

O Level

Chemistry

Session: 1984 June
Type: Report
Code: 5070

CHEMISTRY
ORDINARY LEVEL

Paper 5070/1 (Multiple Choice)

| Item Number | Syllabus Section | Proportion choosing each option (key facilities are asterisked) | | | | | Discrimination (point biserial) |
|-------------|------------------|--|-------|-------|-------|-------|------------------------------------|
| | | A | B | C | D | E | |
| 1 | 4.1 | 0.07 | 0.01 | 0.72* | 0.00 | 0.20 | 0.39 |
| 2 | 4.1 | 0.84* | 0.07 | 0.08 | 0.01 | 0.01 | 0.36 |
| 3 | 5 | 0.02 | 0.39 | 0.09 | 0.32 | 0.19* | 0.53 |
| 4 | 4.2 | 0.08 | 0.65* | 0.10 | 0.10 | 0.07 | 0.43 |
| 5 | 5 | 0.01 | 0.14 | 0.54* | 0.19 | 0.13 | 0.22 |
| 6 | 4.1 | 0.59* | 0.04 | 0.23 | 0.10 | 0.05 | 0.45 |
| 7 | 5 | 0.35 | 0.50* | 0.04 | 0.08 | 0.03 | 0.45 |
| 8 | 6 | 0.06 | 0.04 | 0.05 | 0.61* | 0.24 | 0.41 |
| 9 | 5 | 0.33* | 0.07 | 0.38 | 0.07 | 0.15 | 0.59 |
| 10 | 6 | 0.24 | 0.47* | 0.09 | 0.12 | 0.09 | 0.43 |
| 11 | 7.1 | 0.12 | 0.31 | 0.12 | 0.38* | 0.07 | 0.45 |
| 12 | 7.2 | 0.07 | 0.11 | 0.02 | 0.05 | 0.75* | 0.35 |
| 13 | 7.3 | 0.16 | 0.08 | 0.29 | 0.12 | 0.35* | 0.49 |
| 14 | 8 | 0.04 | 0.81* | 0.09 | 0.05 | 0.01 | 0.24 |
| 15 | 4.2 | 0.08 | 0.03 | 0.52 | 0.35* | 0.02 | 0.49 |
| 16 | 9 | 0.71* | 0.11 | 0.07 | 0.05 | 0.05 | 0.40 |
| 17 | 9 | 0.04 | 0.53* | 0.23 | 0.08 | 0.13 | 0.47 |
| 18 | 10.1 | 0.04 | 0.04 | 0.79* | 0.08 | 0.05 | 0.35 |
| 19 | 10.1 | 0.12 | 0.21 | 0.58* | 0.04 | 0.04 | 0.44 |
| 20 | 10.1 | 0.27 | 0.28* | 0.14 | 0.15 | 0.16 | 0.24 |
| 21 | 10.1 | 0.12 | 0.04 | 0.03 | 0.77* | 0.05 | 0.45 |
| 22 | 10.2(b) | 0.18 | 0.54* | 0.12 | 0.04 | 0.13 | 0.43 |
| 23 | 10.2(b) | 0.09 | 0.16 | 0.09 | 0.46* | 0.21 | 0.38 |
| 24 | 10.2(c) | 0.20 | 0.22* | 0.32 | 0.19 | 0.07 | 0.31 |
| 25 | 10.2(d) | 0.07 | 0.06 | 0.53* | 0.24 | 0.10 | 0.57 |
| 26 | 10.2(e) | 0.69* | 0.16 | 0.03 | 0.06 | 0.06 | 0.37 |
| 27 | 11 | 0.09 | 0.47* | 0.15 | 0.20 | 0.08 | 0.35 |
| 28 | 11 | 0.31 | 0.03 | 0.04 | 0.54* | 0.09 | 0.30 |
| 29 | 11 | 0.61* | 0.20 | 0.06 | 0.07 | 0.06 | 0.26 |
| 30 | 11 | 0.04 | 0.05 | 0.20 | 0.19 | 0.52* | 0.35 |
| 31 | 1 | 0.31 | 0.52 | 0.11 | 0.03 | 0.03 | 0.40 |
| 32 | 2 | 0.08 | 0.12 | 0.15 | 0.33* | 0.32 | 0.13 |
| 33 | 3 | 0.02 | 0.02 | 0.31 | 0.01 | 0.64* | 0.36 |
| 34 | 6 | 0.32 | 0.17 | 0.35* | 0.09 | 0.08 | 0.35 |
| 35 | 7.1 | 0.29 | 0.06 | 0.24 | 0.09 | 0.32* | 0.39 |
| 36 | 7.2 | 0.13 | 0.45* | 0.09 | 0.29 | 0.04 | 0.26 |
| 37 | 8 | 0.36 | 0.23 | 0.22* | 0.07 | 0.11 | 0.18 |
| 38 | 8 | 0.28 | 0.07 | 0.44* | 0.07 | 0.15 | 0.37 |
| 39 | 10.2(c) | 0.08 | 0.58* | 0.09 | 0.18 | 0.07 | 0.36 |
| 40 | 10.2(f) | 0.30* | 0.23 | 0.06 | 0.37 | 0.04 | 0.50 |

Paper 5070/2

The calculations were well answered and presented, but some candidates display a total inability to produce realistic answers e.g. the percentage of carbon in coke was often calculated to greater than 100% with some answers over 1000%!

Section A

- Q.1* on electronic structure proved to a very easy starter.
Q.2 on the Periodic Table also proved to be very easy; those who did not get all three pairs usually managed to score with the chromium and manganese pair.
Q.3 on balancing equations proved to be too difficult, $2\text{Fe}^{3+} \dots \rightarrow 3\text{Fe}^{2+} \dots$ was the commonest answer with those who did not have a clue. The weaker candidates altered the formulae and the charges.
Q.4 was answered correctly by very few candidates. Only the best candidates could recognise an ester. One candidate gave the condition for making an ester as 'boil in a beaker of cold water'.
Q.5 was very easy and nearly all the candidates could give three reasons for speeding up the reaction. A large number of candidates knew the correct catalyst for this reaction.

Q.6 (a) proved that this part of the syllabus is not understood. Answers such as
 - HCl is a gas, therefore is insoluble in all liquids,
 - HCl only conducts if the solution it is dissolved in conducts,
 - HCl is covalent, therefore cannot conduct under any conditions,
 - HCl does not contain a metal and therefore it cannot conduct,
 - HCl in water is an acid, therefore is a non-conductor,
 - HCl when dissolved in an alkali is no longer an acid, therefore the solution is a non-conductor.

(b) Most candidates could distinguish between metals and non-metals.

Q.7 on metal chemistry proved to be a very good discriminator.

Q.8 showed that many schools leave the organic section until last. This question was low scoring, those who did score had some very quaint spellings of alcohol, frequent answers for homologous series were 'similar properties', 'the same type of bonds' and 'they are the same reactivitywise'.

Section B

Question *B1* was the most popular question, probably because the candidates recognised the tests for oxygen and chlorine.

Q.1 (a) on manganese(IV) oxide as a catalyst and as an oxidising agent was very well answered although there was a great deal of MnO_4 as the formula for manganese(IV) oxide.

(b) on conductivity in solution was very poorly answered. There were some very muddled ideas e.g.:

- the solution contains the metal sodium and sodium is a good conductor
- barium (not infrequently Br in formulae such as BrOH) is a weak metal/non-metal
- barium sulphate is covalent
- sodium is a Group I metal and barium is a Group II metal.

(c) was fairly well answered. Nearly all candidates scored on the reactivity section of this question but very few on the reduction of iron(III) chloride by iron. The reason stated for iron(III) compounds going green when reacted with iron was because the solution now contained dissolved chlorine. There is a great deal of confusion between iron(II) compounds and iron(III) compounds. Some candidates even suggested that the pink precipitate was iron(II) sulphate.

Question B2 on milk, was the least popular question. There were strange methods for showing that milk contained water, many producing water rather than testing for water, e.g. leave the milk to go sour, pour off the curds, what is left is water. Few candidates could name a solvent that was insoluble in water. Common answers were fats and bile. Hardly anyone could suggest how to obtain the fat from the solvent layer. In contrast, most candidates had carried out a chromatography experiment, usually with 'smarties', and gave very good accounts of the experiments. The structure of a protein and a synthetic polymer similar in structure to fats were unknown. There were surprisingly few correct answers to the question on the reaction between lactose and concentrated sulphuric acid. The test for calcium ions was well known, although some candidates suggested electrolysis.

Question B3 on the electrolysis of concentrated aqueous sodium chloride was popular and well answered. The two equations were well done, although the odd candidate added electrons to the chloride ion to discharge it. There was some confusion between oxygen and hydrogen, with answers such as "Apply a glowing splint and it goes out with a pop". The uses of hydrogen were better known than the uses of sodium hydroxide. The brighter candidates had read to the end of the paper and gave the manufacture of methanol as a use for hydrogen. The calculation was very well answered, the commonest error was to forget to multiply by 60 to convert minutes to seconds. Few candidates could suggest how to obtain solid sodium hydroxide from an aqueous solution (all that was expected was heat to dryness or heat to crystallising point), many suggested electrolysis. The section on PVC was very well answered, and candidates knew a use for PVC, apart from one who suggested woodwork.

The question on ammonia, B4, was less popular than expected. Some candidates tried to prepare ammonia without using a base. Practically every candidate knew that concentrated sulphuric acid reacted with ammonia, that calcium oxide was a suitable drying agent and the reason why ammonia should be dried before reacting it with sodium. The diagram for removing ammonia from hydrogen was a good discriminator, only the best candidates included a safety device to prevent 'suck-back'. Again, the calculation was well answered. Some candidates forgot to include units for the mass of sodamide. The reaction between a solution of sodamide when added to water and iron(III) chloride was answered by guesswork - many had ammonia reducing the Fe^{3+} .

Q.5 was the second most popular question. Candidates could either suggest how the carbon monoxide was formed, or write the equation for carbon monoxide burning - few managed to score both points. There was a full range of suggestions for the element that burnt with a blue flame (including carbon monoxide), a high proportion gave the correct answer of sulphur. A large number knew that fractional distillation was used to separate mixtures of liquids. There were very few correct observations in the answers to this question, many said copper formed or water formed, and many thought that the copper(II) oxide was reduced by carbon and not the coal gas. The answer to the poisonous nature of coal gas was surprisingly badly answered. Several students suggested that the coal gas produced carbon monoxide when it burnt, rather than stating that it was there to start with. The uses of coke and ammonia were generally well answered as was the equation between hydrogen and carbon monoxide. The commonest wrong answer was $4H + CO \rightarrow \dots$

The calculation proved more difficult than the other two calculations on the paper. Many just divided 12 by 44 and ended up with 27.27%. A lot of lime-water was used to absorb the carbon dioxide instead of sodium hydroxide or potassium

hydroxide. One suggestion was snake-lime!

Paper 5070/3

Q.1.(a) (i) & (ii) Results varied widely within each centre, probably on account of differences in temperature between different parts of the laboratory. Because of this the times of each candidate were marked in terms of their own consistency. On this basis only a minority scored the maximum five marks; three or four was usual, weaker candidates scoring less. Although candidates were instructed to note the time 'to the nearest second', surprisingly many quoted times to 0.1 second and attention is once more drawn to the report on the June 1983 paper when the practice of quoting figures to an unrealistic degree of accuracy was criticised.

(ii) A very small minority of candidates misunderstood the instructions for recording the total time in column D. The majority carried out the instructions correctly and there were few addition errors.

(b) Although pretesting had shown a consistent reduction in time of the order of 10 seconds in 50 when copper (II) sulphate was present, it became abundantly clear that results varied widely, not only between one centre and another but within the same centre. Many candidates and some supervisors reported increases and the mark was awarded provided the answer to (g) was consistent with the result of (b). This was by no means always so.

(c) The better candidates realised that the results led to a straight line graph; a substantial minority produced a wavy line passing through every point. Scales were usually sensibly chosen and points accurately plotted; where misplottings occurred it was usually among the minority who chose awkward scales.

(d) Many of the better candidates did not realise that a straight line graph indicated constant rate. Where the graph was not a straight line, credit was given provided the conclusion was consistent with the graph as drawn. Many of the weaker candidates drew no conclusion about speed from the graph, but merely repeated the times of column B.

(e) (i) This section produced more wrong answers than any other, the correct answer being the average of the column B times in section (a)(iii). Many candidates gave five times this value.

(ii) The better candidates realised that the time would be marginally increased as a result of the slight reduction in surface area. Many gave the same result as (e)(i), a realistic answer which was accepted.

(f) There were many good answers with some exceedingly vague statements from weaker candidates.

Q.2. Observations

It was obvious that the better candidates had seen all that was to be seen and their observations were recorded clearly and accurately. However, a substantial number were less successful and the criticisms which follow apply widely.

1. Most candidates reported the appearance of the precipitate but many did not see it disappear in excess acid and presumably used the suspension for the next test.

2. Where a suspension was carried forward from test 1 its disappearance on adding aqueous ammonia was usually described. Of those who started with a solution far too many missed the appearance of the precipitate, presumably through too rapid addition of alkali. It must be emphasised that candidates were instructed to add aqueous ammonia dropwise and that droppers were provided; moreover attention was drawn to the same point in the report on the June 1983 paper.

Another example of bad technique was shown by the number of candidates who reported a blue precipitate, probably as a result of leaving litmus paper in the solution while adding the alkali. The mistake could have been avoided by rapid dipping and withdrawal of the paper or by spotting.

3. Results were better than those of the other two tests though some candidates appear to have added alkali to the original residue. A small minority reported disappearance of the precipitate in excess alkali.

There were the usual imprecise descriptions from weaker candidates, typically 'solution turns cloudy' to indicate a white precipitate.

Conclusions

Most candidates with the correct experimental evidence deduced zinc and calcium with a tendency to quote irrelevant test numbers in addition to the correct ones. Other errors were confusion of zinc with aluminium or lead and, predictably, copper on the basis of a blue precipitate in test 2.

Q.3. This was an easy question with many candidates scoring high marks. It was, however, surprising that with access to books, a substantial minority made mistakes in the descriptions of the tests. Common among these were transposition of the test for chloride ion.

Candidates should realise that, in describing the result of a test it is essential to state precisely what is observed. Thus, in using aqueous potassium iodide as a test for oxidising agents, it is not enough to state 'iodine liberated'; the actual colour change, 'solution turns brown' (or 'yellow') must be stated.

Of the nine results many candidates returned six or more correct answers with no particular pattern as to which were right and which were wrong.

Paper 5070/4

Q.1. As there was considerable divergence of recorded times by candidates compared to those of the supervisors, candidates results were treated individually and most candidates managed to get at least four timings within a range of three seconds. A significant number of candidates failed to understand what was required in column D and merely repeated the results given in column B.

The mark for the graph was usually obtained quite easily but a substantial minority lost the mark by producing graphs made up of a series of zig-zagged lines or through plotting errors.

There was confusion over speed and time in the answers to parts (d) and (f) by some candidates who answered these parts by merely restating their observations on time made in the first part of the question. A surprisingly large number of candidates missed the fact that a straight line graph indicated a constant speed of reaction.

A few candidates thought that an endothermic change led to an observed temperature rise but it was pleasing to note that the majority of candidates recognised the difference between methanoic and hydrochloric acids in terms of acid strength. Although it was only necessary to indicate the weakness of methanoic acid in part (g), there were many good answers in terms of hydrogen ion concentration. A small number of candidates failed to score in part (h) because they gave formulae rather than the names of acids.

Q.2. This question was found to be quite difficult by the weaker candidates and acted as a good discriminator. Careful addition of reagents and subsequent observations were required. The correct observations were commonest in tests 2 and

3 and invariably led to the correct conclusions. A common fault was the reporting of a blue precipitate, caused by indicator contamination, which led to the incorrect conclusion that copper ions were present. Also the presence of ammonium ions was frequently reported following the addition of aqueous ammonia in test 2. Although some candidates experienced partial oxidation of their iron(II) ions, a 'dirty green precipitate' in test 3 usually led to the correct conclusion.

Q.3. A wide variety of tests for oxidising and reducing agents were permitted even though some of these were not mentioned in the syllabus e.g. the use of hydrogen sulphide solution. It would seem that some candidates had rather extensive lists of tests in their notebooks but no clear idea which would be easiest to perform on an unknown solution. Use of iron salts without subsequent addition of an alkali does not seem to be good chemistry also omission of a suitable acid in tests involving manganate(VII), dichromate and even in the sulphate test was a common fault.

Weaker candidates failed to read the question properly and so gave definitions of oxidising and reducing agents, described reactions involving redox or confused tests completely. Subsequent marks were lost in the last section by these candidates as they had no tests to apply to the given solutions. Most candidates managed to describe the sulphate test properly but only the very best candidates deduced that a sulphate was absent from BB6 – a result obtained by careful observation – and that BB6 contained a reducing agent alone.

Paper 5070/6

Although Question 1 was supposed to be a very easy 'starter' a number of the weaker candidates failed to read the volume correctly.

In Question 2 many candidates described crystals as being monoclinic which, unfortunately, was not what the question required. Any answer indicating that they were long, needle-like crystals was acceptable. A number of the weaker candidates failed to read the thermometer illustrations correctly and other candidates lost marks through not specifying *anhydrous* copper sulphate although most realised that the dissolving process was exothermic. It was unfortunate that a considerable number of candidates ignored the word 'compound' in the last part of the question and named an element instead. There were several guesses in this part of the question and credit was only given for a compound which reacted with water or for sodium hydroxide or for anhydrous salts which were commonly known to dissolve exothermically.

The better candidates found no difficulty with Questions 4 to 10 but the answers to Question 11 were much more varied. Although most candidates correctly completed the observations for Test 1 those for Test 2 were generally incomplete. Many candidates omitted any reference to water vapour or steam being produced and few referred to a black residue. It was surprising in Test 3 how many candidates described the brown ring test as the Examiners are generally of the opinion that the use of sodium hydroxide and Devardas alloy is a much safer combination of reagents. The final mark was for identifying the substance as copper nitrate although some candidates managed to invent other answers.

In Question 12 the weaker candidates were unable to subtract the two numbers to gain the number 5.3. A surprising number of candidates managed to do a variety of incorrect manipulations with this figure to get the concentration of solution A. Most of the errors arose from not appreciating the relationship between 100 cm³ and

1 dm³. In part (a)(ii) the marks were allocated for obtaining the correct relative formula mass for sodium carbonate and indicating that the answer to part (a)(i) should be divided by 106. The statement that solution A was 'too strong' was not acceptable as an answer for part (b), the Examiners only accepting a reference to the fact that the concentration was too high. Candidates must be discouraged from confusing 'strong' and 'weak' with 'concentrated' and 'dilute'. The mark was awarded in part (c) for an answer that was on fifth of that part (a)(ii). Candidates generally were able to complete the burette readings but many lost a mark through recording 11 rather than 11.0 for the second titration. An alarming number of candidates lost marks for the average volume of 'Acid' used because they included the first burette reading. They should have realised that this was not to be used as it varied considerably from the second and third titrations. The better candidates completed part (e) to get a value of 0.197 but a number rounded this off to 0.2 and were penalised for doing so. Burette reading are recorded to three significant figures and, therefore, the answer should also be to the same degree of accuracy.

In Question 13 there were a number of interesting answers to part (a) but only those referring to the movement of ions were accepted. The remainder of the question was straightforward for the majority of the candidates, although a failure to use *moist* litmus paper in testing for chlorine was common.

In Question 14, part (b), acceptable answers included heating, using more concentrated acid, using powdered calcium carbonate but adding a catalyst or stirring was not considered to be a sensible answer in this particular case. A number of candidates did not appear to be familiar with the general method of preparing crystals in part (e) and did not, therefore, specify that the volume should be reduced and the solution left to crystallise.

Question 15 was done well by most candidates but an answer of olive oil in part (a) was not considered acceptable nor was any other oil of vegetable origin as these will react with sodium. In parts (c) and (d), candidates frequently interpreted the observation, instead of stating the observation, as requested.