# CHEMISTRY

**Paper 0620/11**
**Multiple Choice (Core)**

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

## General comments

Candidates found **Questions 3** and **7** to be the most straightforward.

**Questions 11**, **12**, **24** and **25** were challenging for candidates.

## Comments on specific questions

### Question 2

Response **C**: Candidates did not realise that a clock was of no use at all in this experiment.

**Question 11**

Responses **A** and **C**: Both of these responses were more popular than the correct response, suggesting that candidates did not account for the word “element” in the question.

**Question 12**

Response **C**: Candidates realised that the reaction would be slower, but not that a decrease in the mass of magnesium would result in a graph sloping downwards.

**Question 17**

Candidates were not familiar with this part of the syllabus.

**Question 24**

Candidates were not familiar with this part of the syllabus and all four alternatives were equally popular.

**Question 25**

This topic was poorly understood. The correct response, **D**, was the least popular.

**Question 32**

Response **B**: Candidates realised that a carbonate was involved for Y, but made the incorrect choice for X.

**Question 33**

Response **A**: This response was slightly more popular than the correct one. Candidates perhaps confused burning limestone with heating limestone to form lime.

**Question 37**

The test with aqueous bromine was not well known. Response **C** was more popular that the correct response.

**Question 40**

Response **C**: This response was more popular than the correct response.

# CHEMISTRY

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

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

## General comments

Candidates found **Questions 7**, **13**, and **21** to be the most straightforward.

**Questions 6**, **26**, and **34** were challenging for candidates.

## Comments on specific questions

**Question 2**

Response **C**: Candidates did not realise that a clock was of no use at all in this experiment.

**Question 4**

Response **D**: Candidates did not realise that $O^{2-}$ is an ion.

**Question 5**

Response **D**: Candidates knew about diamond and that graphite is soft, but did not take into account “low melting point” in the question.

**Question 6**

Response **C**: This response was more popular than the correct response. Candidates did not take into account the idea of “ion”.

**Question 11**

Response **D**: Candidates did not consider the uses of bitumen.

**Questions 18** and **19**

In both of these questions there were a similar number of candidates opting for each response. Candidates appeared to find questions with more than one piece of information to consider difficult.

**Questions 24** and **26**

Candidates were not familiar with this part of the syllabus.

**Question 31**

Response **B**: Candidates confused the nitrate test with the test for ammonium ions.

**Question 34**

Response **C**: The choice of **C** suggests that the fractional distillation of petroleum is not fully understood.

# CHEMISTRY

**Paper 0620/13**
**Multiple Choice (Core)**

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

## General comments

Candidates found **Questions 5** and **7** to be the most straightforward.

**Questions 3**, **16** and **24** were challenging for candidates.

## Comments on specific questions

### Question 2

Response **C**: Candidates did not realise that a clock was of no use at all in this experiment.

### Question 3

Response **C**: Candidates gave the name of process in step 4 instead of stating how to obtain solid X from mixture Y.

**Question 4**

Response **B**: Candidates chose the total of protons and neutrons instead of simply the number of neutrons.

**Question 6**

Response **B**: Response **B** was more popular than the correct one. Candidates did not realise that hydrogen only needs two electrons for a full shell.

**Question 10**

Approximately equal numbers of candidates chose **A** and **B**. Candidates were not familiar with the difference between the terms endothermic and exothermic.

**Question 12**

Response **A**: Candidates did not realise that with the same quantities of reactants, the same volume would be produced in each case.

**Question 16**

Response **C**: The test for sulfite is new for the 2016–2018 syllabus and many candidates selected the wrong potassium compound. Response **C** was more popular than the correct one.

**Question 17**

Response **A**: Candidates were unsure of the reactions of metal oxides with acids.

**Question 24**

Candidates found this question challenging and all of the alternative responses were popular.

# CHEMISTRY

**Paper 0620/21**
**Multiple Choice (Extended)**

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

## General comments

Candidates performed well on this paper.

Candidates found **Questions 3**, **4** and **29** the most straightforward.

**Questions 21** and **25** were the most challenging for candidates.

## Comments on specific questions

### Question 7

Response **B**: Candidates did not account for the information given about the melting point and electrical conductivity of solid X.

**Question 8**

Response **B**: Candidates did not take account of the fact that benzene is a liquid at room temperature and pressure. Response **B** was more popular than the correct one.

**Question 12**

Response **B**: Candidates knew that the reaction was exothermic but did not correctly account for the temperature change.

**Question 13**

Response **B**: Candidates did not fully understand the processes of bond breaking and formation.

**Question 21**

Response **A**: This response was more popular than the correct response. Candidates seemed confused by having to interpret equations. All responses had a significant number of candidates choosing them.

**Question 25**

Responses **B** and **C**: There was some confusion between the formation of iron in the blast furnace and the production of steel.

**Question 26**

Response **A**: Candidates placed the metals in the reverse order.

**Question 34**

Response **A**: Candidates perhaps confused burning limestone with heating limestone to produce lime.

# CHEMISTRY

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

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

## General comments

Candidates performed well on this paper.

Candidates found **Questions 4**, **6**, **18**, **24**, **26**, **29** and **30** the most straightforward.

**Question 5** was the most challenging for candidates.

## Comments on specific questions

### Question 5

Response **D**: Candidates chose two elements in the same period. Response **D** was more popular than the correct one.

**Question 8**

Response **D**: Candidates appeared to choose the largest number without working out the number of molecules present.

**Question 9**

Response **B**: Candidates did not take into account that two moles of hydrochloric acid are required to produce one mole of carbon dioxide. Response **B** was slightly more popular than the correct one.

**Question 12**

Response **A**: Candidates chose the largest temperature change, which was in the wrong direction for an exothermic reaction.

**Question 15**

Response **A**: Candidates did not take into account the fact that all other conditions, particularly temperature, remained constant.

**Question 19**

Response **A**: Candidates knew that chloride ions form by gaining an electron but did not understand the nature of acids.

**Question 23**

Response **D**: Candidates knew the result for copper and then chose the wrong alternative.

**Question 31**

Response **D**: Candidates knew that galvanising was a way of protecting against rusting but did not know about sacrificial protection.

# CHEMISTRY

**Paper 0620/23**
**Multiple Choice (Extended)**

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

## General comments

Candidates performed well on this paper.

Candidates found **Questions 7**, **15**, **18**, **24**, **29**, **30**, **34** and **39** the most straightforward.

**Question 3** was the most challenging for candidates.

## Comments on specific questions

### Question 3

Response **C**: Candidates chose to name the process in step 4 instead of stating how to obtain solid X from mixture Y.

**Question 4**

Response **B**: Candidates chose the total of protons and neutrons instead of simply the number of neutrons.

**Question 9**

Response **A**: Candidates did not take into account the fact the two moles of sodium hydroxide are required for each mole of sulfuric acid.

**Question 12**

Response **B**: Candidates confused exothermic and endothermic.

**Question 21**

Response **A**: Candidates seemed to assume that response **A** was not a way of making a salt, not realising that this is possible by a precipitation reaction.

**Question 23**

Response **C**: The test for sulfite is new for the 2016–2018 syllabus and many candidates selected the wrong potassium compound.

**Question 28**

Response **B**: Candidates were not clear about the effect of carbon on the properties of steel. They only appeared to know about the effect on strength.

**Question 31**

Response **A**: Candidates knew that galvanising was a way of protection against rusting but did not know about sacrificial protection.

**Question 33**

Response **C**: Candidates knew that the catalyst was involved with the sulfur trioxide but picked the wrong side of the box. This process was not fully understood.

**Question 38**

Response **A**: Candidates knew that the process was fast but did not identify the correct disadvantage.

# CHEMISTRY

**Paper 0620/31**
**Paper 31 Theory**

## Key Messages

- Many candidates need more practice in questions involving qualitative analysis.
- Many candidates need further practice in answering questions involving a range of chemical reactions, especially when extended answers are involved.
- Interpretation of data from tables was generally well done.

## General comments

Many candidates showed a good knowledge of core Chemistry. The standard of English was generally good. Several sections were left unanswered by some candidates, especially Questions **3(d)**, **4(a)**, **6(a)** and **7(e)(iii)**.

Some candidates need more practice in reading questions carefully and noting key words. For example, in Question **4(a)** many candidates did not refer to particles and in Question **5(c)(i)** many did not take notice of the phrase "apart from conducting electricity".

Many candidates need more practice in answering extended questions such as **3(d)** manufacture of lime by thermal decomposition of limestone, **4(a)** particle theory related to diffusion and **6(a)** reactions of acids. Candidates should be encouraged to organise their work and take note of all the reactions asked for in the question. Other candidates need practice in answering questions relating to extraction of information from graphs and tables.

Many candidates need more practice in memorising definitions that appear in the syllabus, such as relative atomic mass and isotopes. Many also need to revise qualitative tests especially flame tests and the test for chlorine.

Many candidates were able to balance chemical equations and some candidates were able to do simple calculations. Other candidates need to revise these areas.

Questions involving chemistry such as atomic structure, properties of materials and the uses of selected elements and compounds were well tackled well by some candidates. Other candidates need more practice in these areas as well as in writing organic structures.

## Comments on specific questions

### Question 1

**(a) (i)** This was almost invariably correct. The commonest error was to suggest helium rather than hydrogen, despite the fact that helium did not appear in the table.

**(ii)** Few candidates identified hydrogen being released at the cathode. The commonest incorrect answers included metals such as lithium, sodium, potassium and copper which were not present in the electrolyte.

**(iii)** Very few candidates identified sulfur. A wide variety of incorrect answers were seen, including both metals and non-metals.

**(iv)** Few candidates identified calcium. The commonest incorrect answers were zinc and aluminium whose precipitates dissolve in excess aqueous sodium hydroxide.

**(v)** Some candidates realised that aluminium is extracted from bauxite. The commonest errors were to suggest copper or potassium.

**(b) (i)** Some candidates were able to explain the meaning of the term isotope but few mentioned atoms. Many answers were imprecise. For example, the unqualified statement "same number of protons and different number of neutrons" does not refer to elements or atoms. It could refer to molecules. Similarly, "elements with different numbers of neutrons" could apply to different elements.

**(ii)** Many candidates calculated the number of neutrons correctly. The commonest error was to suggest a proton number of 80.

**(iii)** Nearly all candidates gave the correct answer for the number of protons. A few suggested the mass number of 124.

**(iv)** Many candidates calculated the number of electrons correctly. The commonest errors were either to add two electrons to the proton number, giving the incorrect answer of 82, or to refer to the charge on the mercury ion, giving an incorrect answer of 2.

**Question 2**

**(a) (i)** Many candidates described two differences in the ionic composition of water samples **A** and **B** by focusing on individual ions. Others made basic errors in comparing the concentration of chloride ions or potassium ions incorrectly. Some candidates made generalisations that were not true. For example, "all the positive ions in sample **A** have a higher concentration than sample **B**". Others made comparisons within each sample. For example, "**A** has high chloride and sodium concentration compared with the other ions".

**(ii)** Nearly all candidates selected the correct ion, magnesium.

**(iii)** Some candidates calculated the mass of sodium ions and correctly showed full working. Common incorrect answers included: 0.2 mg (often because 1 $dm^3$ was taken to be 10 000 $cm^3$); 2000 mg or 50 mg.

**(b)** A minority of candidates knew the flame test to identify sodium ions. Those who did understand that a flame test was required generally got the correct colour. A few suggested red or lilac. The commonest error was to suggest testing the reactivity with water, presumably through reading the stem of the question as sodium metal rather than sodium ions. Other common errors included electrolysis, adding sodium hydroxide or adding litmus.

**(c)** Some candidates realised that the movement described was Brownian motion. The commonest incorrect answers were "diffusion" or "vibration".

**(d) (i)** Nearly all the candidates recognised the symbol for a reversible reaction. The commonest errors involved imprecise writing, for example, "the reaction is both sides".

**(ii)** Many candidates suggested the addition of indicator to the solution under test. Few candidates suggested a comparison with a colour chart or the idea of different colours representing different pH values. Many incorrect answers either referred to one or more specific colours without reference to pH or gave imprecise statements such as "if it's in the acid, it will turn orange".

**(iii)** Some candidates realised that carbon dioxide is responsible for climate change. Others gave imprecise answers such as the unqualified "increases the temperature" or "makes the Earth hotter", rather than "makes the atmosphere hotter".

**(iv)** Many candidates identified a suitable greenhouse gas although some suggested nitrogen or hydrogen. The commonest correct answers referred to methane together with a correct source. A few candidates gave vague or incorrect sources such as "fossil fuels" or "farms".

**Question 3**

**(a)** Some candidates drew correct and clear diagrams to show the electronic structure of a calcium atom. Others did not appear to know that the first electron shell contains two electrons. Common errors included: four electrons in the outer shell; first shell with eight electrons; and the outer shell with eight or more electrons.

**(b)** The commonest error for this question was to reverse the anode and cathode.

**(c)** The equation was generally completed correctly. The commonest errors were H or 2H on the right (rather than $H_2$) or $O_2$ or non-completion of the equation on the right.

**(d)** A small number of candidates gave answers that included the idea of thermal decomposition of limestone and the relevant equation. Most other candidates did not appear to know the thermal decomposition reaction but gave suitable uses of lime. Incorrect and vague statements were often written, many unrelated to the question. Many candidates did not respond to this question.

**Question 4**

**(a)** Some candidates explained diffusion in terms of the kinetic particle theory. Others did not refer to particles and just suggested that the chlorine or the gas moved. Many candidates did not include the word diffusion in their answers and wrote vague or incorrect statements. Some candidates wrote about chlorine moving or the gas spreading out but did not refer to particles or molecules. A significant number of candidates did not respond to this question.

**(b) (i)** Many candidates identified a correct use of $^{235}U$ in terms of energy production or nuclear power stations. Many answers were too vague, for example, "industries", "nuclear use" or "medicine".

**(ii)** Many candidates gave a correct answer referring to cancer. Others gave answers which were far too vague. A small number of candidates gave an industrial use rather than a medical use.

**(iii)** The definition of relative atomic mass was not known by the majority of the candidates. Hardly any candidates mentioned either averages or comparison with $^{12}C$. The commonest incorrect answers were "the total sum of the protons and neutrons" or "the total mass of the element".

**(c) (i)** Most candidates completed the equation correctly. The commonest error was to write $2Cl$ instead of $Cl_2$.

**(ii)** Some candidates gave a use of chlorine in terms of disinfecting swimming pools, bleaching or in water treatment. Other candidates wrote statements that were not specific enough such as "for cleaning" or "to make an acid".

**(iii)** Some candidates linked the acidic oxide, $Cl_2O_7$, to the position of chlorine in the Periodic Table or to the non-metallic nature of chlorine. Other candidates gave incorrect answers relating to the acidity of chlorine or its oxide or tried to make a link to oxygen. Many candidates suggested that $Cl_2O_7$ is a basic oxide, often suggesting that this is because "it has no hydrogen ions".

**(iv)** Few candidates knew the test for chlorine. The commonest error was to suggest that litmus would turn red. A significant number of candidates thought that the litmus would turn blue.

**Question 5**

**(a) (i)** Nearly all candidates related the increase in strength to the increased percentage of carbon. Very few candidates suggested an inverse relationship.

**(ii)** The best answers were given by candidates who suggested that there was no relationship between the percentage of carbon and its average melting point or melting range. Those who referred to melting points alone often did not perform well because they did not imply that it was the average melting point. Those candidates who specified a melting range were often more successful.

**(iii)** Most candidates chose steel **D** and specified resistance to corrosion. A few candidates specified corrosion but omitted to write the letter **D**. The commonest incorrect answer referred to steel **B**. Candidates who stated steel **A** needed to state clearly that it was the strongest rather than just strong: all the steels are strong; the key point is that **A** is the strongest.

**(b)** Many candidates chose **A** as the diagram best representing an alloy. The commonest incorrect answer was to choose **B** in which there is complete regularity in the layers of iron, chromium and nickel, which would be impossible in a bulk manufactured alloy.

**(c) (i)** Some candidates gave good answers based on the strength of the steel core. Others gave incorrect answers which referred to malleability, magnetism, giving protection against corrosion. A significant number of candidates referred to electrical conduction despite the fact that the stem of the question stated “apart from conducting electricity”.

**(ii)** This part was well answered by the majority of candidates. Some answers were too vague. Better performing candidates generally referred to aircraft and linked this to low density.

**(d) (i)** Many candidates gave vague answers and referred to iron rather than aluminium, for example, “iron because oxygen is taken”. Better performing candidates referred to aluminium gaining oxygen.

**(ii)** Many candidates thought that the reaction was endothermic even though they stated that the reactant energy level is above the product energy level. Those who correctly stated that the reaction was exothermic often wrote imprecise statements such as “because it goes up and down”.

**Question 6**

**(a)** Most candidates did not appear to know about the reactions of acids with metals, bases and carbonates. The better performing candidates organised their work carefully giving answers to each of the reactions in turn. Candidates most commonly wrote about the effect on litmus and about the production of hydrogen when an acid reacts with a metal.

**(b) (i)** This was almost invariably correct. Very few candidates suggested that density increases as the number of carbon atoms increases.

**(ii)** Many candidates gave a value of the boiling point of pentanoic acid within the accepted range. The commonest errors were to give a value lower than 170 °C or to give a range that was not totally within the range required, for example, 160–180 °C.

**(iii)** Many candidates deduced that ethanoic acid is a solid at 15 °C but fewer candidates gave the reason. It is not sufficient to refer to the value of the melting point alone. Reference should be made to the melting point being above 15 °C. A considerable number of candidates gave a reason without giving the state or gave the correct state without giving a reason.

**(iv)** Few candidates gave the correct structure of the carboxylic acid group. Common errors included omission of an O atom or incorrect placement of hydrogen (C–H=O). Some candidates gave hydrocarbon structures.

**(v)** Many candidates calculated the relative molecular mass correctly. One common error was to use one or more atomic numbers instead of atomic masses with the calcium often being incorrect but the oxygen and carbon correct. Another error was not multiplying the atomic mass of oxygen by 3. Sometimes it was multiplied by 2.

**(c)** Many answered this correctly. The commonest error was to suggest that salt dissolving in water is a chemical change.

**Question 7**

**(a)** A majority of the candidates identified melting and boiling correctly. The commonest error was to suggest "condensing" for either **A** or, more rarely, for **B**.

**(b)** Many candidates could describe the motion of the particles, but not both the motion and the arrangement. Common incorrect statements regarding the arrangement of the particles were: "far apart", "move freely" or "no definite shape".

**(c)** Few candidates knew the uses of sulfur. The commonest correct answer was "to make sulfuric acid". Common incorrect answers included "disinfectants", "neutralising acids" or vague statements such as "fuel", "solvent" or "industries".

**(d)** Candidates who identified sulfur dioxide often gave a correct effect on health. Others gave answers without reference to sulfur dioxide such as "it harms the eyes". There were a considerable number of imprecise answers such as "dangerous to humans" or "bad for health".

**(e) (i)** Many candidates deduced the correct formula. Common errors included $CH_4S$, $H_4 + C_4 + S$, $C_6H_4S$ or a partial structural formula such as $C_2H_2SC_2H_2$.

**(ii)** Most candidates recognised that a catalyst speeds up the rate of a reaction.

**(iii)** The better performing candidates tended to calculate the mass of thiophene correctly. Common errors included 15.6 × 2.6 = 40.56 or 15.6 + 1.6 = 17.2, with the 1.6 arising from 4.2 – 2.6. A considerable number of candidates did not respond to this question.

# CHEMISTRY

**Paper 0620/32**
**Paper 32 Theory**

## Key Messages

- Many candidates need further practice in answering questions involving a range of processes, especially when extended answers are involved.
- Many candidates need practice in understanding specific terms which appear on the syllabus.
- Some candidates need more practice in interpreting data from tables and graphs.
- Many candidates need more practice in questions involving organic chemistry.

## General comments

Many candidates tackled this paper well, showing a good knowledge of core Chemistry. The standard of English was generally good. Several sections were left unanswered by some candidates especially Questions **3(c)**, **5(a)(iii)** and **7(d)(iii)**.

Some candidates need more practice in reading questions carefully and noting key words. For example, in Question **2(e)(iii)** many candidates did not give an explanation and in Question **4(b)** many candidates did not explain diffusion using particle.

Many candidates need more practice in answering extended questions such as Question **3(c)** production of steel from iron, Question **4(a)** particle theory related to diffusion and Question **6(b)** homologous series. Candidates should be encouraged to organise their work and take note of all the information asked for in the stem of the question. Other candidates need practice in answering questions relating to extraction of information from graphs and tables.

Many candidates need more practice in understanding specific terms that appear in the syllabus, such as compounds and mixtures in Question **5(b)** and homologous series and hydrocarbons in Question **6(a)** and **(b)**. Many candidates also need to revise aspects of organic chemistry such as the uses of hydrocarbon fractions, the structure of alkenes and the concept of saturated and unsaturated hydrocarbons.

Many candidates were able to balance symbol equations and construct word equations. Some candidates were able to undertake simple calculations. Others candidates need to revise these areas. A significant number of candidates also need more practice in interpreting data from tables and graphs such as in Questions **2(a)(i)**, **2(e)** and **6(c)**.

Questions involving general chemistry including, atomic structure, properties of materials and uses of selected elements and compounds were well tackled by some candidates. Others need more practice in these areas.

**Comments on specific questions**

**Question 1**

**(a) (i)** The commonest errors were to suggest copper or argon. Fewer candidates muddled the flame colour with sodium or lithium.

**(ii)** A minority of candidates selected copper as being pinkish-brown in colour. The commonest incorrect answer was to suggest iron. Nickel and zinc were also frequently seen as incorrect answers.

**(iii)** Few candidates chose carbon. The commonest errors were either to select a metal such as iron zinc or calcium or to give the names of two alkali metals.

**(iv)** Some candidates chose helium. The commonest error was to suggest calcium through not reading the stem of question sufficiently carefully where it was stated that the outer electron shell was full. Other common errors included iron and oxygen.

**(v)** Many candidates recognised that iron is extracted from hematite. The commonest errors were aluminium and helium.

**(b)** Many candidates deduced the number of protons, neutrons and electrons. The commonest errors were to suggest 60 and 62 electrons and 47 and 47 neutrons for the two isotopes of silver.

**Question 2**

**(a) (i)** Many candidates described two differences in the ionic composition of water samples **A** and **B** by focusing on individual ions. Others made basic errors in comparing the concentration of sodium ions or chloride ions incorrectly. Some candidates made generalisations, which were not true. For example, "all the positive ions in sample **A** have a lower concentration than sample **B**". Other candidates made comparisons within each sample. For example, "**B** has high $Cl^-$, $Na^+$ and $SiO_3^{2-}$ concentration compared with the other ions".

**(ii)** Most candidates correctly identified the calcium ion as having the lowest concentration. The commonest errors were to suggest magnesium, silicate or hydrogencarbonate.

**(iii)** Better performing candidates tended to answer the calculation correctly. The commonest error was 150 mg obtained by multiplying 15 by 1000 then dividing by 100.

**(b)** Few candidates knew the test for chloride ions. The commonest error was to suggest adding litmus and then expecting the litmus to turn red. Others thought that they were testing for chlorine rather than chloride and suggested that the litmus was decolourised. Sodium hydroxide was the second commonest incorrect test reagent suggested.

**(c)** Many candidates identified the best description of Brownian motion. The commonest incorrect statement selected was "the downward movement of particles in a suspension".

**(d)** Some candidates linked the acidic oxide, silicon(IV) oxide, to the position of silicon in the Periodic Table or to the non-metallic nature of silicon. Others gave incorrect answers relating to the acidity of silicon or its oxide or tried to make a link to oxygen. A considerable number of candidates suggested that silicon(IV) oxide is a basic oxide.

**(e) (i)** Nearly all the candidates recognised that the solubility of oxygen decreases with increasing temperature.

**(ii)** Many candidates read the value of the concentration of oxygen correctly from the graph. Common errors were mainly the result of partially misinterpreting the scale, for example, 12.5, 10.5 or 13 $mg/dm^3$.

**(iii)** Many candidates suggested how corrosion might be affected by a change in temperature but few gave an explanation. Of those that did, many did not refer to the concentration of oxygen or rate of reaction. It was insufficient just to state that the corrosion increases because the rate is faster, as this just repeated the stem of the question. Some extra idea of chemical reactions going faster at higher temperatures or ideas of greater collision frequency were necessary.

**(f)** Most candidates referred to filtration and chlorination, the latter often seen in other forms such as "chlorinization", which conveyed the correct idea. Some candidates referred to boiling or distillation. Other candidates wrote about sedimentation or flocculation, although these are not on the syllabus.

**(g) (i)** A minority of candidates were able to suggest a suitable source of oxides of nitrogen. The majority of correct answers referred to car exhausts. Only a few referred to lightning. Common errors referred to either other substances, for example "nitrogen oxide", "carbon dioxide", "smoke" or the vague "factories", "mines" or "industries".

**(ii)** Some candidates gave suitable answers for the effects of oxides of nitrogen on health. Others tried to make a link between nitrogen dioxide and lung disease, implying bacterial or cancerous growth, or suggested that it was toxic. The latter was not accepted because the effect is not immediate, unlike the effect of carbon monoxide on respiration, unless there is a much higher concentration of nitrogen dioxide in the atmosphere.

**Question 3**

**(a)** Many candidates referred to the iron rather than the water when discussing the reduction reaction. Comments about the iron gaining oxygen without referring to the source of the oxygen were common. Another common error was to focus on the hydrogen and not the hydrogen in the water or the water alone. A significant number of candidates referred to the hydrogen on the right hand side of the equation.

**(b) (i)** Few candidates understood the meaning of the term ore. Better performing candidates followed the stem of the question and referred to rocks containing iron. Common errors included statements such as "original compounds found naturally", "impurities in substances" or "where the iron originally comes from".

**(ii)** Better performing candidates realised that the oxygen reacts with the carbon eventually to form carbon monoxide. Common errors included ideas about cooling the furnace, helping to remove impurities or to react with the iron oxide.

**(iii)** This was the best answered part of this question, with most candidates choosing calcium silicate. There was no common incorrect answer.

**(iv)** Many candidates gave the correct pipe for the removal of the slag. The commonest error was to suggest the pipe for the removal of the iron. Some candidates disadvantaged themselves by writing the letter **S** between the slag removal pipe and the pipe for the oxygen blast so that it was unclear which exit had been chosen.

**(c)** Many candidates muddled the process of steelmaking with the process of extracting iron in a blast furnace. A considerable proportion of the candidates did not respond to this question. The most commonly identified correct impurities were carbon, phosphorus and silicon. Many candidates suggested incorrect impurities such as iron oxide, carbon dioxide or acids. Word equations were rarely written and were often incorrect. Some candidates tried to write symbol equations. These were often incorrect. For this paper, candidates should be advised not to try and write symbol equations unless requested.

**Question 4**

**(a)** Many candidates realised that impurities affected the melting point. Common incorrect answers included, "temperature of the room affects it"; "does not have an accurate melting point"; "the air affects it". A minority of candidates referred, incorrectly, to concentration or the mass taken.

**(b)** Some candidates explained diffusion in terms of the kinetic particle theory. Other candidates did not refer to particles and just suggested that the methyl orange moved. Many candidates did not include the word diffusion in their answers and wrote vague or incorrect statements. Some candidates wrote about methyl orange moving or spreading out and did not refer to particles or molecules or ions.

**(c)** Many candidates knew that methyl orange is red or pink in highly acidic solution. The commonest errors were to suggest purple, yellow or orange. A significant number of candidates suggested green or blue. Candidates should note that methyl orange, as stated in the syllabus, refers to unscreened methyl orange which is not a mixed indicator.

**(d) (i)** Many candidates identified salt and water as products. One common error was to write the name of specific substances for the salt. For example, copper(II) sulfate. Other candidates thought that a metal oxide would be formed. A minority of candidates suggested that carbon dioxide or hydrogen or both were formed.

**(ii)** Most candidates recognised that filtration was the correct method to use. The commonest incorrect answers were distillation or evaporation.

**(iii)** Many candidates gave the sequences EBCAD or EBCDA.

**Question 5**

**(a) (i)** Many candidates balanced the equation correctly. Other candidates realised that the calcium carbonate decomposed but gave other combinations such as $Ca + CO_3$ or $CaO + O_2$. A considerable minority of candidates thought that the formula of calcium oxide was $CaO_2$.

**(ii)** Many candidates realised that the action of heat on limestone is a decomposition reaction. Many candidates suggested "endothermic", which was accepted. The commonest error was to suggest "reduction". "Combustion" and "displacement" were other frequently seen errors.

**(iii)** A considerable number of candidates calculated the relative formula mass of calcium carbonate correctly. An incorrect value of 74 was not uncommonly seen, obtained by adding the atomic numbers of calcium and carbon but then using the correct value for three oxygen atoms. Another common error was 68, obtained by not multiplying the atomic mass of oxygen by 3.

**(b)** Some candidates defined a compound correctly or suggested that the components in a compound could not be separated by physical means. A number of candidates suggested that a mixture could be separated by physical means. Other candidates gave a definition of a compound which was far too vague, for example, "combining two substances together" or "bonding two atoms together". The essential words "elements" or "different atoms" were missing from these definitions.

Many candidates disadvantaged themselves by suggesting that compounds "are mixtures of elements". Some candidates only referred to the fixed composition of a compound or the variable composition of a mixture or that a compound has different properties from the elements it has been made from.

**(c)** Some candidates gave good answers stating that the presence of steel made the bridge stronger. Other candidates did not give a comparative answer, for example "steel is strong". Many candidates referred to heat conductivity or relative expansion, which were not accepted.

**(d)** Most candidates knew that water (or moisture) and oxygen (or air) are essential for rusting. The commonest error was to suggest acid instead of water or carbon dioxide instead of oxygen. A minority suggested "iron", perhaps not realising that steel is largely iron.

**Question 6**

**(a) (i)** Better performing candidates usually gave a good definition of a hydrocarbon. The commonest errors were: the omission of the essential word "only", in terms of carbon and hydrogen; stating that hydrocarbons are a "mixture of hydrogen and carbon"; and inclusion of oxygen.

Very few candidates described the term *fraction* adequately. The commonest error was to give a definition of distillation. Other candidates suggested a substance with a particular boiling point coming off the column. Only a few candidates mentioned a limited range of boiling points.

**(ii)** Many candidates recognised use of kerosene as a fuel for aircraft. The idea of a fuel was essential; the word "aircraft" alone was insufficient. The commonest error was to suggest fuels that are supplied by other fractions, for example "fuel for cars". Another common error was to suggest that kerosene is a lubricant. Fewer candidates recognised that naphtha is used for making chemicals. Common errors included “bitumen” and “fuels”.

**(b)** Most candidates understood the term *homologous series*. The commonest answers which were awarded credit mentioned a functional group or the fact that alkenes have a C=C functional group or are unsaturated. Candidates should note that statements such as “alkenes have a double bond” are not sufficient to define an alkene. Some candidates recognised the similarity of chemical properties in a given homologous series. Those who mentioned physical properties rarely obtained this mark because they suggested either a similarity of physical properties or that the physical properties differ, which is not precise enough to indicate a trend.

**(c) (i)** Many candidates just repeated the stem of the question. Better performing candidates referred to the data in the table by writing something different from what was in the stem of the question. The best answers referred to the figures for the density going up as the number of carbon atoms increases or quoting specific densities for specific alkenes.

**(ii)** Many candidates gave a value of the boiling point of hexene within the accepted range. The commonest error was to give a value lower than 35 °C or just above 85 °C. Other candidates gave a range that was not totally within the range required, for example, 28–36 °C.

**(iii)** Many candidates deduced that pentene is a liquid at –60 °C. Fewer candidates gave the reason. It is not sufficient to refer to the value of melting point and boiling point alone. Reference should be made to the melting point being below –60 °C and the boiling point being above –60 °C. A considerable number of candidates gave a reason without giving the state or gave the correct state without giving a reason

**(d)** Some candidates drew good diagrams to show the structure of ethene. The commonest error was the omission of the double bond.

**(e)** Many candidates gave the correct formula for the 4-carbon alkene. Fewer candidates balanced the equation by adding the correct formula of the alkane. Common errors included $C_6H_{13}$ + $C_6H_{13}$, $CH_2$ or $C_8H_{16}$ as the alkane or splitting up the carbon and hydrogen as $C_{12}$ + $H_{26}$.

**Question 7**

**(a)** Many candidates realised that sodium reacts with air or that argon is unreactive. A considerable number of candidates thought that argon is reactive or just stated that argon is a noble gas. Other candidates incorrectly referred to the density of argon. Some candidates suggested that sodium is reactive but did not state what it was reactive with. It was essential to state that the reactivity related to the reactivity with air because a considerable minority of candidates thought that sodium reacted with argon.

**(b)** This was generally well answered. The commonest error was to tick box **C–D**.

**(c) (i)** Most candidates wrote about gases and liquids in terms of the kinetic particle theory rather than stating their general properties. Candidates generally referred to a gas being compressed and / or not having a fixed volume.

**(ii)** Many candidates realised that the particles are close together. Fewer candidates mentioned the irregular arrangement of the particles. Many candidates gave incorrect answers that implied that the particles in a liquid have large spaces between them. Many candidates correctly described the motion of the particles in a liquid in terms of sliding over each other or relatively slow movement. A minority of candidates suggested that the particles moved fast or freely.

**(d) (i)** Many candidates gave at least one correct difference in the general properties of niobium and sodium. The commonest error was to include information such as atomic radius or atomic number, which are not really chemical or physical properties. A few candidates inverted the properties, for example “sodium is hard and niobium is soft”.

**(ii)** Many candidates gave a suitable molecular or empirical formula. Common errors included Nb + $Cl_5$, $Nb_{10}Cl_2$ and $2NbCl_{10}$.

**(iii)** Most candidates did not recognise that niobium chloride is a simple molecule. Many appeared to think that the presence of niobium made the whole structure metallic despite the presence of the word “molecule” in the stem of the question. Therefore many candidates suggested, incorrectly, that the compound had high melting point, high density and conducted electricity. Many of those candidates who suggested that niobium chloride was either a liquid or a gas did not refer to room temperature. A significant number of candidates suggested chemical properties rather than physical properties.

# CHEMISTRY

**Paper 0620/33**
**Paper 33 Theory**

## Key Messages

- Many candidates need more practice in questions involving qualitative analysis.
- Many candidates need further practice in answering questions involving organic chemistry.
- Some candidates need more practice in reading the stem of the questions carefully and noting key words relevant to the question.
- Interpretation of data from tables was generally well done.

## General comments

Many candidates tackled this paper well, showing a good knowledge of core Chemistry. The standard of English was generally good. Most candidates attempted every part of each question.

Some candidates need more practice in reading questions carefully and noting key words. For example, in Question **3(a)** many candidates conflated the methods of producing ethanol by fermentation and by hydration of ethane, despite it being clear from the stem of the question that fermentation and hydration were distinct. In Question **4(a)** some candidates did not read the stem of the question carefully enough and did not explain diffusion in terms of moving particles. In Question **5(a)** many candidates did not explain their answer, although they were requested to do so.

Some candidates answered the extended Question **5(e)(iii)** on the reaction of carbon dioxide with limewater well. Others need more practice in answering extended questions such as Question **3(a)**, manufacture of ethanol and Question **4(a)**, diffusion. Candidates should be encouraged to organise their work and take note of all the reactions asked for in the stem of the question.

Many candidates need to revise qualitative tests, especially the tests for specific ions such as chromium(III), (Question **1(a)(iii)**), nitrate (Question **2(b)**) and sulfate (Question **5(d)(i)**). Many candidates also need to revise the colours of particular elements and compounds.

Some candidates need further practice in answering questions involving organic chemistry; the reactions of fermentation, hydration of ethene and the structure of ethanol were not always well known.

Many candidates were able to balance symbol equations and some were able to undertake simple calculations. Others need to revise these areas.

Questions involving general chemistry including, atomic structure, properties of materials and uses of selected elements and compounds were well tackled well by some candidates. Other candidates need more practice in these areas.

## Comments on specific questions

### Question 1

**(a)(i)** A majority of the candidates chose oxygen. The commonest errors were to choose either nitrogen or argon.

**(ii)** Many candidates correctly identified lithium. The commonest error was to suggest chlorine. Nitrogen was also given as an incorrect answer by a significant number of candidates.

**(iii)** This was the least well-answered of the part **(a)** questions. Copper was the commonest incorrect answer.

**(iv)** A majority of the candidates identified bromine. Common errors included iodine and copper.

**(v)** This was generally well answered. Krypton and nitrogen were the commonest incorrect answers. A considerable number of candidates chose a metal instead of a gas.

**(b)** Titanium was selected by the majority of candidates. Some candidates omitted reference to low density. A few candidates suggested chromium or copper but few suggested iron.

**Question 2**

**(a)(i)** This was almost invariably correct.

**(ii)** Many candidates correctly identified the sulfate ion. The commonest incorrect answered were sulfur (di)oxide or sulfite.

**(iii)** Many candidates calculated the mass of sodium ions correctly. The commonest errors arose through incorrect addition or subtraction and gave 1.5 or 0.8 g.

**(b)** Few candidates answered this fully correctly. Some candidates suggested the addition of aluminium, other candidates suggested the addition of sodium hydroxide but few candidates suggested that both were needed. Some candidates suggested adding nitric acid to aluminium, forgetting that the nitric acid contained the nitrate ion. Amongst incorrect reagents added, barium nitrate was the commonest. Many candidates suggested that the addition of litmus directly to the nitrate resulted in the litmus turning blue. This was accepted unless there was a statement about ammonia or a gas being produced.

**(c)(i)** Most candidates suggested that the insoluble materials could be filtered off. The commonest incorrect errors were to suggest evaporation or distillation.

**(ii)** A majority of the candidates chose carbohydrate and protein. The commonest incorrect answer was to tick the first box, alkane.

**(iii)** Many candidates described Brownian motion using suitable words such as random or zig-zag. Incorrect answers included: slow movement; diffusion; pushing the particle. Some candidates incorrectly implied that a current in the water moved the particles.

**(d)(i)** Most candidates stated an idea of improving plant growth. Some candidates wrote statements that were too vague, for example “for healthy growth”. A minority of candidates mentioned nitrogen, phosphorus or potassium. Fewer candidates referred to depletion of these elements from the soil by uptake by plant roots and subsequent harvesting.

**(ii)** Some candidates mentioned the formation of ammonia. Very few candidates realised that the ammonia escapes into the air as a gas. A common error was to suggest that nitrogen was lost by calcium nitrate leaching into the soil water. Other candidates tried to suggest that the loss of nitrogen was due to an unspecified catalytic reaction. A considerable number of candidates did not select ammonia specifically from the reactants and products and just repeated the equation in words. For example, “the ammonium nitrate reacts with calcium hydroxide to form calcium nitrate and ammonia”.

**Question 3**

**(a)** Many candidates conflated the methods of producing ethanol and suggested, for example, that “ethene reacts with glucose at high temperature”. Such responses included conflicting statements. Other candidates gave correct reaction conditions or reactants but did not refer to either fermentation or hydration. A greater number of candidates referred to fermentation rather than to hydration of ethene. Many candidates thought that a high temperature is needed for fermentation. Few candidates wrote equations. Word equations for fermentation were almost invariably incorrect, but a common error was to write ethanol as a reactant. Word equations or molecular equations for the hydration of ethene were more likely to be correct. A common error in the production of ethene by hydration was to suggest that yeast was the catalyst.

**(b)(i)** Many candidates deduced that methanol is a liquid at room temperature. Fewer candidates gave a correct reason. It is not sufficient to refer to the value of melting point and boiling point alone. Reference should be made to the melting point being below room temperature and the boiling point being above room temperature. A considerable number of candidates gave a reason without giving the state or gave the correct state without giving a reason.

**(ii)** Many candidates gave a value for the boiling point of pentanol within the accepted range. The commonest error was to give a value lower than 125 °C or well above 145 °C.

**(iii)** Nearly all candidates extracted the correct information from the table and suggested that viscosity increases as the number of carbon atoms increase. The commonest error was to write "increases" without qualifying whether the carbon atoms were increasing or decreasing.

**(c)(i)** Some candidates drew good diagram of the ethanol molecule showing all of the atoms and all of the bonds. Many candidates omitted the O–H bond. Other candidates made the basic error of not realising that hydrogen only forms one bond to another atom. Incorrect structures involving the O and H atoms such as C–H–O and C–H=O were often seen.

**(ii)** Better performing candidates suggested solvent or fuel. Many wrote vague statements such as "for chemical experiments". Other candidates just gave an alternative name such as "for alcohol". Others incorrectly suggested that alcohol was a perfume.

**Question 4**

**(a)** Some candidates explained diffusion in terms of the kinetic particle theory. Other candidates did not refer to particles and just suggested that the blue dye moved. Many candidates did not include the word diffusion in their answers and wrote vague or incorrect statements. Some candidates wrote about the blue dye moving or spreading out and did not include particles or molecules or ions in their response. Some candidates who did refer to particles wrote a lot about crystals dissolving and the difference in particle arrangement in the crystal and liquid to the detriment of writing about diffusion.

**(b)** Many candidates deduced the correct colours of the indicator. A minority of the candidates gave colours which were not in the diagram. Common errors were to suggest blue-green or green for the colour of the indicator in water. The colour of the indicator in acid was generally correct.

**(c)(i)** A majority of the candidates identified the pieces of glassware correctly. The burette was less well known than the pipette. Some candidates called the burette a measuring cylinder or a beaker.

**(ii)** Many candidates discussed allowing the acid to drop into the alkali and mentioned a colour change in the conical flask. Few candidates mentioned adding a suitable indicator into the conical flask before the acid was added. Some candidates suggested adding the indicator after the titration was complete. If an indicator was named, it was usually Universal Indicator, which was not accepted.

**Question 5**

**(a)(i)** Some candidates thought, incorrectly, that the reaction was exothermic even though they mentioned bond breaking or the need for heating. Other candidates suggested that the reaction was endothermic but gave no reason. A common error was to suggest that energy is given out when heating limestone.

**(ii)** Nearly all candidates identified the reaction as being reversible by reference to the double-headed arrow. A few candidates incorrectly referred to the reaction instead of the arrow. For example, "the reaction goes both ways".

**(b)(i)** **L** was misplaced more often than **C**, often being placed at the pipe on the bottom left of the diagram. **C** was also allowed at the top of the furnace where the hopper was open.

**(ii)** Few candidates gave an answer based on providing heat when reacting with air. Common errors included "as a catalyst" or "to remove carbon from limestone".

**(c)** Many candidates answered this correctly. The idea about neutralising the acid was most commonly mentioned. Many candidates realised that lime is basic, even if expressed in rather inaccurate terms.

**(d)(i)** Some candidates knew the test for sulfate ions. Those who selected barium chloride or barium nitrate as a test reagent generally obtained both marks. A wide variety of incorrect answers were seen including the use of litmus, the use of sodium hydroxide or aluminium or various tests for gases.

**(ii)** Many candidates deduced the correct formula for the silicate. Common errors were $2SiO_{12}$, $SiO_6$, and SiO. A significant number of candidates disadvantaged themselves by writing the symbol for sulfur instead of the symbol for silicon.

**(e)(i)** Nearly all candidates identified pH 12 as a strongly alkaline pH. The incorrect pH values of pH 2 or pH 6 were occasionally seen.

**(ii)** Most candidates identified $H_2O$. A few candidates disadvantaged themselves by writing "water" as a word rather than in symbols. The commonest errors were to suggest $H_2$, H or OH.

**(iii)** This was generally the best answered of the extended answer questions on the paper. Many candidates recognised that carbon dioxide reacts with or neutralises the calcium hydroxide. Fewer candidates stated the origin of the carbon dioxide from the air. Better performing candidates also realised that carbon dioxide is an acidic oxide and / or identified the white precipitate as calcium carbonate.

**Question 6**

**(a)(i)** Some candidates realised that the Periodic Table is arranged in order of atomic number (proton number). Other candidates commented on groups or periods. A significant minority of candidates tried to link the position of the elements to decreasing or increasing reactivity, valency or relative atomic mass.

**(ii)** Some candidates realised that metals are on the left of the Periodic Table and non-metals on the right. Other candidates gave answers which were either imprecise or did not relate to chemical or physical properties. Common incorrect answers related to reactivity, electronic structure and density.

**(iii)** Many candidates commented on one trend. The commonest errors were either to suggest that melting points and boiling points increase down Group I or to write about atomic mass or electronic structure. A significant number of candidates did not write about a trend but just gave general properties of the alkali metals.

**(b)(i)** Few candidates knew the colours of the halogens in aqueous solution. Many candidates suggested that chlorine is blue or brown rather than green, or practically colourless in dilute aqueous solution. Other candidates suggested that iodine is black, the colour of the solid, or purple, the colour in some organic solvents.

**(ii)** Few candidates made the correct comparison between the reactivity of iodine and astatine. Many candidates compared the reactivity of astatine with potassium or potassium iodide. Other candidates gave incomplete answers such as "astatine is less reactive" or "astatine is unreactive".

**(c)(i)** Many candidates completed the equation correctly. The commonest error was to write 2H instead of $H_2$.

**(ii)** Some candidates drew clear electronic structures for hydrogen chloride. Common errors included: single circle with $HCl$ written inside; separated atoms; extra electron(s) on the hydrogen; no unpaired electrons on the chlorine atom.

**(iii)** Many candidates completed the word equation correctly. The commonest errors were either to suggest hydrogen or carbon dioxide in place of water or to give incorrect names to the lithium chloride such as lithium hydrochloric acid.

**Question 7**

**(a)** Most candidates correctly identified condensation and freezing. The commonest error was to suggest "sublimation" for either **A** or **B**.

**(b)** Many candidates gave correct answers about the arrangement and motion of the particles in solid phosphorus. The commonest error was to suggest that the particles in the solid are moving slightly from place to place.

**(c)** Some candidates linked the acidic oxide to the position of phosphorus in the Periodic Table or to the non-metallic nature of phosphorus. Other candidates gave incorrect answers relating to the acidity of phosphorus or its oxide or tried to make a link to oxygen. Many candidates suggested that phosphorus(V) oxide is a basic oxide even though they stated that it forms an acidic solution when reacting with or dissolving in water.

**(d)** Most candidates did not recognise that phosphorus sulfide is a simple molecule. Many candidates appeared to think that the structure was a giant structure despite the presence of the word "molecule" in the stem of the question and the diagram showing a discrete molecule. Therefore, many candidates incorrectly suggested that the compound had a high melting point, was hard or strong or dissolved in water.

**(e)** Many candidates identified sulfur dioxide as being the product that was harmful to the environment. Most candidates gave a suitable harmful effect of sulfur dioxide on the environment, the commonest correct answer being "acid rain". Some candidates chose an effect on humans and made reference to cancer or disease. A significant number of candidates gave a correct effect of the gaseous product but forgot to give the name of the gas. A minority of the candidates disadvantaged themselves by rewriting the equation in words and not selecting the sulfur dioxide from the four reactants and products available.

# CHEMISTRY

**Paper 0620/41**
**Theory (Extended)**

## Key messages

When answering a question that involves a calculation, candidates should show their working. This enables the examiner to follow a candidate's working, even if the final answer is incorrect.

For a material to be an electrical conductor, it must contain changed particles that are able to move throughout the structure. The ideas of being "able to move throughout the structure" cannot be replaced by the word "free".

Candidates should know the formula of compounds that are on the syllabus, such as ammonia.

## General comments

Some excellent responses were seen to all questions on the paper.

Question **4(b)** and Question **8(b)** proved demanding for candidates. These dealt with equilibria and kinetics respectively.

## Comments on specific questions

### Question 1

**(a)** This was generally well answered, although **J** was a common incorrect answer, despite **J** being identified as a metal in **(f)**.

**(b)** This was generally well answered, although **J** was a common incorrect answer.

**(c)** Most candidates were able to identify a suitable method of separation.

**(d)** The majority of candidates realised that to separate two liquids the process of fractional distillation would be required. A few candidates opted for "simple distillation" or just "distillation". Some candidates were not familiar with this part of the syllabus, with "crystallisation" being a common wrong answer.

**(e)** Some fully detailed descriptions of an appropriate method of separation were given by better performing candidates. Some candidates focussed on obtaining substance **G** rather than substance **H** and these candidates would have benefitted from reading the question carefully. A few candidates used the terms "filtrate" and "residue" but got them the wrong way round. It is important to use technical terminology correctly. It was not uncommon for candidates to attempt separation by distillation, given that the lowest boiling point component of the mixture boiled at 1413 ºC, this is not a reasonable method to use.

**(f)** Many candidates identified that the conductivity of metals was something to do with electrons. Others were unable to state that the electrons could move throughout the structure. It was common to see responses that stated the electrons were "free" or "delocalised"; neither of these statements state that the electrons can move. Many organic compounds that are not conductors of electricity have delocalised electrons and it is not clear what a "free" electron is.

**Question 2**

**(a)** Most candidates answered **(i)** and **(iii)** correctly. In **(ii)**, the term "sublimation" was less well known.

**(b)** Many candidates incorrectly focussed on the need to provide energy for the particles to move faster rather than the need to overcome attractive forces or bonds between particles.

**(c)** Almost all candidates could correctly state that the pressure was higher in container **E**; many candidates could not explain why. Many candidates focussed on collisions between particles rather than between particles and the walls of the container. A small number of candidates thought that the particles in **E** would move faster.

**Question 3**

**(a)** In **(i)**, the majority of candidates knew that the petroleum needed to be heated before it entered the fractionating column. A significant number of candidates thought that filtration was required. In **(ii)**, a significant number of candidates did not read the question carefully and so rather than give two ways in which fraction **O** differed from fraction **L**, they gave two different uses for the fractions.

**(b)** This question on the characteristics of a homologous series proved to be straightforward for some candidates, but many candidates gave vague answers, such as "they have similar properties". Some candidates did not read the question carefully and rather than give characteristics of a homologous series they gave specific characteristics of alkanes.

**(c)** Some candidates drew the same structure twice but with a different conformation. Other common errors were divalent hydrogen atoms and tri- or penta-valent carbon atoms.

**(d)** This was well answered by the better performing candidates. Other candidates often left this question blank or produced impossible structures.

**(e)** Part **(i)** was very well answered but the empirical formula calculation in **(ii)** proved to be demanding to candidates. Many of the candidates who made progress with the question by dividing by the $A_r$ and then simplifying to get the ratio of 1:1.6, then either rounded the ratio to 1:1.5 (giving the formula $C_2H_3$) or rounded to 1:2 (giving the formula $CH_2$). It should be remembered that the data used for an empirical formula calculation will be derived theoretically and so there should never be any need to round as per the examples given. Many candidates struggled with the calculation in **(iii)**.

**Question 4**

**(a)** In **(i)**, many candidates did not know that both hydrogen and nitrogen are diatomic elements or that ammonia is $NH_3$. In **(ii)**, many candidates knew that nitrogen came from the air. Some candidates also thought that hydrogen came from the air. The temperature of the Haber process in **(iii)** was better known than the pressure. As well as incorrect pressures, there were errors in the units of pressure.

**(b)** Many candidates stated that at equilibrium the concentrations of reactants and products were equal, which is not true; they are constant but they are very unlikely to be equal to each other. Despite the instruction in **(ii)**, it was evident that many candidates did not use the graph provided and so did not realise that as temperature increased, so did the yield of ammonia. For **(iii)**, a significant number of responses focussed on rate rather than yield and so stated that a higher pressure gave a faster rate and so a greater yield. Better performing candidates either used the graph or worked out from the equation provided that an increase in pressure decreased the yield. They then explained this in terms of the number of moles of gas on each side of the equation.

**Question 5**

**(a)** This was not well known. Only a minority of candidates knew that the gas formed at the anode would be oxygen; hydrogen was a very common error. Of those candidates who did identify the gas as oxygen, many could not describe the simple laboratory test. Answers which were clearly contradictory were common, such as testing the gas with a lighted splint with the expected result being that the splint would light. It should be noted that testing a gas with a flame is not a “flame test”.

**(b)** This was not well known. The most common error was to state that the conductivity of the solution was due to electrons rather than ions. It should be noted that “free” is not taken to mean “able to move”.

**(c)** The majority of candidates could explain that reduction was the gain of electrons in part **(i)**; relatively few candidates could identify copper(II) ions as the species being reduced. Most candidates stated copper or simply “the cathode”.

While the majority of candidates could predict how the masses of the electrodes would change in **(ii)**, some candidates just stated that they would change or commented on the size rather than the mass changes. It was not uncommon for candidates to attempt to explain the mass changes in terms of the gain or loss of electrons rather than the gain or loss of copper from the electrode.

Part **(iii)** was only answered well by the better performing candidates. These candidates explained that copper(II) ions are both removed and added to the solution at that same rate. Many attributed the colour to the sulfate ions rather than the copper(II) ions.

**Question 6**

**(a)** Many candidates could correctly describe a polymer as being a large molecule made from many smaller molecules called monomers.

**(b)** Better performing candidates could name the amide or peptide linkage in proteins. The meaning of “biodegradable” was less well known, with many responses suggesting that it meant that it was “kind to the environment” or “did not pollute” rather than it was something that was broken down naturally by microbes. The example of another natural polymer in **(iii)** caused many candidates problems. A common error was to give “carbohydrates” as the answer. Some carbohydrates, such as starch, are natural polymers but others, such as glucose, are not polymers.

**(c)** Some excellent answers were seen to this question. However, many candidates drew structures with di- or trivalent hydrogen or di- or tetravalent nitrogen.

**Question 7**

**(a)** Many candidates answered the calculation correctly. Better performing candidates included clear working out in their responses. A common error was to convert the volume given in $cm^3$ to a volume in $dm^3$ incorrectly.

**(b)** Many candidates realised they had to use the stoichiometric ratio from the equation provided and simply divide the number of moles of $HCl$ by two. However, presumably because the word “gas” was used in the question, some candidates used the number 24 somewhere in their calculation.

**(c)** Better performing candidates clearly showed the steps in their calculations, including the calculation of the $M_r$ of carbon dioxide and then correctly multiplying this figure by the number of moles of carbon dioxide.

**(d)** Better performing candidates were able to calculate the volume of carbon dioxide, while others did not seem to know what to do. Some candidates who had used the value of “24” in their calculations for **(b)** did not use it here.

**Question 8**

**(a)** In **(i)**, many candidates did not read the question carefully and described how the volume of carbon dioxide changed rather than the rate of reaction. Candidates who did describe how the rate of reaction changed often did not explain why the rate of reaction changed. Those candidates who tried to explain why the reaction stopped, often stated that the reactants were used up or the magnesium carbonate was used up, despite the fact that the question stated there was an excess of magnesium carbonate.

Part **(ii)**, was the best answered part of Question **8.** Most candidates could correctly predict that the initial rate of reaction would increase due to a larger surface area of solid. The lack of change in the total volume of gas collected was less well explained; responses were often not based on the number of moles of reactant used.

**(b)** Many candidates did not read the question carefully. The question asked for an explanation of why the rate of reaction of magnesium with hydrochloric acid increased over the first two minutes. Instead, many candidates tried to explain why magnesium reacted more quickly than magnesium carbonate. Better performing candidates answered this question well, stating there would be an increase in temperature and then linking this to why the reaction speeds up.

# CHEMISTRY

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

**Key messages**

Candidates need to be reminded to use correct scientific terms. They should also revise the entire syllabus. It was noticeable that many candidates omitted the questions on the extraction of aluminium, Questions **6(a)** and **(b)**.

Candidates need to be reminded that if **one** use of a substance is asked for, then not more than **one** use should appear in the answer; any incorrect uses will be viewed as a contradiction of correct uses.

Candidates need to be reminded that the number of marks available should act as a guide for the length of answer required.

Some good examination technique was seen with candidates underlining command words in the questions. However, some responses were simply a rewriting of the question. Candidates write answers concise and keep to the space available. Simple use of bullet points, rather than long paragraphs, may help candidates make the key points of an answer.

**General comments**

Candidates seemed well prepared for the Question Paper. There was no evidence that there was insufficient time to complete the paper and there was little evidence of problems in understanding the questions.

**Comments on specific questions**

**Question 1**

**(a)** Some extended answers were given for this one mark question and many candidates wrote well beyond the requirement of the question, which asked them to simply describe the volume and the shape of liquids.

**(b)** Many candidates answered this question correctly. Some candidates did not give the correct arrangement of the particles. Many candidates felt that no arrangement was present in gases and it was not recognised that “fixed positions” does not necessarily mean regularity in solids.

**(c) (i)** and **(ii)**
Both changes of state were well known.

**Question 2**

**(a)** The definition of nucleon number was well known. Some candidates did not state that the protons and neutrons were in the nucleus.

**(b)** The electronic structure of the Na atom was known by most candidates. The electronic structure of the $P^{3-}$ ion was less successfully written down, with many candidates giving the structure of the P atom.

**(c)** Almost all candidates gave a correct medical use for radioactive isotopes, with treating cancer being the most common response seen.

**(d)** The definition of *relative atomic mass* is given in the syllabus. Only a very small percentage of candidates knew that relative atomic mass is an average value and only a small percentage of candidates knew that $^{12}C$ is used as the reference. Very rarely did a candidate state both these points. Many candidates erroneously gave the definition of mass number.

**(e)** Despite not being unable to define relative atomic mass in **(d)**, a significant proportion of candidates were able to state that the relative atomic mass of chlorine is an average mass of (two) isotopes. Weaker answers referred to the chlorine being diatomic in their explanation or suggested chlorine atoms had half a neutron.

**(f)** The question told candidates that aluminium is a metal and asked them to describe the bonding in aluminium. Many candidates took this as a cue to give the bonding in compounds of aluminium, which was not required. Of those who attempted to show metallic bonding, many candidates ignored the instruction to include *appropriate* charges and consequently showed $Al^{3+}$ ions as "⊕", with many candidates assuming the single positive ions to be protons. Most candidates knew that there is a "sea of electrons" surrounding the positive ions. Some candidates thought that the electrons "encircled" the positive ions, rather than existed between them. Very few candidates stated that the bonding was the attraction between the positive ions and the electrons.

**Question 3**

**(a)** The names and percentage of gases in clean, dry air were well known.

**(b)** Most candidates could describe how oxides of nitrogen are formed as a result of combustion of atmospheric nitrogen within the confines of a car engine at high temperatures. These candidates tended to continue to describe that the reaction of these gases with atmospheric water and the formation of acid rain.

Weaker answers stated that nitrogen originated from the fuel and that sulfur dioxide was needed to convert $NO_x$ into acid rain.

**(c)** Most candidates were able to give two common sources of methane such as natural gas. Weaker answers stated that methane was formed as a result of combustion of natural gas.

**(d)** Photosynthesis was the correct answer seen almost universally.

**Question 4**

**(a)** The vast majority of candidates opted to give equations for both reactions, when an observation was a required. It was clear that candidates had seen these test-tube reactions taking place and many were able to state that copper(II) carbonate fizzes in acid. Fewer candidates stated that both reagents dissolve in acid. Some candidates described the dissolving stage but then went on to describe the concurrent formation of a precipitate. Many candidates knew that the resultant solutions were blue.

**(b)(i)** Better performing candidates were able to give a correctly balanced equation. Other candidates gave the correct formula for copper(II) nitrate but were unable to balance the equation.

**(ii)** The idea of typical metals producing a salt plus hydrogen was known by many candidates but frequently it was incorrectly stated that typical metals produce a salt plus *water* with acids.

**Question 5**

**(a)** One common error was to miscalculate the $M$r of $MnO_2$.

**(b)(i)** Many candidates did not attempt this question. The most common colour change given was the reverse of the correct colour change, suggesting that these candidates were familiar with the experiment but had not thought clearly about their answer.

**(ii)** Some candidates were able to produce the correct species and to balance the equation but many candidates then either omitted state symbols completely or suggested (g) or (l) for bromine.

**(c) (i)** and **(ii)**
Most candidates knew that the carbon to carbon double bond is responsible for propene's reactivity. They also knew the reaction is an *addition* reaction.

**(d) (i)** Most candidates knew that the reaction is a *substitution* reaction.

**(ii)** and **(iii)**
The definition of *structural isomerism* was well known in **(ii)** but the poor diagrams of the structural isomers in **(iii)** suggested the definitions given in **(ii)** may have been known but not necessarily understood.

**(e) (i)** The method of determination of an empirical formula from percentage by mass values was known by many candidates. Some unnecessary errors were seen, such as:

- The percentage composition by mass values were divided by atomic numbers rather than by relative atomic masses.
- The initial ratio of moles (I, 0.59 : O, 1.5) was frequently rounded to 0.5 : 1.5 leading to an empirical formula of $IO_3$.
- Instead of doubling the partial whole number ratio of 1 : 2.5 to make the ratio 2 : 5, many candidates incorrectly changed it 1 : 3 leading to an empirical formula of $IO_3$.

**(ii)** Most candidates were able to relate the acidic nature of an oxide of a non-metal, such as iodine, to the expected colour seen in Universal Indicator.

**Question 6**

**(a)** Candidates found describing the extraction of bauxite challenging and key stages such as the use of *molten* cryolite were often omitted. Candidates are advised to consider which facts they need to put into an answer that requires extended writing before commencing their answer. The use of bullet points may help this process.

Candidates found the half-equations difficult and many attempts were incorrect due to an imbalance of charge. This often resulted from using an incorrect number of electrons.

**(b)** Most candidates knew that the anodes were made of graphite and that they react with the oxygen gas produced. Some candidates did not explain this in **(b)**.

**(c)** A wide range of acceptable responses were seen. A large proportion of candidates described aluminium as being "light" rather than having "low density".

**Question 7**

**(a)** Many candidates used non-specific phraseology, such as "made from two or more monomers" and "a chain of monomers".

**(b) (i)** Most knew that hydrolysis was occurring. Candidates need to be aware that hydration is not the same as hydrolysis.

**(ii)** The idea that acidic conditions were needed for hydrolysis of proteins was not widely known.

**(c) (i)** and **(ii)**
Most candidates knew how to determine the $R_f$ value in **(ii)** and went on to demonstrate that they understood what they had written by circling the correct spot in **(iii)**.

**(iii)** Many candidates would have benefitted from considering what to write before commencing. The use of bullet points may also have helped. Many candidates did not label diagrams and these diagrams often had the chromatogram shown with the baseline below the solvent level.

It was clear that for many candidates simple paper chromatography was not well known, as many answers included various spurious uses of locating agents, solvents and amino acids.

**(d)** The majority of candidates were able to show an amide linkage. Sometimes it was as part of a repeat unit rather than as part of a dipeptide. Better performing candidates were able to realise that the second dipeptide involved reversing the order of the two amino acids.

# CHEMISTRY

**Paper 0620/43**
**Theory (Extended)**

## Key messages

Candidates often answer in terms of rate of reaction when questions on equilibrium are asked and *vice versa*. Candidates are advised to treat equilibrium and rates of reaction as two separate topics.

Candidates should be aware that substances that conduct electricity do so because they contain either moving electrons, in metals and graphite, or moving ions, in aqueous solutions containing ions and molten ionic compounds. The word “free” should not be thought of as meaning the same as moving.

Candidates should know that the products of electrolysis are metallic elements or hydrogen at the cathode and oxygen or the halogens at the anode. Molten ionic compounds are decomposed into their elements during electrolysis.

## General comments

Candidates were not confident in writing ionic half-equations.
“

## Comments on specific questions

### Question 1

**(a)** Responses were more likely to give the masses correctly than the charges.

**(b) (i)** This was answered reasonably well. Electrons were the most likely to be omitted from the first part. Nucleon was often seen instead of neutron in the second part.

**(ii)** Reference to number of electrons or electron configuration was given by better performing candidates. A common incorrect response was, “because they are the same element”.

**(c)** This was answered reasonably well. Silicon, silicon(IV) oxide and oxides of carbon were occasionally seen.

**(d)** Many candidates drew single bonds instead of double bonds. Candidates are advised to draw electrons in pencil first and then go over the pencil marks in pen, rather than cross out an answer that they wish to change. Crossings out often make it unclear which is the answer that the candidate wants to be marked. Candidates often used more than the outer shell electrons that were available from one carbon atom and two oxygen atoms. Candidates need to be aware that all three atoms must achieve a full outer shell of electrons.

### Question 2

**(a)** This was often answered well. Some candidates used the nucleon number of 9 to lead to an electronic structure of 2,7. $Be^{2+}$ was occasionally seen as an electronic structure.

**(b)** This was usually answered correctly.

**(c) (i)** Many candidates confused metallic bonding with ionic bonding. Negative ions were commonly seen in addition to positive ions. Protons and atoms were often referred to in an inappropriate way. Electrostatic attraction was usually missing.

**(ii)** Electrons were often referred to, but reference to mobility or movement of electrons was often missing.

**(d) (i)** This was usually answered correctly.

**(ii)** This was often answered correctly although $BeCl$ and BeOH were common errors.

**(iii)** The formula $Na_2BeO_2$ was only seen occasionally. Many other sodium compounds were seen on the right-hand side of the equation, as was the element sodium. $BeO_2$ was also commonly seen as a product.

**Question 3**

**(a)** The "2" in front of $Pb(NO_3)_2$ led to many answers of 662 and 538.

**(b) (i)** There were many correct answers, using a variety of methods. Those candidates who made errors in **(a)** usually made similar errors in calculating the $M_r$ of PbO.

**(ii)** Many candidates calculated the $M_r$ of $O_2$ and used this instead of the molar gas volume.

**(c)** This was usually fully correct, although the phrase "glowing splint" was sometimes absent.

**(d) (i)** "Excess" means more than enough of one reactant, so that the other reactant completely reacts. Some candidates were not familiar with this definition.

**(ii)** An observation was required here, preferably stating that the lead(II) oxide would no longer dissolve. No more bubbling was often seen as an answer, even though there was no gas evolved in the reaction.

**(iii)** The formulae of lead(II) nitrate and nitric acid were often incorrect. Many equations with correct formulae were unbalanced.

**Question 4**

**(a)** Both types of bonding were usually correct, although the bonding in silicon(IV) oxide was sometimes described as *giant* covalent.

**(b)** Tetrahedral, referring to spatial distribution of bonds rather than type of structure, was a very common answer. Lattice was also commonly seen.

**(c) (i)** There were many references to intermolecular forces instead of covalent bonds. Silicon(IV) oxide consists entirely of strong bonds and therefore these bonds will only break at high temperatures. This area of the syllabus needs deeper consideration by large numbers of candidates.

**(ii)** The lack of *moving* charged particles, ions or electrons, was rarely mentioned by candidates.

**(d)** Many candidates referred only to electrons. Solid sodium chloride contains ions and in the solid state the ions are not moving, which is why the solid does not conduct electricity. When molten, conduction of electricity does occur because the ions are moving.

**(e) (i)** This was often answered correctly. Ions were often mentioned as products, as was sodium.

**(ii)** Candidates were not confident with ionic half-equations. Candidates should know that electrons are always on the left-hand side for reactions at the negative electrode, and also that the total charge must be the same on both sides. Hydrogen gas was often represented as H instead of $H_2$.

**(f)** Oxygen was only seen occasionally as the product. Chlorine was also commonly seen, despite reference to a dilute solution.

**(g) (i)** This was answered reasonably well.

**(ii)** $Na^{2+}$ was seen occasionally. Ionic half-equations continue to be difficult for candidates.

**(iii)** The test for chlorine gas was reasonably well known.

**Question 5**

**(a) (i)** Candidates often omitted a source of oxygen or the requirement for heat.

**(ii)** Very large numbers of candidates could write the equation for this reaction.

**(b) (i)** Very large numbers of candidates identified this as an equilibrium or as a reversible reaction.

**(ii)** The oxidation state of vanadium was sometimes absent or sometimes incorrect. Catalysts from other industrial and laboratory reactions were sometimes seen.

**(iii)** Candidates answered this correctly.

**(iv)** Candidates often omitted to refer to the fact that the forward reaction was exothermic and this is what caused a decreased yield of sulfur trioxide at higher temperatures. There were many inappropriate references to rate or to collisions.

**(v)** There were several inappropriate references to yield instead of rate and confusion between equilibrium and rate of reaction.

**(vi)** Candidates often omitted to refer to the fact that there were fewer molecules on the right-hand side compared to the left-hand side and this is what caused an increased yield of sulfur trioxide at higher pressure. There were many inappropriate references to rate or to collisions. The statement that there are fewer molecules in the forward reaction than the reverse reaction is meaningless.

**(c) (i)** This was answered reasonably well, although the word concentrated was sometimes absent. Water was a common incorrect answer.

**(ii)** The equation was often correct. The most common incorrect answer was $2SO_3 + H_2O \rightarrow H_2S_2O_7$.

**(d) (i)** This was commonly answered well.

**(ii)** The equation was occasionally unbalanced. Incorrect species were sometimes included.

**(e)** Not many candidates were aware of the uses of sulfuric acid. Bleaching and paper manufacture were commonly seen.

**(f) (i)** Reference to pH, concentration and chemical properties instead of complete ionisation were commonly seen. “Almost complete ionisation” was not accepted.

**(ii)** “Describe how” requires brief reference to experimental method such as “use a pH meter” or “use Universal Indicator” rather than explanation of theory. Those candidates who referred to pH usually erred on the high side; pH values should have been 1 or less. “Measure pH” needed an additional comment as to how this is done.

**(iii)** A minority of candidates deduced that the acidic hydrogen ion in $C_6H_5SO_3H$ had to be replaced to form the sodium salt $C_6H_5SO_3Na$. Many other sodium salts were seen as products.

**Question 6**

**(a)(i)** Use of the words condense / condensation or polymer / polymerisation were often unsuccessfully used to explain the term required. Reference to a long chain molecule was usually missing. Condensation was usually thought to apply in the physical sense of changing a gas to liquid.

**(ii)** This was answered quite well. The incorrect term “additional” was seen often.

**(b) (i)** There were many correct responses, although some candidates included parts of the boxes. Other candidates included various other parts of the polymer.

**(ii)** Many candidates found this very challenging. Some had the wrong atoms in the monomers. Other candidates did not obey the instruction to "show all the missing atoms and bonds". The O–H bond is just as important as any of the others.

**(iii)** Many candidates gave nylon as a correct answer. Other answers included a variety of polymeric and non-polymeric substances. *Terylene* and carbohydrates were fairly common answers.

**(c) (i)** Amino acids was seen fairly commonly as the only correct answer.

**(ii)** This area of the syllabus was only recognised by a small number of candidates. Fractional distillation was seen often, as were bromine, Benedict's reagent and biuret reagent as locating agents.

# CHEMISTRY

**Paper 0620/51**
**Practical Test**

## Key messages

- Candidates should use a sharp pencil for plotting points and for drawing their lines of best fit. This allows them to correct any errors. The line of best fit might be a curve or a straight line. Straight lines should be drawn with a ruler, but rulers should not be used to join the points on a curve. Lines of best fit should avoid anomalous points.

- 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. White precipitates should not be described as cloudy or milky solids. Candidates should be aware that the mark allocation reflects the number of marks allocated to the question.

- Candidates should be prepared to answer questions requiring the planning of an investigation. Candidates would benefit from attempting past examination questions with this style of question. These can be found on the 0620 Specimen Assessment Materials and on past Alternative to Practical Question Papers.

## General comments

The majority of candidates successfully attempted and completed both practical **Questions 1** and **2**, and there was no evidence that candidates were short of time. A number of candidates did not follow the instructions as detailed in certain parts of **Question 2**.

## Comments on specific questions

### Question 1

**(a)** and **(b)**
The tables of results were completed by all of the candidates. The majority of candidates recorded temperature readings that were comparable to the supervisor for both experiments. Better performing candidates recorded temperatures increasing to a maximum and then decreasing or levelling out, with the maximum reached at a lower volume of acid added for Experiment 2. Some candidates recorded temperatures which did not show an increase as acid was added.

**(c)** Most candidates plotted the points for both experiments on the grid correctly. Points were sometimes plotted incorrectly because the scale on the *y*-axis was misread. Some graphs were not labelled and the use of a ruler to join the points "dot to dot" was sometimes seen. Better performing candidates gave responses which showed two intersecting best-fit straight lines drawn through the points for each experiment.

**(d)** Most candidates worked out the temperature of the reaction mixture after 13 $cm^3$ of nitric acid were added to 50 $cm^3$ of solution **N** in Experiment 1 and showed clearly how they had used their graph. Some errors in reading the scale of the *x*-axis were evident and a number of candidates mistakenly answered in terms of Experiment 2.

**(e)** Phenolphthalein, methyl orange and litmus were the commonest answers. Universal Indicator and pH paper was rejected. A number of incorrect responses, such as starch and potassium manganate(VII) were seen.

**(f)** This was well answered with Experiment 1 commonly given. Better performing candidates were able to communicate the idea that solution **N** was stronger, often in terms of a higher pH or more alkaline. Reference to concentration was not credited, as the stem of the question specified "solutions of **N** and **O** are the same concentration". Vague references to the greater reactivity of solution **N** were prevalent and ignored.

**(g)** The idea of smaller or slower temperature changes was recognised by the better performing candidates. Many responses referred to the doubling of the temperature changes, which showed a lack of understanding.

**(h)** The use of a polystyrene cup in the experiments because it is an insulator of heat was a common correct answer. Vague references to the cost and availability of polystyrene cups were ignored.

**(i)** Most correct responses referred to accuracy as the problem when using a measuring cylinder and suggested replacing it with a burette or pipette. Correct references to heat losses and covering the polystyrene cup with a lid or insulation were also seen. Vague references to parallax errors, thermometer reading errors, not using more than one burette and using the thermometer as a stirrer were common incorrect answers.

**Question 2**

Solid **P** was hydrated aluminium sulfate.

**(a)** Most candidates were able to describe the appearance of solid **P** as a white solid, powder or crystals. The colour of the salt was sometimes missed and a few answers mistakenly referred to the presence of a precipitate.

**(b) (i)** Detailed observations were rare. The presence of condensation / droplets was often not noticed. Vague references to fizzing and effervescence were common. Some candidates recognised that the solid melted, dissolved or turned into a liquid after heating. It was apparent that many candidates had not followed the instruction for testing the gas with cobalt(II) chloride paper. A number of positive tests for chlorine and acidic gases using litmus paper were recorded; in reality, steam / water vapour is evolved.

**(ii)** A wide range of flame colours were recorded, including blue, green, lilac and often yellow. The expected observation was no change in the colour of the flame, which was rarely recorded.

**(c) (i)** Some responses showed that candidates did not follow the instructions given and therefore observations were missed.

**(ii)** This was generally well answered with the recognition of a white precipitate. Some candidates noted the formation of a cloudy or milky solution but did not describe the colour appropriately.

**(iii)** A significant number of candidates obtained a white precipitate when there should have been no reaction for this halide test. Other candidates described effervescence and precipitates dissolving.

**(iv)** This was generally well answered. Vague references to milky, cloudy and bubbles were prevalent.

**(d)** Only the better performing candidates realised that a white solid showed that ions of a transition element were not present. Conclusions that suggested that the white solid showed that a Group I or Group II element was present were insufficient.

**(e)** Better performing candidates realised that the formation of condensation indicated that the solid was hydrated or that water was present. Confused responses discussed the acid-base nature of the solid.

**(f)** Only a minority of candidates were able to suggest the absence of a named metal ion that gives a positive flame test. The majority of candidates correctly deduced that sodium ions were present having recorded a yellow flame colour in **(b)(ii)**.

**(g)** Many candidates referred to the presence of sulfate ions in solid **P** from the white precipitate recorded in **(c)(iv)**. A majority of candidates realised that the tests on the solid indicated the presence of aluminium ions. Incorrect responses such as transition element, ammonium or zinc ions, and nitrate or chloride ions were prevalent.

**Question 3**

Many candidates were ill-prepared for this planning question and did not attempt it. A range of marks was seen. The commonest method chosen was a titration. This showed a lack of knowledge and understanding as mixtures of calcium oxide and calcium carbonate do not dissolve in water and therefore solutions could not be made and used.

A large number of responses lacked detail, e.g. “add Agri Lime **Q** to nitric acid with an indicator”, with no mention of quantities of reactants or the name of the indicator. A significant number of responses referred to the addition of an acid to separate samples of calcium oxide and calcium carbonate which showed a lack of understanding of the question.

# CHEMISTRY

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

## Key messages

- Candidates should use a sharp pencil for plotting points and for drawing their lines of best fit. This allows them to correct any errors. The line of best fit might be a curve or a straight line. Straight lines should be drawn with a ruler, but rulers should not be used to join the points on a curve. Lines of best fit should avoid anomalous points.

- 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. White precipitates should not be described as cloudy or milky solids. Candidates should be aware that the mark allocation reflects the number of marks allocated to the question.

- Candidates should be prepared to answer questions requiring the planning of an investigation. Candidates would benefit from attempting past examination questions with this style of question. These can be found on the 0620 Specimen Assessment Materials and on past Alternative to Practical Question Papers.

## General comments

The majority of candidates successfully attempted and completed both practical **Questions 1** and **2**, and there was no evidence that candidates were short of time. A number of candidates did not follow the instructions as detailed in certain parts of **Question 2**.

## Comments on specific questions

### Question 1

**(a)** and **(b)**
The tables of results were completed by all of the candidates. The majority of candidates recorded temperature readings that were comparable to the supervisor for both experiments. Better performing candidates recorded temperatures increasing to a maximum and then decreasing or levelling out, with the maximum reached at a lower volume of acid added for Experiment 2. Some candidates recorded temperatures which did not show an increase as acid was added.

**(c)** Most candidates plotted the points for both experiments on the grid correctly. Points were sometimes plotted incorrectly because the scale on the *y*-axis was misread. Some graphs were not labelled and the use of a ruler to join the points “dot to dot” was sometimes seen. Better performing candidates gave responses which showed two intersecting best-fit straight lines drawn through the points for each experiment.

**(d)** Most candidates worked out the temperature of the reaction mixture after 13 $cm^3$ of nitric acid were added to 50 $cm^3$ of solution **N** in Experiment 1 and showed clearly how they had used their graph. Some errors in reading the scale of the *x*-axis were evident and a number of candidates mistakenly answered in terms of Experiment 2.

**(e)** Phenolphthalein, methyl orange and litmus were the commonest answers. Universal Indicator and pH paper were rejected. A number of incorrect responses, such as starch and potassium manganate(VII) were seen.

**(f)** This was well answered with Experiment 1 commonly given. Better performing candidates were able to communicate the idea that solution **N** was stronger, often in terms of a higher pH or more alkaline. Reference to concentration was not credited, as the stem of the question specified "solutions of **N** and **O** are the same concentration". Vague references to the greater reactivity of solution **N** were prevalent and ignored.

**(g)** The idea of smaller or slower temperature changes was recognised by the better performing candidates. Many responses referred to the doubling of the temperature changes, which showed a lack of understanding.

**(h)** The use of a polystyrene cup in the experiments because it is an insulator of heat was a common correct answer. Vague references to the cost and availability of polystyrene cups were ignored.

**(i)** Most correct responses referred to accuracy as the problem when using a measuring cylinder and suggested replacing it with a burette or pipette. Correct references to heat losses and covering the polystyrene cup with a lid or insulation were also seen. Vague references to parallax errors, thermometer reading errors, not using more than one burette and using the thermometer as a stirrer were common incorrect answers.

**Question 2**

Solid **P** was hydrated aluminium sulfate.

**(a)** Most candidates were able to describe the appearance of solid **P** as a white solid, powder or crystals. The colour of the salt was sometimes missed and a few answers mistakenly referred to the presence of a precipitate.

**(b) (i)** Detailed observations were rare. The presence of condensation / droplets was often not noticed. Vague references to fizzing and effervescence were common. Some candidates recognised that the solid melted, dissolved or turned into a liquid after heating. It was apparent that many candidates had not followed the instruction for testing the gas with cobalt(II) chloride paper. A number of positive tests for chlorine and acidic gases using litmus paper were recorded; in reality, steam / water vapour is evolved.

**(ii)** A wide range of flame colours were recorded, including blue, green, lilac and often yellow. The expected observation was no change in the colour of the flame, which was rarely recorded.

**(c) (i)** Some responses showed that candidates did not follow the instructions given and therefore observations were missed.

**(ii)** This was generally well answered with the recognition of a white precipitate. Some candidates noted the formation of a cloudy or milky solution but did not describe the colour appropriately.

**(iii)** A significant number of candidates obtained a white precipitate when there should have been no reaction for this halide test. Other candidates described effervescence and precipitates dissolving.

**(iv)** This was generally well answered. Vague references to milky, cloudy and bubbles were prevalent.

**(d)** Only the better performing candidates realised that a white solid showed that ions of a transition element were not present. Conclusions that suggested that the white solid showed that a Group I or Group II element was present were insufficient.

**(e)** Better performing candidates realised that the formation of condensation indicated that the solid was hydrated or that water was present. Confused responses discussed the acid-base nature of the solid.

**(f)** Only a minority of candidates were able to suggest the absence of a named metal ion that gives a positive flame test. The majority of candidates correctly deduced that sodium ions were present having recorded a yellow flame colour in **(b)(ii)**.

**(g)** Many candidates referred to the presence of sulfate ions in solid **P** from the white precipitate recorded in **(c)(iv)**. A majority of candidates realised that the tests on the solid indicated the presence of aluminium ions. Incorrect responses such as transition element, ammonium or zinc ions, and nitrate or chloride ions were prevalent.

**Question 3**

Many candidates were ill-prepared for this planning question and did not attempt it. A range of marks was seen. The commonest method chosen was a titration. This showed a lack of knowledge and understanding as mixtures of calcium oxide and calcium carbonate do not dissolve in water and therefore solutions could not be made and used.

A large number of responses lacked detail, e.g. “add Agri Lime **Q** to nitric acid with an indicator”, with no mention of quantities of reactants or the name of the indicator. A significant number of responses referred to the addition of an acid to separate samples of calcium oxide and calcium carbonate which showed a lack of understanding of the question.

# CHEMISTRY

**Paper 0620/53**
**Practical Test**

## Key messages

- Candidates should use a sharp pencil for plotting points and for drawing their lines of best fit on their graphs. This allows them to correct any errors. The question might require the line of best fit to be a curve or a straight line. Straight lines should be drawn with a ruler, but rulers should not be used to join the points on a curve. Lines of best fit should avoid anomalous points.

- 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. White precipitates should not be described as cloudy or milky solids. Candidates should be aware that the mark allocation reflects the number of marks allocated to the question.

- Candidates should be prepared to answer questions requiring the planning of an investigation. Candidates would benefit from attempting past examination questions with this style of question. These can be found on the 0620 Specimen Assessment Materials and on past Alternative to Practical Question Papers.

## General comments

The majority of candidates successfully attempted and completed both practical **Questions 1** and **2** and there was no evidence that candidates were short of time. Supervisors' results were submitted with all of the candidates' scripts.

There was some evidence that some candidates were ill-prepared for **Question 3**.

## Comments on specific questions

### Question 1

**(a)** and **(b)**
Almost all candidates completed the table of results with results which showed an increase in temperature which was in close agreement with that achieved by the Supervisor. A significant number of candidates did not follow the instructions and added the metals before 60 seconds had elapsed. Consequently, the first three temperatures in both tables were not similar as expected.

**(c)** Points were usually correctly plotted. Some candidates did not label the graphs. Some graphs had points that were joined with a ruler or a graph that bent backwards for the steep part of the curve for Experiment 2.

**(d) (i)** Some candidates misread the graph scale or did not show from where on the graph they had read the value.

**(ii)** Only the better performing candidates were able to add 30 °C to the temperature of the solution at 60 seconds and draw a tie-line to the time at this temperature. Very few candidates then realised that 60 seconds had to be subtracted from this value to calculate the answer.

**(e)** This was generally well answered, with many candidates stating that the reaction would have stopped and so it would return to room temperature or the initial temperature in the table. Vague answers referred to the mixture cooling down and losing energy, which did not answer the question.

**(f)** A common misconception was that taking more readings would make the readings more accurate or more precise. If a reading is subject to an error, just taking more readings will not make that error disappear. However, more frequent readings give more data points which allow a better graph to be drawn.

**(g)** Many responses centred on the relative reactivity of polystyrene and copper. Better performing candidates discussed the insulating effect of polystyrene or the possible loss of energy by a copper can conducting heat.

**Question 2**

Solution **Q** was dilute sulfuric acid and solution **R** was aqueous calcium hydroxide.

**(a) (i)** This was generally well answered. A minority of candidates did not follow the instructions and used litmus paper and recorded a colour change instead of a pH value.

**(ii)** A lack of detail was evident. Many candidates did not record the observation that the mixture formed bubbles, fizzed or effervesced. Some vague responses referred only to a "pop" or to hydrogen.

**(iii)** A lack of detail was evident. Many candidates did not record the observation that the mixture formed bubbles, fizzed or effervesced. Some answers referred to a lighted splint extinguishing or litmus paper changing colour.

**(iv)** This was generally well answered with the recognition of the formation of a white precipitate. Some candidates used terms such as milky, cloudy or solid, which were ignored.

**(b) (i)** This was generally well answered.

**(ii)** This was generally well answered with the recognition of the formation of a white precipitate, which was insoluble in excess aqueous sodium hydroxide. Some candidates used terms such as milky, cloudy or solid, which were ignored.

**(iii)** The incorrect use of terms was prevalent. The expected observation was that a brown precipitate formed. The use of the terms soluble, insoluble, dissolves and solution was often confused. Reference to the formation of a white precipitate showed a lack of care in observing the reaction.

**(iv)** The expected observation was that a green precipitate formed. References to green solutions were common.

**(c)** Many candidates recognised the presence of sulfate ions but did not identify sulfuric acid.

**(d)** The presence of calcium ions was often noted. Many candidates could not relate the observations to the presence of an alkali / hydroxide ions and did not name calcium hydroxide.

**Question 3**

Reference to fractional distillation instead of distillation was prevalent and showed a lack of knowledge and understanding. Many responses then showed a lack of realisation that, if distillation were the first step, the solid left would be a mixture rather than pure sodium carbonate.

Better performing candidates used three different portions of the mixture and were able to suggest a method which would successfully separate the silica, water and sodium carbonate from each portion of the mixture. Candidates found it more difficult to start with one portion of the mixture and correctly sequence the separation stages, i.e. filtration, distillation and evaporation.

# CHEMISTRY

**Paper 0620/61**
**Alternative to Practical**

## Key messages

- Candidates should use a sharp pencil for plotting points and for drawing their lines of best fit on their graphs. This allows them to correct any errors. The line of best fit might be a curve or a straight line. Straight lines should be drawn with a ruler, but rulers should not be used to join the points on a curve. Lines of best fit should avoid anomalous points.

- 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. White precipitates should not be described as cloudy or milky solids. Candidates should be aware that the mark allocation reflects the number of marks allocated to the question.

- Candidates should be prepared to answer questions requiring the planning of an investigation. Candidates would benefit from attempting past examination questions with this style of question. These can be found on the 0620 Specimen Assessment Materials and on past Alternative to Practical Question Papers.

## General comments

The majority of candidates attempted all of the questions. Some candidates were not well prepared for this examination and showed a lack of experience of practical procedures.

Candidates found **Questions 3** and **4** the most demanding.

## Comments on specific questions

### Question 1

**(a)** A minority of candidates identified the electrodes. There were many references to plates and cathodes, which were ignored. A number of answers named compounds of platinum, e.g. platinum oxide, which showed a lack of understanding.

**(b)** Correct references to bubbles, fizzing or effervescence were seen. Comments about the volumes of gases in the tubes or a bulb lighting up were ignored.

**(c)(i)** Some candidates noted that the volume of hydrogen was greater than the volume of oxygen. Other candidates realised that the volume of hydrogen was twice as much as the volume of oxygen. A minority of candidates thought there was more oxygen.

**(ii)** Many candidates realised that water breaks down to form hydrogen and oxygen. Sulfuric acid was a common incorrect answer. A significant number stated that the platinum broke down, which showed a lack of understanding.

**(d)** A large number of candidates did not follow the instruction and gave two tests to distinguish the gases. Using a lighted splint was common, giving a “pop” with hydrogen. A lighted splint would have no effect on oxygen apart from a brighter flame, but many responses stated that “the lighted splint would relight”, not appreciating that it was already lit. A glowing splint would relight in oxygen but there would be no effect in hydrogen, but many candidates thought that it would “pop”.

**Question 2**

**(a)** and **(b)**
The temperatures in the tables of results were completed correctly from the thermometer diagrams by the majority of the candidates.

**(c)** Most candidates plotted the points for both experiments on the grid correctly. Points were sometimes plotted wrongly because the scale on the *y*-axis was misread. Some graphs were not labelled and the use of a ruler to join the points "dot to dot" was seen.

**(d)** Most candidates worked out the temperature of the reaction mixture after 13 $cm^3$ of nitric acid were added to 50 $cm^3$ of solution **N** in Experiment 1 and showed clearly how they had used their graph. Some errors in reading the scale of the *x*-axis were evident and a number of responses chose the wrong curve.

**(e)** Phenolphthalein, methyl orange and litmus were the most common answers. Universal Indicator and pH paper were rejected. A number of incorrect responses such as starch and potassium manganate(VII) were seen.

(f) This was well answered with Experiment 1 commonly given. Better performing candidates were able to communicate the idea that solution **N** was stronger, often in terms of a higher pH or more alkaline. Reference to concentration was not credited, as the stem of the question specified "solutions of **N** and **O** are the same concentration". Vague references to the greater reactivity of solution **N** were prevalent and ignored.

**(g)** The idea of smaller or slower temperature changes was recognised by the better performing candidates. Many answers referred to an increase or doubling of the temperature changes, which showed a lack of understanding.

**(h)** The use of a polystyrene cup in the experiments because it is an insulator was a common correct answer. Vague references to the cost and availability of polystyrene cups were ignored.

**(i)** Most correct responses referred to accuracy as the problem when using a measuring cylinder and suggested replacing it with a burette or pipette. Correct references to heat losses and covering the polystyrene cup with a lid or insulation were also seen. Vague references to parallax errors, thermometer reading errors, not using more than one polystyrene cup and using the thermometer as a stirrer were common incorrect answers.

**Question 3**

**(a)** Better performing candidates realised that the formation of condensation and the colour change of the cobalt(II) chloride paper indicated that the solid was hydrated or that water was present. Confused responses discussed the acid-base nature of the solid.

**(b)** A wide range of flame colours were recorded, including blue, green, lilac and often yellow. The expected observation was no change in the colour of the flame, which was rarely recorded. Some candidates were not familiar with the flame test and referred to the flame going out as if they were testing for gases.

**(c)(i)** Some responses showed that some candidates had never experienced this test and therefore the observations were incorrect. A white precipitate, which dissolved when an excess of aqueous sodium hydroxide was added was the expected answer.

**(ii)** This was generally well answered with the recognition of a white precipitate insoluble in an excess of aqueous ammonia. Some candidates noted the formation of a cloudy or milky solution but did not describe the colour appropriately.

**(d)** Only the better performing candidates realised that no reaction showed that halide ions were not present. Conclusions that suggested it showed halogens were present were not accepted.

**(e)** Many candidates referred to the presence of sulfate ions in solid **P** from the white precipitate recorded in **test 6**. Incorrect responses, such as transition element, ammonium or zinc ions, and nitrate or chloride ions were prevalent.

**(f)** Few candidates realised that aluminium salts are white. Grey, colourless, yellow and other colours were common. Shiny was another response, which showed a lack of knowledge and understanding.

**Question 4**

Many candidates were ill-prepared for this planning question and did not attempt it. A range of marks was seen. The commonest method chosen was a titration. This showed a lack of knowledge and understanding as mixtures of calcium oxide and calcium carbonate do not dissolve in water and therefore solutions could not be made and used.

A large number of responses lacked detail, e.g. “add Agri Lime **Q** to nitric acid with an indicator”, with no mention of quantities of reactants or the name of the indicator. A significant number of responses referred to the addition of an acid to separate samples of calcium oxide and calcium carbonate which showed a lack of understanding of the question.

# CHEMISTRY

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

## Key messages

- Candidates should use a sharp pencil for plotting points and for drawing their lines of best fit on their graphs; this allows them to correct any errors. The line of best fit might be a curve or a straight line. Straight lines should be drawn with a ruler, but rulers should not be used to join the points on a curve. Lines of best fit should avoid anomalous points.

- 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, rather than stating the names of the products formed. White precipitates should not be described as cloudy or milky solids. Candidates should be aware that the mark allocation reflects the number of marks allocated to the question.

- Candidates should be prepared to answer questions requiring the planning of an investigation. Candidates would benefit from attempting past examination questions with this style of question. These can be found on the 0620 Specimen Assessment Materials and on past Alternative to Practical Question Papers.

## General comments

Some candidates did not read the questions carefully and did not understand what was required. This was noticeable in **Question 3** where observations were not given, but equations or named products were. Some candidates did not read the description of the experiment in **Question 2** and this led to errors in later parts of the question.

## Comments on specific questions

### Question 1

**(a)** Most candidates identified the tripod, which was often described as a stand or a Bunsen burner. The condenser caused few problems, although some candidates labelled it as a fractionating column.

**(b)** This question was well answered.

**(c)** The majority of candidates correctly identified the separation method as chromatography.

### Question 2

**(a)** The table of results was completed correctly by the majority of candidates using the measuring cylinder diagrams. Common errors were with the 20 second and 40 second diagrams.

**(b)** Most candidates plotted the points on the grid correctly but many candidates did not make their points clear, especially at the origin. Some candidates incorrectly drew a curve through the anomalous point. The first point was often missed and the last point sometimes plotted incorrectly.

**(c) (i)** The anomalous point was usually identified correctly. Some candidates thought that the point at 180 s was anomalous because it was the same as the previous volume at 160 s.

**(ii)** Good responses referred to the misreading of the measuring cylinder or taking the reading too early. References to the point not being on the curve did not answer the question. Many candidates suggested that some gas had escaped without realising that this would have also affected all subsequent results as well. Vague references to human error or recording errors were ignored.

**(iii)** This was generally well answered. Some candidates did not clearly show on the grid how the answer was worked out.

**(d)** Many candidates stated that the reaction had finished but many gave the incorrect reason that all the magnesium had reacted. This showed a lack of understanding as the hydrochloric acid was the limiting reagent.

**(e) (i)** A significant number of candidates added the two volumes to get 101 $cm^3$ instead of subtracting to get 13 $cm^3$.

**(ii)** Many candidates divided by 30 s instead of 20 s, which showed a lack of understanding. Some candidates did not give a unit. Many gave the correct unit of $cm^3/s$.

**(f)** This question was well answered. Most candidates sketched either a steeper curve from the origin or a curve levelling out at the same volume. Better performing candidates did both.

**(g)** The idea of the reading being caused by air being displaced by the addition of 30 $cm^3$ of hydrochloric acid was only recognised by the better performing candidates. Many responses referred to the trapping of the air in the measuring cylinder before the acid was added, not appreciating that the diagram at the start of the question showed that the cylinder was full of water. A large number of responses referred to the rapidity of the reaction causing the 30 $cm^3$ reading, which was incorrect.

**(h)** Most correct responses referred to accuracy as the problem when using a measuring cylinder and suggested replacing it with a gas syringe, burette or pipette. References to repeating the experiment and taking the average of the results were also seen. Some candidates did not following the instruction to explain their suggested improvement. References to speeding up the reaction by using powdered magnesium or raising the temperature were common incorrect answers.

**Question 3**

Candidates found this the most challenging question on the paper. Some candidates stated additional wrong observations and some candidates did not describe observations at all but stated what products were formed.

(**a) (i)** Most candidates were able to give a pH value in the range of pH 1–3. Some candidates mentioned litmus or Universal Indicator turning red or gave a pH value greater than 7.

**(ii)** The idea that copper(II) oxide would dissolve in hot dilute hydrochloric acid to form a green / blue solution was generally not known. Many candidates gave bubbles or a precipitate as the observation. Colour changes to orange were also common. A common misconception was that there would be no reaction because copper is unreactive.

**(iii)** Detailed observations were rare. Many candidates gave the limewater turning milky but omitted the bubbling / effervescence. Some candidates gave the bubbling but no test for the gas.

**(iv)** This was generally well answered with the recognition of a white precipitate. Some candidates noted the formation of a precipitate but did not describe the colour appropriately. A common answer was no reaction, which showed a lack of knowledge and understanding.

**(b)** Many candidates identified solution **T** as iron(III) nitrate. Some mistakenly thought that the ammonia formed in the third test indicated the presence of ammonium ions. Incorrect responses such as transition element, calcium or zinc ions, and iodide or chloride ions were prevalent.

**Question 4**

Most candidates were well-prepared for this planning question. A few incorrect methods involving chromatography were seen. Many candidates drew a correctly labelled diagram.

Only the better performing candidates cleaned the ring before electroplating it and fewer removed it at the end and washed and dried it. A number of responses mentioned rotating the ring during electrolysis to ensure even coating. Dissolving copper(II) sulfate crystals in water was often implied rather than being explicit. Some responses suggested the use of copper(II) sulfate crystals or molten copper(II) sulfate as the electrolyte.

# CHEMISTRY

**Paper 0620/63**
**Alternative to Practical**

**Key messages**

- Candidates should use a sharp pencil for plotting points and for drawing their lines of best fit on their graphs. This allows them to correct any errors. Points are best plotted with a cross (×) to ensure that they are not obscured by either the grid lines or the line of best fit. The question might require the line of best fit to be a curve or a straight line. Straight lines should be drawn with a ruler, but rulers should not be used to join the points on a curve. Lines of best fit should avoid anomalous points.

- Observations are those which you can see. For example, “fizzing” is an observation but “a gas was given off” is not. Smells, such as the pungent smell of ammonia or the bleach or swimming pool smell of chlorine, are also acceptable as observations.

- When a question asks for the name of a chemical, a correct formula is always acceptable. However, if a candidate answers with an incorrect formula, then the mark will not be awarded.

**General comments**

The majority of candidates successfully attempted all of the questions.

**Question 4** was a planning task, testing the preparation of a soluble salt. There were several acceptable routes, most of which seemed familiar to candidates. The quality of answers was generally good.

**Comments on specific questions**

**Question 1**

**(a)** Most candidates included retort or clamp in the response for stand. The trough was not well known as a piece of apparatus used in the collection of gases.

**(b)** The question was well answered with most candidates appreciating that the mineral wool absorbed the paraffin oil. Many responses mentioned the fact that the mineral wool stopped the oil making contact with the aluminium oxide or increased its surface area.

**(c)** This question was very well answered by the vast majority of candidates. The small proportion of incorrect answers mentioned tests for other gases.

**(d)** Some candidates mentioned “suck back”, while others described the water moving up the delivery tube or into the test-tube, sometimes even explaining the phenomenon. Many candidates thought that the delivery tube was removed to stop more gas being collected.

**Question 2**

**(a)** Nearly all candidates could read the thermometer readings correctly.

**(b)** Nearly all candidates could read the thermometer readings correctly.

**(c)** The graphs were generally well plotted. Some candidates incorrectly used a ruler for the section 22–71 °C in Experiment 2. The plotting of the points was excellent throughout, although many candidates did not label the two graphs.

**(d)** Part **(i)** of this question was well answered but most candidates found **(ii)** very challenging. Many candidates did appreciate that they had to consider a value of 52°C, obtained by adding 30°C to the start temperature of 22°C, and then proceed to obtain a reading for the time of the reaction at 52°C. Candidates did not grasp the idea that 60 s must be subtracted from the graph value, as the reaction did not start until 60 s, when the magnesium was added to the copper(II) sulfate solution.

**(e)** A large proportion of candidates appreciated that the solution would return to room temperature, although many contradicted the value in the question by stating an incorrect initial or room temperature, such as 25 °C. The fact that the reaction had completed was well understood.

**(f)** This question was poorly answered, with most candidates making reference to “more accurate” or “more reliable”, rather than realising that it simply gave more data. Only a small proportion of candidates understood that more readings would give a smoother curve or a more accurate graph.

**(g)** Some candidates correctly answered in terms of insulation and reduction of heat loss. Many candidates thought that copper(II) sulfate and the copper can would react together.

**Question 3**

**(a) (i)** The vast majority of responses mentioned a pH value of below pH 7.

**(ii)** Candidates must realise that observations in reactions such as this one involve more than the test for the gas. In this case, there would also have been effervescence and the magnesium would dissolve or disappear.

**(iii)** Most candidates appreciated the gas released was carbon dioxide and correctly gave the test and result. The correct observation such “effervescence” or “solid disappears” was only seen in a small proportion of responses.

**(iv)** This question was well answered, although a common incorrect answer was “no change”.

**(b)** This question proved challenging to candidates and a wide range of chemicals and ions were included in the responses. Some candidates mentioned several ions and often contradicted a previous correctly identified ion.

**Question 4**

This question was answered in a variety of ways. Most candidates used one sample of the cleaner and covered two or three separation techniques. The most obvious method was to carry out filtration to remove the insoluble silica, followed by simple distillation to obtain water and then either further evaporation or crystallisation to obtain sodium carbonate.

Sometimes candidates carried out this separation by using three separate samples of the cleaner mixture. By doing this, candidates did not have to place the separation in a correct sequence. However, candidates often did not successfully separate the sodium carbonate from the silica.

One of the most common errors was an inappropriate sequence. A typical and common example included evaporation and condensation of water, before collecting sodium carbonate and silica together after the evaporation of the water. This did not separate the silica and sodium carbonate.

A small number of candidates did not identify the correct context and tried to separate the components by chromatography, while an even smaller number carried out some form of titration.

It is very important that candidates read the question carefully before they start to answer it. Many responses started by making the mixture before beginning to separate it, which was not necessary.