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

General comments

Overall the candidates found this to be an accessible paper. **Questions 1**, **3**, **4**, **5**, **8**, **21** and **29** were found to be easiest. Candidates found **Questions 7**, **16**, **22** and **31** more challenging. There was a wide distribution of marks, with some candidates doing particularly well. Candidates should take particular care when answering a question which includes the word 'not', **Question 30**. The word is written in bold to help the candidate take note.

Comments on specific questions

Question 2

Candidates should make sure that the measurement apparatus is suitable for the precision of the measurement needed. In this question, 25.00 cm^3 could only be provided using a pipette and not a measuring cylinder. Option **A** was a common incorrect answer.

Question 7

This question was not well answered. Candidates confused bonding within molecules and attractive forces between molecules. Candidates should also recall that molecules have covalent bonds between their atoms. Options **A** and **B** were common incorrect answers.

Question 13

A commonly chosen incorrect option was **A**. Candidates should take care to note whether the electrolysis occurs in a molten state or in water (aqueous). From their knowledge of the reactions of Group I elements with water, candidates should also be able deduce that sodium could not form in water.

Question 16

Candidates who performed less well were more likely to give any of the incorrect options, which suggests guessing. Many gave option **B**, suggesting confusion between the terms 'reduction' and 'reducing agent'. The mnemonic OILRIG, 'oxidation is loss' and 'reduction is gain' of electrons could help candidates recall the transfer of electrons.

Question 20

Many candidates appeared to have guessed on this question. For these candidates, there was a slight preference for option **B**, where candidates have been unable to both interpret whether the reaction is endothermic or exothermic and how pressure affects the position of this equilibrium.

Question 22

Although most candidates answered this correctly, option **C** was a common error. Where information about compounds not found on the syllabus is given, candidates should take their time to read and understand the information before answering the question. Many candidates appeared to have guessed on this question.

Question 26

Some candidates incorrectly chose options **A** and **B**, showing confusion between the extraction of iron in the blast furnace and the extraction of aluminium by electrolysis.

Question 30

Candidates should take particular care when answering a question which includes the word 'not'. The word is written in bold to help the candidate take note. Many candidates chose option **C**, which is a correct statement but not the answer to the question asked.

Question 31

Although there was a slight preference for the correct answer, the overall distribution suggests that many candidates were guessing. All the options were frequently chosen.

Question 36

Some candidates chose option **A**. Choosing the incorrect chemical formula for an organic compound is a common mistake. Candidates should take particular care when writing formulae of alkanes and alkenes.

Question 38

Most candidates were able to recall that unsaturated hydrocarbons can be manufactured by cracking. A significant minority chose option **C**, confusing the colour observed during the reaction of bromine with an unsaturated compound.

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

- If the symbol or formula of a chemical is asked for, a name will not gain credit. This was the case in **Question 6(c)(i)** where the formula of the substance (ethene) was asked for. Candidates who wrote 'ethene' received no credit.

- Where names of organic compounds are asked for, candidates should not give a formula as a correct name shows understanding of the prefix and of the suffix of organic nomenclature.

- Where responses require one answer, e.g. **Question 1(d)**, where one process and one type of reaction were asked for, then candidates should only give one response as additional incorrect responses could potentially negate a previous correct response.

General comments

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

Many candidates found **Question 6**, involving organic chemistry, challenging.

Candidates seemed well prepared for mole calculation questions.

Comments on specific questions

Question 1

(a) Most candidates were able to describe the properties of a gas and a solid. The properties of a liquid caused problems, with many candidates only selecting either the touching or the random movement of particles.

(b) (i) Most candidates appreciated that boiling occurs at a specific temperature and many went on to state that evaporation was a surface phenomenon.

Weaker responses often used both answer lines to state the same point, e.g.:
1 boiling occurs throughout a liquid
2 evaporation happens at the surface of a liquid.

(ii) Both processes were well known by most of the candidates.

(c) A good proportion of candidates could draw the cooling curve correctly, although there were a significant number who drew the horizontal line level with **B** rather than Y. Better responses ensured the horizontal line was level with Y by drawing a horizontal construction line.

(d) (i) Most candidates recognised the description of dissolving, but weaker responses stated 'mixing' or 'diffusing'.

(ii) Precipitation (often misspelt as 'percipitation') was slightly less well known and 'neutralisation' or 'crystallisation' were common errors.

Question 2

(a) (i) Most candidates were able to describe these acids as 'strong'; some rephrased the information given and answers such as 'completely ionised' or 'dilute' were seen.

(ii) The equation caused considerable problems with only small numbers of candidates appreciating the formation of H^+ ions. Many of those who realised that sulfate ions were formed did not balance the equation. A very common incorrect response was to show the formation of water and sulfur dioxide.

(iii) The colour of methyl orange in acid was generally well answered; sometimes there seemed to be confusion with phenolphthalein as 'colourless' was seen.

(b) (i) Errors such as 'Aq', 'AQ' or 'G' were seen very infrequently. From the information given, candidates were expected to appreciate that the reactants were '(s)' and '(aq)'. Many assumed the dilute acid was '(l)'. Candidates were expected to use their knowledge of reactions of acids and carbonates to appreciate that zinc nitrate was '(aq)'. Many erroneously opted for '(s)'.

Weaker responses did not include brackets around the state symbols.

(ii) Many candidates carried out the calculation perfectly; others started well but struggled with the concentration stage, often forgetting to convert using 1000.

Many candidates successfully calculated the mass of 1 mole of $ZnCO_3$ in their working, but then wrote a different value (usually 2.5 g as given in the question) on the answer line.

Question 3

(a) This simple recall question was poorly answered. Many responses only had '+' and '–' for the relative charge of a proton and electron. Many charges on masses were seen or the mass of a neutron was given as zero.

Candidates should be advised not to represent the absence of a charge on a neutron with a dash as, unfortunately, this reads as a minus sign.

(b) This question was excellently answered by many candidates, but candidates who performed less well struggled to achieve more than the straightforward part for sulfur. The identification of the bromide in the final task sometimes caused confusion, with Se often recorded and often the mass number was recorded as 80, not 79.

Question 4

(a) This question asked candidates to explain the exothermic nature of the reaction based upon energy changes of bond breaking and bond making.

Three simple statements would have sufficed:

- bond breaking takes in energy
- bond making releases energy
- the energy change of bond making is greater than bond breaking.

Very few candidates gave all three statements and poor phrasing was common.

A typical answer such as 'more energy is released in bond making than breaking' incorrectly suggests bond breaking also releases energy.

Similarly, 'less energy is required to break bonds than make bonds' suggests bond making requires energy.

Weaker responses ignored the idea of bond breaking / making and thought it was sufficient to write that the process was exothermic because 'energy is lost'.

(b) (i) Most candidates struggled with this question. Although many candidates appreciated that the product was at a lower energy level, sometimes the line drawn was not labelled with the product.

The idea of activation energy was poorly represented with few drawing the traditional 'hump'. Candidates should realise that energy increases are represented by upward, single-headed arrows.

The ΔH arrow had to be a single-headed arrow, going from the energy level of the reactants to the energy level of the products.

Better responses drew a horizontal construction line from the energy level of the reactants and ensured both the activation energy arrow and the ΔH arrow started from the correct point. Weaker responses frequently contained arrows which did not cover the full energy change they were meant to represent.

(ii) The role of the catalyst was well known, although some assumed it was the identity of the catalyst which was required.

(c) (i) (ii) Candidates were asked to describe the effect, if any, on the position of equilibrium when factors were changed. Thus, both answers needed a statement such as, 'the equilibrium moves to the right / left / or does not move'. Very few candidates expressed answers in such a succinct manner and many rambling, self-contradictory responses were seen.

One frequently seen response in **(i)** was that the equilibrium shifted to the side where there was lower pressure; this gained no credit as both sides have equal pressure.

One frequently seen response in **(ii)** was that the equilibrium shifted to the endothermic side; this gained no credit as reactions do not have endothermic / exothermic *sides*.

Candidates were required to explain their description in the change of equilibrium and in **(i)** most realised that increased pressure would shift the equilibrium towards the side with the fewer moles.

The explanation of equilibrium shift in **(ii)** needed the simple fact that the forward reaction was exothermic.

Weaker responses attempted to give explanations based upon changes to reaction rate or changes in collision rate.

(d) This was a challenging question. The energy change (1545 kJ / mol) when product bonds are made was often correctly calculated, but few candidates successfully progressed beyond this.

Most candidates did not appreciate that the 230 kJ / mol of energy released in the reaction must be used in the calculation.

(e) The dot-and-cross bonding diagram was generally well done. The most common error was to either omit or miscount the non-bonding electrons. One simple way of checking that all non-bonding electrons have been drawn is to draw these in pairs – it is easier to quickly count three pairs than six individual dots.

Some candidates opted to use a third type of electron symbol (e.g. a small triangle) to represent electrons from a third type of atom and this was accepted.

Question 5

(a) Although metallic bonding was recognised by many candidates, there were many who thought it was ionic or covalent bonding. Some candidates thought that the question related to bonding between iron and potassium and their subsequent descriptions gained little credit.

For those who did opt for metallic bonding, the description relied upon three key points:
- positive (or metal) ions (in a lattice)
- mobile (or delocalised) electrons
- *attraction* between the two oppositely charged particles.

Most candidates omitted the last point.

Candidates should be made aware that the term 'free electrons' does not mean 'mobile electrons'.

(b) (i) Most candidates recognised the description of 'malleability', although 'ductile' was a common error.

(ii) Most candidates appreciated that the key point to this response was that layers of particles (positive ions) can slide over one another.

(iii) Most candidates did not appreciate that a comparative answer was needed, so a statement such as 'copper is a good conductor' was insufficient. Good comparative responses included, 'copper is a better conductor (than other transition elements)'.

(c) A good proportion of candidates performed well, but some did not appreciate that the question asked about physical properties, so responses such as 'good catalysts' or 'variable oxidation number' received no credit. Also, physical properties common to all metals such as 'good conductor of electricity' were common responses.

(d) (i) This question was designed to tests candidates' knowledge and understanding of Group I elements. Most of the better performing candidates were able to recall the colours of the flames of Na and K and nearly all candidates spotted that a colourless solution would remain when rubidium reacted with water. Only a very few were able to describe the increased reactivity of rubidium with water. The best responses stated, 'more vigorous effervescence than potassium'.

(ii) (iii) These parts were well answered.

(iv) Most candidates gave a correct response in the form of a whole number for the pH of an alkaline solution. Some candidates opted for a range, but weaker responses often included 7 in their range.

(v) The equation was poorly written with a very only small proportion of candidates managing to correctly identify the formula for sodium oxide.

(e) (i) Most candidates knew that the Haber process produced ammonia, but weaker responses gave N as a reactant and NH_4 as a product.

(ii) The conditions for the Haber process were well known.

Question 6

(a) The general formula of alcohols was well known but candidates needed to take care over use of subscripts. Frequently $C_nH_{2n+1}OH$ was seen, which did not receive credit.

(b) Most candidates were able to point out that ethanol does not contain only carbon and hydrogen due to the presence of an oxygen atom (other acceptable terms included hydroxyl group, OH group). However, it is incorrect to say that ethanol contains hydroxide ions or oxygen molecules.

(c) (i) The identity of the source of ethanol was well known, but many candidates misread the question and gave the name 'ethene' instead of its formula.

(ii) Glucose (or any sugar) was well known as the source of ethanol in fermentation.

(d) The equation for the combustion of ethanol was poorly answered. Many candidates did not seem familiar with the requirement for oxygen as a reactant in complete combustion. Various carbon-based products were often seen, for example methane, in combination with carbon dioxide and water.

(e) (i) Although most candidates showed a good understanding of empirical formula, frequently the molecular formula of **X** was given.

(ii) Many candidates included one ester link in their structure but only a small proportion of candidates achieved gave a fully correct structure for **X**.

(iii) This was answered correctly by most candidates.

(f) (i) Most candidates correctly named the functional group as carboxylic acid (carboxyl was also accepted), although a significant number gave –COOH as the answer and did not gain credit.

(ii) Very few candidates were able to determine the structure of **Y**. Some correct structures did not show the O–H bond.

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 before writing their response when answering **Question 4**. Otherwise, extra sentences often need to be inserted to cover missing points realised later.
- 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.
- Burette readings should be recorded to at least one decimal place.
- Candidates should be aware that the mark allocation reflects the number of valid points to be made for parts of questions.

General comments

The majority of candidates successfully completed all questions and there was no evidence that candidates were short of time. The complete range of marks was seen with some candidates performing very well. The paper discriminated successfully between candidates of different abilities but was accessible to all.

Candidates in most centres are becoming more familiar with the planning task set in **Question 4**. Candidates would be well advised to plan out their answers before writing them as this will avoid steps being out of sequence.

Most 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) (i) Credit was awarded for correctly labelling the dilute hydrochloric acid and the marble chips.

(ii) A small number of candidates were confused and named a burette.

(b) Most candidates realised that the carbon dioxide would escape and would not be collected. Better responses explained that this was because it was denser than air and that it should be collected over water or using a gas syringe.

(c) Most candidates correctly drew a calibrated syringe to show how the gas could be collected and its volume measured. Collection over water using a measuring cylinder was acceptable. Incorrect answers using gas jars or test-tubes were prevalent.

(d) This was a good discriminating question. The best responses filtered off the chips, washing them and drying and weighing the unreacted chips. A significant number of other candidates detailed methods involving subtracting the final mass of the flask from the original mass, which showed a lack of understanding.

Question 2

(a) Almost all candidates correctly completed the tables of results from the burette diagrams. The commonest error was recording the initial volume in Experiment 1 as 8 cm^3 instead of 8.0 cm^3. A small number of candidates could not read the volumes and appeared never to have used a burette.

(b) The colour change for methyl orange was not well known, with many getting it the wrong way round.

(c) Good responses realised that the reaction was between an acid and a carbonate, so that fizzing / bubbles would be observed.

(d) (i) This was generally correctly answered. Most candidates realised that a larger volume of acid was used in Experiment 1 but fewer went on to say it was twice as much.

(ii) Few candidates could explain that the different volumes were because of the different concentrations of the acids. Vague reference to different solutions or strengths of acids were common.

(e) Most candidates did not deduce that double the volume of solution **L** would need double the volume used in Experiment 3.

(f) This was well answered. Most knew that the burette was rinsed to remove contaminants from the previous experiment.

(g) This was a good discriminating question. Vague answers referred to drying the burette. Few understood that the burette should then be rinsed with solution **L** to remove the remaining water which would, otherwise, dilute solution **L** when placed in the burette.

(h) The use of a white tile to make the colour change of the indicator more obvious gained credit. A range of incorrect answers referred to ‘stopping heat losses’ and ‘improving the stability of the flask’.

(i) Repeating an experiment alone does not improve the reliability of the results. If the results are compared and found to be similar, or if anomalies are discarded, then the results are more reliable.

(j) The use of a measuring cylinder was known to cause inaccuracies and most went on to replace it with a pipette or burette. Vague references to reading errors were common.

Question 3

(a) Many candidates gained credit for the observation that there would be no reaction.

(b)(i)(ii) The majority of candidates gave a correct observation and identified ammonia correctly.

(c) Many candidates reported the formation of a cream precipitate. A significant number stated that the precipitate would be cream-yellow or white cream and gained no credit.

(d) Only a minority of candidates knew that the solution would go yellow or orange as bromine would be displaced. Effervescence and formation of precipitates were common guesses.

(e) Many candidates incorrectly identified the presence of sodium in liquid **P** from the flame colouration. A number recognised the presence of an unsaturated organic compound / alkene from the result of the aqueous bromine test. References to metallic ions were common.

Question 4

The complete range of marks was seen in this planning question.

Candidates were asked to plan an investigation to obtain a sample of cobalt metal from a carbonate ore.

A large number of candidates attempted to make crystals of a cobalt salt from reacting the ore with a dilute acid, which was often not named. Many candidates mistakenly assumed that the filtration or crystallisation of the salt solution would produce a sample of cobalt metal. Many did not crush the lump before starting, using a pestle and mortar.

Methods that would work were reduction and electrolysis, and some good descriptions were given. Methods involving displacement by a more reactive metal often wrongly used copper or sodium.

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.