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

General comments

A number of questions were not particularly testing but like all the questions on the paper they proved to be very good discriminators between the candidates.

Comments on specific questions

Question 5

There proved to be a strong distractor in this question and this was **C**. Although most noble gases have eight electrons in their outer shell candidates ignored the gas helium which only has two electrons in its outer shell.

Question 6

Most metal oxides are ionic and will conduct electricity when molten. However, ionic compounds only conduct electricity when their ions are free to move and the ions cannot move in the solid state. Thus the very popular distractor **C** was incorrect.

Question 12

Provided that candidates realised that bond breaking requires energy and that bond making releases energy this question was answered by correctly distinguishing between alternatives **C** and **D**.

Question 22

In the manufacture of aluminium the tap hole at the bottom of the cell is to run off the molten metal and aluminium oxide does not conduct electricity unless molten, making alternative **A** correct.

Question 24

Alloys are hard because the layers of atoms will not slide over each other due to the irregularities in the sizes of the atoms. Hence the differences in atomic radius explain the hardness of alloys.

Question 30

Most candidates had no problem in rejecting responses **A** and **B**, opting for **C** or the correct answer **D**.

Question 39

Alternative **A** was very popular despite it requiring the least work in order to calculate its empirical formula, CH_2.

Paper 5070/02
Theory

General comments

This question paper generated a wide range of marks, from single figures to scores approaching 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, both ***Sections A*** and ***B*** contained material which even the stronger candidates found difficult. Hence marks above 40 in ***Section A*** and totals above 68 were rare. Candidates should be advised to take particular care in their use of technical words. The terms atom, molecule, ion, element, compound etc. have precise meanings and they cannot be used indiscriminately.

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 must 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

A high scoring question with the majority of the candidates scoring either three or all four marks. The few errors were random with the exception of giving barium sulphate as the yellow solid in **(d)**.

Question 2

This question generated a wide range of marks.

(a) This part was poorly answered. Rushing into ‘a sea of electrons’, candidates failed to mention the essential cation in the structure. The fact that an electric current is a flow of electrons was rarely mentioned.

(b) Again, poorly answered. The wording of the question and the mark allocation clearly indicated that two statements were expected. The majority of the candidates gave only one fact. Another failing was to state that mild steel has a low percentage of carbon and ignore the question’s request for comments on the physical properties of the various steels.

(c)(i) The essential conditions for the rusting of iron were very well known.

(ii) This was also well known. Many answers also included reference to sacrificial protection, although this phrase was not needed to answer this question.

(d) Two properties of the transition metals were given by many candidates. With the word 'only' in the question, melting points and densities were not accepted. A careless error was to state that 'they are coloured'. Coloured compounds was the key point.

(e) Although many candidates showed that they were familiar with the method of completing this calculation, unjustified approximations in the arithmetic spoiled many answers. As examples, 0.547/39 is not 0.01 and 0.195/56 is not 0.003. Since the data in the question was quoted to three decimal places, candidates should also work to three figures.

Answer: **(a)** $K_4FeC_6N_6$.

Question 3

Parts **(a)** and **(b)** of this question were well answered but **(c)** was not.

(a) That the noble gases were missing from Mendeleev's table was the chosen answer of the majority. The Examiners also accepted missing transition elements.

(b) There was a very long list of acceptable answers to this question. The most popular statements were to note the interchange of the positions of the groups and the periods and the appearance of hydrogen in Group One in Mendeleev's table.

(c) Poorly answered because the candidates did not appreciate that observations must be events which can be seen or heard. Hence violent reaction does not score a mark but an explosion does score. The equation was rarely scored, either because it was not given or because the product was frequently shown as rubidium oxide.

Question 4

This question generated scores in the six to eight range. All nine marks was very rare.

(a) Boiling point as the key property was well known.

(b)(i) Not many candidates knew that naphtha was essentially a feedstock and hence was used to make other useful products. Confusion of naphtha with kerosene or petrol was common.

(ii) Conversely the use of bitumen for surfacing roads was very well known.

(c)(i) The Examiners expected two statements here. One explaining the meaning of saturated and the other explaining hydrocarbon. The majority of the candidates explained only one of the two terms, usually saturated.

(ii) The structure of methane was very well known.

(d) Most candidates gained at least one of these two marks by referring to the production of 'more useful products'. For the second mark the Examiners were looking for a specific product such as hydrogen, alkenes petrol etc.

Question 5

A high scoring question with only **(a)** causing problems.

(a)(i) Many candidates could correctly relate the ion discharge to the relative positions in the activity series.

(ii) This was not so well answered. Many candidates referred to an increase in the concentration of sodium hydroxide, hence merely repeating the wording of the question. Mention of the removal of chloride ions leaving the hydroxide ions was required.

(b)(i) The test for chlorine was very well known.

(ii) An unexpectedly large number suggested using a glowing splint to test for hydrogen.

(c) This type of use of chlorine was very well known.

(d) The only acceptable answer was that burning hydrogen produces water, which is not a pollutant. To state that hydrogen itself is not a pollutant was not accepted.

(e)(i) The majority of candidates gave potassium chloride and fluorine as the products of this reaction.

(ii) Conversely, the correct products of this reaction were usually given.

Question 6

This proved to be the most difficult question in the section with many scores of zero.

(a) Since the question asked for the electronic structures, the full structures were expected. Giving the outer shells only was not accepted. Too many gave diagrams of the two atoms rather than of the two ions asked for in the question.

(b)(i) All too few referred to the attraction between the ions. The words atom, molecule and bond have no place in a response to this question.

(ii) To compare the two, mention of both the comparative charges on the ions and the forces between them was required. To state that magnesium gave two electrons to oxygen was not relevant here.

(c) Attempting to explain these facts as due to the movement of electrons was a frequent error. Again, the only correct term was ions. Movement of atoms or molecules is meaningless in this context.

Section B

Each of the four questions in this section attracted equal numbers of responses.

Question 7

This question tended to generate marks in the middle of the range.

(a) Perhaps two thirds of the candidates could describe a source of ozone. The rest merely blamed car exhausts.

(b) Many were aware that CFCs were involved in ozone depletion. The essential role of chlorine atoms, derived from the CFCs, was very rarely given. Causing skin cancers was by far the most popular health hazard quoted by the candidates.

(c)(i) There was confusion between the exothermic and endothermic nature of bond formation and bond breaking. Phrases such as the frequent 'energy is needed to form bonds' were unacceptable.

(ii) The majority of the answers merely repeated the statement that a temperature increase increases the rate of the reaction. The Examiners were looking for the increase in kinetic energy leading to an increase in collision frequency.

(iii) This calculation was well done. As for **Question 2 (e)**, to approximate 48/16 as 0.3 was not justifiable.

Answer: **(c)(ii)** 47.6 kJ.

Question 8

This was the question in this section with the lowest mean mark. For many candidates only the two marks in part **(a)** were scored.

(a) Many could successfully arrive at 0.216 g of silver.

(b) The common score on this question was only one or two of the three marks available. Many answers did not contain a clear definition of oxidation and reduction, either in terms of oxidation numbers or of electron transfer. Statements such as 'copper(I) chloride is oxidised to copper(II) chloride' were too imprecise to gain credit.

(c) This was very badly answered. All too many equations had copper as a reaction product, or contained a statement that as silver was below copper in the activity series, there would be no reaction. Candidates must read the question carefully. The products of this reaction were clearly given in the stem of the question.

(d)(i) Again correct equations were uncommon. An incorrect formula for copper(II) hydroxide and missing the 2 before the OH^- were the errors made.

(ii) Precipitates of sodium chloride were as frequent as those of copper(II) hydroxide.

Answer: **(a)** 0.216 g.

Question 9

Failure to read the question and respond carefully to it were the causes of low marks on this question.

(a)(i) Iron as the catalyst was well known. Iron(III) oxide was also accepted as an alternative catalyst.

(ii) The majority of the candidates gave a correct equation.

(iii) Failure to read the question resulted in candidates quoting figures from memory. This part must be answered by studying the information and the graph and arriving at 280°C and 400 atm. as the required answers.

(iv) Although many correctly remarked on the increase in rate, the answer was spoiled by also adding an increase in yield. The graph clearly shows that this is not correct.

(b) The effect of a catalyst on the rate of a reaction was well known. For the other two marks, mention of the lowering of the activation energy and hence a reduction of the overall energy requirements was required.

(c) The mark for this equation was rarely scored. Incorrect formulae and a failure to balance the equation were the common reasons. To show NH_4OH as a product was not accepted. Those candidates who had this formula had made it impossible for them to answer the final part of the question.

Question 10

This was the highest scoring question in ***Section B***, although all ten marks was not often seen.

(a) Butanoic acid as the next member of the series was well known.

(b) Similarly the formula of the sixth member of the series was usually scored. The expected error of $C_6H_{13}CO_2H$ was occasionally seen.

(c) The structure of the ester was well known. Most candidates worked it out by writing the equation in full structural form.

(d) The majority gave either potassium dichromate(VI) or oxygen as the oxidising agent. Potassium manganate(VII) was also seen and accepted.

(e) The equation was rarely correct, the formula of magnesium ethanoate being shown as CH_3CO_2Mg. However, the calculation following from the candidate's equation was almost always fully correct.

(f) That ethanoic acid is a weak acid and hydrochloric acid is strong was given by many candidates. The continuation to relate this fact to the comparative hydrogen ion concentrations of the two solutions was not given that often.

(g) Rather more than half the candidates scored this equation.

Answer: **(e)** 0.60 g.

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, however, a few candidates appeared to be unfamiliar with one or both of the exercises.

Comments on specific questions

Question 1

(a) The titration was generally well done, with many candidates scoring full, or nearly full marks. Although acid/base titrations, are relatively straightforward, the overall standard was very pleasing. 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.

It is clear that a few candidates 'alter' their results at a late stage to 'improve' them. This often leads to candidates losing marks. It is always advisable to record results as soon as possible and to have confidence in their accuracy.

(b) Candidates were required to use their titration results to calculate the concentration of hydrochloric acid in solution **P**. Most candidates were able to do this successfully and there were only a few examples of candidates inverting the volume ratio or using a mole ratio of anything other than 1:1. Answers were required to three significant figures and this caused some problems especially when the answer was less than 0.100 mol/dm^3. There is considerable confusion over the difference between three significant figures and three decimal places.

Question 2

This was a relatively complex exercise and many 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. In general candidates used the correct chemical terms, with 'precipitates dissolving to form solutions' rather than 'cloudy mixtures turning clear'.

Solution **R** was sodium thiosulphate and solution **S** was potassium iodide.

Test 1

When dilute hydrochloric acid is added to **R** there is no initial reaction but a white precipitate of sulphur forms slowly, the precipitate becomes more yellow in colour with time. All three observations were required. On heating, sulphur dioxide, which turns acidified potassium dichromate(VI) green, is produced. Only a small number of candidates tested for sulphur dioxide although significantly more candidates noted that the gas turns litmus red. A surprising number of candidates detected chorine, carbon dioxide or ammonia.

Test 2

Addition of **R** to acidified potassium manganate(VII) cause the purple solution to be decolourised. 'Turns clear' is not an acceptable alternative. On standing a white/yellow precipitate is formed. As the precipitate is relatively 'thin' in this test, 'turns cloudy' or forms a 'white solution' was allowed.

Test 3

When equal volumes of aqueous silver nitrate and solution **R** are mixed a precipitate which is initially white is formed. This precipitate then changes colour rapidly, to yellow then red and finally black. All of these changes were expected but a range of colours was acceptable.

Test 4

The addition of aqueous lead(II) nitrate to **R** produces a white precipitate which is insoluble in dilute nitric acid.

Test 5

When **S** is added to acidified potassium manganate(VII), a red/brown solution is produced. The colour of this solution is very dependent on the amount of iodine produced so a range of colours from yellow to brown was acceptable. However a solution is formed not a precipitate. Addition of **R** causes the solution to turn colourless and then to form a precipitate similar to that formed in *Test 2*.

Test 6

Addition of **S** to silver nitrate produces a pale yellow precipitate of silver iodide. White was not acceptable but yellow was allowed, provided the precipitate in *Test 7* was described as being 'more' yellow.

Test 7

With lead(II) nitrate a bright or darker yellow precipitate is formed, this is not soluble in nitric acid. However, dilution of the mixture with water and subsequent heating should have caused the precipitate to dissolve. Very few candidate noted this change, although more recognised that on cooling crystals rather than a precipitate are formed.

Conclusions

The formation of a yellow precipitate with lead(II) nitrate and the colour of the solution produced with potassium manganate(VII) should have confirmed that **S** was an iodide. The formula was asked for but the name was allowed.

In *Test 5*, **S** acts as a reducing agent, the iodide ion is oxidised to iodine hence **S** is a reducing agent. Then **R** also acts a reducing agent, reducing the iodine back to iodide. Very few candidates recognised this and many clearly guessed.

Paper 5070/04
Alternative to Practical

General comments

The Alternative to Practical Chemistry paper is designed to test the candidate's knowledge and experience of practical chemistry. Skills including recognition and calibration of chemical apparatus and their uses, recall of experimental procedures, handling and interpretation of data, drawing and interpretation of graphs, analysis of unknown salts, volumetric analysis and associated calculations are expected.

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 the quality of drawing appropriate lines and curves through the points continues to improve. Candidates should be instructed to plot points and read graphs wherever possible to half of a small square. Where appropriate, lines and curves should be drawn through zero except where instructions suggest otherwise.

There is evidence of an increase in the number of candidates who are able to correctly read burette diagrams and successfully complete subsequent calculations.

Comments on specific questions

Question 1

The diagram shows a syringe and the volume of gas is 12 cm^3.

Question 2

(a)(b) In **(a)** the colour of the precipitate is white and in **(b)** it may be removed from the mixture by filtration. Several candidates incorrectly suggested decantation.

(c) The number of moles of barium chloride and magnesium sulphate was 0.0012 and 0.0015 respectively.

(d) The number of moles of barium sulphate produced was determined by the limiting reactant, i.e. 0.0012 moles of barium chloride. On multiplying this value by the molar mass of Barium sulphate, 233, an answer of 2.80 g was obtained. However if one or both of the mole calculations in part **(c)**, or the formula of barium sulphate was incorrect, marks were awarded for the correct usage of any incorrect value or formula.

Question 3

(a) This question produced many different answers but an answer suggesting why lead bromide cannot conduct in the solid state but can do so in the molten state was required. Good answers referred to mobile ions (not electrons) being present in the molten but not in the solid state. Answers of the type 'so that it conducts' were insufficient to gain the mark.

(b)(i)(ii) Bromine is produced at electrode **A** and is a red/brown gas.

(iii)(iv) Lead is produced at electrode **B** and collects on the bottom of the beaker below the electrode. Marks were lost if gas or vapour was omitted from the appearance of bromine in **(ii)** and lead collecting on the electrode in **(iv)**.

(c) The gases produced at electrodes **C** and **D** are chlorine and hydrogen respectively.

Many candidates continue to confuse the tests for hydrogen and oxygen. The test for hydrogen must include a reference to the insertion of a flame or burning splint into the test tube containing hydrogen not a glowing splint. Pops in a flame is acceptable but 'burns with a pop' should be discouraged.

(d) Sodium is produced at an electrode by using molten sodium chloride. Concentrated sodium chloride was not acceptable.

Questions 4-8

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

Question 9

A large number of candidates produced perfect answers to this question.

The majority of candidates correctly read the burette diagrams. The titres are 25.9, 25.4, and 25.6 cm^3.

Most candidates gave the correct colour change for methyl orange, although many gave the correct colours in reverse.

The answers to the calculations are:

(e) Using the mean titre of 25.5 cm^3 the number of moles of hydrochloric acid is 0.00204; **(f)** 0.00102; **(g)** 0.0102; **(h)** 106; **(i)** 1.08; **(j)** 0.90; **(k)** 4.90. Candidates must show an accurate answer to the final calculation, **(k)**, before deducing that the value of x is 5.

Candidates should be instructed that answers must not be rounded down or up, e.g. many answers to **(e)**, **(f)** and **(g)** were given as 0.002, 0.001 and 0.01.

Question 10

This was a standard analysis question, in this case of iron(III) nitrate.

Test **1** gives a coloured solution. The mark was lost if words such as substance, compound or precipitate was mentioned.

The observation to both tests **2** and **3** was a red/brown precipitate, which was insoluble in excess.

The standard test for a nitrate is the addition of aqueous sodium hydroxide followed by aluminium foil.

The solution was then warmed. A gas, ammonia is evolved, and may be confirmed by an appropriate test. Any other correct test for a nitrate is acceptable e.g. the 'brown ring test'.

Question 11

This question produced some very good answers. The correct temperatures, 32, 55, 69, 80 taken from the thermometer diagrams, together with those shown in the second table were used to produce a curve and straight line respectively. The plotting of points and the consequential readings from the graph were generally accurate to the required half a small square.

Extrapolations caused problems to several candidates. The two most common errors were: extrapolating the potassium chlorate(IV) curve to pass through zero, and extrapolating the upper end of the same curve vertically to pass through the final point of the potassium chloride line. The extrapolation mark was lost in both cases.

Answers to **(c)** are **(i)** 0.35 g, **(ii)** 3.30g, and **(iii)** 90°C although the candidate's values, taken from their own graphs were accepted where correct.

(d) This required the candidate to read from the graph the mass of salt at the point where the line and curve crossed. This mass should then be multiplied by 10 in accordance with the definition of solubility.

The final question, **(e)**, asked for the appearance of the tube containing 3.0g of potassium chlorate(IV) in 10.0 g of water. Only part of the salt would have dissolved and an answer suggesting that there would be a solution together with some undissolved salt was required. There were some excellent answers in which candidates calculated the masses of the salt that would have dissolved and not dissolved.

Conclusion

It is encouraging to see the continuing improvement in the accurate drawing of graphs and the consequential reading points from the graph.