CHEMISTRY

Paper 0971/12
Multiple Choice (Core)

There were too few candidates for a meaningful report to be produced.

CHEMISTRY

Paper 0971/22
Multiple Choice (Extended)

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

General comments

Questions 3, **8**, **27** and **28** were found to have the lowest demand. Candidates found **Questions 9**, **20**, **26**, **34** and **36** to have the highest demand. Questions on organic chemistry showed significant discrimination between candidates.

Comments on specific questions

Question 5

Option **A** was the most common incorrect answer. At this level, candidates would be expected to predict ionic bonding between metallic and non-metallic elements.

Question 6

This question discriminated well between candidates. Many candidates chose option **A**. Candidates should be able to draw dot-and-cross diagrams for all the molecules shown. A quick sketch may aid candidates in answering similar questions.

Question 9

This was a demanding question. Option **B** was chosen by most candidates. This may be related to the question asking for the option which was 'not' correct.

Question 11

Most candidates identified the neutralisation reaction. Confusion between the terms endothermic and exothermic was evident, with option **C** being the most common incorrect answer.

Question 14

This question discriminated well between candidates. Option **B** was a common incorrect choice.

Question 15

A few candidates suggested options **A** or **B**. Many candidates chose option **D**, confusing the highest point and maximum volume with the fastest rate.

Question 20

This question was not well answered. Candidates appeared to ignore or to not understand the relevance of the information given in the stem of the question. Insoluble calcium sulfate would need to be formed by precipitation. The most common answer was option **A**.

Question 22

This was a strongly discriminating question. There was evidence of guessing by some candidates.

Question 26

Candidates should be prepared to recall the order of reactivity and the reactions of each metal. Although relatively few candidates thought that silver would react with steam, a large number thought that it would react with a dilute acid. Option **B** was a common answer.

Question 31

Most candidates narrowed their choice to either options **B** or **C**. Many candidates then thought that the formation of oleum required a catalyst and selected option **C**.

Question 34

Candidates taking the supplement tier are required to be able to draw the structures of organic compounds containing four carbon atoms. A quick sketch would have helped candidates in this question. Overall, the distribution of the choices suggests that many candidates were guessing.

Question 36

Overall, there was a slight preference for the correct answer, but some candidates appeared to be guessing. Candidates should be reminded that alkenes react in addition reactions - this would have allowed them to eliminate half the options in this question.

Question 39

Option **C** was most commonly chosen by candidates who performed less well overall. Candidates should be remined that in organic compounds, carbon forms four bonds, hydrogen one and oxygen two. Hydrogen would therefore not form a double bond and option **C** could be eliminated.

Question 40

Some candidates appeared to be guessing. Questions may be presented in unfamiliar context, in this case the formation of *Kevlar.* Candidates should use the linkages in the structures shown to identify the type of polymer.

CHEMISTRY

Paper 0971/32
Theory (Core)

There were too few candidates for a meaningful report to be produced.

CHEMISTRY

Paper 0971/42
Theory (Extended)

Key messages

- Candidates should not use charges when writing chemical equations.
- Candidates should not provide fractions as answers to calculations.
- When determining the M_r of a substance, candidates should clearly state that the number they have determined is in fact the M_r, rather than a random number.
- Candidates need to consider the valencies of atoms; divalent hydrogen atoms and pentavalent carbon atoms were commonly seen in the structures drawn.

General comments

Candidates appeared to have sufficient time for all questions to be answered.

The standard of calculation work seemed better than in previous series.

Comments on specific questions

Question 1

(a) Most candidates knew that there were four bonds in diamond, although there were several other suggestions.

(b) The correct term 'giant covalent' was frequently seen.

Common incorrect or incomplete responses were: 'giant' and 'giant lattice' both of which did not include the covalent nature of diamond. Weaker responses described properties of diamond such as 'strong' and 'hard' rather than the structure.

(c) Silicon(IV) oxide or silicon dioxide was known by most candidates.

(d) The idea of graphite having layers of atoms was well known. Less well described was the hexagonal arrangement of atoms within these layers.

(e) Most candidates were aware that mobile electrons allow graphite to conduct electricity. The term 'free electrons' gained no credit.

(f) Candidates coped well with this calculation and 60 was frequently seen. 120 was a common error.

(g) The use of limewater to test for carbon dioxide was well known.

Question 2

(a) Weaker responses simply repeated the information given in the question that 'sodium is a reactive metal' with no further information offered. Better responses appreciated that sodium is stored under oil to prevent reaction with oxygen and / or water. 'Air' and 'moisture' were acceptable alternatives.

(b) (i) 'Oxidation' was seen more frequently than the correct response 'combustion'.

(ii) A selection of incorrect colours was seen in some responses.

(iii) The symbol of sodium and the formula of sodium oxide were given in the question. Better performing candidates were able to include O_2 as a reactant and correctly balance the equation. Others gave an equation with correct formulae but balanced it incorrectly. Some candidates opted to give their own formula of sodium oxide, despite Na_2O being given.

(iv) For many candidates, the charge was the only correct response given. Common errors were to show the eleventh electron on the sodium ions, to add a third shell to the oxide ion or to show eight dots instead of six dots and two crosses in the oxide ion's outer shell.

(c) (i) The syllabus definition of a base as a proton acceptor was well known.

(ii) The question asked for a pH number to be given, i.e., one number should be given. Many candidates opted to give a range of numbers, which was acceptable if the range indicated the pH was only within the range 12 to 14. Candidates who wrote 'above pH 12' were not given credit as, for example, this could include pH 16.

(iii) Relatively few candidates knew that methyl orange was yellow in alkaline conditions. The most common error was 'pink'. Many candidates wrote a mixture of colours, e.g., red / yellow.

(iv) Candidates should be reminded that fractions as answers to calculations will not receive credit.

Candidates should also be reminded that leaving the M_r calculation as a sum, e.g. M_r(NaOH) = 23 + 16 + 1 may also not receive full credit.

The most common error was to determine the moles of Na by dividing 0.345 g by 46 (46 is twice the A_r of Na), presumably due to the stoichiometric coefficients given in the equation.

(d) (i) Relatively few candidates knew the term for making an insoluble solid from solutions of two aqueous solutions was 'precipitation'.

(ii)(iii) Neither the colour (red-brow) nor name of the insoluble solid (iron(III) hydroxide) formed were well known. White was the most frequent colour error and sodium chloride was the most frequent error when attempting to identify the insoluble solid.

(iv) Candidates continue to struggle with ionic equations for precipitate formation. Ionic equations will always have two reactant *ions* and one product compound. The sequence of state symbols will always be (aq) + (aq) → (s). Many candidates attempted to write the complete symbol equation. Candidates might be advised to identify the solid product and 'split' this up into its constituent ions. These will be the reactants.

Question 3

(a) Few candidates knew that zinc blende was usually the ore used in this process. Many compounds containing sulfur, and many that do not, were suggested

(b) This question had a wide range of incorrect responses with vague statement processes involving oxygen as opposed to air. Roasting in air was rarely seen.

(c) The name 'Contact process' was well known, although many thought it was the 'Haber process'.

(d) (i) Most candidates gained full credit. Others gave a range of values with some of the range being outside acceptable values. Candidates should be advised to give single values only. Frequently, values associated with the Haber process were seen.

(ii) Vanadium(V) oxide was very well known as the catalyst, although an incorrect oxidation number of vanadium was often seen.

(iii) Many candidates wrote vague statements such as ‘forward rection equals backward reaction’ and did not mention rates. A very common error in the second part of the question was stating ‘concentration of reactants and products are equal’. Relatively few correctly stated ‘concentration of reactants and products are constant’.

(iv) Although some well-expressed answers were seen, many other candidates did not address the key focus of the question about *equilibrium*. Candidates should know that it is the *equilibrium* which shifts and not the reaction. The reason for the shift in equilibrium should be given. Many candidates struggled with their words and gave very unclear answers. There was some confusion of left and right, with contradictory statements such as ‘the equilibrium shifts towards the reactants’ followed by ‘the equilibrium shifts to the right-hand side’.

More candidates could give a correct explanation than describe what happened to the position of equilibrium. Many irrelevant comments about rate changes were seen. Candidates should be aware that there is no such thing as an ‘endothermic side’ to a reaction. There is an ‘endothermic *direction*’, however.

(v) Most candidates knew that particles gain more energy. Many candidates omitted the most obvious comment that the rate increases. Many stated that the *frequency* of collisions increases, although many candidates wrote ‘there are more collisions’. Few indicated that a *higher proportion* (or higher percentage) of collisions have enough energy to produce a reaction. ‘More collisions having enough energy to produce a reaction’ is insufficient.

(e) Most candidates named the compound correctly. Errors included ‘ammonia’ or ‘ammoniam’ instead of ammonium and ‘sulfide’ or ’sulfite’ instead of sulfate.

Question 4

(a) This equation was not done well, despite the formula of magnesium sulfate being provided. The most common error was the omission of hydrogen as a product or attempts such as ‘$Mg + SO_4 \rightarrow MgSO_4$’.

(b) Most candidates gave suitable answers here. Weaker responses described what would be seen *during* the reaction.

(c) It was apparent that candidates were unfamiliar with the terminology of simple procedures involved in salt preparation. ‘Filtrate’ was by far the most common response seen.

(d) (i) ‘Saturated’ was well known.

(ii) Only a very small minority of candidates linked the reduction in solubility to a decrease in temperature. Most talked about ‘solidifying’ or ‘freezing (from a melt)’ or just ‘crystals forming’.

(e) (i) The terms ‘hydrous’ and ‘anhydrous’ were often seen instead of ‘hydrated’.

(ii) Many candidates were able to calculate the M_r of $MgSO_4$ and used this to determine the number of moles of $MgSO_4$. A much smaller proportion understood how to calculate the moles of water involved in the formula and thus did not determine the value of *x*.

(f) Very few candidates knew the equation for the decomposition of $Mg(NO_3)_2$.

Question 5

(a) The general formula of alkanes was well known, but candidates need to be careful in the use of subscript. $C_nH_{2n}+2$ or C_nH2_{n+2} did not receive credit.

(b) Most candidates made the connection with light, but many omitted the ‘ultraviolet’ requirement.

(c) Most candidates correctly identified the type of reaction as substitution.

(d) Many candidates correctly identified hydrogen chloride as the other product of the reaction. Weaker responses stated ‘hydrochloric acid’. ‘HCl’ was not credited as a name was asked for, and HCl could be interpreted as hydrochloric acid.

(e) (i)(ii) These questions asked for the identity of two energy changes. ‘Activation energy’ was well known as the answer to **(i)**, but many identified the energy change in **(ii)** as ‘energy change’ rather than ‘energy change of reaction’. Weaker responses stated ‘endothermic’ and ‘exothermic’ respectively.

(iii) The question asked candidates to explain how the energy profile diagram shows the reaction was exothermic, but most candidates did not address the question and related the overall energy change to breaking and making of bonds with no reference to the diagram at all.

(f) In general, candidates were confident in performing the two calculations involving bond energies, and the answers 3050 kJ and 3170 kJ were frequently seen. However, a significant minority did not realise that the net energy change was found by subtracting 3170 from 3050 to give –120 kJ / mol. Doing the reverse subtraction to give +120 kJ / mol was a common error.

Question 6

(a) The general formula of carboxylic acids, $C_nH_{2n+1}COOH$, was well known, but candidates need to be careful in the use of subscript. $C_nH_{2n+}1COOH$ did not receive credit.

(b) The name, methanoic acid, was well known. Candidates should be aware that the correct spelling is important for organic chemicals. ‘Methenoic acid’ suggests the presence of an alkene group.

(c) Many candidates did not understand the definition of a molecular formula and gave the condensed structural formula HCOOH.

(d) The ability to convert the structure of methanoic acid into a dot-and-cross diagram was done well. Candidates should understand that a single bond is one dot / cross pair and double bonds are two dot / cross pairs. All the non-bonding electrons were frequently omitted.

(e) (i) The correct name, propyl methanoate, followed by a correct structure was frequently seen. However, ‘methyl propanoate’ occurred frequently as an incorrect answer.

(ii) Nearly all candidates knew that water was produced during ester formation.

(iii) Candidates who performed well were aware that methyl propanoate was an isomer of propyl methanoate. Ethyl ethanoate was another acceptable response as an example of an isomer of a four-carbon ester. Candidates only need to know the names of straight chained esters so attempts at branched esters including the use of numerals such as propyl 2-methanoate received no credit.

Butanoic acid was usually correctly identified as the four-carbon carboxylic acid.

CHEMISTRY

Paper 0971/52
Practical

There were too few candidates for a meaningful report to be produced.

CHEMISTRY

Paper 0971/62
Alternative to Practical

Key messages

- Candidates should go through their plans when answering **Question 4** before writing their response.
- There is no need to list apparatus or variables at the start of the plan.
- When a question asks for the name of a chemical, a correct formula is always acceptable. However, if a candidate answers with an incorrect formula, then credit will not be awarded.
- Candidates should be aware that the mark allocation reflects the number of valid points to be made for parts of questions.

General comments

Most candidates successfully completed all questions and there was no evidence that candidates were short of time. The complete range of marks was seen.

The paper discriminated successfully between candidates of different abilities but was accessible to all.

The majority of candidates were able to complete tables of results from readings on diagrams and then handle the data obtained as in **Question 2**.

Comments on specific questions

Question 1

(a) Credit was awarded for correctly naming the beaker. A small number of candidates were confused and named a burette or flask. A common error was to think that the label pointed to the chromatography paper.

(b) Most candidates gained partial credit. The solvent level was often drawn above the baseline.

(c) Most candidates correctly named a dropper or (teat) pipette. Incorrect answers using burettes or syringes were prevalent.

(d) A significant number of candidates described the colour spreading or the solvent reaching the baseline.

(e) Chromatography was generally well known.

Question 2

(a) Most candidates correctly completed the tables of results from the thermometer diagrams. The commonest error was to round all values to whole numbers. Many candidates did not seem to have understood what was wanted for ‘temperature change since the start’ and gave temperature changes from the previous reading. A number of candidates produced random numbers.

(b) The *y*-axis was often an incorrect scale and temperatures were plotted instead of temperature changes. Curves were often not smooth, and labels were missing.

(c) This was generally well answered. A small number misjudged where 13 cm^3 would be and read off the value for Experiment 2 instead of Experiment 1.

(d) Few candidates could explain that this was because the acid was in excess. ‘Reaction had finished’ was creditworthy. Vague references to solutions being used up were frequent.

(e) Many candidates did not deduce that solution **G** was more concentrated. The idea of changing concentrations was common.

(f) This was well answered. Most candidates knew that the polystyrene cup would be an insulator. A common misconception was that the polystyrene cup would react with the acid or melt.

(g) Vague answers referred to a burette being hard to use or not big enough.

Question 3

(a) Many candidates gained credit for identifying carbon dioxide.

(b) The majority of candidates correctly identified a carbonate.

(c) Many candidates reported the formation of a white precipitate. A significant number stated that the precipitate would be cream-yellow or white-cream and was insoluble.

(d) Candidates knew that the precipitate would be insoluble.

(e) Many candidates incorrectly described a change.

(f) A white precipitate was often given.

Question 4

Candidates were asked to plan an investigation to compare two hydrogels.

The complete range of marks was seen in this planning question. The quality of responses was often centre dependent.

A large number of candidates did not give fully quantitative answers by not using a known or stated mass of hydrogel. A common error was not to mix the hydrogel with water or not stating how the unabsorbed water is removed from the hydrogel.

Suitable apparatus was required; this should be stated in the method and not in a list of apparatus since an item named in an apparatus list does not make it clear for what that apparatus was used.

A minority of candidates used the wrong method such as fractional distillation or chromatography. These methods showed a lack of knowledge and understanding.

A significant number of candidates did not attempt the question at all.