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

General comments

One question in particular, **Question 25**, proved a real stumbling block and guessing was widespread amongst the candidates. All the other questions discriminated well between the candidates. Only two questions, **Question 1** and **Question 7** had success rates of over eighty percent, and even then they discriminated well between the successful and the less successful candidates.

Comments on specific questions

Question 6

Almost one third of the entry thought, incorrectly, that alternative **D** was correct. The question was testing the knowledge that the number of protons in an atom is equal to the number of electrons.

Question 9

Methane is a molecule consisting of a carbon atom bonded by four covalent bonds to four hydrogen atoms. Hence the number of electrons involved in covalent bonding, in methane, is 4 x 2 = 8.

Question 16

The large number of candidates that chose **B** did not realise that it is bond breaking that absorbs energy, nor did they realise that bond breaking and bond making must both be considered when working out the energy change in a reaction.

Question 19

Sodium chloride is a neutral salt and when dissolved in water or hydrochloric acid it does not change the pH of the original solution. The neutralisation of hydrochloric acid by sodium hydroxide is how sodium chloride is prepared in the laboratory.

Question 30

Concentrated aqueous ammonia always smells of ammonia gas i.e. it is always giving off ammonia. The solubility of gases decreases with increase in temperature, therefore on heating, aqueous ammonia gives off more ammonia and thus the very popular alternative **A** was incorrect.

Question 33

Alternative **A** was too strong a distractor with over half the candidates choosing this alternative.

Question 36

Almost all the candidates knew that compounds containing a carbon-carbon double bond decolourise bromine water, thus alternatives **C** and **D** were very popular. The realisation that an acid with sodium carbonate always produces carbon dioxide led the candidates to the answer **D**.

Paper 5070/02
Theory

General comments

A broad range of achievement was seen across the cohort of candidates assessed, but most candidates gave performances in the lower mark range. A very small minority of individuals gained very high marks. The ***Section B*** questions proved very challenging for most candidates. Many did not attempt all the available part questions but left areas of blanks on their Papers.

In ***Section A***, a crossword was used for **AI** for the first time on this Paper. All candidates knew how to enter words on the crossword, but some failed to realise the importance of checking spellings (element spellings are all given on the Periodic Table on the back page). Wrongly spelt words in a crossword do not score.

A common reason scoring poorly in questions that demand explanations was that many candidates gave general answers, sometimes clearly learned by heart. If the question asks for an explanation of a process, it is important that the candidates deal specifically with the context given, rather than talking in vague terms only. A general answer is unlikely to gain full marks because it does not show that the candidate can apply their knowledge. This occurred, for example, in ***Section A*** **Question 2 (e)** and ***Section B*** **Question 10 (b)**.

In calculations, it was noticed this year that some candidates round up answers to 2 or 3 significant figures in the middle of calculations and carry their rounded value forward. This can lead to a significant error in the final numerical value calculated. Answers are accepted as fully correct if they are given to two or more significant figures, but candidates should not round up in the middle of their working.

Areas of the Syllabus that are well understood include energy level diagrams, diffusion rates of gases, dot and cross diagrams and metal bonding and properties.

Candidates' skills in predicting observations have improved steadily over recent years. Areas of the Syllabus that were less well understood included writing ionic equations, calculations (particularly percentage yield) and strong and weak acids.

Comments on specific questions

Section A

Question A1

Most candidates scored at least three marks. Candidates should note that when entering answers in a crossword, the spelling must be correct. A common error was the misspelling of fluorine as 'flourine'. Some weak candidates gave 'metals' as positively charged ion, rather than 'cation', and some called the sub-atomic particle a 'neutral' rather than a 'neutron'.

Question A2

Most knew the formula of ammonia and could correctly calculate molecular mass for **(a)**. Some gave 'hydrochloric acid' instead of the correct 'hydrogen chloride' as the name for HCl, failing to recognise that the table contained gases not solutions. Others gave wrong names such as 'hydrochloride'. Almost all gained some credit in the rest of the question. A common error was giving chlorine as the gas that turned litmus red.

For **(e)**, some candidates gave general answers, such as, 'lighter gases travel faster', rather than applying their understanding to the process in the question. A better answer was 'ammonia gas is lighter and so travels faster'. A candidate giving the latter answer has applied their knowledge to the context and is showing a higher level of achievement.

Question A3

Most candidates completed the table correctly. Common errors were giving 'C_3H_5OH' as the formula of propane, implying that they had not read the information carefully, and 'cracking' as the process of manufacture of propane from crude oil. The calculation for **(b)** proved difficult for many candidates. A common error was to work in moles only, rather than comparing energy values per kilogram as the question asked. For **(c)** most candidates focused on the ease of use of ethanol as a fuel due to its liquid nature. Some made vague references to 'less polluting' which did not score. Few recognised that ethanol is a renewable fuel whereas propane is not. The energy level diagram was very well completed, but some candidates did not follow the question instruction which asked for the *names* of products, and gave only formulae.

Question A4

Metallic bonding and properties are clearly very well understood by candidates; they scored well on this question. Some lost marks by lack of precision in their answers e.g. 'electrons carry charge' does not explain conduction, candidates needed to state clearly that the electrons move. Some gave chemical properties rather than physical for **(b)** e.g. 'coloured compounds'. Most read the graph to gain two marks, but some reversed the boiling point and melting point. Some candidates thought that the tungsten would melt just above its melting point e.g. 'at 3450 °C'. A mark was deducted here if the units were omitted from the answers.

Question A5

Most answered **(a)** and **(b)** correctly. Part **(c)** was poorly answered, with many candidates struggling to correctly write the ionic equation. Common errors included:

- incorrect charges on ions e.g. Mg^+ or Ag^+;
- giving an unbalanced equation;
- omitting state symbols;
- giving a full equation.

(c)(ii) was answered well. Candidates are now scoring much better than in previous years in questions that ask for observations to be predicted. Some, however, failed to score by describing the formation of a precipitate.

Question A6

Many candidates attempted to draw covalent, rather than ionic, structures for sodium oxide. Some omitted the charges from the ions. The equation in **(b)** was usually correct. The calculation proved less accessible. Most correctly calculated that 62 g of sodium oxide contain one mole, but fewer managed to correctly apply the reacting ratio to calculate the concentration.

Question A7

This question was the least well answered of the ***Section A*** questions. In **(a)**, Examiners allowed 'error carried forward' so an incorrect molecular formula could still score if the empirical formula followed logically from it. Many candidates did not know the difference between empirical and molecular formulae. Linking properties of phosphorus oxide to its structure and bonding proved problematic for most candidates. Most recognised that non-metal oxides are acidic. Far fewer linked the low melting point of phosphorus(III) oxide to its simple molecular structure. Many gave the reason that the 'bonding is covalent', which was not enough to score because giant covalent structures have high melting points. Most candidates correctly linked the covalent nature of the bonding to its non-conduction, but some talked in vague terms about 'no electrons available'.

Question A8

The marks awarded for this question showed a very broad spread of achievement. Candidates had difficulty with both the chemistry of reaction rates and with the percentage calculation in **(d)**. In **(a)** most gained a single mark for commenting on the fall in mass differences between readings. Only very able candidates commented explicitly on a decrease in rate by linking mass lost to time. A range of methods of doing this were accepted, including:

- a mathematical calculation of rate per minute;
- a comment about 'per unit time';
- recognition that the readings were taken at regular (or 4 minute) intervals.

Some candidates confused the units, mixing seconds and minutes in their answers. In part **(b)** several common errors were seen. Firstly, many candidates described why the reaction stops rather than slows down, e.g. by commenting on the acid being 'used up'. Less able candidates talked about the amount of acid decreasing. Few recognised that the important point is that the concentration of acid is falling, leading to a decrease in rate. Some thought that the surface area of the sandstone was the limiting factor. Many candidates gave a general answer that did not link to the specific reaction involved. They talked in general terms about 'fewer particles colliding' but did not link this to the sandstone and acid involved in this context. Such answers can only gain partial credit, because the candidates have not shown that they can apply their knowledge to the context of the question.

Part **(c)** was well answered, with most candidates choosing to collect their gas in a gas syringe. However, many candidates had difficulty with the calculation in **(d)**. Only more able candidates realised that the mass lost was due to carbon dioxide gas evolved. Those who did not realise this could not complete the part question. Partial credit was given if the answer showed understanding of working out percentages from masses, allowing an error carried forward on incorrectly calculated mass values.

Section B

Question B9

This question gave generally high marks. Poor choice of words sometimes lost marks in **(a)**, e.g. 'the oxygen dissolves the graphite anode'. Many did not clearly state that it was the oxygen evolved in the process that reacts with the graphite, implying that the oxygen was from air. A large number failed in attempting to write the ionic equation for the formation of oxygen. Common errors included:

- starting with OH^- instead of an oxide ion;
- giving an unbalanced equation e.g. $O^{2-} \rightarrow O_2 + 2e$;
- giving the wrong number of electrons;
- putting the electrons on the left hand side.

Parts **(b)** and **(c)** were very well answered. Candidates understand the role of cryolite in the process, and know the uses and properties of aluminium very well. In **(d)**, almost all candidates knew that there is an oxide layer that protects aluminium, but the differences in observations were less commonly correct. Common errors included thinking that both strips would produce bubbles or that the elements in the sandpaper would react with the acid. Most correctly deduced the oxidation state change, but some gave an ionic equation instead. This did not gain any marks because it does not state the oxidation numbers involved.

Question B10

This was the least popular choice of the optional questions. In **(a)** most candidates described acids as containing H^+ ions, but fewer knew that salts contain metal cations. The equation in **(b)** was very well done by all but the weakest candidates, but fewer could give two other formulae for salts. Many repeated NaH_2PO_3 which was the salt given in the question. The definitions of strong and weak acids usually scored one of the available two marks for recognising that sulphuric acid is more fully dissociated than ethanoic acid in solution. Fewer stated that sulphuric acid dissociates fully.

Part **(c)(ii)** was an opportunity for candidates to apply their knowledge to a new, problem solving situation. A wide variety of answers was seen and most revealed that many candidates only have a partial understanding of the differences between strong and weak acids. Some lost all marks by choosing to measure pH, in spite of the instruction 'other than measuring pH' which appeared in the question. Others confused acid strength with acid concentration, choosing to carry out a titration or measure the amount of gas produced by a reaction with a metal or carbonate. The best answers carried out experiments to measure rate by the collection of gas at time intervals by reaction with suitable metals or metal carbonates. Copper or very reactive metals did not score full marks as these are not appropriate choices. A surprising number of candidates tried to use substances mentioned in other questions, e.g. calcium carbonate or aluminium. Candidates should be discouraged from using this as an exam technique. In this case, neither substance reacts well with dilute sulphuric acid. Some candidates used electrical methods of measuring conductivity but often confused voltage and current, hence failing to score full marks.

Question B11

Almost all correctly identified that the type of polymerisation was addition. A few gave 'condensation' as their answer, showing confusion due to there being two different monomers reacting. For **(b)** almost all candidates could draw the polymer chain, but a large number did not identify the repeating unit, as the question asked, but drew a chain of multiple monomers joined together. This answer did not answer the question and so lost all marks. The idea that each of the monomers can join to itself was subtle, and only the most able candidates spotted this to gain a mark in **(c)**. Most gave vague comments about the products of polymerisation being difficult to control. Such answers were not awarded any credit.

The equation in **(d)** was intended to be a straightforward task but candidates found unexpected difficulty in deducing the formula for butadiene, despite its structure being shown above. Common errors included:

- using the wrong formula for butadiene e.g. C_3H_8, C_4H_8;
- giving methane, CH_4, or water as the other product;
- failing to balance the equation.

Where errors occurred, an error carried forward was allowed into the calculation for **(e)**. All knew uses for hydrogen, the only common error being to state that it is used 'in balloons'. In **(e)** many candidates did not know how to carry out a percentage yield calculation and failed to include any consideration of expected mass by considering reacting mole ratios. Many divided the mass obtained (2.16 kg) by the mass of butane used (2.90 kg) and multiplied by 100. Such answers gained no credit.

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 questions

Question 1

(a) In the first part of the exercise, candidates were required to add dilute hydrochloric acid to solid **T**, and then perform a number of tests on the resulting solution. Although this part of the exercise was generally well done, a number of candidates decided at an early stage that the compound was calcium carbonate and crossed out their original correct observations and replaced them with 'theoretical results'. Candidates should be encouraged to trust in their experimental observations and not to try to 'guess' the identity of the unknown substances given to them.

Test 1

The addition of dilute hydrochloric acid to **T**, zinc carbonate, causes it to effervesce and produce a gas which turns limewater cloudy and therefore is carbon dioxide. In this type of exercise, candidates are require to make the observation, effervesces, and then test for and name the gas evolved. A surprising number still leave out one of more of these scoring points. The zinc carbonate dissolves to give a colourless solution.

Tests 2 and 3

When either aqueous sodium hydroxide or ammonia is added to the solution produced in *Test 1*, a white precipitate, which dissolves in excess to produce a colourless solution, is seen. Clear is not an alternative to colourless. Virtually all candidates scored the white precipitate mark, but many found it harder to decide if it then dissolved in excess.

Conclusion

Correct observations lead to the conclusion that **T** is zinc carbonate, credit was given to those candidates who identified the metal or carbonate ions without identifying the compound completely. A surprising number gave the answer as just zinc (or calcium) and appeared to think that **T** was a metal rather than a compound.

(b) Candidates were required to calculate the relative formula mass of **T**, most were able to do this successfully.

(c) The titration was exceptionally well done, with most candidates scoring full, or nearly full marks. 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.

(d) – (g) Although the majority of candidates were able to calculate the correct concentration of the acid, the rest of the calculations proved to be very difficult. In **(d)** there were very few occasions of candidates using anything other than a 1:1 mole ratio or inverting the volume ratio. The answer was required to three significant figures, very few candidates over approximated. Very few candidates appreciated that the answer to **(e)** simply required them to subtract their answer to **(d)** from 0.500, this gives the number of moles of hydrochloric acid which had reacted with **T**. The answer to **(f)** required them to divide their answer to **(e)** by 2, this was usually appreciated, although a significant number multiplied by 2. To obtain the final mass of **T**, the number of moles obtained in **(f)** was multiplied by the relative formula mass found earlier or by 140. Candidates who had an answer to **(f)** usually scored the mark for **(g)**. The calculation was marked consequentially throughout.

Question 2

This was a relatively straightforward exercise, and the overall marks were very high. 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.

Test 1

Addition of aqueous barium nitrate to **P**, iron(II) ammonium sulphate, produces a white precipitate which does not dissolve when nitric acid is added. There were very few cases of 'white solutions' or the mixture 'turning milky'.

Test 2

When aqueous sodium hydroxide is added to **P**, a green precipitate of iron(II) hydroxide is produced, this does not dissolve in excess alkali but does begin to darken or turn brown when left exposed to the air. This final observation was required.

Test 3

When the mixture from *Test 2* is warmed, ammonia is produced and this turns damp red litmus blue. Both comments were required. Both sulphur dioxide and chlorine were claimed by a surprisingly large number of candidates.

Test 4

The addition of hydrogen peroxide, causes the solution to become yellower. The final colour of this solution is dependent on the concentration of the hydrogen peroxide, accordingly a range of colours was acceptable. However there is no precipitate at this stage. When sodium hydroxide is added a red-brown precipitate of iron(III) hydroxide is now produced. The mixture also effervesces and produces oxygen which can be tested for with a glowing splint.

Conclusions

The ions present were Fe^{2+}, NH_4^+ and SO_4^{2-}. Most candidates gave Fe^{2+} and SO_4^{2-}, but NH_4^+ was much less common. Many candidates also suggested Fe^{3+}, presumably due to the brown precipitate in *Test 4* and NO_3^- There were very few examples of names rather than formulae or incorrect formulae.

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 examined including 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 of plotting points on graphs and there is evidence of a general improvement in the drawing of appropriate smooth curves.

There continues to be a significant number of candidates who confuse the tests for the gases Hydrogen and Oxygen.

The use of indicators and the knowledge of colour changes to determine the end-point in titrations is necessary and are generally well known but the actual colour change is often reversed. This was particularly evident in this examination where aqueous potassium manganate(VII) was used as the titrating solution.

Comments on specific questions

Question 1

This question required the candidate to state which piece of apparatus was the most suitable for the purpose. The correct answers were **D**, a funnel for helping to pour a liquid into a container with a narrow neck; **B**, a volumetric flask for titrations; and **E**, a measuring cylinder for transferring 80 cm^3 of a liquid into a container. **F**, a burette, was accepted as an alternative for the measuring cylinder.

Question 2

(a) Acceptable answers for the appearance of solid zinc are silver, grey and shiny but not white. Aqueous copper(II) sulphate is blue.

(b) Three different observations were required for the reaction between zinc and aqueous copper(II) sulphate. Possible answers included: zinc dissolves, reacts; a red or copper deposit; solution warms up, bubbles, effervesces or a gas is evolved.

(c) Acceptable answers for the type of reaction were displacement, redox or exothermic.

Question 3

Candidates were given diagrams of four electrolysis experiments and were asked to state the electrode(s) at which certain elements were produced.

(a) Hydrogen was produced at electrodes L, N and Q.

(b) Oxygen was produced at electrode M.

(c) Sodium was produced at electrode S.

(d) Chlorine was produced at electrodes K, P, and R.

In all cases for any incorrect electrode marks were deducted from the marks gained.

Questions 4 - 8

The correct answers to the multiple choice **Questions**, **4** to **8** were **(d)**, **(a)**, **(c)**, **(b)**, and **(b)** respectively.

Question 9

Parts **(a)** to **(c)** involved the analysis of the fertiliser, **F**, which was later volumetrically analysed to determine its percentage iron content.

(a) Dissolving **F** in water produced a coloured or green solution. Reference to solids or substances were not acceptable.

(b) The addition of aqueous sodium hydroxide produced **(i)** a green precipitate **(ii)** which was insoluble in excess of the reagent. **(iii)** Heating the mixture produced a gas or ammonia, which turned litmus blue. The colour change of the litmus must refer to the gas, as the alkaline solution would also produce the same colour change. Failure to do this lost the mark.

(c) Acceptable tests for the sulphate ion included combinations of aq.$Ba(NO_3)_2/HNO_3$ and aq.$BaCl_2/HCl$ producing a white precipitate. The observation mark was only gained as a result of a correct test for the sulphate ion.

(d) The mass of **F** used in the experiment was 6.95g.

(e) A pipette was the most suitable apparatus for this purpose.

(f) Acceptable colour changes were colourless, green or yellow to pink or purple. As mentioned earlier in the Report it was disappointing to see a large number of candidates give the correct colour change but the wrong way round. Candidates should be advised to always consider carefully, which solution is in the titrating flask before deciding on the initial colour.

(g) The correct volumes of **G**, as a result of the burette volume readings were: 25.2, 24.4 and 24.6 respectively, giving a mean value using readings 2 and 3 of 24.5 cm^3. In cases where incorrect reading of the burettes resulted in different volumes of **G**, candidates were given credit for choosing the two closest volumes, which may not have been 2 and 3, to produce their mean value.

(h) The answers to the calculation were:

0.00049, **(i)** 0.00245, **(j)** 0.0245, **(k)** 1.37g, **(l)** 19.7%.

In all cases any incorrect answer to any part of the calculation may be correctly used in the following parts and gain the marks. Any rounding up or down was penalised once only e.g. 0.00049 becoming 0.0005.

Question 10

(a) Candidates were required to read the thermometer diagrams giving temperature values of 26, 35, 47, and 60 respectively. These results were plotted on the first graph and joined by a smooth curve. Marks were awarded for accurate plotting of these results and the quality of the smooth curve. The resulting curve was used to produce answers to parts **(c)** and **(d)**.

A common error was in the reading of the thermometers a number of candidates reading the values as 20.6 rather than 26, 30.5 rather than 35 etc. Although the initial marks were lost candidates could still gain the following marks so long as they plotted 20.6, 30.5 etc.

The candidate's graphs were read to assess their answers to parts **(c)** and **(d)**. The answer to part **(d)** was obtained by reading from the graph the temperature at which the time was 55s, half the initial time of 110s.

(e) A second plot of points was required for part **(d)** from which parts **(f)** and **(g)** could be answered. Part **(g)** proved to be very difficult for the majority of candidates although it was pleasing to see a good proportion realising that to get the answer they had first to read from the first graph the time, 60s, for 30°C and then on the second graph read the concentration at a time of 60s which should give a concentration of 0.05 mol/dm^3.

Question 11

This question involves various aspects of water and its purification.

(a) The rain water would boil at a lower temperature as the sea water contains salts, which increases its boiling point.

(b) Sodium chloride is the main constituent of sea water.

(c) Sea water may be converted to drinkable water by either distillation, desalination or ion exchange.

(d) Chlorine, tested by the bleaching of litmus, should be used to kill any bacteria.

(e)(i) Sodium, in its reaction with water, produced hydrogen, which is tested by its ability to 'pop' in a flame.

(ii) Candidates are asked to give two different observations. Possible observations included, sodium dissolved, reacted vigorously, burst into flames, moved around the surface of the water, effervesced or a gas was evolved and the solution, which contained litmus, turned blue.

Further general comments

In **Questions 2 (b)** and **11 (e)** marks are only awarded for observations, not theoretical answers e.g. in **2 (b)** several candidates stated that zinc sulphate was produced. This is not an observation and hence would not be given credit.