# CHEMISTRY

**Paper 0620/12**
**Multiple Choice (Core)**

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

## General comments

Candidates performed reasonably well on this paper.

**Questions 1**, **11**, **24** and **29** proved to be particularly straightforward. **Questions 3**, **17**, **18**, **23** and **30** proved to be more challenging.

## Comments on specific questions

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

**Question 5**

Option **C** – Candidates knew that one electron was involved but chose the wrong option.

**Question 9**

Option **B** – Candidates did not realise that ions, and not electrons, transfer charge through the electrolyte.

**Question 10**

Option **B** – Candidates correctly chose the biggest energy change but did not realise that it showed energy being absorbed.

**Question 12**

Option **C** – Candidates missed the fact that excess calcium carbonate was added. This option was more popular than the correct one.

**Question 17**

Approximately equal numbers of candidates selected each option. This indicates that many candidates were guessing.

**Questions 18**

Approximately equal numbers of candidates selected each option. This indicates that many candidates were guessing.

**Questions 23**

Approximately equal numbers of candidates selected each option. This indicates that many candidates were guessing.

**Question 26**

Option **B** – Candidates chose correct properties but did not relate them to the use.

**Question 27**

Option **C** – Candidates did not realise that soluble substances are not removed by water treatment. This answer was more popular than the correct one.

**Question 37**

Option **C** – Candidates did not realise that alkenes are produced by cracking.

**Question 30**

Approximately equal numbers of candidates selected each option. This indicates that many candidates were guessing.

# CHEMISTRY

**Paper 0620/22**
**Multiple Choice (Extended)**

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

## General comments

Candidates performed very well on this paper.

**Questions 1**, **2**, **3**, **4**, **5**, **7**, **8**, **10**, **14**, **18**, **22**, **23**, **24**, **32**, **34**, **35**, **36**, **37** and **38** proved to be particularly straightforward. **Question 40** proved to be more challenging.

## Comments on specific questions

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

**Question 15**

Option **C** – Candidates did realise that using a smaller volume of acid would yield a smaller volume of hydrogen.

**Question 20**

Option **B** – Candidates missed the fact that in '1' the excess reactant is a liquid.

**Question 21**

Option **C** – Candidates correctly identified iron(II) but did not take into account the anion test.

**Question 27**

Option **B** – Candidates did not read all of the question and chose the replacement of the electrode without realising that it is the anode that reacts.

**Question 31**

Option **C** – Candidates chose the correct equation but did not know how oxides of nitrogen form in an engine.

**Question 40**

Option **A** – Candidates did not realise that the different monomers meant that the polymer was not nylon but a protein. This option was more popular than the correct one.

# CHEMISTRY

**Paper 0620/32**
**Theory (Core)**

## Key messages

- Interpretation of data from tables and completion of chemical equations was generally well done.
- Some candidates would benefit by improving their knowledge of specific chemical terms and processes.
- Many candidates need more practice in writing with precision.
- Some candidates need more practice in answering questions about practical procedures.

## General comments

Many candidates tackled this paper well, showing a good knowledge of core chemistry. Nearly all candidates were entered at the appropriate level and many candidates performed well. The standard of English was generally good. Very few of the questions were left unanswered.

Many candidates were able to extract information from tables, balance symbol equations and undertake simple chemical calculations.

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

Some candidates need more practice in writing answers with the correct level of detail, using specific chemical terms. For example, in **Question 2(c)** few candidates used the term (thermal) decomposition and in **Question 6(a)(i)** many did not refer to 'thermal' or 'heat'. In **Question 6(a)(iv)** many did not used the terms erosion or (chemical) weathering. Other candidates need more practice in writing definitions. For example, in **Question 1(b)** many candidates wrote about substances rather than elements or atoms and contradicted themselves by mentioning mixtures. Many candidates could improve their response by writing with greater specificity. In **Question 2(d)(i)** (deducing and explaining which substance is reduced) many candidates did not specify exactly which substance is losing the oxygen; these responses only referred to elements which appear on both sides of the equation. In **Question 3(a)** some candidates wrote vague answers about washing or making chemicals, without giving a specific example. In **Question 5(c)** some candidates wrote 'decreased' without stating whether the decrease was up or down the group. In **Question 7(b)** many candidates gave the generic name 'salt' rather than writing the specific name of the salt in the equation box. In **Question 7(d)** some wrote vague answers relating to heat being absorbed without mentioning that it is the atmosphere that is warming. In **Question 8(d)** many wrote that 'chlorine is more reactive', without comparing it to what it was more reactive than.

Some candidates would benefit from further revision of specific topic areas such as the use of air and limestone in the blast furnace for the extraction of iron (**Questions 2(b)(ii)** and **2(c)**) and the production of ethanol by fermentation (**Question 4(d)**).

Many candidates would benefit from learning specific practical procedures. For example, in **Question 5(d)(iii)** most candidates gave colours relating to pH values rather than stating how to use the universal indicator solution by comparison with the colours on the indicator colour chart. In **Question 6(b)(i)** many candidates just wrote about theoretical aspects of rate of reaction instead of stating what should be measured and the apparatus needed for measurement.

Some candidates need to revise qualitative tests for specific ions and molecules. The answers to the questions about the test for iodide ions (**Question 1(a)(iii)**), the bromine water test for unsaturated compounds (**Question 4(a)(iii)**) and the flame colour test for potassium (**Question 5(d)(ii)**) were often incorrect.

**Comments on specific questions**

**Question 1**

Many candidates identified at least three of the substances correctly in **(a)**. Fewer gave a convincing description of the term compound in **(b)**. Most candidates were able to construct the correct dot-and-cross diagram for hydrogen chloride in **(d)**.

**(a) (i)** Some candidates identified potassium manganate(VII). Others suggested aluminium oxide, calcium oxide or one of the organic compounds in the list. The commonest error was to suggest nitrogen dioxide.

**(ii)** A majority of the candidates correctly identified methane. The commonest error was to suggest nitrogen dioxide.

**(iii)** A minority of the candidates recognised that iodides give a yellow precipitate on addition of silver nitrate. The commonest error was to suggest calcium bromide. Other errors frequently seen were nitrogen dioxide or potassium manganate(VII).

**(iv)** Some candidates realised that calcium oxide is used in flue gas desulfurisation. The commonest errors were to suggest either ethane, ethene or methane, perhaps because these are gases.

**(v)** More candidates gave the incorrect answer, ethane, instead of the correct answer, ethene, perhaps because the first four letters of ethane and ethanol are the same.

**(b)** Many candidates gained credit for the idea that a compound is formed from two (or more) different elements. Others wrote vague statements about substances combining. Few candidates mentioned atoms or ions combining. A minority of the candidates wrote specifically enough to gain full credit. Few mentioned bonding or <u>chemical</u> combination. Although some candidates wrote about fixed proportions of elements, this was not sufficient. Many candidates contradicted themselves, e.g. 'it is a mixture of elements combined'.

**(c)** Most candidates gave a correct dot-and-cross diagram. The commonest errors were: to omit the electrons on the chlorine atom; to give the chlorine atom seven unpaired electrons or draw an extra electron on the hydrogen atom.

**Question 2**

Some candidates gave good answers to **(a)**, **(b)(i)**, **(d)(ii)** and **(e)**. In **(b)(ii)** many did not explain the purpose of the limestone added to the blast furnace or gave answers which were too vague. Others did not understand the importance of the combustion of coke in air / oxygen or to form carbon monoxide or carbon dioxide in **(c)**. Few referred to the iron(III) oxide in explaining the reduction in **(d)(i)**.

**(a)** A majority of the candidates recognised hematite as the common ore of iron. The commonest error was to suggest 'iron oxide'.

**(b) (i)** Nearly all candidates recognised that the slag floats on the iron. The commonest error was to suggest that 'the slag comes out first'. A few candidates referred to melting points rather than the position in the blast furnace.

**(ii)** A minority of the candidates referred to the limestone. Incorrect substances added included calcium oxide, coke and hydrogen. Many candidates appeared to muddle the processes in the blast furnace with those used in steelmaking. There was frequent reference to reaction of the impurities with oxygen or oxide formation. Few candidates mentioned the decomposition of calcium carbonate.

**(c)** This was the least well answered part of this question. A majority of the candidates wrote vague answers such as 'to provide oxygen for the reaction', 'so the substances get heated' or 'to heat the furnace'. The best responses mentioned reaction with carbon to provide heat or referred to the formation of carbon dioxide or carbon monoxide.

**(d) (i)** The best answers referred to the removal of oxygen from the iron oxide. A very small number of responses included a good explanation of reduction in terms of gain of electrons by the iron in the iron oxide or decrease in oxidation number of the iron. Candidates must be specific when they answer this type of question: they must refer to the iron in the iron oxide and not give a general statement about oxidation such as 'oxidation is loss of oxygen' or 'because there is a loss of oxygen'. The latter statement cannot be accepted because there is no loss of oxygen in the overall equation.

**(ii)** Many candidates calculated the mass of iron correctly. The commonest incorrect answer was 5.7, obtained by inverting the $\frac{11.2}{6}$ in the calculation.

**(e)** A majority of the candidates deduced the correct numbers of electrons, protons and neutrons. The commonest errors were to suggest 58 protons (using mass number rather than atomic number) or 28 neutrons (mathematic error in subtraction).

**(f)** A majority of the candidates identified the two correct statements. The commonest error was to suggest that iron has a low density. A few thought that iron was brown in colour.

**Question 3**

This was the best answered question on the paper. Most candidates performed well in **(b)**, **(d)** and **(e)**. In **(a)** some wrote answers that were too vague or gave uses that were non-industrial. Many candidates answered **(d)** well; others did not express themselves clearly when explaining the purpose of filtration in water treatment.

**(a)** The best answers referred to the use of water as a solvent or as a coolant. Many candidates wrote answers that were too vague or could refer to home uses, e.g. 'for chemical reactions', 'cleaning', 'washing'. Better responses included specific uses of water as a reactant in large scale industrial processes, e.g. 'for making sulfuric acid'. A significant minority of candidates gave the incorrect answer, 'neutralisation'.

**(b)** A majority of the candidates identified the neutral pH correctly. The commonest error was to suggest pH 0.

**(c)** Good answers included ideas about the removal of insoluble materials by filtration and the killing of bacteria by chlorine. Some responses were too vague, such as 'filtration removes small particles' or 'bacteria are removed by chlorine'. The first of these answers does not mention insolubility and the word particles could refer to molecules. The second of these answers is not specific enough and could imply that the bacteria are just taken out of the water but not killed.

**(d)** The commonest errors were 'sublimation' in place of melting and 'cooling' or 'evaporation' in place of condensing.

**(e)** Nearly all the candidates deduced the correct order of reactivity. The commonest error was to reverse copper and nickel.

**Question 4**

Responses to **(a)(ii)** and **(b)** were generally correct. A minority of the candidates were able to identify the carboxylic acid functional group correctly in **(a)(i)** and draw the correct displayed formula for ethanol in **(c)**. Some knew the test for unsaturation in **(a)(iii)**. Others either muddled this with other tests or gave incorrect colour changes. In **(d)** only a minority of the candidates gave a good description of fermentation. Most gave incorrect answers which included details of the hydration of ethene.

**(a) (i)** Many candidates identified the carboxylic acid functional group. The commonest errors were either to include the carbon atom adjacent to the –COOH group or to include the double bond. A considerable number of candidates did not respond to this question.

**(ii)** A majority of the candidates deduced the correct molecular formula. The commonest error was to include a functional group, e.g. $C_5H_7OH$ or $C_4H_7COOH$. Others did not count the number of each type of atom correctly.

**(iii)** The best answers gave the correct test reagent (bromine or aqueous bromine) as well as the correct result for the unsaturated and saturated compound, e.g. turns colourless and remains orange. A considerable proportion of the candidates reversed the colour changes or gave incorrect colours, e.g. 'goes yellow' (for unsaturated compound) or turns from colourless to red (for saturated compound). Others suggested combustion and the limewater test for carbon dioxide.

**(b)** Most candidates gave the correct relative molecular mass. The commonest error was 57 due to the addition of only one hydrogen atom rather than four.

**(c)** Some candidates gave a suitable definition of a hydrocarbon including the words 'compound' and 'only' in their answers. Most responses did not specify that the only atoms were hydrogen and carbon.

**(d)** Very few candidates knew the correct conditions or reagents for fermentation. Most muddled the conditions or reagent with those for the hydration of ethene, e.g. yeast and high temperature, yeast and ethene, steam and glucose. Many wrote vague statements about the temperature and pH, e.g. 'the proper temperature', or a 'pH that is not too acid'. Others suggested that a high pressure should be used. The process name, distillation, used to separate the ethanol for the rest of the reaction mixture was known by most candidates.

**Question 5**

Most candidates were able to deduce the values for melting point and conductivity in **(a)** and balance the equation in **(d)(i)**. Some candidates answered **(b), (c)** and **(d)(ii)** well. Others either did not use the information given correctly in **(b)** and **(c)** or had not learned the flame colours in **(d)(ii)**. Few candidates gave an accurate enough answer to **(d)(iii)**, where most just wrote down colours at particular pH values instead of concentrating on the practical procedure required.

**(a)** Most candidates were able to use the information in the table correctly to deduce the melting point of rubidium and the conductivity of sodium. The commonest errors were to give values lower than 31°C for the melting point of rubidium or values higher than 30 for the relative conductivity of sodium. A few candidates did not respond to this question.

**(b)** Most candidates deduced the correct state, although a few suggested 'liquid' or 'semi-solid'. Fewer gave a correct explanation in terms of a comparison of the temperature, 20°C, with the melting point. Some candidates did not refer to the temperature 20°C and just gave simplistic answers, which repeated the data in the stem of the question, e.g. 'because the melting point is 29°C and the boiling point is 669°C'.

**(c)** Most candidates recognised the trend; others did not mention the position in the group, e.g. 'it increases' (unqualified), or suggested an increase down the group.

**(d) (i)** Many candidates balanced the equation correctly. The commonest errors were: 2H or $H_2O$ instead of $H_2$.

**(ii)** Some candidates identified the correct flame colour of potassium. Others either gave incorrect colours (red or green being the commonest) or vague statements such as 'neutral colour'.

**(iii)** Many candidates wrote imprecise or incorrect answers which did not refer to a practical method. Many muddled the test with that of litmus and wrote statements such as 'the litmus paper goes red'. Few suggested the idea of comparing the colour with the universal indicator colour chart. Many wrote vague statements such as 'you can tell by its colour' or gave colours specific to particular pH values, e.g. 'if its orange its pH is acid'.

**Question 6**

Most candidates identified combustion in **(a)(iii)** and suggested the correct effect of size and temperature on the reaction rate in **(b)(ii)**. Fewer could identify a salt correctly in **(a)(ii)**. Others gave answers that were too vague when defining exothermic (**(a)(i)**) or explaining the effect of acid rain on buildings (**(a)(iv)**). The practical procedure for finding the rate of reaction involving evolution of a gas was generally not well explained.

**(a) (i)** Many candidates referred correctly to the transfer of thermal energy or heat to the surroundings. Some did not mention heat or thermal energy or suggested that energy was absorbed.

**(ii)** Some candidates correctly identified magnesium nitrate as a salt. The commonest error was to suggest that magnesium nitrate is an oxide.

**(iii)** A majority of the candidates recognised the combustion reaction. The commonest error was to suggest cracking. A few thought that the type of reaction was neutralisation.

**(iv)** A minority of the candidates gave suitable chemical terms for the reaction of acid rain with buildings. The best answers referred to chemical weathering or erosion of the surface. Common errors included: discoloration of the surface, dissolving, melting or rusting (rather than corrosion). Others suggested effects that were too drastic, e.g. destroys the building or weakens the building. A significant minority did not read the stem of the question properly and gave effects of acid rain on humans, trees or lakes.

**(b) (i)** Few candidates gained full credit. Many responses did not include practical procedures and just stated the effect of temperature and concentration on rate of reaction. The best answers mentioned measurement of the volume of gas or volume of hydrogen as well as the apparatus required, e.g. gas syringe. Others wrote answers that were too vague such as ‘measure the volume’. This could refer to the volume of solution as well as the volume of gas. Others wrote about ‘change of temperature’ but did not qualify this. Generally, candidates correctly referenced time.

**(ii)** A majority of the candidates gained full credit. The commonest errors were: ‘rate increases when large pieces are used because there is a larger surface area’ or reference to time of reaction rather than rate of reaction. Some candidates wrote about the reaction being ‘slow’ or ‘fast’. This is not sufficient because the reaction may be slow or fast anyway. The comparative is needed, i.e. slower or faster.

**Question 7**

Many candidates were able to provide some of the electrolysis arrangement in **(a)(i)**. Others need more practice at identifying the products at the electrodes during the electrolysis of sulfuric acid (**(a)(ii)**) and naming the products formed when an acid reacts with a carbonate (**(b)**). Most knew the test for carbon dioxide in **(c)**.

**(a) (i)** Few candidates showed test-tubes over each electrode for collecting gases. Many of those who suggested a method of gas collection drew a funnel over the whole beaker or showed gas syringes above each electrode. Other common errors included: drawing wires going through the electrolyte; reversing the anode and cathode and labelling the anode of the power pack or cell rather than the anode of the electrolysis cell. The anode is where oxidation takes place and this is the negative electrode in an electrochemical cell or battery.

**(ii)** A minority of the candidates gained full credit. The commonest errors were to suggest sulfur or sulfate at either electrode or oxygen at the negative electrode. The commonest correct answer was hydrogen at the negative electrode.

**(b)** Some candidates correctly identified both sodium sulfate and water. The commonest errors were to suggest the generic ‘salt’ instead of the specific ‘sodium sulfate’ or to suggest ‘hydrogen’, ‘oxygen’ or ‘carbon dioxide’ in place of water. The commonest errors in naming the salt were to suggest either ‘sodium’ or ‘sodium chloride’.

**(c)** Many candidates knew the test for carbon dioxide. The commonest error was to suggest using a lighted splint that was extinguished. This test is not specific enough. Others muddled the test with that for carbonates by adding hydrochloric acid and then suggesting some other test. The bromine water test for unsaturation was sometimes given as a test for carbon dioxide.

**(d)** Some candidates gave the simple answers 'climate change' or 'global warming', both of which were acceptable. Others wrote statements about absorbing heat or increasing temperatures, which were too vague because they do not refer to what is absorbing the heat. Others suggested that the Earth's surface absorbed the heat rather than the atmosphere. A significant proportion of the candidates incorrectly referred to the depletion of the ozone layer.

**Question 8**

This was one of the best answered questions on the paper. Many candidates identified the gas in **(a)(i)** and the reversible reaction in **(c)**. Most were able to balance the equation in **(d)(i)**. Fewer candidates were able to describe molecules containing two atoms as being diatomic in **(b)** or compare the correct species in the question about relative reactivity in **(d)(ii)**.

**(a) (i)** Most candidates realised that ethane is a gas. The commonest error was to suggest graphite.

**(ii)** Many candidates suggested the correct answer of ionic bonding. The commonest errors were to refer to covalent bonding or the general term 'chemical bonding'.

**(iii)** A majority of the candidates realised that sodium chloride is soluble in water. The commonest error was to suggest structure **F** (methane).

**(iv)** This was the least well answered of the **(a)** questions relating to structure. The commonest incorrect answer was **E** (sodium chloride), which only conducts when molten or in aqueous solution. A considerable number of candidates suggested **C** (diamond).

**(b)** Some candidates suggested the term diatomic. Others suggested 'compound' or gave the name of a specific compound. The commonest error was to suggest helium. This is perhaps because these candidates knew that di- means two but ignored the '–atomic' and focused on the fact that helium is the second element in the Periodic Table.

**(c)** The explanation of the reversible reaction symbol was almost invariably correct.

**(d) (i)** Most candidates balanced the equation correctly. The commonest errors were to write $2Cl$ or $Cl$ instead of $Cl_2$.

**(ii)** A minority of the candidates compared the reactivity of chlorine and iodine correctly. Many did not write with enough precision and gave incomplete answers such as 'chlorine is more reactive'. It is important that a comparison is made because many candidates compared the reactivity incorrectly, e.g. 'chlorine is more reactive than iodide' or 'chlorine is more reactive than potassium'. Some candidates compared the position of chlorine and iodine in the group without mentioning the order of reactivity.

# CHEMISTRY

**Paper 0620/42**
**Theory (Extended)**

## Key messages

- Candidates must read questions carefully to ensure that the answer given addresses what has been asked. This particularly applies to questions which ask for either names, formulae or word equations. For example, **Question 1(c)(i)** was designed to test if candidates knew the systematic names of lower alkanes; many gave the formula. **Question 1(e)** asked for a simple word equation; many tried to give a chemical equation, which often contained errors.

- When drawing organic structures, candidates should be aware that structures will require all bonds to be drawn and thus the valency of the atoms used needs to be correct. Trivalent and pentavalent carbon atoms were seen in **Question 5(a)(ii)** and divalent hydrogen atoms and/or monovalent oxygen atoms were often seen in the linkages given in **Question 5(c)(i)**.

- In extended questions such **Question 3(b)**, candidates should be advised to present their answers in short sentences or bullet points. Longer rambling sentences tend to lead to repetition of facts, often showing contradictions to earlier comments.

- If a single property is asked for, two or more properties should not be given as incorrect statements may contradict correct answers.

## General comments

Most candidates seemed well prepared for this paper and there were some excellent scripts seen. There were few unanswered questions. Most candidates attempted to show full working in calculations.

Knowledge of ionic equations for precipitation and ionic half-equations for reactions taking place at electrodes were often not well known.

## Comments on specific questions

### Question 1

**(a)** Most candidates correctly identified fractional distillation.

**(b)** Most candidates gained full credit. Naphtha was rarely spelt correctly and care should be taken that erroneous responses such as naphthalene are not given.

**(c) (i)** This question required the systematic names of any two of the first three alkanes. Many candidates made it harder for themselves by writing formula.

**(ii)** The majority of candidates gained full credit. A significant minority were unable to balance the equation, usually as a result of using an incorrect number of moles of oxygen. A significant number of candidates used 1 mole of butane and balanced the rest of the equation against this. This method is acceptable.

**(iii)** Nearly all candidates knew carbon monoxide was the toxic gas formed by incomplete combustion.

**(d) (i)** The behaviour of the trends of viscosity and flammability were well known. Many candidates misinterpreted the question and attempted to give definitions for the terms without relating the differences in these properties to the two fractions.

**(ii)** Most candidates were aware that the given properties were dependent upon the length of the carbon chain within the molecules. Many answers were not clearly expressed. The commonest error was 'the number of carbon *molecules*' or just 'the number of molecules'.

**(e)** The word equation for the overall reaction taking place within a fuel cell was made difficult by many candidates who opted to give the more difficult symbol equation, often losing the mark for using incorrect symbols. A significant number of candidates attempted ionic half-equations.

**Question 2**

**(a) (i)** Nearly all candidates answered this correctly.

**(ii)** Many candidates had learnt this definition as it appears in the syllabus and performed well. It was clear that many of those who tried to explain electrolysis did not appreciate that it is a decomposition process whereby a molten or aqueous ionic compound is broken down using electricity. Common errors included omitting the physical state, suggesting 'separation' (a physical change) was occurring or stating the compound was broken down into 'ions' (the compound already exists as ions).

**(b) (i)** Cryolite was known by nearly all as the substance used to reduce the operating temperature of the process.

**(ii)** The majority of candidates did not appreciate that the environmental benefit of running a process at a lower temperature was that the reduction in use of fossil fuels would lead to reduced global warming. Many candidates assumed lower temperatures would mean less heat loss and then incorrectly linked this to reduced global warming.

**(iii)** The aluminium (cathode) ionic half-equation was generally known, although often unbalanced in terms of electrons gained. The anode ionic half-equation was less well known. Many incorrect anions were seen, including $O^-$, $O_2^-$ and $OH^-$. Where $O^{2-}$ was seen, this was invariably unbalanced both in terms of electrons lost and molecules formed.

**(iv)** Most candidates were aware that the hot carbon anode reacted with the oxygen produced on it and carbon dioxide was formed

**(c) (i)** The term *amphoteric* was well known.

**(ii)** The majority of candidates knew the name of the salt formed was aluminium sulfate; the correct formula was less well known.

**(iii)** The idea that an amphoteric oxide reacts with a base to form a salt plus water was not well appreciated. When water was not seen, a variety of incorrect responses included sodium aluminate (which is the actual salt formed), sodium oxide, hydrogen and aluminium hydroxide.

**(iv)** Most candidates were able to secure both marks for this decomposition equation. Weaker responses did not follow the help given in the question regarding aluminium hydroxide's formula nor the stated products.

**(v)** The expected answers of aluminium carbonate and aluminium nitrate were the most common answers seen. Credit was also given for aluminium sulfate as this too will decompose to form the oxide.

**Question 3**

**(a)** The majority of the candidates knew selenium was the required answer, tellurium was seen often presumably from those who forgot about Period 1. Those who read VI as IV gave germanium or tin.

**(b)** Rambling responses were common, which contained needless repetitions and contradictions. Better responses were succinct and often in bullet point form. An example of succinctness might be:

- Calcium atoms have two outer shell electrons and lose these to form ions with the formula $Ca^{2+}$.
- Chlorine atoms have seven outer shell electrons and gain one electron to form ions with the formula $Cl^{-}$.

Common errors were to state that chlorine molecules lose electrons; giving resultant ions as $Cl_2^{-}$ or writing ionic half-equations, which contradicted good chemistry already given e.g. $Ca + 2e^{-} \rightarrow Ca^{2+}$.

**(c) (i)** The majority of candidates suggested an appropriate boiling point.

**(ii)** Most candidates knew that stronger forces give higher boiling points. A few candidates incorrectly stated that strong forces mean higher boiling points rather than using the comparative; few candidates went on to state the particles between which these forces occurred were molecules.

**(iii)** The covalent bonding of $PCl_3$ was well known. Occasionally, non-bonding electrons were omitted on C*l* atoms or P atoms and occasionally there was an error in the number of non-bonding electrons on an occasional C*l* atom, presumably as a result of miscounting. This simple error could readily be avoided by drawing all non-bonding electrons as pairs. Three pairs of electrons are easier to count than six individual electrons.

**(d) (i)** Candidates were familiar with what an equilibrium is, although many gave answers which were too vague to acquire credit. Examples of loose wording include 'forward reaction equals backward reaction' (no mention of rate) and 'concentrations of reactants and products are the same', when what should have been written was 'concentrations of reactants and products *remain* the same' or 'concentrations of reactants and products remain constant'.

**(ii)** Candidates are advised to think carefully before putting pen to paper for this type of question. The candidates' wording was not always easy to understand and often contradictory, for example 'the equilibrium shifts towards the reactants' followed by 'the equilibrium shifts to the right-hand side'. Many irrelevant comments about rate change were seen. Candidates should be aware that there is no such thing as an 'endothermic side' to a reaction; there is, however, an endothermic *direction*.

**(iii)** All knew that particles gain more energy; many candidates omitted the most obvious comment that rate increases. Most responses stated that the *frequency* of collisions increases; although many candidates wrote 'there are more collisions'. It was rare to see the statement 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)** This calculation was well answered. Some candidates used the wrong $M_r$ for lithium fluoride.

**(f) (i)** Many candidates did not appreciate that an ionic bond is an attraction between oppositely charged ions. Many candidates spent time describing how an ionic bond is formed, which was not asked for in this question.

**(ii)** Most candidates knew that ionic substances have high melting points and (therefore high boiling points) as one physical property. The other physical property described was the ability to conduct electricity when molten (or when aqueous). Candidates who used the phrase ‘conducts electricity *only* when molten’ could not receive credit.

**Question 4**

**(a)** The Haber process was well known.

**(b) (i)** Most of the answers seen were correct. ‘Grey-green’ (confusion with chromium) and ‘white’ (indicating non-transitional behaviour) were two common errors.

**(ii)** Candidates appear to struggle with ionic equations for precipitate formation. Such equations have two reactant ions and one product compound. The sequence of state symbols is (aq) + (aq) → (s). Candidates are advised to identify the solid product and ‘split’ this up into its constituent ions. These will be the reactants.

**(c) (i)** Most knew that potassium manganate(VII) was acting as an oxidising agent; many opted to describe it as a catalyst.

**(ii)** Despite being told that the reaction occurred at room temperature, some extreme temperatures and pressures were seen. ‘Catalyst’ was a common answer. Relatively few realised the potassium manganate(VII) needed to be acidified.

**(iii)** Most knew that oxidation involved the loss of an electron.

**(iv)** The majority of candidates knew the purple potassium manganate(VII) turned colourless.

**(d)** Most determined the correct charge on the iron in both cases.

**Question 5**

**(a) (i)** Monomer was universally known.

**(ii)** Candidates were required to show every atom and every bond in their diagrams. Many opted to show methyl groups as $CH_3$.
Common incorrect responses included:
- a repeat unit with continuation bonds
- a repeat unit without continuation bonds (meaning two C atoms having three bonds)
- a monomer unit with continuation bonds (meaning two C atoms having five bonds).

**(b)** It was generally known that condensation polymerisation produces a second, small molecule (usually water) when the monomers combine.

**(c) (i)** Candidates were required to connect up the boxes with correctly drawn and correctly orientated amide links and to include continuation bonds. The latter was often omitted.

**(ii)** Nylon was well known. A few opted for Terylene.

# CHEMISTRY

**Paper 0620/52**
**Practical Test**

## Key messages

- Candidates are advised to avoid giving ranges in answer to questions which require a numerical answer (such as **Question 2(b)**), as the entire range given by the candidate must fall within the range of acceptable answers.
- Candidates should avoid giving two answers to questions that require only one. For example, in **Question 2(a)(iii)** one change was asked for. If candidates give two changes then both must be correct for credit to be awarded.
- Candidates need to read the question paper with care. Where a question requires something to be drawn on a diagram or graph, as in **Question 2(h)**, there will not be a response line to write on. **Question 2(h)** was often not attempted on the paper – possibly because candidates did not read the question carefully and failed to follow the instruction.

## General comments

The paper was generally well answered, with very few blank spaces. The vast majority of candidates successfully obtained results for both the quantitative and qualitative tasks and attempted all of the questions. Many excellent results for the qualitative task were seen.

## Comments on specific questions

### Question 1

**(a) (i)** Almost all candidates correctly noted that the tube became warmer. A small number of candidates reported that the temperature dropped during the reaction.

**(ii)** The vast majority of candidates were able to state correctly that the reaction was exothermic. However, a number of candidates wrote ‘enothermic’ – a mixture of the spelling of ‘exothermic’ and ‘endothermic’. This answer could not receive credit; candidates need to ensure that if they are writing ‘exothermic’ that the ‘x’ is not ambiguous and written to look like an ‘n’.

**(iii)** The best answers suggested a method of cooling the reaction vessel, such as immersing it in a water bath. A common error was to suggest that the vessel should be insulated. This would have the opposite effect to that desired. The reaction is exothermic and so causes an increase in temperature of the reactants; insulation would prevent the loss of heat from the reaction vessel and so cause the temperature rise to be even greater.

**(b)** Almost all candidates were able to record results for all five experiments. Only a small minority of candidates recorded the times in minutes and seconds rather than just in seconds. The vast majority of candidates recorded results showing the expected pattern of results, namely decreasing times as the volume of acid increased. The expected time for Experiment 5 was approximately half the time for Experiment 3 and the majority of candidates obtained results that showed this.

**(c)** Some excellent graphs were seen, although there were a number of common problems:

- Graph scales should be chosen such that the plotted data takes up over half of the available space and it is recommended that each major grid line should be equivalent to 1, 2, or 5 (or those numbers multiplied by 10n) – this is indicated in the mathematical requirements in the syllabus and by the Association for Science Education (A.S.E.). Some candidates selected graph scales where each major grid line corresponded to awkward values (such as 15). Unsurprisingly, these candidates often lost marks for plotting the data incorrectly as they struggled to interpret their own scales.
- While some excellent graph lines were seen, it should be noted that straight lines drawn through points which lie clearly on a curve were not credited, neither were 'curves' formed from straight sections or showing a clear point of inflection as the line just weaves from point to point. Very thick or multiple lines were also not credited.

**(d) (i)** Most candidates clearly showed their working on the grid and recorded a correct value for the time. A significant number of candidates did not show any working and so could not be awarded one of the two marks available. A small minority of candidates tried to take readings at an incorrect volume of sulfuric acid (8.2 and 11 $cm^3$ being the more common wrong volumes chosen).

**(ii)** The majority of candidates used the fact that the total volume of acid and water was 20 $cm^3$ in each experiment and correctly calculated the required volume of water to be 11 $cm^3$. A few candidates showed working of unnecessarily complex calculations and reached incorrect answers.

**(e) (i)** A large number of candidates were able to correctly deduce the units of rate of reaction. Candidates are expected to be able to round numbers correctly and incorrect rounding (such as 1.175 rounded to 1.17) was not credited.

**(ii)** Most candidates realised that the experiment with the shortest time had the greatest rate of reaction. However, a few candidates felt the need to calculate the rate of reaction for all five experiments.

**(f)** Most candidates correctly stated that a burette is more accurate than a measuring cylinder. However, answers based on measuring cylinders having a greater parallax error or being easier to spill were not credited since these are due to the user of the apparatus and not the apparatus itself.

**(g) (i)** The best responses stated some of the gas made would be lost. Answers based on difficulties in starting the stop-watch while replacing the bung were not credited since the question specifically asked why the reaction starting as soon as the magnesium is added decreased the accuracy.

**(ii)** Some excellent answers using a bifurcated flask or suspending the magnesium on a length of thread were seen. A common error was to add the acid through a hole in the bung using apparatus such as a burette. This would cause a huge error in the results, since as the acid is added it will displace air from the tube and so cause a large increase in the volume of gas collected. Another common error was to suggest that doing multiple experiments and taking the mean would reduce this error. Taking a mean of multiple results reduces the effect of random errors; however, the loss of gas before the bung is inserted is a systematic error caused by the design of the experiment and is not reduced by finding a mean, as gas will be lost every time the experiment is done.

**(h)** Most candidates were able to sketch a correct graph for a higher temperature. Some candidates did not clearly label their graph.

**Question 2**

**(a)** It should be noted that 'clear' and 'transparent' are synonyms for each other and neither mean the same as 'colourless'. The solution should have been described as 'colourless'.

**(b)** Most candidates were able to suggest a pH within the acceptable range (0 to 3). Some gave a pH range rather than a specific number. When a range is given, the entire range must be correct, so an answer of pH 1 to 4 would not gain credit as 4 is outside of the allowed range of 0 to 3. Unless specifically asked for in a question, candidates should avoid giving ranges in their answers.

**(c)** In this question, solid sodium carbonate was added to solution **J** and the gas given off tested. The expectation was that candidates would state that effervescence was seen and then give the result of the positive gas test carried out. In this case, lists of negative tests were ignored. The expected positive test was that the gas turned limewater milky. Some candidates incorrectly reported lighted splints causing a pop or glowing splints relighting. Some candidates reported multiple positive tests, which meant that the marks for the correct test and result could not be awarded.

**(d)** This was well answered; a small number of candidates contradicted themselves by saying the precipitate was soluble.

**(e)** Most candidates were able to identify solution **J** as hydrochloric acid. Some candidates were confused by the fact that the acid was the substance being tested rather than a reagent used to test another substance, and so concluded that solution **J** must contain carbonate ions since carbon dioxide was formed in **(c)**.

**(f)** The reaction produces ethanoic acid and many candidates correctly reported a sour or pungent smell, descriptions such as 'fruity' or 'sweet' were not credited since ethanoic acid is neither fruity nor sweet. The question instructed candidates to smell the product of the reaction, despite this some candidates did not make any comment related to smell.

**(g) (i)** There should have been no visible change on addition of aqueous sodium hydroxide, although a smell of ammonia may have been noted – most candidates correctly stated one of these two observations. Any answers which implied a change, such as 'the solution *becomes* colourless' were not credited. Some answers suggested a few candidates ignored the instruction to make a solution from solid **K**, as their description involved crystals, which should have dissolved before the test was carried out.

**(ii)** Again, candidates were expected to record the results of a positive gas test, which, in this case, was red litmus paper turning blue. A few candidates stated that blue litmus turned red or that litmus was bleached, along with descriptions of positive tests for hydrogen or oxygen – results that could not have been obtained in this reaction.

**(h)** The question asked for the identification of one ion in solid **K**. Most candidates who followed this instruction gained credit by stating that the ion was ammonium. A significant number stated the ion was ammonia and so did not gain the mark. Candidates who attempted to identify two ions present almost always gained no credit as the second ion was very rarely stated to be ethanoate (which candidates are not expected to be able to identify). A common error was to state that nitrate ions were present, for which there was no evidence in the question.

**Question 3**

Most candidates were able to perform well on this planning task. Very few candidates tried a non-chromatography based approach.

The most common error was one of omission, with candidates assuming that they had a sample of the black dye, while the question stated they had the roots. This resulted in candidates not being able to gain credit for extracting the dye from the roots – the expected method for this being to crush the roots with a suitable solvent using a pestle and mortar.

There were many good and clear descriptions of the chromatography process. Common errors were using a solvent up to the depth of the spot of dye rather than ensuring the solvent level was below the dye or baseline. The aim of the experiment was to find how many different coloured substances were contained in the black dye; comments on using a locating agent for invisible colours were ignored (as if the compounds are coloured, they cannot be invisible). The simplest way of finding how many coloured compounds are in the dye is to count the spots obtained as a result of chromatography. Calculation of the $R_f$ value of each spot to identify the substances was also credited as if you know what the substances are, then you also know how many substances there are.

# CHEMISTRY

**Paper 0620/62**
**Alternative to Practical**

## Key messages

- Candidates are advised to avoid giving ranges in answer to questions which require a numerical answer (such as **Question 3(a)**) as the entire range given by the candidate must fall within the range of acceptable answers.
- Candidates should avoid giving two answers to questions that require only one. For example, in **Question 2(a)(ii)** one change was asked for. If candidates gave two changes then both must be correct for credit to be awarded.
- Candidates need to read the question paper with care. Where a question requires something to be drawn on a diagram, as in **Question 1(b)**, there will not be a line to write on. **Question 1(b)** was one of the questions most often not attempted on the paper – possibly because candidates did not read the question carefully and failed to follow the instruction.

## General comments

The paper was generally well answered, with very few blank spaces. The vast majority of candidates were able to complete tables of results from readings on diagrams and then handle the data obtained.

## Comments on specific questions

### Question 1

**(a)** Almost all candidates were able to identify the thermometer correctly and the majority also successfully identified the round-bottomed flask. Common incorrect answers referred to the flask as being either conical or a beaker.

**(b)** Good responses correctly identify where water entered the condenser. It was evident that the majority of candidates were not familiar with the direction of water flow in a condenser.

**(c) (i)** The flammability of alcohols was identified as a safety issue by the majority of candidates.

**(ii)** The solution to this problem, although correctly answered by most candidates, proved to be more demanding for some. Incorrect suggestions such as heating to a cooler temperature or with something that produces a smaller flame were not uncommon.

**(d)** The majority of candidates were able to describe the role of the condenser in cooling the vapour. The question asked candidates to ‘describe how’ and so answers that just stated the condenser condenses the gas did not gain credit as there was no description of how this is achieved.

**(e)** Many fully correct answers were seen. A few candidates seemed to have confused the process with industrial fractional distillation and stated that the one with the highest boiling point will condense first and so be collected first.

**Question 2**

**(a) (i)** The vast majority of candidates were able to state correctly that the reaction was exothermic. However, a number of candidates wrote ‘enothermic’ – a mixture of the spelling of ‘exothermic’ and ‘endothermic’. This answer could not receive credit; candidates need to ensure that if they are writing ‘exothermic’ that the ‘x’ is not ambiguous and written to look like an ‘n’.

**(ii)** The best answers suggested a method of cooling the reaction vessel, such as immersing it in a water bath. A common error was to suggest that the vessel should be insulated. This would have the opposite effect to that desired. The reaction is exothermic and so causes an increase in temperature of the reactants; insulation would prevent the loss of heat from the reaction vessel and so cause the temperature rise to be even greater.

**(b)** Almost all candidates were able to complete the table correctly. A small minority recorded the time in Experiment 1 in minutes and seconds rather than just in seconds as instructed.

**(c)** Many excellent graphs were seen, although there were a number of common problems:

- Graph scales should be chosen such that the plotted data takes up over half of the available space and it is recommended that each major grid line should be equivalent to 1, 2, or 5 (or those numbers multiplied by 10n) – this is indicated in the mathematical requirements in the syllabus and by the Association for Science Education (ASE). For these results, a scale of each large grid square representing 20 seconds was expected. Some candidates selected graph scales where each major grid line corresponded to awkward values (such as 12, 15 or 16). Unsurprisingly, these candidates often lost marks for plotting the data incorrectly as they struggled to interpret their own scales.
- The data, when plotted correctly, formed a curve of decreasing negative gradient. Hence, the expected line was a smooth curve. Lines formed from straight sections or showing a clear point of inflection were not credited. Very thick or multiple lines were also not credited.

**(d) (i)** Most candidates clearly showed their working on the grid and recorded a correct value for the time. A significant number of candidates did not show any working and so could not be awarded one of the two marks available. A small minority of candidates tried to take readings at an incorrect volume of sulfuric acid (8.2 and 11 $cm^3$ being the more common wrong volumes chosen).

**(ii)** The majority of candidates used the fact that the total volume of acid and water was 20 $cm^3$ in each experiment and correctly calculate the required volume of water to be 11 $cm^3$. A few candidates showed working of unnecessarily complex calculations and reached incorrect answers.

**(e) (i)** A large number of candidates were able to correctly deduce the units of rate of reaction. Candidates are expected to be able to round numbers correctly and so an answer of 0.55 was not credited as correct rounding gives 0.56.

**(ii)** Most candidates realised that the experiment with the shortest time had the greatest rate of reaction. However, a few candidates felt the need to calculate the rate of reaction for all five experiments.

**(f)** Most candidates correctly stated that a burette is more accurate than a measuring cylinder. Answers based on measuring cylinders having a greater parallax error or being easier to spill were not credited since these are due to the user of the apparatus and not the apparatus itself.

**(g) (i)** Candidates more familiar with this kind of practical work were able to state correctly that some of the gas made would be lost. Answers based on difficulties in starting the stop-watch while replacing the bung were not credited since the question specifically asked why the reaction starting as soon as the magnesium is added decreased the accuracy.

**(ii)** Some excellent answers using a bifurcated flask or suspending the magnesium on a length of thread were seen. A common error was to add the acid through a hole in the bung using apparatus such as a burette. This would cause a huge error in the results, since as the acid is added it will displace air from the tube and so cause a large increase in the volume of gas collected. Another common error was to suggest that doing multiple experiments and taking the mean would reduce this error. Taking a mean of multiple results reduces the effect of random errors; however, the loss of gas before the bung is inserted is a systematic error caused by the design of the experiment and is not reduced by finding a mean, as gas will be lost every time the experiment is done.

**Question 3**

**(a)** Most candidates were able to suggest a pH within the acceptable range (0 to 3). A number of candidates ignored the fact that the universal indicator had turned red (as opposed to orange or yellow) and so included pH values of above 3 in their answers and so were not credited. Some gave a pH range rather than a specific number; when this is done the entire range must be correct, so an answer of pH 1 to 4 would not gain credit as 4 is outside of the allowed range of 0 to 3. Unless specifically asked for in a question, candidates should avoid giving ranges in their answers.

**(b)** Most candidates were able to correctly identify the gas formed as carbon dioxide. Some candidates wrote the same with hyphens (such as carbon-di-oxide); it should be noted that the name carbon dioxide is unhyphenated.

**(c)** Most candidates were able to identify solution **J** as hydrochloric acid. Some candidates were confused by the fact that the acid was the substance being tested rather than a reagent used to test another substance, and so concluded that solution **J** must contain carbonate ions since carbon dioxide was formed in **test 2**.

**(d)** The test described in this question was the test for sulfate ions. Since ammonium nitrate does not contain any sulfate ions, the expected answer was ‘no reaction’ or ‘no change’. While most candidates did this correctly, many incorrectly wrote down the positive result of a sulfate ion test.

**(e)** Where a question states that the gas given off was tested and then asks for observations, the observations recorded should include the result of the positive gas test. Since the gas formed was ammonia, the observations should have included the fact that red litmus paper turns blue. There is no credit for listing negative gas tests. Other incorrect positive gas tests or observations will contradict the correct answer and result in credit not being awarded.

**Question 4**

Most candidates were able to perform well on this planning task. Very few candidates tried a non-chromatography based approach.

The most common error was one of omission, with candidates assuming that they had a sample of the black dye, while the question stated they had the roots. This resulted in candidates not being able to gain credit for extracting the dye from the roots – the expected method for this being to crush the roots with a suitable solvent using a pestle and mortar.

There were many good and clear descriptions of the chromatography process. Common errors were using a solvent up to the depth of the spot of dye rather than ensuring the solvent level was below the dye or baseline. The aim of the experiment was to find how many different coloured substances were contained in the black dye; comments on using a locating agent for invisible colours were ignored (as if the compounds are coloured, they cannot be invisible). The simplest way of finding how many coloured compounds are in the dye are to count the spots obtained as a result of chromatography. Calculation of the $R_f$ value of each spot to identify the substances was also credited as if you know what the substances are, then you also know how many substances there are.