CHEMISTRY

GCE Ordinary Level

Paper 5070/01
Multiple Choice

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

General comments

Overall the questions had good statistics with the incorrect answers each obtaining an acceptable proportion of the incorrect choices. **Questions 2** and **25** were the only questions that proved to be easy. A further two questions, **Questions 19** and **38** proved to be poor discriminators.

Comments on specific questions

Question 4

Only alternative **D** was unpopular indicating that almost all the candidates realise that molecules are moving in a liquid.

Question 5

Alternatives **C** and **D** were the two most favoured answers. This was no doubt because compounds of sodium are colourless and compounds of copper are coloured. The knowledge that sodium salts are soluble identified **C** as the answer.

Question 8

Elements are identified by the number of protons in the nucleus. The question stated that the particle had seven protons in its nucleus and therefore the identity of the particle could only be related to one element namely nitrogen.

Question 11

Aluminium ions, Al^{3+}, are more positive than magnesium, sodium and zinc ions (Mg^{2+}, Na^{+}, Zn^{2+}) and thus aluminium provides three electrons per atom to the 'sea of electrons' in aluminium metal.

Question 13

Both hydrogen and oxygen form diatomic molecules and therefore two moles of hydrogen molecules and one mole of oxygen molecules would combine to form two moles of water. The failure to appreciate the significance of the word *molecule* meant that the incorrect alternative **D** was a strong distractor.

Question 33

In the main, candidates chose either alternative **A** or **B**. In the blast furnace carbon reduces iron(III)oxide to iron due to the greater chemical reactivity of carbon compared to iron. Thus alternative **A** was correct and **B** incorrect.

Question 38

Cholesterol is an alcohol. The significance of the 'ol' at the end of the name cholesterol was only appreciated by a small percentage of the entry. Consequently this question had the worst statistics of all the questions used in this section of the examination.

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 can be congratulated on the clarity of their presentation of their answers.

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 30 were rare. Fewer than 20 was a frequent score. All five questions contained something that caused problems, even for the better candidates.

Question 1

Just three or four was a common score and all six marks was rare. The Examiners accepted answers either with or without the (aq) symbol.

(a) Ammonia solution as an alkali was well known.

(b) Dichromate(VI) and manganate(VII) were equally frequent responses. Weaker candidates failed to copy the formula correctly, giving $KCrO_7$, KCr_2O_7 and K_2CrO_7.

(c) The part with the highest incidence of wrong answers. Possibly through failure to read the question, many gave one of the oxidising agents rather than the solution used to test for an oxidising agent.

(d) Fewer than half of the candidates recognised the pink-brown solid as copper.

(e) Dichromate(VI) was more popular than manganate(VII) and the more confident candidates gave both possibilities.

(f) The chloride was the common wrong answer.

Question 2

The candidates found this to be a difficult question. Frequently only two marks were scored, usually from part **(c)**.

(a)(i) Few candidates used the data correctly. Chlorine in excess because 142 g is greater than 2.5 g was one type of error. Frequently 2.5 mol of hydrogen and 4 mol of chlorine were given.

(ii) Rarely correct with 2.5x184 = 460 being a very common error. The few who correctly calculated 230 kJ then gave an incorrect unit, kJ/mol.

(b) The answers often lacked clarity. As a common example, 'More energy is need to form bonds than to break them' was typical. The Examiners required three unambiguous statements. Energy is absorbed in breaking bonds. Energy is released in bond formation. More energy is released than is absorbed.

(c) This bonding diagram was well known.

(d)(i) Repetition of the energy statements given in **(b)** did not score. Reference to the energy levels in the diagram was required.

(ii) Few candidates could correctly label the activation energy. An arrow from the 2NO line to the top of the curve was the frequent suggestion.

Question 3

A source of some marks for all of the candidates, but high marks were rare.

(a) For carbon monoxide, the pattern for carbon dioxide had to be followed. Hence incomplete combustion of a fuel was the only acceptable answer. 'From car engines' was not allowed.

The sources of methane as decay of vegetable matter or from ruminants were not known. From a car engine was a common misconception. To suggest that a source of methane is combustion of a fuel was a common, serious misconception. Its contribution to global warming was well known, with poisonous or harmful being the common incorrect alternatives.

The possible sources of sulphur dioxide were better known than for methane, as was its contribution to acid rain.

(b)(i) The figure was usually correct with a value from 0.525 to 0.530 being accepted.

(ii) The car engine as this source was well known.

(iii) The graph reading was well done. Any time from 2.30 to 3.30 was allowed.

(iv) The possible effect of ozone in the lower atmosphere was not known. Often the same answer was given here as in **(c)(i)**.

(c)(i) The absorption of u.v. was well known. Reflection of u.v. was not accepted.

(ii) CFC's were well known. Failure to read the question occasionally led to the answer 'aerosols'.

Question 4

A very high scoring question with many candidates scoring full marks.

(a) Almost always correct.

(b) The increase in rate with increasing temperature was very well known. One error seen was to state that the number of collisions increases rather than the correct statement of increasing collision frequency.

(c)(i) The majority of the candidates had a correct equation.

(ii) Either this was correctly answered or it was left blank.

(iii) Usually correct. Occasionally an error was made with the *M*r of calcium carbonate.

Question 5

Many candidates scored more than half of the total marks but full marks were very rare.

(a) This industrial process was well known with fermentation being the common wrong idea. Candidates should be encouraged to give specific temperatures and named catalysts rather than the vague 'With a catalyst at a high temperature'.

(b) This oxidising agent was well known. The Examiners accepted both potassium dichromate and potassium permanganate but not potassium dichromate(VII) or potassium manganate(VI).

(c)(i) Water, as the other product was well known.

(ii) Both sulphuric and phosphoric acids were accepted, but not dilute sulphuric acid. Platinum, nickel and vanadium(V) oxide were the candidate's common choices.

(iii) Dynamic equilibrium was not well understood. The most direct approach was that the rates of the forward and backward reactions are equal. Many candidates stated that equal masses of reactants and products were present.

(d)(i) The answers showed confusion between weak/strong and dilute/concentrated. Another common error was to state that a weak acid has a pH value of 3 to 6.

(ii) Hydrogen was recognised by the majority of the candidates.

(iii) This formula defeated all but the strongest candidates. Oxides and carbonates were common answers with CH_3COOMg being frequently seen.

Section B

The four questions in this section were about equally popular. **Question 8** had the highest mean mark and **Question 9** had the lowest mean of the four questions. In general, the candidates found it easier to score in this section than in ***Section A***.

Question 6

A generally high scoring question and certainly the one most likely to lead to more than half of the marks being scored.

(a) The two half equations were usually correct and the explanation of oxidation, either in terms of electron loss or as increase in oxidation number, were well explained.

(b) This section was very well answered.

(c) The Examiners were surprised by the extent of the knowledge of the candidates. Lengthy accounts describing a multiplicity of processes were often given. Marks were only lost by a failure to respond to the question, which asked for an explanation of the stages. Hence mere listing of the processes could not score.

(d) This calculation was very well done. Although not necessary, most candidates began by writing the equation for the reaction.

Question 7

This was a popular question. Full marks were comparatively rare.

(a) This was usually correctly answered. The Examiners expected one decimal place in the answers, 13.9% for potassium nitrate and 21.2% for ammonium sulphate.

(b) Very extensive and knowledgeable answers were seen. Many had scored the maximum three marks well before the end of their accounts.

(c) This was not well answered. Calcium hydroxide reacts with nitrates releasing nitrogen was a common error.

(d) The test for a sulphate was well known.

Question 8

The most popular question and also the one most likely to lead to full marks.

(a) Correct structures were given by most candidates. Some were also able to name their structures. The main error was to give structures for butane.

(b) The general formula for an alkane was very well known.

(c) Some candidates failed to score by merely repeating the data without making a comment. That the energy varies with the carbon content was a common vague response, which did not score. "Decreases" was required.

(d) This equation was usually correct.

(e) Many candidates could arrive at 0.02 mol of carbon and 0.05 mol of hydrogen. Regretfully this ratio was then rounded to an empirical formula of CH_3 or CH_2.

(f) Bromine as the reagent to distinguish between alkanes and alkenes was well known.

Question 9

A well answered question but full marks were rare.

(a) Although three marks were shown, many answers gave only one observation. Many correct statements on the relative reactivities of the Group I metals were made, but they did not respond to the question's request for observations. Gas/hydrogen evolved is not an observation. The possible observations include floats, bubble, flame, runs about, melts, explodes and dissolves.

(b)(i) Recognising that the colour of aqueous bromine depends very much on its concentration, a range of colours were accepted. Candidates who reported bromine gas were not credited.

(ii) Only the better candidates scored this ionic equation.

(c)(i) Ionic and covalent bonding in lithium fluoride were equally frequent. For the ionic structures, a mark was frequently lost through failing to show the inner electron pair of the fluoride ion. Note that the question asked for all the electrons to be shown.

(ii) The explanation of conductivity was usually well described. The movement of ions was well understood, even by those candidates who had shown covalent bonding in **(i)**.

(iii) A high melting point was well known and was the only one of the various possibilities given.

Paper 5070/03

Practical Test

General comments

The overall standard was pleasing with many candidates demonstrating a sound understanding of both qualitative and quantitative techniques. However the calculation was less well done than expected.

Comments on specific questions

Question 1

(a) *Identification of the acid*

This was a relatively simple exercise where candidates were expected to add (a) lead(II) nitrate, (b) silver nitrate and (c) barium nitrate to solution **P** which was described as being either sulphuric acid or hydrochloric acid. **P** was sulphuric acid so the expected answers were (a) white precipitate, (b) no reaction and (c) white precipitate. Although most candidates carried out the exercise successfully, many lost marks for incomplete or vague answers. 'Turns milky' or 'white solution' are not acceptable alternatives to 'white precipitate'. A correct set of observation leads to the correction conclusion that **P** is sulphuric acid. Somewhat surprisingly, given the opening sentence, a substantial number of candidates identified **P** as nitric acid. There were a number of even more unlikely answers such as ammonia or sodium hydroxide.

(b) *Titration*

Although most candidates coped with the standard acid/base 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 result (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) *Calculation*

The calculation of the molar concentration of the acid was, unexpectedly, less well done than in the past, with many candidates making no attempt at the exercise. Having identified the acid as sulphuric acid, candidates were required to use a mole ratio of 2:1 for the sodium hydroxide: sulphuric acid reaction. Those that used a 1:1 ratio were penalised, but could still score two of the three marks available. Those that identified the acid as hydrochloric acid in part **(a)** did not suffer this further penalty.

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

$$\frac{\text{Conc. acid} \times \text{Vol. acid}}{1} = \frac{\text{Conc. NaOH} \times \text{Vol. NaOH}}{1 \text{ or } 2}$$

Any equivalent method involving calculating the number of moles of sodium hydroxide in 25 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

Answers to this question were a little disappointing. Candidates had problems associated with describing the various colours seen and reporting their observations in sufficient detail. There was a noticeable tendency for answers to include the test as well as the observation, e.g. 'when sodium hydroxide was added the orange solution turned yellow'. In this case 'solution turned yellow' was all that was needed. By repeating the test, candidates often ran out of space and missed out important observations. For most tests a simple description, 'blue precipitate' or 'precipitate dissolved to give a green solution' is all that is required.

Test on Solution **R** (potassium chromium(III) sulphate, chrome alum)

Test 1

Addition of barium nitrate gives a precipitate, which when allowed to stand is clearly white. This precipitate does not dissolve on the addition of nitric acid. The marks for 'white' and 'precipitate' were awarded independently, allowing 'blue or green precipitate which is insoluble in acid' to score two out of three marks. Many candidates again lost marks for statements such as 'turns cloudy'. The formation of a precipitate (of any colour) allows the anion in **R** to be identified as sulphate. Iodide was the most common wrong answer, presumably because of the yellow colours involved later, carbonate, chloride and nitrate were also seen. There were also a significant number of positive ions quoted, iron(II) and copper(II) being the most common.

Test 2

The addition of a small amount of sodium hydroxide produces a green precipitate which dissolves in excess to give a green solution. White was not an acceptable description of the colour. Only a relatively small number of candidates scored all three marks for this part of the exercise.

When hydrogen peroxide is added, there are a number of colour changes, but the final product is a yellow solution. The mixture also effervesces and gives off oxygen, which relights a glowing splint. All three final points scored. A number of candidates thought that hydrogen was evolved. Although oxygen often relights a <u>glowing</u> splint with a 'pop', hydrogen only 'pops' with a <u>lighted</u> splint. Less understandably, ammonia and carbon dioxide were also detected.

Test on Solution **S** (potassium chromate(VI))

Test 3

Addition of sodium hydroxide turns the solution yellow, but there is no precipitate at this stage. However the addition of barium nitrate does produce a precipitate, which on standing is seen to be yellow. Understandably many thought the precipitate was white. When nitric acid is added the precipitate dissolves and the solution turns orange. It is not usually acceptable to say that the 'original' colour is seen.

Test 4

Acidification of **S** produces no change but when hydrogen peroxide is added there are two main sets of observations. The solution turns very dark blue and then green. Both colour changes were expected, although a range of colours was accepted. A precipitate is not formed in this reaction. In addition to the colour changes, there is effervescence and the gas is again oxygen. Candidates are always expected to make the observation, effervesces or bubbles, then test and name the gas. A considerable number of marks are lost by candidates giving incomplete answers. Hydrogen was again often reported as was sulphur dioxide, presumably because of the colour changes involved.

<u>Conclusion</u>

Candidates were expected to use the observation to suggest a property of transition metals illustrated by these reactions. Although transition metals do have high melting points and act as catalysts, the only acceptable answers were that transition metals show a number of oxidation states. Reasonable variations on this answer, using valencies instead of oxidation states, were allowed.

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 include recognition and calibration of chemical apparatus and their uses, recall of experimental procedures, handling and interpretation of data, analysis of unknown salts and calculations. The standard in general is being maintained and the majority of candidates show evidence of possessing many of the aforementioned skills. Most candidates show competency of plotting graphs although a common error is not to include the zero point in the curves.

Comments on specific questions

Question 1

The volume of liquid in the measuring cylinder was 31 cm^3.

Question 2

(a) The temperature values were 23 and 28 giving a temperature rise of 5°C.

(b) This suggests that the reaction is exothermic.

(c) The solution turns litmus blue and its pH may be measured by using a pH meter or Universal indicator (not a pH scale). The pH would be expected to lie in the range of 7 to 14.

(d) Alternatives to Potassium would be Sodium or any Group I metal, but not Group II.

Question 3

(a) The acid is nitric acid of formula $HNO_{3.}$

(b) The best method of producing good quality crystals is by method 1, and the crystals may be removed by filtration or decantation.

(c) The molar mass of NH_4NO_3 is 80g.

160g of the salt thus produces 56g of nitrogen.

This mass of nitrogen is 2 moles having a volume of 48dm^3.

In each stage of the calculation, any error may be carried forward and if used correctly gains the mark(s).

A common error was using the molar mass of nitrogen as14 giving a volume of 96cm^3.

(d) The NH_4^+ ion may be tested by warming with aq. NaOH to give ammonia.

The NO_3^- ion requires aluminium to be present with aq NaOH to give ammonia .

Other acceptable tests for NO_3^- include the 'Brown Ring' test.

Questions 4 to 8

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

Question 9

(a) The best apparatus for this purpose is a pipette.

(b) The colour change of the indicator is yellow to pink or red.

(c) The intention of this question was for the candidate to realise that such a small titre would reduce the accuracy of the experiment.

(d) The burette should be washed with water followed by the diluted acid. No other combination was acceptable.

(e) The volumes of acid used were 19.7,19.1 and 19.3 giving a mean value of 19.2 cm^3.

Answers to **(f)** 0.0025 moles, **(g)** 0.005 moles, **(h)** 0.26 mol/dm^3, **(i)** 2.6 mol/dm^3.

Question 10

This question involved the analysis of calcium sulphate, $CaSO_4$.

Test 1 should show a colourless solution. Answers stating a colourless compound or solid were not allowed.

Test 2 gives a white precipitate insoluble in excess.

Test 3 - the correct response is a presence of a slight white or no precipitate.

No marks were given for statements such as ‘nothing happened’.

Test 4 is a test for the sulphate ion. The addition of either barium nitrate or chloride with either nitric or hydrochloric acid gives a white precipitate.

Question 11

(a) The correct values were 37,48,56 and 60.

All volumes should be plotted on the grid including zero and the points for both experiments should be connected by a smooth curve which should in both cases be extrapolated to zero. Failure to do this would prevent the reading of the volume for experiment 1 at 30 seconds. The curve for experiment 3 must show a steeper slope at the start from zero giving the same finish point at $60cm^3$.

(c) The experiment finished at the same point in all experiments because the number of moles of acid was the same in each, the acid being the limiting reagent. Similar answers involving calcium carbonate were incorrect. The highest rate in all cases was at the start of the experiment. Answers to explain this must involve a chemical explanation such as the concentrations are at their highest, or that there are more collisions etc.

The answers to **(e)** are 48 cm^3 and 27 cm^3 respectively but may be different on the candidates graph.

If the volumes have been read correctly marks were awarded.

The main error here was not realising that each small square was 3 cm^3.

(g) This experiment would produce 60 cm^3 as in the other experiments as nitric acid like hydrochloric acid is a monobasic acid.