CHEMISTRY

Paper 0620/12
Multiple Choice (Core)

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

General comments

Performance on the paper was generally good; some candidates found parts of the paper more difficult.

Candidates found **Questions 26** and **29** straightforward. **Questions 8**, **18** and **24** were more challenging for many candidates.

Comments on specific questions

The following responses were common wrong answers to the questions listed.

Question 1

Response **A** – Candidates were unsure of the meaning of condensation and sublimation.

Question 12

Response **C** – Candidates knew that the reaction would speed up but did not realise that the loss of carbon dioxide results in mass decrease.

Question 18

Response **C** – This response was far more popular than the correct response. Candidates did not realise that copper metal does not react with dilute sulfuric acid.

Question 19

Response **B** – Candidates knew that the proton number was used to order elements but were unclear about the trends in each group.

Question 24

Response **B** – This response was much more popular than the correct one. Candidates correctly used the reaction with acid but did not know the effect of reactivity on the stability of metal oxides when heated with carbon.

Question 30

Response **A** – Candidates did not know that argon was present in the air and many did not recognise the significance of the word ‘clean’.

Question 31

Response **D** – Candidates recognised two compounds that are fertilisers but did not realise that phosphorus was necessary.

Question 34

Response **C** – Candidates correctly ignored the neutral plot but did not always understand the relationship between pH and acidity.

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Paper 0620/22
Multiple Choice (Extended)

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

General comments

Candidates performed well on this paper.

Most candidates found **Questions 3**, **4**, **18**, **24**, **27**, **29**, **32** and **36** straightforward. **Question 20** was challenging for many candidates.

Comments on specific questions

The following responses were popular wrong answers to the questions listed.

Question 9

Response **B** – Candidates did not realise that when copper electrodes are used the anode dissolves away and no gas is released. This reaction is the basis of copper refining.

Question 15

Response **D** – Many candidates were not familiar with the reactions of silver halides in light.

Question 16

Response **C** – Candidates knew that the energy of molecules increases but did not realise that this also means they move faster and so collide more frequently.

Question 20

Response **C** – This response was more popular than the correct one. Candidates did not realise that copper metal does not react with dilute sulfuric acid.

Question 21

Response **D** – Candidates knew that the proton number was used to order the elements but were unclear about the trends of melting points in the two groups.

Question 23

Response **C** – Candidates knew the trend in reactivity in Group **I** but not in Group V**II**.

Question 25

Response **B** – Candidates were looking for a reaction which showed the extraction of aluminium and many did not realise that the answer chosen does not occur in the extraction of aluminium.

Question 28

Response **B** – Many candidates chose –153 as the lowest boiling point when in fact, it is the highest.

Question 34

Response **C** – Candidates correctly ignored the neutral plot but did not always understand the relationship between pH and acidity.

Question 40

Response **A** – This response was more popular than the correct one. Many candidates did not check that the correct groups were opposite each other.

CHEMISTRY

Paper 0620/32
Theory (Core)

Key messages

- Many candidates need more practice in memorising qualitative tests for specific ions and molecules.
- Some candidates would benefit from improving their knowledge of specific chemical terms. The terms mixture, compound, elements and molecule were often used interchangeably.
- Some candidates need more practice in answering questions requiring free response and in organising their work. Candidates should take note of each bullet point in a question to ensure that all relevant points have been answered.
- A few candidates selected more than one answer for a question and so could not gain credit.

General comments

Many candidates tackled this paper well, showing a good knowledge of core Chemistry. Nearly all candidates were entered at the appropriate level. The standard of English was generally good. A few of the questions were left unanswered by a minority of candidates.

Some candidates need more practice in writing answers with the correct amount of detail for core level. Some candidates disadvantaged themselves by including material from the supplement. For example, in **Questions 2(c)(i)** and **6(b)(iii)** answering the questions about oxidation and reduction in terms of either electron loss/gain or change in oxidation number often led to incorrect answers. In contrast, some candidates wrote too much and repeated themselves, sometimes resulting in writing contradictory statements. For example, in **Question 7(a)** some candidates first wrote that water is a product of the reaction of calcium oxide with acid and then wrote in another place that the product was hydrogen.

Many candidates needed to show a better understanding of qualitative tests for specific ions and molecules. The answers to the questions about the tests for oxygen (**1(c)**), chloride ions (**2(a)(iv)**) and carbonate ions (**8(b)(ii)**) were often incorrect.

Many candidates were able to extract information from tables and balance symbol equations.

Questions involving general Chemistry including, electrolysis, atomic structure and many aspects of simple organic chemistry were answered well by many candidates.

Comments on specific questions

Question 1

(a) (i) Many candidates identified oxygen as a diatomic molecule. The most common error was to suggest the interhalogen compound (compound **D**). Compound **C** (carbon dioxide), was also a common error.

(ii) A majority of the candidates correctly identified sodium bromide. The most common error was to suggest compound **B** (dibromoethane).

(iii) A majority of the candidates recognised that oxygen is an element. The most common errors were to suggest either compound **A** (sodium bromide) or compound **B** (dibromoethane).

(iv) Nearly all the candidates recognised that carbon dioxide is a product of respiration. The most common incorrect answer was substance **E** (oxygen).

(v) This was the least well answered question in **(a)**. The most common incorrect answers were to suggest either compound **B** (dibromoethane) or the interhalogen compound (compound **D**).

(b) Most candidates gained at least partial credit. The most common errors were: 17 protons; 8 or 17 neutrons; 9 electrons. A few candidates added the atomic number to the mass number when calculating the number of neutrons.

(c) Stronger responses described the correct test for oxygen involving the relighting of a glowing splint. However, many just mentioned the use of either a splint (unqualified) or a lighted splint. Others reversed the test and suggested that a lighted splint glows. Many suggested the use of a flame test or litmus.

Question 2

(a) (i) A majority of candidates calculated the relative molecular mass of ethanol correctly. The most common errors related to the use of atomic numbers rather than atomic masses or to some type of mole calculation involving the relative atomic mass of calcium. The most common of these incorrect answers was 6.4 mg obtained by $(20 \times 40) \div 125$.

(ii) Many candidates correctly identified potassium ions. The most common error was to suggest calcium ions. A significant number of candidates suggested substances that did not appear in the table, e.g. lithium ions, water.

(iii) Some candidates gave the correct name (magnesium sulfate). Others either gave the formula or gave incorrect names. The most common of these was magnesium sulfur oxide. A small number of candidates ignored the sulfur and incorrectly suggested that the compound was magnesium oxide.

(iv) A minority of candidates gave a completely correct description of a test for chloride ions. Some confused this test with the test for chlorine and suggested the use of litmus paper. Others suggested that a flame test be used. Many did not mention the use of nitric acid or gave the wrong acid, often hydrochloric acid. Another incorrect test reagent often given was sodium hydroxide.

(b) (i) A majority of the candidates identified the carboxylic acid group correctly. The most common error was to circle only the C=O group.

(ii) Some candidates deduced the correct formula of lactic acid. A significant number of candidates did not count the atoms correctly. The most common errors were either to reduce the number of carbon or hydrogen atoms by one, e.g. $C_2H_6O_3$ or to write a partial molecular formula, e.g. $C_3H_5O_2OH$.

(c) (i) Some candidates gave a good explanation of reduction in terms of removal of oxygen. Others gave a correct explanation in terms of gain of electrons. A significant number of candidates who chose the electron route incorrectly suggested that electrons are lost. Many candidates gave answers which were too vague or confusing, e.g. ‘to decrease the number of something’ or ‘reduction of oxygen’.

(ii) Many candidates calculated the relative molecular mass of ethanol correctly. The most common errors involved either incorrect addition or the use of atomic number instead of atomic mass.

Question 3

(a) Many candidates gained at least partial credit for this question. Some candidates gave well-written answers mentioning diffusion and including the (overall) movement of particles from a higher concentration to a lower concentration. However, others made vague statements about the colour spreading out or the iodine dissolving without mentioning particles. Some candidates only wrote about the process of dissolving and did not mention the spreading of the particles throughout the liquid.

(b) (i) This was answered well by many candidates and most gained at least partial credit. The most common error was to give an incorrect value for the melting point, usually above –7°C. A few candidates did not respond to this question.

(ii) Many candidates suggested that fluorine is lighter in colour intensity than chlorine but few gave the correct trend in colour of the halogens. The most common errors were either trying to relate the colour intensity to the melting point or trying to relate colour intensity to reactivity.

(iii) Many candidates realised that bromine is liquid at 40°C. Fewer gave a complete explanation for this in terms of both melting point and boiling point. Many just repeated the values of the melting point and boiling point without referring to 40°C. Others referred to room temperature instead of 40°C. A significant minority thought that the bromine should be in the solid state.

(c) Nearly all candidates gained at least partial credit for balancing the equation. The most common error was to suggest 2Br or Br instead of Br_2.

Question 4

(a) A minority of candidates selected both correct statements about a homologous series but nearly all the candidates selected one correct statement. The most common error was to tick the second box from the top (similar physical properties). A few candidates ticked only one box.

(b) Most candidates gave the correct answer ‘alkane’. The most common errors were either ‘anes’ or ‘alkene’. A few candidates just repeated the word ‘hydrocarbon’ which was in the stem of the question.

(c) Stronger responses gave a suitable definition of a hydrocarbon including the words ‘compound’ and ‘only’ in their answers. However, most candidates gave vague or incorrect answers such as ‘it contains hydrogen and carbon molecules’. A significant number of candidates suggested that hydrocarbons are mixtures or elements. Many forgot the important words ‘only’ or ‘no other substance’.

(d) Many candidates drew the correct structure of ethane. The most common errors were either leaving off one or more hydrogen atoms or drawing the structure of methane or the addition of a C=C bond. Some candidates drew a dot-and-cross diagram but these were not always correct.

(e) (i) Most candidates gave at least one correct condition for cracking. ‘High temperature’ or ‘heat’ was the most common correct answer. A few candidates did not gain credit because they suggested ‘temperature’ or ‘pressure’ unqualified. Some candidates gave values but either did not put a unit such as °C, or gave a unit which did not fit, e.g. ‘5 Pascal’s instead of ‘5 atmospheres’ and so could not be credited.

(ii) Most candidates gave the correct molecular formula. Common errors included $C_{11}H_{26}$, C_2H_6 and C_6H_{12}.

(f) A wide variety of incorrect answers was seen, suggesting that many candidates were unfamiliar with this reaction. The most common incorrect answers were carbon dioxide and alcohol. Ethane, oxygen, acid and glucose were other common incorrect answers.

(g) Most candidates gained partial credit and many gained full credit for ‘monomers’ and ‘addition’ in the correct places. The most common incorrect answer was to give ‘polymers’ instead of ‘monomers’. Only a few candidates suggested ‘condensation’ instead of ‘addition’.

Question 5

(a) (i) Many candidates answered well and referred to the fact that the magnesium floated (on top of the magnesium chloride). The most common errors were to refer to the intensity of the grey colour in the diagram, to refer to reactivity or to refer to the cathode.

(ii) Many candidates correctly identified chlorine. The most common error was to suggest ‘chloride’. Other common errors were oxygen or hydrogen.

(iii) Many candidates wrote imprecise or incorrect answers as to why air is not blown over the molten magnesium such as ‘the air can combine with the atmosphere’ or ‘air can react with the magnesium chloride’.

(iv) Many candidates identified a suitable unreactive gas and argon was the most common correct answer. The most common incorrect answers were hydrogen, oxygen or carbon dioxide. A few candidates gave chlorine or bromine.

(b) (i) Most candidates identified aluminium and most of these referred to its low density. The most common incorrect answer was to refer to the strength of aluminium. A minority of candidates gave cobalt instead of aluminium. A few candidates disadvantaged themselves by suggesting that aluminium is less dense than air.

(ii) Some candidates correctly identified aluminium but a significant number gave 'cobalt' and referred to its strength or high melting point.

(iii) Many candidates realised that cobalt and nickel are transition elements. The most common incorrect answer was gallium.

(c) Most candidates gave at least one correct property associated with transition elements and many gave two correct properties. The most common error was to suggest general metallic properties such as lustre and electrical conductivity.

(d) (i) Some candidates gave a good definition of an alloy. Others made no mention of a mixture or used incorrect terminology such as 'a compound of two different metals'. A significant number of candidates either suggested that 'an alloy is a mixture of elements' or 'a mixture of non-metals'. A few just gave the name of an alloy.

(ii) A minority of the candidates referred to the alloy being stronger or harder than the corresponding metals. Many did not use the comparative, e.g. 'alloys are strong', 'alloys are light' and so could not be credited. Others gave answers which were too vague, e.g. 'shows the properties of both metals'.

Question 6

(a) (i) Some candidates identify methane as the main component of natural gas. Others gave incorrect answers such as carbon dioxide or carbon monoxide. Water, ethene and nitrogen were other incorrect answers which were occasionally given.

(ii) This was generally well answered and most candidates referred to 'making the reaction faster'. The most common error was reference to 'slows down the reaction'. A few candidates did not refer to rate.

(b) (i) Many candidates were able to name sulfuric acid. The most common error was sulfur dioxide. A significant number of candidates wrote the formula (often incorrectly as H_2SO_3) instead of the name.

(ii) A minority of the candidates gave a suitable effect of acid rain on buildings. Many referred to changing the colour or damaging paintwork. Others gave answers which were too vague or too drastic, e.g. 'reacts with them', 'damages them', 'destroys them', 'makes them weak'.

(iii) Some candidates explained oxidation by referring to the addition of oxygen to sulfur dioxide. Others either gave a generalised definition of oxidation or referred to the nitrogen dioxide rather than sulfur dioxide. A few candidates gave answers which were too vague, e.g. 'the sulfur dioxide goes to sulfur trioxide'. A significant number of candidates tried to answer in terms of electron transfer or changes in oxidation number. Many of these answers were incorrect because they referred to sulfur dioxide as a whole rather than the sulfur.

Question 7

(a) Many candidates answered this question well. Some candidates did not write about the effect of acids on a named indicator or only wrote about the effect of acids on either calcium oxide or magnesium. Many candidates repeated themselves and sometimes wrote conflicting statements. Common errors included: carbon dioxide, hydrogen or hydroxide being formed when calcium oxide reacts with hydrochloric acid; water being formed when magnesium reacts with hydrochloric acid; red litmus being used as an indicator. Some candidates attempted to write symbol equations for the reactions rather than word equations. The products of these symbol equations were accepted if they were correct but the formulae of the chlorides were often incorrectly written as $CaCl$ and $MgCl$.

(b) (i) Some candidates correctly identified the reaction as 'neutralisation'. Other answers were either vague, e.g. 'acid-base' or incorrect, e.g. 'endothermic'. A few candidates wrote an equation instead of naming the type of reaction.

(ii) Most candidates suggested the correct pH of 13. The most common error was to suggest pH 2. A significant number of candidates chose pH 7.

(iii) Some candidates correctly identified ammonia. A few candidates incorrectly suggested ammonium or ammonium hydroxide. The most frequently seen error was to suggest hydrogen.

(iv) Many candidates selected the correct statement about sodium hydroxide. A common incorrect answer was to select the third box down from the top (sodium boils between 319°C and 1 390°C).

(v) A minority of candidates explained why the ingredients used in medicines have to be pure. The best answers referred to side-effects or stated 'harms the body'. Many answers were vague, e.g. 'doesn't react in the body' or made reference to melting or boiling points. Some candidates thought that the question was about sodium hydroxide rather than medicines in general and wrote about acid-base reactions of sodium hydroxide.

Question 8

(a) (i) Many candidates realised that the rate of reaction decreases when the concentration of hydrochloric acid decreases. The most common errors were to write about time instead of rate or to give answers which were not comparative, e.g. 'the rate would be slow'.

(ii) Many candidates gave a reason for their answer although this was not required. Some candidates incorrectly thought that the rate of reaction would increase because the surface area was greater. A common error was to suggest that the rate of reaction does not change because there is the same amount of iron present.

(iii) A majority of the candidates predicted that the rate would increase. The most common errors were to write about time instead of rate or to give answers which were not comparative, e.g. 'the rate would be fast'.

(b) (i) Many candidates gave the correct name of an ore of iron other than siderite. The most common errors were to suggest 'bauxite' or 'limestone'.

(ii) Only the strongest responses gained full credit here. Many candidates referred to reactions in the blast furnace. Some obtained partial credit for mentioning that carbon dioxide is released or for the use of limewater. Others suggested that a white precipitate is formed when hydrochloric acid is added. A significant number of candidates did not answer this question.

(c) Many candidates gave the correct order of reactivity. The most common error was to completely reverse the order.

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Paper 0620/42
Theory (Extended)

Key messages

- Candidates need to be reminded that if **one** property is asked for, as in **Question 1(c)(iv)**, then no more than one should be given in answers as any incorrect properties given will be viewed as a contradiction to correct ones.
- If observations about a substance are asked for, such as silver chloride in **Question 2(c)(i)**, candidates should be made aware that substances should be described by (at least) two words. The first word should be a colour (or colourless if applicable) and the second word should be the state.
- In calculation work, such as in **Questions 2(c)(iv)** and **4(b)(i)**, candidates should show their working to allow credit for 'error carried forward' where this is relevant. Candidates should be advised to include words indicating what they are attempting to do within their working, such as 'number of moles of …'.
- Candidates need to be reminded that a word equation, unless specifically asked for, will receive no credit in place of a correct symbol chemical equation.

General comments

Candidates generally answered well and there was no evidence that there was insufficient time for candidates to complete the paper.

Comments on specific questions

Question 1

(a) (i)–(vi)
Most candidates could identify the majority of the gases asked for. It was noticeable that the term 'diatomic molecule' was not always known.

(b) (i) Nearly all candidates knew a covalent bond involved sharing electrons; only a very small minority knew it involved sharing a pair of electrons.

(ii) The dot-and-cross diagram of NF_3 was well known, with all but a few candidates showing three shared pairs of electrons. Weaker responses tended not to show non-bonding electrons as pairs and consequently some of the three F atoms had five or seven non-bonding electrons. These candidates may have found it easier to count three pairs.

(c) (i) Many candidates tried to explain the meaning of mixture by using the words 'mix', 'mixing' or even 'mixture' in phrases such as 'a mixture of substances'.

(ii) Most candidates knew that 21% of air was oxygen.

(iii) Many candidates wrote very detailed descriptions describing the fractional distillation of liquid air including the extraction of carbon dioxide, water vapour and noble gases which were not asked for.

(iv) The idea of different boiling points being the key property which allows N_2 and O_2 to be separated was well known. Some candidates include a second, incorrect property, such as differing densities, and could not be credited.

Question 2

(a) (i) This was answered well by candidates.

(ii) A number of candidates answered this question incorrectly, possibly because they misread the question, as many incorrect responses included '17' (the number of electrons in an atom), '7' (the number of electrons in an outer shell of an atom) and '8' (the number of electrons in an outer shell of an ion).

(iii) Argon, the correct response, was the most common answer seen, although neon was also a popular response.

(b) (i) The definition of electrolysis was well known and some well learnt responses were seen. Candidates need to be reminded that it is a breakdown (or decomposition) of a compound rather than a separation process involving the formation of ions.

(ii) The three products of electrolysis of concentrated aqueous sodium chloride were well known, although frequent incorrect responses included oxygen and occasionally, sodium.

(iii) The ionic half equation was known by many candidates; state symbols were frequently omitted or were incorrect due to H^+ ions being given as gaseous.

(c) (i) Candidates knew that solid silver chloride would form but often vague descriptions of observations or even names of the solid product received no credit. In this case 'white' was usually omitted from answers.

(ii) Candidates often focused on the collection of a pure residue, and the vague comment, 'to remove (soluble) impurities' was frequently seen.

(iii) Candidates generally answered this question well.

(iv) Some well set out and fully correct answers were seen. A common error was to miss out the final 90% step. In weaker responses, working out was poorly set out so that it could not be clearly followed. Candidates should be advised to include words within their working.

(v) The equation for the thermal decomposition of sodium nitrate was not well known and $NaNO_2$ was rarely seen as the product. Instead, many unusual sodium-based products were seen. Many candidates started with hydrated crystals and simply dehydrated them.

Question 3

(a) (i)–(vi)
This series of questions based upon the limestone cycle were answered well. Candidates found the equation in **(v)** more challenging due to water either being omitted as a product or being substituted by hydrogen.

(b) A minority of candidates could determine the formula of magnesium nitrate correctly with $MgNO_3$ being a very common error. As there is effervescence between an acid and a carbonate, candidates were expected to show the other two products as H_2O and CO_2 rather than H_2CO_3.

(c) Many candidates knew the method to follow and gained credit for division of the mass of the element by its relative atomic mass. Some excessive rounding after the first step saw a significant number of candidates end up with the wrong answer.

Question 4

(a) (i) Many candidates gave the correct definition; there were a number of vague and irrelevant comments about properties of bases.

(ii) Many candidates opted to include water as a product. Partial credit was frequently awarded for identifying the correct ammonium compound relative to the acid used in the reaction. Candidates who chose to provide a chemical equation were rarely successful.

If candidates write word equations over two lines, they should avoid writing the word equation in such a way as to introduce ambiguity.

e.g.	ammonia	+	hydrochloric acid	→	ammonium chloride

This would be the expected way to write a word equation with the second word of a substance appearing below the first word.

If written in a more linear manner, the words may look like:

ammonia + hydrochloric acid → ammonium
chloride

This introduces a substance which may be taken as having the name 'ammonia chloride'.

(b) (i) Candidates needed to determine the number of moles of NH_3 used and then use the stoichiometric ratio seen in the equation to determine the number of moles of Cl_2 needed and finally convert this value to a gas volume (in cm^3) by multiplying by 24 000.

Some candidates tried a non-mole method based upon reacting masses and were usually unsuccessful.

(ii)–(iii)
Many candidates successfully gained full credit in the calculation sections and went on to explain why this reaction was exothermic, (i.e. more energy was released in bond formation than used in bond breaking). Occasionally in **(iii)**, candidates had the direction of energy change incorrect, (i.e. more energy was used in bond formation than used in bond breaking or more energy was released in bond formation than released in bond breaking).

(c) (i) Most candidates realised that NH_3 was a reducing agent because it underwent oxidation. Stronger responses were able to explain what the oxidation was in terms of electron loss or change in oxidation state.

(ii) Platinum was probably the most often suggested metal as a catalyst from the list of five, but few candidates gave the reason that platinum was the only transition element in the list. Many candidates thought it was because platinum was (relatively) inert.

Question 5

(a) 'Homologous series' was almost always seen, although the occasional 'functional group' or just 'homologous' was seen.

(b) The general formula for alcohols is $C_nH_{2n+2}O$, although $C_nH_{2n+1}OH$ was accepted.

(c) (i) Stronger responses stated that steam was the reagent needed under conditions of a catalyst, and some even named the catalyst. Water, if seen with a temperature above 100°C as a condition, was allowed as the reagent.

(ii) The equation for the combustion of propan-1-ol was often not done well. Many candidates wrote an incorrect formula for propan-1-ol; oxygen was not always seen as a reactant and there were many incorrect products such as alkanes. For those with the correct species, $5O_2$ instead of $4\frac{1}{2}O_2$ was occasionally seen, possibly as a result of the oxygen atoms in the alcohol being ignored when balancing.

(d) (i) The structure of the linkages tended to be correct but often continuation bonds were missing at the end of the structure.

(ii) Although most candidates knew that the breakdown of carbohydrate polymers was an example of hydrolysis, many opted for hydration. Catalytic cracking was another frequently seen error.

(iii) The conditions needed for the breakdown of carbohydrate polymers were known by only a small number of candidates. If acid was used, heat would frequently be omitted and enzymes (if seen) was frequently accompanied with impossible temperatures.

(e) (i)–(iv)
The responses to this series of questions showed candidates had a good understanding of chromatography involving colourless solutes.

CHEMISTRY

Paper 0620/52
Practical Test

Key messages

- Candidates should be familiar with the technique of carrying out a flame test.
- In qualitative analysis exercises, candidates must follow the instructions given and record all observations.
- 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. A range of marks was seen, with some candidates answering very well.

Supervisors' results were submitted by the majority of Centres with the candidates' scripts. Very few comments were submitted by supervisors after carrying out the experiments. The results obtained by some supervisors and candidates for **Question 1** suggested that some Centres did not use reagents that were close to the concentrations specified in the Confidential Instructions.

Comments on specific questions

Question 1

(a), (b) and (c)
Almost all candidates completed the tables of results. Credit could sometimes not be awarded due to candidates:
- not recording all readings to one decimal place,
- incorrectly recording initial burette readings in **(a)** at values other than 0.0 cm^3,
- incorrectly recording final burette readings as values less than initial burette readings or values greater than 50 cm^3,
- giving a large difference between the titres in **(a)** and **(b)**.

(d) (i) Many candidates described the initial colour as orange instead of yellow and so could not be awarded credit. Some candidates described the final colour as green or colourless.

(ii) A minority of candidates correctly answered with the observation that bubbles were formed. There were a significant number who stated that the volume increased.

(e) This was generally answered well with Experiment 3 being the expected response.

(f) The majority of candidates answered the question correctly and named a burette or pipette. A significant number thought a (graduated) beaker or a measuring cylinder, which they had just used, would be more accurate.

(g) Many candidates mistakenly thought that changing the temperature would change the volumes of dilute hydrochloric acid used. Stronger responses gained full credit for stating that there would be no effect on the volume as warming the solution of sodium hydroxide would only affect the rate and not change the volume or concentrations of the reactants.

(h) (i) This question was answered correctly by most candidates. Some candidates got the ratio the wrong way round or did not follow the instruction 'Determine the simplest whole number ratio' and gave fractions or ratios to one or two decimal places.

(ii) Many candidates gave incorrect references to solutions of different concentrations being used in Experiments 1 and 3 and showed a lack of knowledge and understanding. Stronger responses realised that the use of different indicators resulted in different volumes of dilute hydrochloric acid being used.

(i) Many candidates thought that universal indicator was only a test paper and that testing would be necessary after each addition of hydrochloric acid. References to pH were ignored. Other candidates thought that universal indicator was colourless, or would not change colour or that it would react with the mixture. However, stronger responses understood that there would be more than one colour change and it would be difficult to find the end point.

(j) The idea that the reliability of the results could be checked by repeating the experiments was well understood and scored partial credit. The mark allocation indicated that reference to comparing or averaging the results obtained was also expected.

Some candidates wanted to repeat the experiments with different volumes or concentrations of solutions and showed a lack of understanding, as did those who wanted to repeat them without using an indicator.

Question 2

Solution **M** was aqueous iron(III) chloride.
Solid **N** was basic copper(II) carbonate.

Tests on solution **M**

(a) (i) Most candidates correctly stated that the solution was yellow or brown. References to red/orange, green or precipitate could not be credited.

(ii) This question was generally well answered but a few candidates gave pH values of 7 or more. Solution **M** was acidic.

(b) The majority of candidates reported the formation of a yellow precipitate instead of a white precipitate. This showed a lack of practical expertise and experience when carrying out the halide test.

In coloured solutions, candidates needed to let the precipitate settle out to see the colour more clearly. Some candidates gave two colours and could not be credited.

(c) Some candidates reported the formation of a white precipitate. A significant number of candidates implied some sort of colour change or effervescence. This test for a sulfate should be negative and responses such as no change, no reaction or no precipitate scored credit.

(d) The formation of a brown precipitate was often described. Yellow and red were common answers. References to cloudy or solid formation instead of the term precipitate were ignored.

(e) Most candidates identified the presence of iron(III) ions but a number stated that iron(II) or just iron ions were present. Most candidates identified the correct halide ion based on their observation in **(d)**.

Tests on solid **N**

(f) Most candidates correctly stated that the solid was green. References to a blue solid could not be credited.

(g) At least four points were expected in answers to this question as indicated by the mark allocation. The solid turning black and testing the gas with limewater, which turned milky, were common creditworthy answers. A small number of candidates successfully noted the formation of liquid drops or condensation on the walls of the test-tube; answers such as gas, vapour or smoke formed were considered too vague for credit. Some impossible test results with splints were seen, e.g. lighted splints popping and glowing splints relighting. A number of candidates reported that the gas bleached litmus paper and that it was chlorine.

Some candidates reported fizzing on adding hydrochloric acid which indicated that they were not following instructions.

(h) Many candidates successfully carried out a flame test and recorded a green or green-blue colour as expected. Some red, lilac and yellow observations were inexplicably recorded. A minority of candidates were clearly unfamiliar with a flame test.

(i) Credit was awarded for recording the formation of a brown colouration or effervescence. A significant number of candidates described the formation of a green precipitate and could not be credited.

(j) Many candidates correctly identified copper carbonate. There were some references to chloride and sulfate.

Question 3

Despite the fact that they were measuring the rate of reaction between magnesium ribbon and dilute sulfuric acid, a number of candidates used hydrochloric acid and tried to grind the ribbon into a powder. A significant number of candidates heated the reactants with a Bunsen burner and carried out a series of experiments at different temperatures which showed a lack of understanding.

Most candidates described a method involving collecting and measuring the volume of hydrogen and timing. Timing at set intervals was well described but timing until the reaction stopped often lacked detail as to how they would know when the reaction stopped. Timing when the reaction started was a flawed method as the reaction is instantaneous. Using a gas syringe was a common correct method but those candidates who used collection over water, often used a test-tube instead of a measuring cylinder but still claimed they would be able to measure the volume. Stronger responses measured the loss in mass of the reactants using a balance and were able to score full credit. Weaker responses chose less appropriate methods, such as counting bubbles or vaguely timing how long it took for the gas produced to give a pop with a lighted splint.

A minority of candidates could describe how the results could be used to find the rate of the reaction and vague references to the rate being the same as the time of the reaction were common. Good answers gave experimental details. Credit was awarded for the following points:

- adding magnesium and sulfuric acid
- using a suitable container with the ability to have a bung
- giving a method of measuring the volume of gas
- starting the timing/using of a stopwatch
- measuring volume of gas
- measuring and recording results at a set time/at known intervals/at end of reaction
- showing that rate = volume ÷ time.

A significant number of candidates did not include a diagram as requested.

CHEMISTRY

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Key messages

- Before answering a question, candidates should read it carefully and ensure that they know and understand what the point of the question is. A good example of this guidance not being followed was **Question 1(f)** where many candidates did not use the information provided to answer the question.
- Candidates should be prepared to answer questions requiring the planning of an investigation.

General comments

The vast majority of candidates successfully attempted all of the questions. The full range of marks was seen and the paper was accessible to all candidates. Candidates found **Questions 1(c)**, **2(j)** and **4** more demanding than the others.

The majority of candidates were able to correctly complete tables of results from readings on diagrams in **Question 2**.

Comments on specific questions

Question 1

(a) (i) A lot of candidates drew the solvent front. Credit for the level of the solvent was awarded for drawing a line between the base line and the bottom of the paper, which did not touch the dot showing the mixtures of dyes.

(ii) This question was well answered with water or an organic solvent a common correct response. A small number of candidates used acids or marker pens and gained no credit.

(b) This question was generally well answered. However, responses such as ninhydrin or locating agent showed a lack of understanding.

(c) There was a lack of detail in many of the answers given. Stronger answers referred to keeping the base line above the solvent level or stated that the paper should not fall into the solvent as the dyes would mix.

(d) Many responses showed an understanding that dye **B** was a mixture of two substances and/or one of these was dye **D**.

(e) A large number of incorrect responses referred to dye **C** being colourless, pure, only one substance or too dense to move. Stronger responses realised that dye **C** was insoluble in the solvent.

(f) Despite the instructions given, many candidates were unable to measure the distances required to score full credit. A range of R_f values was accepted from 0.56 to 0.64. Many candidates got the fraction the wrong way up.

Question 2

(a), (b) and (c)
Almost all candidates completed the tables of results successfully.

(d) Many candidates described the initial colour as orange instead of yellow and could not be credited. Some candidates described the final colour as green, blue or colourless.

(e) The majority of candidates realised that the flask was rinsed with distilled water to clean it and remove impurities from the previous experiment. Vague comments about removing traces of indicators were ignored.

(f) Answers to this question were generally correct with Experiment 3 being the expected response.

(g) The majority of candidates answered the question correctly and named a burette or pipette. A significant number thought a (graduated) beaker or a measuring cylinder, which was used originally, would be more accurate.

(h) Many candidates mistakenly thought that changing the temperature would change the volumes of dilute hydrochloric acid used because the reaction would be faster. Stronger responses gained full credit for answers stating that there would be no effect on the volume of acid as warming the solution of sodium hydroxide would only affect the rate and not change the volume or concentrations of the reactants.

(i) (i) This question was answered correctly by most candidates. Some candidates got the ratio the wrong way round or failed to follow the instruction 'Determine the simplest whole number ratio' and gave fractions or ratios to one or two decimal places.

(ii) Many candidates gave incorrect references to solutions of different concentrations being used in Experiments 1 and 3 and showed a lack of knowledge and understanding. Stronger responses realised that the use of different indicators resulted in different volumes of dilute hydrochloric acid being used.

(j) Many candidates thought that universal indicator was only a test paper and that testing would be necessary after each addition of hydrochloric acid. References to pH were ignored. Other candidates thought that universal indicator was colourless, or would not change colour or that it would react with the mixture. However, stronger responses understood that there would be more than one colour change and it would be difficult to find the end point.

(k) The idea that the reliability of the results could be checked by repeating the experiments was well understood and scored partial credit. The mark allocation indicated that reference to comparing or averaging the results obtained was also expected.

Some candidates wanted to repeat the experiments with different volumes or concentrations of solutions and showed a lack of understanding as did those who wanted to repeat them without using an indicator.

Question 3

(a) This was generally well answered with brown or yellow scoring credit. A number of candidates followed their chosen colour with the description of solid or crystals, not realising that solution **M** was being tested.

(b) This question was generally well answered with the recognition of the formation of a white precipitate. Additional incorrect observations, e.g. effervescence, meant that credit could not be awarded.

(c) Some candidates reported the formation of a white precipitate. A significant number of candidates implied some sort of colour change or effervescence. This test for a sulfate should be negative and responses such as no change, no reaction or no precipitate scored credit.

(d) (i) This question was well answered. The formation of a brown precipitate was often described correctly. Some confusion with the test for iron(II) ions was seen.

(ii) Most candidates knew that the precipitate was insoluble in excess sodium hydroxide.

(e) The gas produced in **test 1** was identified correctly by some candidates.

(f) Copper carbonate was identified correctly by nearly all candidates.

Question 4

There were some excellent answers for this question.

Despite the fact that they were measuring the rate of reaction between magnesium ribbon and dilute sulfuric acid, a number of candidates used hydrochloric acid and tried to grind the ribbon into a powder. A significant number of candidates heated the reactants with a Bunsen burner and carried out a series of experiments at different temperatures which showed a lack of understanding.

Almost all candidates scored some credit for adding magnesium to sulfuric acid in a suitable container.

Most candidates described a method involving collecting and measuring the volume of hydrogen and timing. Timing at set intervals was well described but timing until the reaction stopped often lacked detail as to how they would know when the reaction stopped. Timing when the reaction started was a flawed method as the reaction is instantaneous. Using a gas syringe was a common correct method but those candidates who used collection over water, often used a test-tube instead of a measuring cylinder but still claimed they would be able to measure the volume. Stronger responses measured the loss in mass of the reactants using a balance and were able to score full credit. Weaker responses chose less appropriate methods such as counting bubbles or vaguely timing how long it took for the gas produced to give a pop with a lighted splint.

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