# CHEMISTRY

**Paper 0620/11**
**Multiple Choice**

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

## General Comments

Candidates performed quite well on this paper. **Questions 2**, **6**, **11**, **15**, **21**, **22**, **23**, **36** and **38** proved particularly straightforward with more than 80 % of candidates choosing the correct response. **Questions 19**, **32** and **35** proved to be difficult with less than 40 % of candidates choosing the correct response.

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

## Comments on Specific Questions

### Question 1

Response **B**. Candidates spotted 'close together' but did not read on to notice that the particles 'move'.

### Question 3

Response **C**. Candidates did not realise that merely filtration could be used to gain water from sand and water. Distillation would also work but response **C** gave an answer which would not work for salt and water.

**Question 12**

Response **B**. Candidates did not read the question fully. A radioactive isotope would be exothermic but would not need oxygen.

**Question 15**

Response **A**. Candidates clearly did not realise that bromine is not a gas.

**Question 18**

Response **C**. Candidates all knew that **B** and **D** correctly described a base but some were unsure of the other two reactions.

**Question 19**

Response **B**. Response **C** was more popular than the correct answer. Candidates clearly missed the point that copper does not react with dilute sulfuric acid whereas zinc oxide does.

**Question 20**

Response **A**. Candidates did not remember the sodium hydroxide tests for zinc and aluminium correctly.

**Question 24**

Response **B**. Candidates either remembered the litmus test wrongly or saw blue and did not see the 'to red' part.

**Question 26**

Response **A**. It is, sadly, a common misconception that all metals are attracted to magnets.

**Question 27**

Response **C**. Candidates must have misread the question as 'which gives the best reaction?'.

**Question 30**

Response **D**. Candidates knew the test for water but did not note the boiling temperature of the liquid concerned.

**Question 31**

Response **C**. **A** and **D** are more obviously wrong and candidates did not calculate the correct answer.

**Question 32**

Response **B**. Candidates did not know the source of lead pollution in air.

**Question 33**

Response **A**. Candidates missed the point that cars are painted and also did not realise that stainless steel was an alloy.

**Question 35**

Response **C**. This response was more popular that the correct answer. Candidates were not familiar with this source of methane which is a relatively new addition to the syllabus.

**Question 37**

Response **B**. Candidates mistakenly thought that petroleum was a compound.

**Question 39**

Response **A**. Candidates must have chosen this by mistaking fuel oil for just fuel.

**Question 40**

Response **D**. Alternatives **B** and **C** were more obviously wrong and candidates linked glucose with oxygen possibly by thinking of respiration or photosynthesis.

# CHEMISTRY

**Paper 0620/12**
**Multiple Choice**

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

## General Comments

Candidates performed quite well on this paper. **Questions 3**, **6**, **7**, **10**, **11**, **15**, **16**, **18**, **19**, **21**, **36** and **38** proved particularly straightforward with more than 80 % of candidates choosing the correct response. **Question 20** proved to be difficult with less than 40 % of candidates choosing the correct response.

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

## Comments on Specific Questions

### Question 1

Response **B**. Candidates spotted 'close together' but did not read on to notice that the particles 'move'.

### Question 5

Response **C**. Candidates did not realise that merely filtration could be used to gain water from sand and water. Distillation would also work but response **C** gave an answer which would not work for salt and water.

**Question 9**

Response **A**. Candidates did not realise that the question was asking about molten compounds.

**Question 13**

Response **B**. Candidates did not read the question fully. A radioactive isotope would be exothermic but would not need oxygen.

**Question 16**

Response **A**. Candidates clearly did not realise that bromine is not a gas.

**Question 20**

Response **B**. Response **C** was more popular than the correct answer. Candidates clearly missed the point that copper does not react with dilute sulfuric acid whereas zinc oxide does.

**Question 22**

Response **A**. Candidates did not remember the sodium hydroxide tests for zinc and aluminium correctly.

**Question 23**

Response **C**. Candidates all knew that **B** and **D** correctly described a base but some were unsure of the other two reactions.

**Question 24**

Response **D**. Candidates knew the test for water but did not note the boiling temperature of the liquid concerned.

**Question 27**

Response **A**. It is, sadly, a common misconception that all metals are attracted to magnets.

**Question 29**

Response **C**. Candidates must have misread the question as 'which gives the best reaction?'.

**Question 30**

Response **B**. Candidates either remembered the litmus test wrongly or saw blue and did not see the 'to red' part

**Question 31**

Response **A**. Candidates missed the point that cars are painted and also did not realise that stainless steel was an alloy.

**Question 33**

Response **B**. Candidates did not know the source of lead pollution in air.

**Question 34**

Response **C**. Candidates were not familiar with this source of methane which is a relatively new addition to the syllabus.

**Question 38**

Response **A**. Candidates must have chosen this by mistaking fuel oil for just fuel.

**Question 40**

Response **B**. Candidates mistakenly thought that petroleum was a compound.

# CHEMISTRY

**Paper 0620/13**
**Multiple Choice**

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

## General Comments

Candidates performed well on this paper. **Questions 2**, **3**, **4**, **6**, **8**, **10**, **11**, **15**, **16**, **18**, **20**, **36** and **38** proved particularly straightforward with more than 90 % of candidates choosing the correct response. There were no questions where fewer than 40 % of candidates chose the correct response.

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

## Comments on Specific Questions

### Question 5

Response **C**. Candidates did not realise that merely filtration could be used to gain water from sand and water. Distillation would also work but response **C** gave an answer which would not work for salt and water.

**Question 13**

Response **B**. Candidates did not read the question fully. A radioactive isotope would be exothermic but would not need oxygen.

**Question 17**

Response **A**. Candidates clearly did not realise that bromine is not a gas.

**Question 19**

Response **A**. Candidates did not remember the sodium hydroxide tests for zinc and aluminium correctly.

**Question 21**

Response **B**. Response **C** was more popular than the correct answer. Candidates clearly missed the point that copper does not react with dilute sulfuric acid whereas zinc oxide does.

**Question 22**

Response **C**. Candidates all knew that **B** and **D** correctly described a base but some were unsure of the other two reactions.

**Question 24**

Response **D**. Candidates knew the test for water but did not note the boiling temperature of the liquid concerned.

**Question 26**

Response **B**. Candidates either remembered the litmus test wrongly or saw blue and did not see the 'to red' part.

**Question 28**

Response **C**. Candidates must have misread the question as 'which gives the best reaction?'.

**Question 29**

Response **A**. It is, sadly, a common misconception that all metals are attracted to magnets.

**Question 31**

Response **A**. Candidates missed the point that cars are painted and also did not realise that stainless steel was an alloy.

**Question 32**

Response **B**. Candidates did not know the source of lead pollution in air.

**Question 34**

Response **C**. This response was more popular that the correct answer. Candidates were not familiar with this source of methane which is a relatively new addition to the syllabus.

**Question 37**

Response **A**. Candidates must have chosen this by mistaking fuel oil for just fuel.

# CHEMISTRY

**Paper 0620/21**

**Core Theory**

## Key Messages

- Questions requiring simple answers to inorganic chemistry were generally done well as were questions involving equations, calculation of molecular mass and graphical work.
- Questions on some aspects of practical procedures (e.g. chromatography) were well known. Descriptions of other procedures, such as titrations, need to contain more focused explanations.
- Some candidates need more practice on answering questions requiring extended answers e.g. **Question 2(b)** and **3(d)(i)**. Questions involving extended writing need to contain the same number of relevant points as the number of marks available.
- It is important that candidates read the question carefully in order to understand what exactly is being asked.
- Many candidates need more practice at answering questions on environmental aspects of chemistry and qualitative analysis tests for specific ions and molecules.

## General Comments

Many candidates tackled this paper well, showing a very good knowledge of core Chemistry. Good answers were seen to most parts of **Question 1** and **Question 3**. Nearly all candidates were entered at the appropriate level.

The rubric was occasionally misinterpreted. For example, in **Question 3(b)** some candidates wrote about chemical reactivity or density rather than metallic character whilst in **Question 5(a)(iii)** some candidates wrote about molecular collisions rather than relating the speed of reaction to temperature. A considerable number of candidates left blank spaces in **Question 2(d)** (test for iron(III) ions), **Question 4(a)** (test for unsaturation), **Question 6(e)** (methane in the atmosphere) and in **Question 7(d)** (titration).

The extraction of information from tables of data and the drawing of a graph were generally well done. Candidates performed less well on questions where the information was couched in unfamiliar terms. For example, in **Question 2(b)** only a few could explain convincingly the reason why the volume of air did not change. In **Question 5(a)(iii)** and **5(b)** many candidates wrote about time or used the kinetic theory in their answers rather than writing about speed of reaction.

The standard of English was good and seemed more accurate than in previous November sessions. A few candidates wrote their answers in the form of short phrases or bullet points. Candidates are less likely to write vague statements or contradict themselves if this is done. As in previous sessions, quantitative tests for specific groups were not well known. For example, a considerable number of candidates were challenged by **Question 4(a)** where the bromine water test to distinguish between ethene and ethane was required. In organic chemistry, many candidates could identify the alcohol functional group and understood addition polymerisation. Fewer could describe the conditions for cracking. Many candidates had a good knowledge of inorganic chemistry and could interpret formulae and balance symbol equations, correctly.

**Comments on Specific Questions**

**Question 1**

Most candidates scored well on this question, **(a)(i)** and **(c)** almost invariably being correct.

**(a)**

**(i)** Most candidates could describe an area in everyday life where the purity of substances is important. A few did not gain credit because they gave vague answers such as 'kitchens' or 'lakes'.

**(ii)** Some candidates realised that the boiling point of water would be affected by impurities. The commonest incorrect answer was that mineral water boils at 100 $^{o}$C.

**(b)** Most candidates labelled the chromatography diagram correctly. The commonest incorrect answer was to label the chromatography paper as the solvent and the solvent as the chromatography paper.

**(c)**

**(i)** Most candidates gained credit for this part. The commonest incorrect answer was **B**.

**(ii)** Nearly all candidates gave the correct answer. A few incorrectly suggested **A**, **B** and **D**.

**(iii)** This was invariably correct.

**Question 2**

Part **(a)** and **(e)** were generally done well. In **(b)** and **(c)** some candidates gave a good explanation of the observations made when iron rusts. Others gave vague answers or referred to the water rather than oxygen. Few candidates knew the test for iron(III) ions in **(d)**.

**(a)** Most candidates realised that air and water are required for rusting. A significant minority only gave one of these requirements.

**(b)** Some candidates gave a good explanation of why the water level increased then remained constant. Others referred to air rather than oxygen or suggested that the water was being used up in the rusting. Many just referred to the situation at the start and after 4 weeks and did not give an explanation of why there was a contraction in the volume of the air in the cylinder in the first 2 weeks. Others thought that the rust itself was a limiting factor and that once formed on the surface, no more oxygen could react.

**(c)** About half the candidates realised that the iron at the start was a grey or silvery colour. Others suggested, incorrectly, that it was 'blue' or 'a normal' colour. Many thought that rust was yellow or white in colour. A significant minority gave answers which were not observations e.g. reference to volumes of air or just stating 'normal' and 'rusted'.

**(d)** Those candidates who knew that sodium hydroxide was the test reagent usually got the correct colour change. Most candidates suggested adding hydrochloric acid rather than sodium hydroxide. Fizzing with acid or water was a common incorrect answer. Several candidates thought that a magnet would test for the ions.

**(e)** Most candidates could write the word equation. Common errors were iron chlorine instead of iron chloride and writing the name of the type of reaction rather than the equation.

**Question 3**

Most candidates performed well on this question, parts **(a)(d)(ii)** and **(f)** being particularly well done. Some candidates described characteristics other than metallic character when answering **(b)**. Many candidates were awarded full credit for good descriptions of the structure of the aluminium atom. Others only wrote about the electrons.

**(a)**

**(i)** Most candidates recognised that Mg or Na form basic oxides. The commonest incorrect answers were P, Si or Ar.

**(ii)** Many candidates correctly selected 2 acidic oxides from the list. Others wrote down one acidic and one basic oxide, even when they had written down a basic oxide in **(i)**.

**(b)** Some candidates realised that the metallic character decreases across a period but most gave answers which were not related to metallic properties. The commonest error was to suggest 'the elements get less reactive across a period'. Changes in other properties across a period were also mentioned e.g. density, melting point.

**(c)** About half the candidates realised that the proton number determines the order of the elements in the Periodic Table. The commonest errors were to suggest number of electrons or relative atomic mass.

**(d)**

**(i)** Some candidates gave excellent answers mentioning the particles in the nucleus as well as the number of electrons and the electronic configuration. Others did not write enough, usually because they only referred to the electrons rather than to the protons and neutrons. Credit was most commonly awarded for the electronic configuration and the correct number of protons and neutrons. The word 'nucleus' was seldom used.

**(ii)** Most candidates extracted the correct pieces of information from the table. Typical errors were to refer to strength, melting points and (less commonly) price.

**(e)** About half the candidates gained full credit. The commonest error was to write bromine as Br rather than $Br_2$. Most candidates correctly balanced the equation. Candidates who received no credit usually wrote $H_2O$ or C*l* in place of $Br_2$.

**(f)** Many candidates realised that argon has a complete outer shell of electrons. The commonest error was to suggest 2 electrons in the outer shell. The (incorrect) use of argon for filling balloons was also seen fairly often.

**Question 4**

Many candidates gave good answers to **(a)(iii)**, **(a)(iv)** and **(c)**. Fewer could describe a test to distinguish ethene from ethane or give the conditions required for cracking.

**(a)** Some candidates gave good answers which indicated that bromine would go from orange to colourless when ethene is bubbled through it but there is no colour change when ethane is bubbled through. Others just wrote that 'there will be a colour change' (without any details) or 'one reacts and the other doesn't'. Many candidates did not respond to the question.

**(b)**

**(i)** Some candidates mentioned high temperature and catalyst. Candidates receiving only partial credit generally mentioned high temperature only. Many gave incorrect answers referring to a requirement for water, high pressure or details of the apparatus. Some just stated temperature, which is insufficient to receive credit.

**(ii)** Many candidates realised that there were separate layers of gas and liquid; most just referred to bubbles rather than the separate layers.

**(iii)** Many candidates calculated the molecular mass of propene correctly. The main errors were to use atomic numbers, to make addition errors or to use formulae other than that given for propene.

**(iv)** A majority of the candidates gave the correct formula. A few put just 4 or $CH_2$.

**(c)** Most candidates realised that poly(ethene) is formed by addition polymerisation. More candidates received credit for 'polymerisation' rather than 'addition'. 'Condensation' or 'neutralisation' were the usual replacements for the word addition. 'Dehydration' or 'fermentation' occasionally replaced the word polymerisation.

**Question 5**

Many candidates gained credit in **(a)(i)** and **(ii)** and **(c)(i)** and **(ii)**. Graph plotting was, on the whole, accurate. Many candidates gave vague answers relating how temperature and concentration affect the speed of a reaction. Few knew how to remove sulfur dioxide from flue gases.

**(a)**

**(i)** Most candidates plotted the graph accurately and drew the best curve through the points. Some plotted the first point (15 $^{o}$C) incorrectly. A small number of candidates joined up the points using straight lines.

**(ii)** Most candidates realised that the reaction was fastest at 75 $^{o}$C. A considerable minority suggested that 15 $^{o}$C or 15-30 $^{o}$C was the temperature at which the reaction was fastest.

**(iii)** About half the candidates gained credit here. Many just referred to temperature rather than increase (or decrease) in temperature. Many referred to the movement and collision of molecules rather than the effect on speed of reaction.

**(b)** Many candidates realised that the speed increases as the concentration increases. Many others suggested that the reaction was slower when the concentration increased.

**(c)**

**(i)** About half the candidates correctly identified sodium chloride. Common errors were ammonia, sulfur or sulfur dioxide.

**(ii)** Most candidates correctly identified group VI. There was no consistent incorrect answer, but groups 1, 2, 3 or 4 were often seen rather than groups 7 or 0.

**(iii)** Many answers to this question were too vague. A definite effect was required rather than the generalisation 'acid rain'. Typical vague answers included 'affects lungs', 'poisons us' and 'affects the ozone layer'.

**(iv)** Few candidates realised that flue gas desulfurisation involves the reaction of an acidic gas with the base calcium oxide. The commonest incorrect answer was nitrogen dioxide. Potassium nitrate was also commonly seen as an incorrect answer.

**(v)** Some candidates referred to both the magnesium and sulfur dioxide and gained full credit. Many only wrote about one aspect of a redox reaction, often the oxidation part. There were many vague answers such as 'sulfur is now alone' which were deemed insufficient to receive credit.

**Question 6**

This was the lowest scoring question on the paper. The context of the question in terms of the apparatus (Bunsen burner and U-tubes) seemed to make the candidates guess many of the answers. Part **(e)** posed the most problems for candidates. Few knew a source of methane or an effect of methane on the atmosphere. As has been noted in previous Principle Examiner Reports for Teachers, this is a topic which candidates need to revise more.

**(a)** About half the candidates received full credit. Those who wrote oxygen as $O_2$, generally gained credit for balancing the equation. Common errors were $H_2O$, OH or $O_3$ instead of $O_2$.

**(b)** About half the candidates recognised that carbon monoxide would be formed. Common errors included carbon dioxide and chlorine. The latter can only be explained if candidates are muddling methane up with other pollutant gases in the atmosphere such as CFCs.

**(c)** There were some good answers to this question. Some referred to the lack of oxygen or unburnt gases. The commonest errors centred on the matchstick e.g. 'the wood is not reactive' or were vague statements e.g. 'because of the flame'.

**(d)**

**(i)** Few candidates realised that water turned white copper sulfate blue, perhaps because of the context of the question. The commonest error was to suggest 'ammonia'. 'Chloride' was often written.

**(ii)** A considerable number of candidates did not answer this question. Many vague answers were given such as 'evaporation', crystallisation' and 'doing the experiment backwards'. Chlorine appeared again here – 'adding chlorine' was not uncommonly seen as an answer.

**(iii)** Some candidates gave good answers relating the increase in the mass of the tube to the increased mass of carbon dioxide absorbed. Many only gained partial credit because they did not heed the word 'explain' in the stem of the question and only stated that there was an increase in mass. A large proportion of the candidates suggested that the tube would decrease in mass.

**(e)**

**(i)** Few candidates knew a source of methane in the atmosphere. Common incorrect answers included 'cars', 'clouds' and 'ozone'. There were many vague answers such as 'contamination by cows'.

**(ii)** The effect of methane in the atmosphere was not well known. The commonest incorrect answers included 'harms plants' and 'affects crops'. The commonest vague answers were 'it increases temperature' and 'blocks sunlight'.

**Question 7**

A few candidates performed well on this question. Others received no credit for counting the atoms in citric acid or for explaining how to carry out a titration. Many could identify the alcohol functional group and showed an understanding of how to separate a solid from a solution.

**(a)** About a third of the candidates realised that a drop in temperature meant that the reaction was endothermic. A greater proportion of candidates incorrectly thought that the reaction was exothermic.

**(b)**

**(i)** Many candidates recognised the alcohol functional group. Common errors were to put a circle around the COOH group or around the carbon atom as well as the OH group i.e. HOC.

**(ii)** A minority of candidates counted the atoms correctly. The two main errors were to regard the formula as a series of separate compounds e.g. $C_3H_4$ + COOH + $COOH_3$ or to guess an empirical formula e.g. $CH_2$. Sometimes oxygen was left out altogether.

**(c)**

**(i)** Many candidates gave good answers explaining clearly the nature of enzymes. Others realised that enzymes were present in living things but did not mention their catalytic nature.

**(ii)** This was generally well answered. The commonest errors were to suggest 'fractional distillation' or 'heating'.

**(iii)** The limewater test was well described by many candidates. Others either left the question unanswered or suggested that carbon dioxide pops with a glowing or lighted splint.

**(d)** Many candidates left this question unanswered. Credit usually awarded was for the addition of the alkali to the acid (although many thought that this was the other way round). Few mentioned adding an indicator and just stated that the solution changed colour.

**Question 8**

Some candidates showed a sure grasp of electrolysis. Others gave answers in **(c)** and **(d)** which showed that they did not know how the products formed when a solution of sodium chloride is electrolysed, differ from the products of the molten salt.

**(a)**

**(i)** The cathode was generally correctly identified. The commonest error was to suggest **E**. The commonest incorrect answer for the electrolyte was to again suggest letter **E** (which is the anode).

**(ii)** Most candidates recognised graphite to be the most likely anode. The commonest error was to suggest sodium.

**(b)** Many candidates realised that the sodium floats on top of the melt if it is less dense. There were many rather vague answers such as 'the sodium is up'.

**(c)** Some candidates correctly predicted that chlorine is formed at the anode. Chloride was a common error. Many more candidates suggested incorrect products such as sodium, S (possibly arising from the incorrect symbol for sodium) and hydrogen. Aluminium was not uncommonly seen as an incorrect answer, perhaps through candidates not looking at the question in context and merely looking back at the diagram, thinking that it was a cross section of the cell used in this electrolysis.

**(d)** Some candidates realised the difference in the products formed when a solution of sodium chloride is electrolysed. Others suggested that chlorine or hydrogen were formed at the cathode. Carbon dioxide was not uncommonly suggested to be either an anode or cathode product.

# CHEMISTRY

**Paper 0620/22**

**Core Theory**

## Key Messages

- Questions requiring simple answers to inorganic chemistry were done well, while answers to physical properties and practical procedures need to contain more focused explanations.
- Questions on atomic structure and organic chemistry were generally well done, while some candidates need more practice in answering questions relating to petroleum fractionation.
- It is important that candidates read the question carefully in order to understand what is exactly being asked.
- Questions involving extended writing need to contain the same number of relevant points as the number of marks available.
- Interpretation of data from graphical information should be as precise as possible.

## General comments

Many candidates tackled this paper well, showing a very good knowledge of core Chemistry. Good answers were seen to most parts of **Question 1** and **Question 2**. Nearly all candidates were entered at the appropriate level.

The rubric was occasionally misinterpreted. For example, in **Question 2(a)** some candidates gave properties rather than uses whilst in **Question 5(b)(iv)** many wrote about acidity and alkalinity rather than changes in pH. Many candidates ignored the instruction to tick two boxes in **Question 6(e)** and only ticked one box. A considerable number of candidates left blank spaces in the calculation in **Question 5(b)(ii)** and in the formula calculation **Question 6(d)**. Many candidates did not draw the arrow in **Question 4(c)(i)**. Candidates should make sure that they also answer questions of this nature, where there is no answer line.

A considerable number of candidates did not respond to **Question 7(d)** which required knowledge of the chemical test for ammonium ions. The extraction of information from graphs was not always precise enough and greater precision is also required in the interpretation of information given in the stem of the question. For example, in **Question 2(b)(i)** and **3(b)(ii)** many candidates wrote about volumes of oxygen or time rather than concentrations.

The standard of English was good and seemed more accurate than in previous November sessions. Some candidates wrote their answers in the form of short phrases or bullet points. Candidates are less likely to write vague statements or contradict themselves if this is done. As in previous sessions, quantitative tests for specific groups were not well known. For example, a considerable number of candidates were challenged by the question on the test for ammonium ions (**Question 7(d)**). The products of electrolysis of aqueous sodium chloride and the nature of the electrodes used were also not well known (**Question 5(c)**) and some candidates kept repeating themselves unnecessarily. In organic chemistry, many candidates could write the correct displayed formulae of ethane and ethanol, whilst others had a limited knowledge of petroleum fractionation and homologous series. Many candidates had a fairly good knowledge of inorganic chemistry and many could interpret formulae and write equations, including symbol equations, correctly.

**Comments on Specific Questions**

**Question 1**

This was the best answered question on the paper. Most candidates had a sure grasp of which pieces of apparatus are used for particular purposes and many were able to complete the equation in **(b)(iii)**.

**(a)**

**(i)** Few candidates realised that in order to measure out a volume of liquid accurately, a burette is superior to a measuring cylinder.

**(ii)** Nearly all candidates correctly identified the dropping pipette.

**(iii)** Nearly all candidates correctly identified the condenser.

**(iv)** Nearly all candidates correctly identified the flask.

**(v)** Most candidates correctly identified the burette. A significant number of candidates who gained credit in **(i)** gave the incorrect answer **B** here. This suggests that they did not read the stem of the question which states that each letter can be used more than once.

**(b)**

**(i)** This was well answered, limestone being the commonest correct response. Marble and chalk were less often seen. The commonest incorrect responses were haematite, graphite and salt. A small number of candidates suggested the incorrect answer igneous rocks.

**(ii)** Only about a third of the candidates realised that carbon dioxide is heavier than air, despite the information from the diagram. The commonest error was to suggest that it is lighter than air. A significant number thought that it had the same density.

**(iii)** The equation was generally successfully completed. The major error was to suggest that hydrogen rather than water is the product. Some candidates incorrectly put oxygen in the left-hand space or put a 2 in front of the water.

**Question 2**

This question was generally well done. Most candidates had a good grasp of atomic structure as shown by good answers to **(b)(ii)** and **(c)(iii)**. Fewer candidates described observations in **(c)(i)**, many just referring to the chemical reaction and the products formed.

**(a)**

**(i)** Many candidates realised that copper could be used in electrical wiring. Some gave answers relating to pans used for cooking. Others did not gain credit because they gave too vague an answer writing about wiring or utensils without any further qualification.

**(ii)** The commonest correct answer referred to jewellery or electrodes. Some did not gain credit because they referred to electrolysis in general or suggested that platinum is used to make cars or aircraft. The answer ‘alloy’ was also too vague – a specific use was required.

**(iii)** The commonest correct answer referred to the use of aluminium in aircraft bodies. Some gained credit for mentioning its use in overhead electricity cables. The commonest incorrect answers arose because of vague writing e.g. ‘in wires’, ‘as an alloy’.

**(b)**

**(i)** Many candidates gave an answer referring to the poisonous nature of lead or the effect of lead on the nervous system. Some did not gain credit because they wrote about cancer in general or non-specific effects on the stomach e.g. causes stomach ache.

**(ii)** The correct number of protons and neutrons was generally given. The commonest errors were to suggest 82 neutrons and 127 protons or suggest that there are 207 of one or other of these particles.

**(c)**

**(i)** Many candidates wrote about the reaction itself (e.g. there is a violent reaction) or described the products including what happens when litmus is put into the solution. The latter was not mentioned in the question and so could not be given credit. Many thought that sodium would catch fire immediately. It only does so when there is a restricted amount of water. The best answers included the sodium darting about on the surface, making bubbles and a fizzing (sound).

**(ii)** Many candidates gained partial credit for either sodium hydroxide or hydrogen. Significantly fewer gained full credit. The commonest error was to suggest that sodium oxide is formed. Other common errors were to suggest water or oxygen instead of hydrogen and sodium chloride instead of sodium hydroxide.

**(iii)** Many candidates gained full credit here. The commonest error was to suggest positive (ion) instead of negative ion. A less common error was to suggest molecule instead of ion. Those candidates who did not get the first marking point (electron) usually gave answers which appeared to be random.

**Question 3**

This question was well done by some candidates. Many candidates interpreted much of **(b)** incorrectly and the information on the graph was not always given to the accuracy required. Many candidates gave good answers to **(a)** and **(c)**. Others did not interpret the information correctly.

**(a)** This was generally well done with most candidates gaining at least partial credit. Common errors included just writing manganese dioxide rather than mentioning the same mass of manganese dioxide, referring to the time taken for the experiment or referring to the apparatus e.g. same gas syringe.

**(b)**

**(i)** Many candidates were content to refer to the time or the volume of oxygen rather than stating that the rate increased when the concentration increased. A considerable number did not understand that rate is inversely related to time and wrote that the higher the concentration, the slower is the rate.

**(ii)** Reference to volume of oxygen or time rather than the concentration or amount of hydrogen peroxide present was the main error.

**(iii)** Most candidates gave answers that where not accurate enough. This was especially relevant to line **A**, where most candidates gave the inaccurate answer 25. The answer relating to line **B** was more successfully answered by most candidates.

**(c)** Many candidates used the information in the table to successfully answer the question. Some appeared to relate the question to the activity series rather than the effectiveness of the catalysts. A few candidates wrote magnesium or manganese twice through carelessness.

**Question 4**

This question was one of the least well answered on the paper. Parts **(a)**, **(c)(ii)** and **(c)(iii)** posed problems for many. The structure of ethane was well known and many realised that it was a saturated compound.

**(a)** Only about a third of the candidates remembered that methane is the main substance found in natural gas. Many gave the incorrect answer 'hydrogen'. Others were probably thinking of the gases in the air when they gave answers such as nitrogen or oxygen. Crude oil was also another incorrect answer often seen.

**(b)** The structure of liquids was better known than in previous November sessions of this examination. Many candidates realised that the particles are close together, even if they expressed it in incorrect terms e.g. the implication of a structure rather like a solid. Others gave vague statements such as 'they are a little far apart' or 'less far apart than in a gas'. Such statements were not sufficient to gain credit. Most realised that the particles were arranged randomly or irregularly. Fewer gave convincing statements about how the particles moved. The best answers indicated restricted movement.

**(c)**

**(i)** This was well answered, most candidates realising where the vaporised petroleum enters the column. A significant number of candidates did not respond to this question.

**(ii)** Very few could explain that a fraction is a group of molecules with similar boiling points or a range of boiling points fairly close to each other. Most answers concentrated on the distillation process itself and the separation by different boiling points. Others responded by giving a mathematical definition of a fraction.

**(iii)** A few candidates understood the relative positions of naphtha and diesel in the fractionation column. Others placed diesel or petrol where naphtha should be or wrote paraffin or petrol in place of diesel. A significant number named specific substances, hydrogen, methane and propane being common incorrect answers. Petroleum was also not uncommonly seen as an incorrect answer.

**(iv)** The structure of ethane was well understood by many candidates. Common errors were to draw the structure of methane, to draw ethane with a double bond or to place C atoms where H atoms should be.

**(v)** Most candidates understood that ethane is a saturated hydrocarbon. Amongst the candidates there was an equal proportion of the incorrect answers unsaturated, polymerises and alkene.

**Question 5**

Part **(a)** of this question was well answered and many could do the calculation in **(b)(ii)**. The other parts were done well by some candidates but not by others. In **(b)(iv)** many candidates did not gain the credit they might have done because they referred to changes in acidity rather than to changes in pH.

**(a)** Nearly all the candidates could successfully match the definitions to the relevant scientific words.

**(b)**

**(i)** Many candidates realised that a strongly alkaline solution is nearer pH 13 than pH 8. Many need to revise the pH scale, the incorrect answers pH 7 and pH 5 being quite commonly seen.

**(ii)** Well over half the candidates could do the formula mass calculation. Common errors were to multiply the atomic masses rather than add them, to use the atomic numbers rather than atomic masses and to calculate the formula mass of potassium hydroxide rather than sodium hydroxide.

**(iii)** Under half the candidates realised that this was a neutralisation reaction. The commonest answer was exothermic. Displacement was another incorrect answer commonly seen.

**(iv)** Many candidates made only passing reference to pH. Many just wrote that 'the solution will get more acidic'. Some thought that the pH would go up at first and then go down again. Many did not read the question well enough and missed the statement 'until the hydrochloric acid is in excess'. This meant that they only wrote about what happens up to the neutralisation point.

**(c)** A few candidates answered this extended response question very well. Some candidates repeated themselves or wrote rather vague statements. Many defined what a cathode and anode is or wrote about bulbs lighting up. None of these things were required by the question. The main errors were in suggesting that copper electrodes were used, not giving a reason for the use of graphite electrodes, not stating any observations of what happens during the electrolysis, suggesting that sodium is formed at the cathode or suggesting that chlorine is formed at the cathode.

**Question 6**

Parts **(b)(ii)**, **(c)(ii)** and **(e)** were particularly well answered. Few candidates could relate the structures of diamond and graphite to their properties and uses. Many left the electronic structure question in **(d)** blank but those who attempted it often gave the correct electron arrangement.

**(a)** A few candidates gave good answers referring to the use of coke as a reducing agent. Many knew that it was used to extract metals from their oxides. Others did not read the stem of the question to relate coke to coal. This led to incorrect answers such as 'for drinks', 'for cleaning' and 'for coatings' being seen quite often.

**(b)**

**(i)** A few candidates were able to link the structure of graphite to its use as a lubricant. The commonest error regarding graphite was to suggest that the atoms slide, rather than the layers slide. Many candidates had some idea why diamond is hard. Very often the answers were too vague. If strong bonds were mentioned, 'in all directions' or 'lots of' was not mentioned (and vice-versa).

**(ii)** Most candidates realised that diamonds can be used for cutting or drilling. Incorrect answers usually related to the use of diamonds in jewellery or vague statements about diamond not melting or not breaking.

**(c)**

**(i)** Just under half the candidates gained credit for this part. Common errors included ammonia instead of ammonium, ammonium sulfuric instead of ammonium sulfate and sulfur dioxide

**(ii)** This was generally well answered, most candidates choosing nitrogen. Sulfur was the commonest error.

**(d)** Most candidates who answered this question realised that there were two electrons in each of the 'overlap' regions. The commonest error was to put extra electrons on the outer shell of the carbon atom in between the bonding electrons. A few candidates also gave hydrogen 8 electrons in its outer shell rather than 2.

**(e)** This was well answered. A significant minority of the candidates only gave 1 tick despite the stem of the question clearly stating that 2 should be shown. The commonest error was to suggest that most of the sulfur dioxide comes from car exhausts.

**Question 7**

This was the least well done question on the paper, parts **(a)**, **(c)** and **(f)** did not score well in comparison with the other parts. Parts **(c)** and **(f)** were practically orientated. Candidates need to practice these types of questions more and learn more precisely, the details in the qualitative analysis tests for specific ions.

**(a)**

**(i)** Some candidates had a clear understanding of the term *homologous series* and gained full credit. Others had a vague idea but were not accurate enough in their definitions. For example 'they have a similar formula' or 'they have a molecular formula' is not sufficient for 'same general formula'. Similarly 'they have a functional group' is not sufficient - it must be the same functional group. Common errors included long chains, they contain carbon and hydrogen or referring to alcohols only rather than giving a generalised definition e.g. they have an OH group.

**(ii)** The structure of ethanol was better drawn than in previous sessions. Common errors included a double bond between the C and the OH group, linking the OH group incorrectly i.e. C – H – O and drawing a carbonyl rather than an OH functional group.

**(b)**

**(i)** About half the candidates gained credit here. The main errors were either to suggest endothermic or to write exothermic without any explanation.

**(ii)** About half the candidates realised that iodine is grey or black in colour. The commonest errors were to suggest brown, blue or, less often, purple.

**(c)** A few high-scoring candidates gave excellent answers in which the excess zinc was first removed by filtration followed by evaporation to the point of crystallisation and then leaving to crystallise. Most seemed not to realise that the excess zinc should first be filtered off and so they could not gain credit for a suitable method of crystallisation.

**(d)**

**(i)** Some candidates obtained the correct formula, $ZnI_2$, by ion counting. Others just did not count the ions and just wrote ZnI or counted them and gave the incorrect ratio, $Zn_2I$. Other common errors were $Zn_5I_{10}$ and writing incorrect charges on each species.

**(ii)** Most candidates recognised that ZnI is a giant ionic structure. The commonest error was to suggest metallic or giant covalent.

**(e)** This was better done than **Question 6(c)(i)** with ammonium rather than ammonia being seen more often. Nearly all candidates identified water. Fewer identified ammonium nitrate; ammonium nitric acid often being written instead. Ammonium nitrate was also written as a variety of other nitrogen compounds. Zinc nitrate was generally identified correctly.

**(f)** Many candidates gave the test for ammonia gas. Few realised that sodium hydroxide had to be added (with warming) to distinguish ammonium ions from ammonia gas. Consequently only a few candidates gained credit for this. Most of the candidates, who suggested that sodium hydroxide should first be added, went on to state that a white precipitate is formed.

# CHEMISTRY

**Paper 0620/23**

**Core Theory**

## Key Messages

- Questions requiring simple answers to inorganic chemistry were done well, while answers to physical properties and practical procedures need to contain more focused explanations.
- Questions on atomic structure and organic chemistry were generally well done, while some candidates need more practice in answering questions relating to petroleum fractionation.
- It is important that candidates read the question carefully in order to understand what is exactly being asked.
- Questions involving extended writing need to contain the same number of relevant points as the number of marks available.
- Interpretation of data from graphical information should be as precise as possible.

## General comments

Many candidates tackled this paper well, showing a very good knowledge of core Chemistry. Good answers were seen to most parts of **Question 1** and **Question 2**. Nearly all candidates were entered at the appropriate level.

The rubric was occasionally misinterpreted. For example, in **Question 2(a)** some candidates gave properties rather than uses whilst in **Question 5(b)(iv)** many wrote about acidity and alkalinity rather than changes in pH. Many candidates ignored the instruction to tick two boxes in **Question 6(e)** and only ticked one box. A considerable number of candidates left blank spaces in the calculation in **Question 5(b)(ii)** and in the formula calculation **Question 6(d)**. Many candidates did not draw the arrow in **Question 4(c)(i)**. Candidates should make sure that they also answer questions of this nature, where there is no answer line.

A considerable number of candidates did not respond to **Question 7(d)** which required knowledge of the chemical test for ammonium ions. The extraction of information from graphs was not always precise enough and greater precision is also required in the interpretation of information given in the stem of the question. For example, in **Question 2(b)(i)** and **3(b)(ii)** many candidates wrote about volumes of oxygen or time rather than concentrations.

The standard of English was good and seemed more accurate than in previous November sessions. Some candidates wrote their answers in the form of short phrases or bullet points. Candidates are less likely to write vague statements or contradict themselves if this is done. As in previous sessions, quantitative tests for specific groups were not well known. For example, a considerable number of candidates were challenged by the question on the test for ammonium ions (**Question 7(d)**). The products of electrolysis of aqueous sodium chloride and the nature of the electrodes used were also not well known (**Question 5(c)**) and some candidates kept repeating themselves unnecessarily. In organic chemistry, many candidates could write the correct displayed formulae of ethane and ethanol, whilst others had a limited knowledge of petroleum fractionation and homologous series. Many candidates had a fairly good knowledge of inorganic chemistry and many could interpret formulae and write equations, including symbol equations, correctly.

**Comments on Specific Questions**

**Question 1**

This was the best answered question on the paper. Most candidates had a sure grasp of which pieces of apparatus are used for particular purposes and many were able to complete the equation in **(b)(iii)**.

**(a)**

**(i)** Few candidates realised that in order to measure out a volume of liquid accurately, a burette is superior to a measuring cylinder.

**(ii)** Nearly all candidates correctly identified the dropping pipette.

**(iii)** Nearly all candidates correctly identified the condenser.

**(iv)** Nearly all candidates correctly identified the flask.

**(v)** Most candidates correctly identified the burette. A significant number of candidates who gained credit in **(i)** gave the incorrect answer **B** here. This suggests that they did not read the stem of the question which states that each letter can be used more than once.

**(b)**

**(i)** This was well answered, limestone being the commonest correct response. Marble and chalk were less often seen. The commonest incorrect responses were haematite, graphite and salt. A small number of candidates suggested the incorrect answer igneous rocks.

**(ii)** Only about a third of the candidates realised that carbon dioxide is heavier than air, despite the information from the diagram. The commonest error was to suggest that it is lighter than air. A significant number thought that it had the same density.

**(iii)** The equation was generally successfully completed. The major error was to suggest that hydrogen rather than water is the product. Some candidates incorrectly put oxygen in the left-hand space or put a 2 in front of the water.

**Question 2**

This question was generally well done. Most candidates had a good grasp of atomic structure as shown by good answers to **(b)(ii)** and **(c)(iii)**. Fewer candidates described observations in **(c)(i)**, many just referring to the chemical reaction and the products formed.

**(a)**

**(i)** Many candidates realised that copper could be used in electrical wiring. Some gave answers relating to pans used for cooking. Others did not gain credit because they gave too vague an answer writing about wiring or utensils without any further qualification.

**(ii)** The commonest correct answer referred to jewellery or electrodes. Some did not gain credit because they referred to electrolysis in general or suggested that platinum is used to make cars or aircraft. The answer ‘alloy’ was also too vague – a specific use was required.

**(iii)** The commonest correct answer referred to the use of aluminium in aircraft bodies. Some gained credit for mentioning its use in overhead electricity cables. The commonest incorrect answers arose because of vague writing e.g. ‘in wires’, ‘as an alloy’.

**(b)**

**(i)** Many candidates gave an answer referring to the poisonous nature of lead or the effect of lead on the nervous system. Some did not gain credit because they wrote about cancer in general or non-specific effects on the stomach e.g. causes stomach ache.

**(ii)** The correct number of protons and neutrons was generally given. The commonest errors were to suggest 82 neutrons and 127 protons or suggest that there are 207 of one or other of these particles.

**(c)**

**(i)** Many candidates wrote about the reaction itself (e.g. there is a violent reaction) or described the products including what happens when litmus is put into the solution. The latter was not mentioned in the question and so could not be given credit. Many thought that sodium would catch fire immediately. It only does so when there is a restricted amount of water. The best answers included the sodium darting about on the surface, making bubbles and a fizzing (sound).

**(ii)** Many candidates gained partial credit for either sodium hydroxide or hydrogen. Significantly fewer gained full credit. The commonest error was to suggest that sodium oxide is formed. Other common errors were to suggest water or oxygen instead of hydrogen and sodium chloride instead of sodium hydroxide.

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**(ii)** This was generally well answered, most candidates choosing nitrogen. Sulfur was the commonest error.

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**(ii)** The structure of ethanol was better drawn than in previous sessions. Common errors included a double bond between the C and the OH group, linking the OH group incorrectly i.e. C – H – O and drawing a carbonyl rather than an OH functional group.

**(b)**

**(i)** About half the candidates gained credit here. The main errors were either to suggest endothermic or to write exothermic without any explanation.

**(ii)** About half the candidates realised that iodine is grey or black in colour. The commonest errors were to suggest brown, blue or, less often, purple.

**(c)** A few high-scoring candidates gave excellent answers in which the excess zinc was first removed by filtration followed by evaporation to the point of crystallisation and then leaving to crystallise. Most seemed not to realise that the excess zinc should first be filtered off and so they could not gain credit for a suitable method of crystallisation.

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**(i)** Some candidates obtained the correct formula, $ZnI_2$, by ion counting. Others just did not count the ions and just wrote ZnI or counted them and gave the incorrect ratio, $Zn_2I$. Other common errors were $Zn_5I_{10}$ and writing incorrect charges on each species.

**(ii)** Most candidates recognised that ZnI is a giant ionic structure. The commonest error was to suggest metallic or giant covalent.

**(e)** This was better done than **Question 6(c)(i)** with ammonium rather than ammonia being seen more often. Nearly all candidates identified water. Fewer identified ammonium nitrate; ammonium nitric acid often being written instead. Ammonium nitrate was also written as a variety of other nitrogen compounds. Zinc nitrate was generally identified correctly.

**(f)** Many candidates gave the test for ammonia gas. Few realised that sodium hydroxide had to be added (with warming) to distinguish ammonium ions from ammonia gas. Consequently only a few candidates gained credit for this. Most of the candidates, who suggested that sodium hydroxide should first be added, went on to state that a white precipitate is formed.

# CHEMISTRY

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

## Key Messages

There are three elements to preparing for this examination. They are;

- Learn the Chemistry as specified in the current syllabus. This is best achieved by a steady acquisition throughout the course. Learning should be an active process, just reading notes or a text book is an inefficient method of acquiring knowledge. There should be an element of self-assessment or testing. Without a secure base of relevant material, a creditable examination grade will not be achieved.

- The acquisition of the required skills is the next step. These would include the various types of calculation specified in the syllabus, writing formulae and equations. These skills need to be practised.

- The final element of this preparative phase is examination technique. It is a lack of competence in this attribute which is a major cause of disappointing grades. Proficiency in this technique can only be acquired through practice on past papers, using published mark schemes and seeking guidance from your teacher.

Even if these three elements are securely in place, there is still one crucial skill and that is the ability to communicate. This deserves a lot more attention during the actual examination and currently it is a major reason why credit cannot be awarded. The problems range from poor quality handwriting and diagrams, ambiguities and not directing the response to the requirements of the question. Most of these shortcomings could be rectified by more care and attention – preferably think first write second.

## General Comments

Teachers might like to pass on the following advice to future candidates.

If the allocated space is insufficient or it is necessary to redraft the response, please give a clear reference to the new location, for example - see page 11.

The time allocated for the completion of this paper seems to be adequate for most of the candidates. It is strongly advised that any spare time is used to check the answers. Are the comments correct, is the meaning clear and above all do they answer the question? Candidates are strongly advised to read the question as well as their responses when reviewing their answers.

Are any alterations clear? If there is any doubt delete the original attempt and rewrite it clearly. Remember that the onus is on the candidate to make their meaning clear. Do not make your writing smaller and smaller to fit your answer into the immediately available space.

## Comments on Specific Questions

### Question 1

**(a)** The random nature of the responses indicated that many candidates were guessing rather than basing their answers on a sound knowledge of the classification of oxides. This belief was further reinforced as a significant proportion of candidates suggested the same oxide for two different part questions, for example **(i)** and **(ii)**; this is impossible.

**(b)** Almost the entire entry attributed acid rain to the presence of sulfur dioxide in the atmosphere. Most suggested its presence was due to the combustion of fossil fuels rather than of fossil fuels which contained sulfur. There was a very widespread misconception; carbon monoxide was believed to be the second oxide responsible for acid rain. Even those who correctly identified nitrogen dioxide did not offer an adequate explanation for its presence – oxygen and nitrogen in the air react at high temperatures to form this oxide. This reaction does not occur in the exhaust of the vehicles.

**(c)**

**(i)** The popular and correct choice of another ionic oxide is strontium oxide. Aluminium oxide was also accepted.

**(ii)** Provided the candidate arrived at the correct formula for lithium oxide, the rest of the information was usually correct. A minority believed that the formula is LiO rather than $Li_2O$.

**Question 2**

**(a)**

**(i)** Quite a range of natural sources was suggested by the candidates. Gases from the digestive systems of animals, particularly cows, and from the decomposition of organic matter were the popular choices.

**(ii)** Carbon dioxide and water were correctly given by most of the candidates.

**(b)** The knowledge of the three processes was acceptable. A little more detail would have been beneficial for example; the combustion of fossil fuels or carbon- containing fuels or respiration is the process by which organisms obtain energy. The addition of the underlined words or phrases would have improved many answers. More emphasis should have been given to the concept that the percentage of carbon dioxide in the atmosphere is determined by the balance between the three processes.

**Question 3**

**(a)**

**(i)** Most of the candidates knew that the main ore of aluminium is bauxite. A few thought it was hematite.

**(ii)** The most common explanation was that the presence of cryolite reduces the melting point (from 2000 to 900 $^{o}$C), this reduces the energy needed and decreases the cost of the process. An alternative reason is that the presence of cryolite increases the conductivity of molten alumina.

**(iii)** Copper is less reactive than hydrogen so it is discharged at the cathode. Hydrogen is less reactive than aluminium so it is discharged at the cathode, the aluminium ions remain in solution. At this level the explanation has to be in terms of reactivity. Candidates found it difficult to formulate a coherent explanation so correct comments about the reactivity of these three elements gained credit.

**(b)** The equation for the cathode reaction was usually correct but the equation for the discharge of the oxide ion proved to be more difficult; either it did not balance or the electron transfer was incorrect. At least one ionic equation was expected as were comments of the type, 'the aluminium ion accepted electrons and was reduced to the metal'. Many candidates did not account for the presence of carbon dioxide by the reaction of oxygen and the carbon anode

**(c)**

**(i)** This part was very well answered.

**(ii)** Essentially aluminium is the conductor; it is a much better conductor than steel. Aluminium is used because it is a good conductor and has a low density. It is not used to protect the steel from corrosion. The steel core is used to provide strength to the cable with the possible advantages of the cable does not break/reduces sagging/greater separation of pylons.

**Question 4**

**(a)** The rates of the forward reaction and reverse reaction are equal. The word *rate* was omitted on many scripts. For further credit, candidates needed to state that the concentrations of reactants and products remain constant, they do not change with time. A common misconception is that they are equal.

**(b)** There were some excellent answers to this question with a minority of the candidates confidently applying their understanding of the effects of pressure on the various gaseous equilibria. Almost the entire entry could correctly interpret the graphs and describe the effect of pressure on the percentage of the products. Matching the graph to a reaction proved more problematical and even if this was achieved, giving the reason provided another challenge. The reason had to include a comparison of either the volumes of products and reactants or the number of moles/molecules of reactants and products.

**Question 5**

**(a)**

**(i)** Questions of this type should produce clear focused comments of the type:

- reaction rate is decreasing,
- because the concentration of bromine is decreasing,
- when the graph levels, the rate is zero, all bromine used up.

The attempts to explain the shape of this graph lacked cohesion and focus.

**(ii)** There was a much higher level of success predicting that the graph would be steeper/rate faster because the rougher surface would have a greater surface area.

**(iii)** Very few candidates did not receive at least partial credit on this question.

**(b)**

**(i)** The change was correctly identified by the majority as Fe to $Fe^{2+}$ and a correct reason given; either electron loss or an increase in oxidation state/number.

**(ii)** A minority thought that the reductant is $Br_2$ not Fe.

**(c)** This was very well answered by most of the candidates. The most frequent reason for not awarding full credit was the omission of the word “precipitate”. A particularly commendable and original suggestion was – add bromine to both. With $Fe^{2+}$ it turned colourless, with $Fe^{3+}$ it remained brown.

**Question 6**

**(a)**

**(i)** Only about half the candidates could write the structural formula for ethanoic acid. Quite a common mistake was to include a double bond between the carbon atom and the hydroxyl group.

**(ii)** A higher proportion knew the structural formula of ethanol.

**(b)**

**(i)** A number of candidates did not attempt to name the ester. A selection of incorrect names included alcohol, ethene, ethyl and glucose.

**(ii)** The proportion succeeding with this type of question seems to be increasing. There needed to be a correct ester linkage, evidence of continuation and writing the correct organic groups rather than the “boxes”.

**(iii)** Most could quote pollution problems caused by non-biodegradable polymers – visual pollution, danger to animals, shortage of landfill sites, blockage of drainage, formation of toxic gases when burnt etc.

**(c)** This is mainly an exercise in observation, all the required information is given on the diagrams, for example in the structure of nylon the amide linkages are arranged CONH then NHCO whereas in a protein they are arranged CONH then CONH. There are other acceptable differences between the structures but the above is the easiest and the most obvious.

**Question 7**

**(a)**

**(i)** All the Group 1 metal hydroxides, including lithium, were accepted. A significant proportion of the candidates answered this part correctly.

**(ii)** The instruction "write an equation" should be interpreted as write a symbol equation not a word equation. This relatively simple equation defeated most of the candidates with the most common mistake being:

$Cu(OH)_2 \rightarrow Cu + H_2O$

There were also some strange attempts at writing the formula of copper(II) hydroxide such as COH and $C_2OH$; not even the symbol for copper was correct.

**(iii)** These two hydroxides, sodium hydroxide and copper(II) hydroxide, behave differently because of the difference in reactivity of the metals. Candidates should be aware reactive metals have stable compounds and vice versa.

**(b)**

**(i)(ii)** The action of heat on nitrates is a topic which has to be learnt by heart. There is no other way of accessing the information. The majority of candidates could not recall the decomposition products of zinc nitrate or the equation for the thermal decomposition of potassium nitrate.

**(c)** Compared with **(a)** and **(b)**, there were a number of positive features in the candidates' responses to **(c)**. This was probably due to the fact that it is essentially skills-based rather than factual recall. The majority of candidates answered **(i)** and **(ii)** correctly and then identified **equation 3** as being the equation for the decomposition of sodium hydrogencarbonate. The explanation why the data indicated this equation proved rather more challenging but a considerable minority gave a clear, logical justification of their choice of **equation 3**.

# CHEMISTRY

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

## Key Messages

There are three elements to preparing for this examination. They are;

- Learn the Chemistry as specified in the current syllabus. This is best achieved by a steady acquisition of knowledge throughout the course with thorough revision prior to examination. Learning should be an active process, just reading notes or a text book is an inefficient method of acquiring knowledge. There should be an element of self-assessment or testing. Without a secure base of relevant material, a creditable examination grade will not be achieved.

- The acquisition of the required skills is the next step. These would include the various types of calculation specified in the syllabus, writing formulae and equations. These skills need to be practised.

- The final element of this preparative phase is examination technique. It is a lack of competence in this attribute which is a major cause of disappointing grades. Proficiency in this technique can only be acquired through practice on past papers, using published mark schemes and seeking guidance from your teacher.

Even if these three elements are securely in place, there is still one crucial skill and that is the ability to communicate. This deserves a lot more attention during the actual examination and currently it is a major reason why credit cannot be awarded. The problems range from poor quality handwriting and diagrams, ambiguities and not directing the response to the requirements of the question. Most of these shortcomings could be rectified by more care and attention – preferably think first write second.

## General Comments

The usual advice given to candidates is to read the question. On the evidence of this paper, the advice needs to be expanded to include read the question carefully with understanding and then consider exactly what is required to conform to the requirements of the question. A few examples are quoted to illustrate this point.

**Question 2(b)(iii)** – state **another** use of sulfur dioxide, this means a use not mentioned in the question. Too many candidates stated ‘as a preservative’ or ‘to make sulfuric acid’, both of which are mentioned in the question.

**Question 5(b)** - give two other characteristics of a homologous series. In the introduction both variation of physical properties and similar chemical properties are mentioned which precludes their inclusion in the answer.

## Comments on Specific Questions

### Question 1

**(a)** Generally the first line in the table was correct. The number of protons, neutrons and electrons in the cobalt(II) ion proved more difficult. The significance of the positive charge was not appreciated by many candidates. Ionic charges only influence the number of electrons.

**(b)**

**(i)** The preferred definition is – atoms of the same element have the same number of protons but a different number of neutrons or nucleons. The number of electrons has no relevance to this issue.

**(ii)** There are only two acceptable answers – same number of protons or the same electron distribution. It would improve the quality of the answers if candidates realised that all atoms or ions of the same element have the same proton number.

**(iii)** Most candidates could recall an industrial use of a radioactive isotope. Particularly popular were the detection of leaks and control of the thickness of paper. Medical uses were equally well known; by far the most common suggestion was the treatment of cancer but it is to be noted that radiotherapy and chemotherapy are not the same.

**Question 2**

**(a)** It was necessary to point out that sulfur dioxide would be formed and then mention one of the harmful consequences of atmospheric sulfur dioxide. Candidates tended to either identify the gas formed and not mention possible damage to the environment or health or not identify the gas but describe its deleterious effects. This question could be used for future candidates to illustrate the importance of thinking about the mark allocation and the expected response.

**(b)**

**(i)** Some pleasing answers were given which mentioned a greater surface area and the consequent increase in reaction rate. The popular misconception was that small droplets reduced the risk of an explosion.

**(ii)** Most of the candidates were familiar with the idea that sulfur dioxide could kill micro-organisms and could act as an anti-oxidant; these are the mechanisms for preserving food.

**(iii)** Too many candidates did not heed the instruction “give another use of sulfur dioxide” and suggested making sulfuric acid.

**(c)** The majority were familiar with this process and were awarded at least partial credit. The most common reasons for not awarding credit were the wrong oxidation number in the catalyst, vanadium(IV) oxide not vanadium(V) oxide, not mentioning the pressure or omitting the equation.

**(d)** This was quite well done by the majority.

**Question 3**

**(a)**

**(i)** The need for air or oxygen was almost universally recognised but the need to heat or roast the ore was less familiar.

**(ii)** A suitable reductant, carbon or carbon monoxide was specified.

**(b)** There were some excellent answers to this question. “Dissolve in” was accepted as an alternative to react. In contrast other candidates ignored or did not appreciate the significance of the comment “the oxide is insoluble in water” and suggested the use of an indicator, either litmus or universal indicator; both would be ineffective.

**(c)**

**(i)** Many candidates omitted the word ‘rate’ in their statement the forward reaction = the backward reaction. Further credit was available for a comment about the constancy of the concentrations of the reactants and products or that macroscopic properties do not change. A widespread misconception was that the concentrations of reactants and products are equal.

There were some accurate responses to **(ii)** and **(iii)** showing a good understanding of the principles of equilibria.

**Question 4**

**(a)**

**(i)** The question asked for a diagram with the formula, the charges on the ions and the arrangement of the valency electrons around the negative ion. This should be interpreted as **one** diagram not three separate diagrams. There were many good diagrams which were awarded full credit. The main errors seen were wrong valency, giving the symbol of fluorine as F*l* and drawing a covalent structure.

**(ii)** Strong forces or bonds between ions was the required response.

**(b)**

**(i)** The structure of silicon(IV) oxide is easier to describe than draw. Four oxygen atoms around one silicon atom, two silicon atoms around one oxygen atom and the structure is tetrahedral.

**(ii)** Silicon(IV) oxide does not conduct and scandium fluoride does conduct (in the liquid phase).

**(iii)** Scandium fluoride has ions which can move when molten or in aqueous solution. Free electrons, not ions, were mentioned on many scripts and scandium not scandium fluoride was discussed. The conductivities of these two compounds, scandium fluoride and silicon(IV) oxide was frequently reversed.

**Question 5**

**(a)** Virtually all the candidates could complete the table correctly.

**(b)** The major problem in this part was to repeat characteristics already given in the question rather than **other** characteristics. These would include:

- general formula,
- consecutive members differ by $CH_2$,
- common methods of preparation,
- same functional group.

**(c)** Most had some idea how to proceed with this type of formula. The omission of the non-bonding pairs on the oxygen atom marred many good attempts.

**(d)**

**(i)** The structural formula of propanoic acid was drawn correctly on many scripts although a minority gave the formula of butanoic acid instead.

**(ii)** Very few realised that this oxidation occurred in the presence of oxygen/air and <u>bacteria</u> rather than yeast.

**(e)** The ester formed would be propyl ethanoate and not as widely thought methyl propanoate. This error was usually continued in the structural formula. Ester linkages often contained hydrogen atoms or hydroxyl groups.

**Question 6**

**(a)**

**(i)** It was generally realised that an excess of carbonate would neutralise all the acid. It is not true to state that the reaction would be complete, this is impossible with an excess of one reactant.

**(ii)** Many of the explanations were not specific to this reaction and related to filtration in general - to remove a solid from a liquid instead of to remove unreacted nickel(II) carbonate.

**(iii)** Many explanations here lacked clarity.

**(iv)** Most received partial credit for drying the crystals between filter paper, further credit was available for filtering off the crystals or washing them, both before drying. Any source of gentle heat was accepted as a means of drying the crystals.

**(b)**

**(i)** Potassium carbonate is soluble in water. This is the reason why a different experimental method has to be used. Candidates described the properties of potassium and the risk of an explosion.

**(ii)** This is a standard method of preparing a soluble salt from a soluble base; titration. The majority could not recall this preparative route and resorted to the method described in the question which is used with an insoluble base.

**(c)** This question divided the candidates into those who were both familiar and competent with this type of calculation, those who were not.

**Question 7**

**(a)** This apparently simple question defeated the vast majority of the candidates many of whom resorted to the term fraction in a mathematical context. A fraction is the distillate collected in a given boiling point range - say 40 to 100 $^{o}$C.

**(b)**

**(i)** Multiples of the correct equation were accepted. The biggest challenge was balancing the oxygen atoms. A few candidates could not recall the products of the complete combustion of an alkane.

**(ii)** Despite the phrase “another reason” in the question, many candidates still gave the reason as – ‘cannot use leaded petrol with a catalytic converter’ instead of the toxicity of lead compounds and/or their effect on health.

**(iii)** The interpretation of the name dibromoethane would have benefited from a more thoughtful analysis. *Dibromo* indicates two bromine atoms per molecule. Please note atoms not molecules. *Eth* indicates two carbon atoms per molecule. Finally the most challenging part *ane*. One of the following would be acceptable: C-C present, no C=C, saturated.

The compound is not an alkane and to state that it does not contain a double bond would not suffice; a more specific response was needed – it does not contain C=C.

**(iv)** Creditably, most realised that the missing information was the position of the bromine atoms in the molecule.

**(c)** Most arrived at the correct value of n. A predictable error was to invert the ratio.

**(d)** This question was well answered, particularly changing the oxides of nitrogen into nitrogen and the associated change of carbon monoxide into carbon dioxide.

# CHEMISTRY

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

## Key Messages

When making comparisons or distinctions between two things as in **Questions 3(a), 4(c)(ii)** and **6(a)** it is essential to refer to both things that are being compared e.g. in **Question 6(a)** to say that nickel forms coloured compounds would not receive credit, but saying that only nickel forms coloured compounds would be credited. Similarly when making a comparison it is necessary to specify which substance is being discussed. In **Question 6(a)** it is insufficient to say that one produces coloured compounds and the other does not without saying which substances are being referred to in each case.

## General Comments

There were some excellent scripts and candidates should be commended for this.

The spaces in which candidates write their answers are an approximate guide as to the amount that needs to be written to achieve full credit. Candidates who use more than the available space are not penalised for doing so, but it is often the case that candidates who write too much do not write in a concise enough manner for the Examiners to understand the point(s) being made. Those who use the blank pages to write answers on should indicate this in the main body of the script.

Presentation continues to be a problem. If candidates change their minds about what they wish to write down they are strongly advised to cross out their answer and rewrite another one, rather than alter the answer they have written as this invariably means that the answer becomes illegible.

If an answer is crossed out and rewritten elsewhere on the paper, there must be an indication, in the space where the original answer was, of where the new answer is to be found. This can be done by writing e.g. 'please go to page 11' or by use of arrows.

## Comments on Specific Questions

### Question 1

**(a)**

**(i)** Potassium was a common answer. This is presumably the most reactive metal the candidates have seen. Reactivity does continue to increase down group 1, and either caesium or francium were accepted as the correct answer.

**(ii)** Many candidates answered this correctly. Mercury, which is a metallic element, was occasionally given.

**(iii)** Uranium was a very common correct answer.

**(iv)** Astatine and iodine, which are both correct, were seen quite often.

**(v)** Antimony, which is in period five, was a very common incorrect response. Candidates should realise that the two elements hydrogen and helium constitute period one.

**(vi)** Noble gases were almost always correctly identified as being used to fill lamps.

**(b)(c)** These were both answered correctly by the majority of candidates

**Question 2**

**(a)**

**(i)** It is not possible to explain the term 'monomer' by using the word monomer or to explain the term 'condensation polymerisation' by using the words condensation or polymerisation. Candidates should ensure that they can give precise explanations of what these words and phrases mean.

MONOMER: When describing a monomer it was essential that candidates referred to the starting materials that make a polymer as opposed to describing a section of the polymer chain. A monomer is the small molecule used to make a polymer.

CONDENSATION POLYMERISATION: Candidates often mentioned that condensation polymers are made from two different monomers. It is also necessary to refer to removal of a simple molecule. Joining two molecules together with the removal of a small molecule is condensation, but it is not polymerisation unless the formation of a polymer is also mentioned.

**(ii)** Candidates usually achieved credit for drawing the correct linkage. Polymers must be shown with continuation bonds at both ends to emphasise the fact that the polymer extends in both directions to form a long chain.

**(b)**

**(i)** This was answered very well. Biological catalyst is what candidates are advised to write as opposed to natural catalyst.

**(ii)** Denaturation was known by the majority of candidates. Enzymes cannot die because they were never living.

**(iii)** Many candidates provided the appropriate amount of detail of how a mixture of sugars could be separated and identified by paper chromatography. The spots on the chromatogram are colourless because sugars are all colourless. This is why a locating agent is needed. Ninhydrin is used as a locating agent for amino acids as opposed to sugars.

Fractional distillation, which is used to separate a mixture of liquids, was occasionally seen. Sugars are all solids at room temperature. Paper chromatography separates sugars which are in aqueous solution. Benedict's solution and iodine were occasionally mentioned. These are both used to test for carbohydrates. Separation of a mixture of carbohydrates can only be achieved by chromatography.

**Question 3**

**(a)** There were a number of excellent answers to this question using a variety of different methods including adding sodium hydroxide solution and heating to produce ammonia gas (with ammonium ions), observing the precipitate formed (with calcium ions) or using flame tests. Observing effects of the two fertilisers on the growth of plants would take rather too long as well as not making the necessary distinction asked for in the question. A test can be carried out in a test tube and give an immediate observation which leads to an immediate conclusion.

The reagent was sometimes missing, which meant that no credit could be awarded. Heating alone, or adding an indicator, would not differentiate between the two solids. Aluminium was occasionally seen in addition to sodium hydroxide. This is a test for nitrates as opposed to ammonium ions.

**(b)** Many candidates were aware of the necessary conditions of temperature, pressure and catalyst. Some excellent answers received full credit. Omission of the equation may possibly have been an oversight. Reading the question carefully continues to be an important requirement of answering any examination question

**(c)** Candidates are advised to consider that the three essential plant nutrients are nitrogen, phosphorus and potassium (commonly referred to as NPK).

**(d)**

**(i)** Many candidates realised that it was necessary for a fertiliser to dissolve in water in order to be effective. Comments on NPK occurred regularly. It is unnecessary for all fertilisers to contain all three of the elements required for nutrition.

**(ii)** Oxidant and reductant were mentioned more often than base. If an ion has become more or less negatively charged it does not indicate that it has been oxidised or reduced. The charges on the ions are not oxidation numbers. Similarly if an ion has an extra hydrogen atom added to it, this does not mean that it has been reduced. $PO_4^{3-}$ has had $2H^+$ ions added to make it into $H_2PO_4^-$, therefore it is acting as a base.

**(e)** Plants could not thrive if strong caustic alkalis such as sodium hydroxide or potassium hydroxide were added to soil. Both are highly corrosive and would cause more problems to the plants than the level of soil acidity caused by acid rain. Some realised that a base was required, although they omitted to name a suitable one. Others thought that 'control' meant that they were required to measure soil acidity with universal indicator rather than neutralise it.

**Question 4**

**(a)**

**(i)** The majority of candidates realised that steel was an alloy. Iron is the constituent of steel that distinguishes it from other alloys.

**(ii)** The expected answer was that (oxidation is) loss of electrons and the majority gave this. When answering questions of this type, complex sentence construction can be self-defeating. It is unnecessary to refer to atoms, molecules, ions, elements or compounds, because oxidation is not specific to any of these. If it is not absolutely clear that the candidate has used the right terminology, the Examiner cannot award credit.

**(b)** The question asks about movement of electrons. Many of the answers did not comment on electrons, preferring to talk about oxidation/reduction, ion formation and differences in reactivity, all of which may have been stated correctly but did not answer the question that was asked. The rusting of magnesium was mentioned occasionally. Only iron can form rust, because rust is hydrated iron(III) oxide.

**(c)**

**(i)** This question was answered very well.

**(ii)** When candidates are making a comparison between two methods, it is essential that they make it absolutely clear which method they are referring to. In this case it is essential that candidates make it clear whether they are referring to sacrificial protection or cathodic protection, rather than make statements such as one requires electricity and the other does not.

**Question 5**

**(a)** Most candidates knew that the reaction required light. Stating that 'light is necessary to initiate the reaction or to increase the rate' merited the award of further credit.

**(b)**

**(i)** Percentages up to 1 % for carbon dioxide received credit, but it was interesting to note that a large number of candidates thought that the percentage of carbon dioxide was much higher than 1 % and in some cases (much) higher than the percentage of oxygen.

**(ii)** This question was answered very well. Glucose (which many achieved through a correct formula), sugar(s) or carbohydrate(s) were all acceptable as products of photosynthesis (as opposed to food). The other three marking points were awarded very often, although there was occasional confusion between photosynthesis and respiration.

**(c)** Much of the information required to achieve credit is in the stem of the question. The skill required by the candidate was largely to extract the relevant information and use it to explain how the (black and white) image is formed. Although the word black is written underneath the formula of silver, some candidates thought that the black colour was due to bromine.

**Question 6**

**(a)** Melting point, boiling point, density and conduction of heat and electricity were seen frequently, although these are all physical rather than chemical properties.

Colour of compounds or ions is traditionally regarded as a chemical property of transition elements and was an acceptable answer if it was made clear that it referred to compounds or ions and not the elements themselves.

To make a comparison of two things they must both be referred to. Many candidates only referred to one of the elements and were not awarded any credit.

**(b)**

**(i)** It is not possible to predict whether a reaction is exothermic or endothermic by looking at the number of substances on both sides. Many assumed that because two substances are combining to make one substance in the forward reaction this means that the forward reaction is exothermic (because bonds are being formed). The reality is that both the forward and reverse reactions involve bond breaking and bond making and the only way to answer this type of question is to decide which way the equilibrium shifts when temperature changes by consideration of whether the reaction is exothermic or endothermic..

**(ii)** Candidates are told that the forward reaction is favoured by an increase in pressure; therefore credit was available for the explanation that this is favoured because there are more molecules/moles on the left hand side of the equation or less molecules/moles on the right hand side of the equation. Statements such as 'the forward reaction has fewer moles' needed more detail. More preferable is 'there are more moles on the left hand side'. Many answers referred to exothermic or endothermic changes and even to collision theory.

**(iii)** It seems that many thought that carbon monoxide was the impurity. There was also confusion with the blast furnace process. Slag was regularly mentioned as a by-product.

**(iv)** 'Refining' is a method of purification and does not involve a chemical change. Therefore methods based on a process similar to the blast furnace process or any method based on reduction with a chemical reducing agent is not appropriate.

**Question 7**

**(a)** Many answers were correct and included full and clear working out.

**(b)**

**(i)** Some excellent clear diagrams were seen. This question was answered very well.

**(ii)** If an expanded formula is not shown, candidates are likely to draw polythene, which many of them did. Many of the polymers had pentavalent and trivalent carbon atoms as well as divalent hydrogen atoms and double bonds.

**(iii)** Many excellent calculations were done. The correct answer of -130 kJ/mol was calculated correctly by many candidates either by consideration of all the bonds in the reactants and products or just by consideration of the bonds broken and formed which involves less work but produces the same answer.

Some candidates missed out bonds when calculating either energy required or energy produced (or both). It is advisable to make a list of the bonds on both sides of the equation before doing the numerical calculation.

**(c)**

**(i)** Incorrect names such as but-1-ol, buta-1-ol and but-1-anol were seen occasionally.

**(ii)** The bromine atoms joined onto the carbon chain in positions 1 and 2. Incorrect linkages such as –Br- were seen very occasionally.

**(iii)** This was hardly ever done correctly. The idea was to add on one hydrogen atom and one iodine atom. $I_2$ was very common as well as names and organic formulae. When a formula is asked for in the question it is necessary to give a formula as the answer.

# CHEMISTRY

**Paper 0620/04**

**Coursework**

**General Comments**

The November entry for this component was, as usual, small.

Centres which enter candidates regularly for this component again scored well.

It is clearly an advantage to have a well organised department which prepares candidates thoroughly for the assessment. This enables the candidates to show their ability to the best advantage.

Over the past two sessions there have been Centres which clearly did not understand the requirements of this component of the syllabus. In extreme cases work was submitted which showed no evidence of the Centre having read the assessment criteria and where there seemed to be little justification for the marks awarded.

In other cases work had been submitted according to the procedures outlined in the syllabus but the nature of the exercises used did not permit candidates to demonstrate their ability.

In both instances a very significant reduction in the marks awarded was necessary.

Centres are reminded that it is a requirement that Centres should be accredited following training before they are entitled to submit candidates for this alternative component.

There is a distance training course available for any Centres who wish to gain this accreditation.

# CHEMISTRY

**Paper 0620/51**

**Practical Test**

## Key messages

- Candidates should be reminded that they are advised to read all of the instructions before starting the experiments in **Question 1**.
- Candidates should always record details of all observations in **Question 2**.

## General comments

The majority of candidates successfully completed both questions and there was no evidence that candidates were short of time. Supervisors' results were submitted with the candidates' scripts and no problems were reported. The Examiners use Supervisors' results when marking the scripts to check comparability.

## Comments on specific questions

### Question 1

**(a)(b)** All of the candidates carried out the two experiments.

The tables of results were often correctly completed. A minority of candidates did not follow the instructions and recorded temperature rises from one minute onwards instead of 1.5 minutes onwards.

Some candidates had results which were not comparable to the Supervisor's results for Experiment 2. The temperature rises recorded were less than expected for a number of candidates. This was probably due to candidates not stirring the mixture as instructed.

**(c)** The majority of candidates successfully plotted the results for both experiments on the grid provided. However, a few candidates omitted the room temperatures for the first three readings. A significant number of candidates were unable to draw smooth line graphs and omitted the labels for the graphs.

**(d)** Some of the candidates worked out the temperature of the reaction mixture in Experiment 2 instead of Experiment 1.

**(e)** This was generally well answered though 'endothermic reaction' was a common incorrect answer. Credit was given for displacement or redox reaction.

**(f)** Most answers to **(i)** correctly referred to the greater temperature rise in Experiment 1 compared to Experiment 2. A lack of understanding was evident in **(ii)** with vague answers not specifying the greater reactivity of zinc.

**(g)** This was a good discriminating question. A large number of the candidates incorrectly thought that the temperature rise would be lower if less copper sulfate solution was used.

**(h)** Good answers successfully identified that lumps of zinc would react slower or produce a lower temperature rise and linked this to the greater surface area of the zinc powder.

**Question 2**

**(a)** Some candidates did not describe the colour of each liquid in **(i)**. 'Colourless' was awarded credit while references to clear or transparent were not. Some candidates were unable to describe the smell of liquid **R** which was dilute ethanoic acid. A number of candidates described a smell for liquid **Q** which was distilled water. In **(ii)** the pH values generally scored credit and were compared to the Supervisor's results. The pH of distilled water was surprisingly significantly less than 7 for one Centre.

**(b)(c)** The test for the gas given off by liquid **P**, sulfuric acid, was often missing and hydrogen recorded as given off with no evidence. Observations for **(b)** and **(c)** were often poorly recorded and a notable number of answers referred to the reaction of distilled water with both magnesium and a marble chip. No reaction/change was the expected observation here

**(d)** This was a good discriminating question. Very few candidates followed the instructions correctly and therefore missed the formation of a blue solution followed by a white precipitate.

**(e)** The temperatures recorded varied from 54 $^{o}$C to 102 $^{o}$C. Credit was given for a reading of 98-102 $^{o}$C.

**(f)** Very few correct answers were seen here. Candidates were unable to link their pH result with the presence of a strong acid.

**(g)** A minority of candidates successfully identified liquid **Q** as distilled water.

**(h)** Credit was given here for identifying the presence of an acid.

# CHEMISTRY

**Paper 0620/52**

**Practical Test**

## Key messages

- Candidates should be reminded that they are advised to read all of the instructions before starting the experiments in **Question 1**.
- Candidates should always record details of all observations in **Question 2**.

## General comments

The majority of candidates successfully completed both questions and there was no evidence that candidates were short of time. Supervisors' results were submitted with the candidates' scripts and no problems were reported. The Examiners use Supervisors' results when marking the scripts to check comparability.

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**(b)(c)** The test for the gas given off by liquid **P**, sulfuric acid, was often missing and hydrogen recorded as given off with no evidence. Observations for **(b)** and **(c)** were often poorly recorded and a notable number of answers referred to the reaction of distilled water with both magnesium and a marble chip. No reaction/change was the expected observation here

**(d)** This was a good discriminating question. Very few candidates followed the instructions correctly and therefore missed the formation of a blue solution followed by a white precipitate.

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**(f)** Very few correct answers were seen here. Candidates were unable to link their pH result with the presence of a strong acid.

**(g)** A minority of candidates successfully identified liquid **Q** as distilled water.

**(h)** Credit was given here for identifying the presence of an acid.

# CHEMISTRY

**Paper 0620/53**

**Practical Test**

## Key Messages

- Supervisors should submit results for both questions, not just **Question 1**.
- Candidates should be instructed to record details of all observations in **Question 2**.

## General comments

The majority of candidates successfully completed both questions and there was no evidence that candidates were short of time. Supervisors reported very few problems with the requirements of this practical examination. The Examiners use Supervisors' results for both questions when marking the scripts to check comparability.

Some candidates noted the initial burette readings in **Question 1** as 50.0 $cm^3$ with the difference recorded in the final reading box and the final reading in the difference box. Centres who use burettes with an initial reading of 50.0 $cm^3$ instead of 0.0 $cm^3$ should inform the Examiner on the Supervisor's report.

There was an improvement in the number of candidates giving detailed observations in **Question 2**. The paper successfully differentiated between candidates of different ability.

## Comments on specific questions

### Question 1

**(a)(b)(c)** All of the candidates carried out the three experiments and recorded the volume of dilute sulfuric acid required to react with the three solutions of sodium hydroxide.

The table of results was generally, fully and successfully completed. A minority of candidates were unable to complete the table correctly with readings being entered in the wrong boxes. A number of candidates did not record the readings to one decimal place.

Some candidates had results which were not comparable to the Supervisor's results.

**(d)** A significant number of candidates gave the initial colour of the sodium hydroxide solution with the phenolphthalein indicator as purple or red instead of pink.

**(e)** A minority of candidates described the chemical reaction as a titration which showed a lack of understanding.

**(f)**

**(i)** Despite the expected volumes being recorded in the table, the experiment that used the greatest volume of sulfuric acid was sometimes incorrectly identified.

**(ii)** This was a good differentiating question. A significant number of candidates thought that solution **B** was the least concentrated solution of sodium hydroxide as it required the largest volume of dilute sulfuric acid to be neutralised. Similarly that **C** was the most concentrated solution as it required the smallest volume of sulfuric acid.

**(g)** This was generally well answered. Some candidates did not realise that the volume in Experiment 2 was double that of Experiment 1 and just said 'greater volume'.

**(h)** The majority of candidates understood that twice as much sulfuric acid would be used. However, a significant number of candidates were unable to give a numerical value for the volume using their result for Experiment 3.

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

**(j)** This was a good discriminating question. Only the more able candidates understood the effect on the results if the solutions of sodium hydroxide were warmed. There would be no effect on the volume of dilute sulfuric acid added as there is no change in the concentration of the solutions or the quantities used. Some candidates correctly discussed the fact that only the speed of a reaction is affected by the change in temperature which was irrelevant in this investigation.

Many answers erroneously referred to less acid being needed to neutralise the solutions of sodium hydroxide at higher temperatures.

**(k)** This question showed good differentiation between candidates. Credit was given for any correct method that would work. These methods included the use of electrolysis, thermometric titrations and evaporation of solutions to dryness.

Common incorrect methods discussed the use of Universal Indicator to show the different pH of the solutions of sodium hydroxide. However, the pH of these solutions would be very similar. Many answers involved the addition of inappropriate reagents, e.g. magnesium or calcium carbonate, to solutions of sodium hydroxide to compare the rate of reaction.

Despite being asked to suggest a different method, some candidates merely changed the indicator or the acid and used the same titration method. No credit was given for these responses.

**Question 2**

**(a)** This was generally well answered.

**(b)** Again, this was generally well answered however a surprising number of candidates recorded the appearance of a white precipitate in **(i)** when no reaction or change was expected. Observations in other parts of **(b)** were often correctly recorded as white precipitate in **(ii)** and brown precipitates in **(iii)** and **(iv)** respectively.

**(c)** The tests on solid **E** showed a lack of detail in recording the observations. Good answers included a description of the condensation of a liquid on the cooler parts of the test-tube and that the colour of the solid remained white when heated. Guesses were evident with regard to testing the gas evolved. Glowing splints relighting or popping were common and the pungent smell of ammonia with red litmus turning blue was also described. The gas given off was carbon dioxide and many candidates successfully tested the gas with the limewater provided as specified in the confidential instructions for Supervisors.

Descriptions of effervescence in **(i)** and **(ii)** were often missing despite being obvious observations.

**(d)(e)** This was generally well answered. The majority of candidates were able to deduce that salt **D** was iron(III) chloride and that the gas given off was carbon dioxide.

**(f)** Only the more able candidates concluded that a non-transition metal carbonate/hydrogen carbonate was present in solid **E**. Credit was given for reference to named carbonates such as sodium, calcium, magnesium etc.

# CHEMISTRY

**Paper 0620/61**

**Alternative to Practical**

## Key Messages

Questions requiring candidates to compare or explain quantitative information should be answered with extended prose and not merely a restatement of numerical data.

## General Comments

The vast majority of candidates attempted all of the questions. The paper discriminated successfully between candidates of different abilities but was accessible to all.

Candidates found **Questions 1, 2** and **6** to be the most demanding.

The majority of candidates were able to complete the tables of results from readings on diagrams and plot points successfully on a grid as in **Question 4**.

## Comments on Specific Questions

### Question 1

**(a)** A surprisingly small number of candidates were awarded full credit here. Answers indicated that some candidates had not seen a gas syringe before because answers such as measuring cylinder, pipette and funnel were common incorrect responses used to complete the box. Most candidates correctly inserted an arrow indicating the heat but some showed the syringe being heated showing a lack of understanding, while others just left the arrow out.

**(b)** This was generally not well answered. The use of a spatula was not well known. A range of incorrect responses included spoons, funnels, beakers, tongs, burettes and pipettes.

**(c)** Many wild guesses indicated that many candidates did not realise that copper(II) oxide was formed and hence the colour of the solid formed would be black. Commonest answers were blue, orange, green and red.

**(d)** This was a good discriminating question. Only the more able could describe the expansion of gases at higher temperatures and therefore the need for the remaining gas to cool to room temperature to obtain an accurate final volume reading. Many answers referred to safety considerations or the need to ensure that the reaction had finished which showed a lack of knowledge and understanding.

### Question 2

**(a)** A significant number of candidates were unable to plot the points correctly. Smooth S-shaped curves with a vertical portion were rare. Many graphs drawn included the anomalous point and were therefore not smooth line graphs.

**(b)** The more able candidates successfully identified the anomalous point.

**(c)**

**(i)** This was generally well answered but some candidates had problems reading the scale.

**(ii)** The more able candidates extrapolated the curve back to the *y*-axis where 0 $cm^3$ of sodium hydroxide had been added to find the pH of the nitric acid.

**(d)** A large number of candidates were unable to use the graph to answer this question, not realising that the steep portion of the graph occurred when 25.0 $cm^3$ of potassium hydroxide solution had been added. However, candidates should know that the pH of a neutral solution is 7.

**(e)** A lack of knowledge and understanding was apparent. The evaporation of the neutral solution of potassium nitrate obtained at the end point was realised by only a minority of candidates. References to evaporation to crystallising point and a method of drying the crystals were generally missed. Credit was given for the heating/evaporation of a solution of potassium nitrate regardless of how it had been obtained. Confused answers discussed adding excess of one of the reagents, filtering and boiling to dryness.

**Question 3**

**(a)** This was well answered.

**(b)** A line on the diagram to show the initial level of the solvent was frequently not drawn. Only the more able candidates drew a line beneath the origin. Many lines were drawn above the origin, often through the spots, which indicated a lack of knowledge and understanding.

**(c)** Most candidates realised that the ink would separate or dissolve in the solvent and interfere with the results or that the graphite in the pencil would not dissolve or interfere in the process. Vague references to 'it' were not awarded credit e.g. 'it would interfere with the results'.

**(d)** The majority of candidates could interpret the chromatogram and successfully identify similarities and differences between the coloured mixtures **A** and **B**.

**(e)** This was generally correct though some answers lacked detail. Vague responses such as 'amino acids' and 'different colours' were not awarded credit.

**Question 4**

**(a)(b)** The two tables of results were completed correctly by the vast majority of candidates.

**(c)** Most candidates plotted the points on the grid correctly. Some graphs drawn were not smooth lines and labels were sometimes missing.

**(d)** Some candidates could not read the scale on the *x*-axis. A common error was to indicate the temperature of the reaction mixture at 1 minute 7.5 seconds instead of 1 minute 15 seconds.

**(e)** This was generally well answered. Redox and displacement were given credit in addition to the expected answer which was exothermic.

**(f)** Part **(i)** was often correct with candidates identifying a greater temperature rise using zinc. Subsequently most candidates stated in **(ii)** that zinc was more reactive than iron though some vague references to concentration and the greater reactivity of iron were made.

**(g)** A large number of answers showed a lack of understanding. If half the volume of copper sulfate solution were used the temperature changes would be the same or higher depending on whether excess metal powder was added or not. Many candidates assumed that the temperature changes would be lower or half as much.

**(h)** This was generally well answered. Many good responses discussed the reaction or temperature change being slower or taking longer because the surface area of the lumps would be less than the surface area of the powder.

**Question 5**

**(a)**

**(i)** Reference to both colourless and no smell was required for credit to be awarded. Many answers surprisingly referred to a variety of smells for aqueous sulfuric acid and received no credit.

**(ii)** The pH value was often correctly stated.

**(b)** Many responses did not give observations such as bubbles and lighted splint pops. 'Hydrogen formed' is not an observation.

**(c)** The test for sulfate ions is well known and the formation of a white precipitate was recognised by the majority of candidates.

**(e)** A minority of candidates identified liquid **Q** as ethanoic acid. Many answers gained partial credit for 'acid'.

**(f)** Most candidates correctly deduced that liquid **R** was water.

**Question 6**

This was a good discriminating question. The quality of answers spanned the entire spectrum. Many candidates used 1 $dm^3$ of seawater despite being told in the stem of the question, 'you will be provided with a small bottle of seawater'. 1 $dm^3$ of seawater was often heated followed by vague descriptions of weighing the salts with little experimental detail evident.

Other candidates did not measure the volume of seawater and evaporated seawater and then weighed the crystals formed directly on a balance.

Vague references to distillation were common and many candidates just filtered the seawater to obtain the required salts. Some candidates discussed heating the seawater to crystallising point when evaporation to dryness and constant mass was required.

Well planned answers from more able candidates gave essential experimental detail with a clear practical method and a means of calculating the mass of salts in 1 $dm^3$ of seawater.

Credit was awarded for:

- measured volume of seawater using a measuring cylinder but not 1 $dm^3$,
- seawater in named apparatus suitable for heating e.g. evaporating basin or beaker,
- mass of named apparatus,
- evaporation to dryness,
- calculating mass of salts in 1 $dm^3$ of seawater.

Some candidates did not attempt this question.

# CHEMISTRY

**Paper 0620/62**

**Alternative to Practical**

## Key Messages

Questions requiring candidates to compare or explain quantitative information should be answered with extended prose and not merely a restatement of numerical data.

## General Comments

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

The majority of candidates were able to complete a table of results from readings on diagrams as in **Questions 2** and **4**, and plot points successfully on a grid as in **Question 2**. A minority of candidates did not attempt **Question 6**.

## Comments on Specific Questions

### Question 1

**(a)** Only the more able candidates gave water as the answer in the box. Hydrochloric acid was a common response among many random answers. In **(a)(ii)** two correctly placed arrows were rare and a surprising number inserted a heat arrow under the water trough.

**(b)** This was generally well answered. Magnesium hydroxide, magnesium sulfate and magnesium chloride were common incorrect answers.

**(c)** This was well answered, though there were a significant number of glowing splints used instead of lighted splints.

**(d)** Good answers referred to the possible suck back of water or the highly exothermic nature of the reaction and rapid contraction of the glass. Confused answers gave vague references to pressure and the thickness of the glass.

### Question 2

**(a)** This was generally well answered. The table of results was correctly completed by most candidates.

**(b)** Candidates generally plotted the points correctly. A significant number did not plot the origin point. Too many candidates drew a line through the anomalous point and a few dot to dot straight lines were seen.

**(c)** The anomalous point was usually correctly identified. Good estimates of the correct value were often given but the indication on the grid was not clearly shown in some cases.

**(d)** Confusion was evident between the rate of the reaction and the volume of gas produced. The most common misconception was to claim that the reaction got faster. The explanation frequently showed a lack of knowledge and understanding. Mentions of the acid being used up or acid concentration decreasing were only given by the most able candidates. Many candidates referred to the using up of the zinc or the reactants in general.

**(e)** The sketch for the higher temperature in **(i)** was often correct. The sketch for the lumps curve in **(ii)** often went too high and joined the original graph. A small number of candidates did not read the question and drew just one sketch line graph and labelled it 50 $^{o}$C and lumps.

**Question 3**

**(a)** Most answers were correct but some candidates thought that the acid was warmed to start the reaction or to evaporate water.

**(b)** This was a good discriminating question. Confused answers referred to 'the acid being in excess'.

**(c)** Good answers showed an understanding that the metal may react with acid while the glass would not react. Many answers mistakenly focused on the thermal conductivity of the metal.

**(d)** This was a good differentiating question. Correct responses specified that there would be no more gas given off or the presence of excess cobalt carbonate. Confused answers referred to the formation of a precipitate or commonly 'when there is no solid left'.

**(e)** This was generally well answered but a common misconception was to evaporate the solution to dryness to obtain crystals.

**(f)** Many candidates gained partial credit for identifying the loss of water or the solid becoming anhydrous. The correct colour change was rarely given. Some candidates confused this with copper sulfate and claimed that the solid would turn white.

**Question 4**

**(a)(b)** The table of results was usually completed though surprisingly few candidates were awarded full credit for it; volumes often not being recorded to one decimal place.

**(c)** The majority of answers were correct. Some guesses such as 'to make it a fair test/accurate' were seen.

**(d)** Many incorrect responses referred to starch as a catalyst.

**(e)** Most candidates realised that double the volume of sodium thiosulfate was used in Experiment 2. Part **(iii)** was a good differentiating question. Many candidates were unable to express a coherent explanation in terms of concentration or strength of the solutions. Many candidates thought that using more volume of a solution meant it was more concentrated and stated that solution **G** was more concentrated than solution **F**. Vague answers were erroneously based on the different reactivity of the solutions or just stated 'different solutions were used'.

**(f)** There were some well explained correct responses. Others lacked the explanation and some, despite getting the idea of half as much used, could not divide 23 by 2.

**(g)** References to temperature changes, human errors, inaccurate measurement of starch and different starting volumes were not awarded credit. Meaningful sources of error and subsequent improvements to reduce these sources of error were only given by more able candidates. Good answers referred to the use of a measuring cylinder and overshooting the end point which could be remedied by using a burette/pipette and repeating the experiments respectively.

**Question 5**

**(a)** A significant number of responses were penalised by stating that the solution was a solid or a precipitate.

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

**(c)** Contradictory statements in **(ii)** such as 'dissolves to give a dark blue precipitate' were not awarded credit.

**(e)** Candidates found it difficult to draw conclusions as to the nature of liquid **J**. Only a minority of candidates realised that the liquid was an organic compound. Many responses referred to acids, ammonia or other inorganic compounds.

**Question 6**

**(a)** This was generally well answered with candidates having a good knowledge of the test for ammonia. The commonest mistake was heating with sodium hydroxide to describe a test for an ammonium salt.

**(b)** This was a good discriminating question. More able candidates described a titration procedure using a named indicator and detailing essential measurements to be recorded.

Credit was given for other descriptions of adding a measured volume of nitric acid to a measured volume of Kleen Up/ammonia solution using named apparatus.

Many incorrect answers thought that ammonia had to be released as a gas and collected in a syringe while others discussed fractional distillation or chromatography at length.

# CHEMISTRY

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

## Key Messages

Candidates who performed well on this paper showed the following characteristics:

- They could take readings from the instruments shown in the diagrams (**Questions 1** and **4**).
- They could draw accurate bar charts and graphs with smooth lines of best fit (**Questions 2** and **3**).
- They knew the qualitative analysis tests and the expected results (**Question 5**).
- They were familiar with laboratory apparatus and techniques (**Questions 1, 4** and **6**).

## General Comments

The vast majority of candidates successfully attempted all of the questions. The paper discriminated successfully between candidates of different abilities but was accessible to all.

## Comments on Specific Questions

### Question 1

**(a)** The majority of candidates correctly identified all three pieces of apparatus. The most difficult was the evaporating basin.

**(b)** Nearly all candidates knew that the separation technique was filtration or filtering.

**(c)** Nearly all candidates knew that apparatus **C** would be used to obtain crystals from a solution.

### Question 2

**(a)** Most candidates knew how to read the thermometer diagrams correctly and could also calculate the temperature rises.

**(b)** The majority of candidates correctly plotted the temperature rises and drew the bar chart correctly. It is expected that an appropriate scale will be chosen, which uses most of the graph paper.

**(c)** Nearly all candidates realised that calcium gave the highest temperature rise and that copper did not react and therefore gave no temperature rise. It is important to read the command words in the question, in this case “state and explain”, in order to gain full credit.

**(d)** This was generally well answered.

**(e)** This part of the question differentiated well, with the more able candidates realising that the temperature rise would be halved. Changing the volume does not change the concentration.

### Question 3

**(a)** There were many excellent smooth curves going through all the plotted points other than the incorrectly plotted point. Double lines, uneven lines and the use of a ruler should all be avoided.

**(b)** Most candidates correctly identified the incorrectly plotted point, even if they had drawn their curve through it.

**(c)** Most could interpret the graph, realising that the solubility decreases as the temperature increases.

**(d)** A line below the original line for all of its length was correctly given by a large majority of candidates.

**Question 4**

**(c)** The burette diagrams were well read by nearly all candidates. There should always be one decimal place, even for the initial reading 0.0 $cm^3$. The differences were very well calculated.

**(d)** Pink to colourless was not a well-known colour change, only the more able candidates getting it right.

**(e)** Although neutralisation was the expected answer, exothermic was also accepted. Most candidates scored credit.

**(f)** Both parts were usually well answered, although the order was often reversed in **(ii)**.

**(g)** Double the volume was used in experiment 2, as identified by most candidates. A significant number missed the quantitative answer, saying only that more was used.

**(h)** The correct answer, 10.4 $cm^3$, was given by most candidates.

**(i)** Burette or pipette were very common correct responses.

**(j)** Many answers concentrated on the rate of reaction, which was not what the question was asking about. The more able candidates realised that the volumes used would not be affected by an increase in temperature

**(k)** There were many different answers to this question. A lot were imaginative and correct, using a good understanding of chemistry. These included temperature measurements, conduction of electricity, evaporation and reaction with ammonium compounds and metals such as aluminium. Candidates should realise that pH paper and Universal Indicator would not distinguish between different concentrations of the same strong alkali.

**Question 5**

**(a)** The various shades of yellow to brown were accepted here. Some answers referred to the solid state, ignoring the “solution” in the question. There were quite a few “colourless” solutions.

**(b)** A large majority correctly gave “no change” for the barium chloride test and went on to give a white precipitate followed by red-brown precipitates for the last two parts.

**(d)** Carbon dioxide was correctly identified by the vast majority of candidates.

**(e)** The presence of a carbonate was correctly inferred by most candidates. Far fewer realised that it was probably a Group 1 or 2 metal carbonate (or zinc carbonate) because it was white.

**Question 6**

**(a)** The definition of solvent was reasonably well known, although candidates had some difficulty putting it into words. The better attempts referred to the solvent as the liquid in which solutes dissolved.

**(b)** Nearly all candidates recognised the hazard sign as flammable.

**(c)** Fractional distillation was given correctly by most candidates.

**(d)** Chromatography was well known and detailed descriptions of the practical procedure were comprehensive. Consequently the majority of candidates obtained full credit on this question.