(VII) solution is added. The colour then changes to purple or pink at the end-point.

(c) Most candidates read the burettes correctly and deduced the correct mean value to be used in the calculations. In cases where incorrect readings are used, candidates should take the closest two volumes to calculate their mean value, not necessarily the second and third.

The correct mean titre of 25.4 cm^3 gives the following answers to the calculations:

(d) 0.000508, **(e)** 0.00254, **(f)** 0.0254, **(g)** 3.86 g, **(h)** 3.10 g, **(i)** 0.172 moles, **(j)** 6.78.

Throughout the calculations candidates must maintain the accuracy of their calculations. Rounding up or down will lose marks. e.g. **(d)** 0.000508 becomes 0.0005, (0.00051 is acceptable), 0.0254 becomes 0.025 etc. The final mark is awarded so long as the accurately calculated value, e.g. 6.78, is shown. Any error to one part of the question may be used in subsequent parts to gain the marks, so long as the calculations using this incorrect value are correct.

Question 10

This was a standard analysis question. The correct answers are:

(1) A coloured solution is produced, not coloured solids or compounds.

(2) A blue precipitate, insoluble in excess. It is important that the word precipitate is used not alternatives such as deposit or solid.

(3) A blue precipitate, soluble in excess to produce a *dark* blue solution. The colour of the final solution should be a darker blue than the original.

(4) The test for a chloride involves the addition of dilute nitric acid and aqueous silver nitrate, producing a white precipitate. The use of the word acidified loses the first mark. Several candidates suggest the use of aqueous lead(II) nitrate. This is not acceptable as it does not exclude the possible presence of a sulphate ion.

Question 11

(a) The reading of the thermometers, 36.3 and 25.8°C respectively were generally correct, giving a temperature rise of 10.5°C to be used in subsequent calculations.

(b)(i) The formula for butan-1-ol produced a number of errors including, missed hydrogen atoms, bonds with out hydrogen atoms shown and the inclusion of one or more double bonds in the structure.

The relative molecular mass **(ii)** is 74 giving **(iii)** 0.0062 moles of the alcohol. As before, rounding down to 0.006 moles lost the mark. The answer space for **(iv)** showed the answer to be in kJ/mole but several candidates incorrectly divided their answer by 1000.

(c) The points were correctly plotted on the graph by most candidates and the value for propan-1-ol correctly recorded. The graph should be read to half a small square.

(d) There were similar errors in the structure for propan-2-ol to those shown in the structure for butan-1-ol.

(e) Reasons for the use of the same temperature rise included, to act as a control and to standardise the experiment. Any reasonable explanation based on the experiment was awarded the mark.

This question was generally answered well and many high scoring answers were seen.