CHEMISTRY

Paper 0620/11
Multiple Choice

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

Candidates performed well on this paper. **Questions 2, 3, 4, 10, 11, 21, 28, 31** and **36** proved to be particularly straightforward with a large majority selecting the correct answer.

Question 12 proved to be the most difficult with less than half the candidates selecting the correct answer.

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

Question 5

Response **C**. Candidates chose this response because they missed the emboldened word 'elements'. Particles 3 and 4 are not both atoms.

Question 7

Response **A**. Candidates realised that a group 1 element forms a positive ion but, perhaps, did not read the rest of the possible responses.

Question 9

Response **A**. Candidates saw that A had the correct numbers of atoms but did not read further to find the correct chemical formula in response D.

Question 12

Response **A**. This response was slightly more popular than the correct one. Candidates knew which element went to which electrode but did not take account of the fact that the ions are discharged at the electrodes.

Question 18

Response **C**. Candidates got the two processes the wrong way round. Perhaps not realising that the reverse reaction was required not the one printed.

Question 20

Response **A**. Candidates realised that the element was a metal but did not know that metallic oxides are basic.

Question 32

Response **B**. Candidates must have thought that nitrate and ammonium ions contained different fertiliser elements.

Question 33

Response **B**. Candidates realised that the green solid was copper carbonate but did not read further than alternative B or considered that carbon was the gas produced.

Question 37

Response **A**. This is difficult to explain, perhaps chosen because it contains the most **fuel** oil.

CHEMISTRY

Paper 0620/12

Multiple Choice

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

Candidates performed well on this paper. **Questions 1, 10, 23** and **31** proved to be particularly straightforward with a large majority selecting the correct answer.

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

Question 11

Response **A**. Candidates misread the question and assumed that aqueous potassium chloride was the electrolyte.

Question 12

Response **C**. Candidates appeared to read only the beginning and the end of the sentence. They knew that in exothermic reaction energy was given out but not that the temperature must consequently rise.

Question 13

Response **C**. Candidates knew that natural gas was the least polluting fossil fuel but did not know that nuclear fuels do not produce greenhouse gases.

Question 18

Response **C**. Candidates gave an answer based on the printed equation rather than the reverse reaction which was asked for.

Question 20

Response **A**. Candidates did not realise the importance of stating that excess acid was added. This means that filtering is not necessary as all the solid has reacted.

Question 30

Response **D**. Candidates did not realise that treatment is only essential if the water is used for human consumption.

Question 33

Response **A**. Candidates knew that sulfur dioxide is mainly from power stations but were not as sure about nitrogen dioxide from motor car engines.

Question 37

Response **A**. This is difficult to explain unless candidates though that fuel oil was fuel for cars.

Question 39

Response **D**. Candidates were possibly confused by the name 'polyethene' considering this to be an alkene.

CHEMISTRY

Paper 0620/13

Multiple Choice

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

Candidates performed well on this paper. **Questions 3, 4, 8, 11, 19** and **29** proved to be particularly straightforward with a large majority selecting the correct answer.

Questions 15, 25, 32 and **34** proved to be the most difficult with less than half the candidates selecting the correct answer.

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

Question 5

Response **B**. Candidates chose this response because they knew graphite is a form of carbon. However, this fact does not explain its use in pencils.

Question 6

Response **C**. Candidates chose this response because they missed the emboldened word 'elements'. Particles 3 and 4 are not both atoms.

Question 9

Response **A**. Candidates saw that A had the correct numbers of atoms but did not read further to find the correct chemical formula in response D.

Question 10

Response **A**. Candidates realised that a group 1 element forms a positive ion but, perhaps, did not read the rest of the possible responses.

Question 12

Response **A**. Candidates realised that combustion was exothermic but did not know that electrolysis involved the input of energy.

Question 14

Response **C**. Candidates knew that endothermic reactions take in energy but mistakenly thought that this caused an increase in temperature.

Question 15

Response **A**. This response was more popular than the correct one. Candidates knew which element went to which electrode but did not take account of the fact that the ions are discharged at the electrodes.

Question 17

Response **A**. Candidates must have misread the heading of the temperature column as 'increased'.

Question 20

Response **C**. Candidates got the two processes the wrong way round. Perhaps not realising that the reverse reaction was required not the one printed.

Question 21

Response **A**. Candidates realised that the element was a metal but did not know that metallic oxides are basic.

Question 23

Response **B**. Candidates were probably thinking of 'neon' lights.

Question 32

Response **B**. Candidates must have thought that nitrate and ammonium ions contained different fertiliser elements.

Question 34

This question was not well answered. Responses **A** and **B** were both quite popular indicating that candidates found the observations difficult to interpret.

CHEMISTRY

Paper 0620/21
Core Theory

Key Messages

- Questions on general chemical properties were generally well done by most candidates. Other candidates need more practice in answering questions relating to practical methods, especially chromatography.
- Some candidates need more practice with questions involving balancing equations and many candidates need more practice at questions involving organic chemistry.
- It is important that candidates read the questions carefully in order to understand what is exactly being asked.
- In questions involving free response answers it is important to use the information provided in the stem of the question.
- Questions involving the interpretation of data were generally well done.
- Candidates should be reminded to read the question paper very carefully and ensure that their answer addresses the question on the paper.

General comments

Many candidates tackled this Paper well, showing a good knowledge of core Chemistry. Good answers were seen to many parts of most questions. Nearly all candidates were entered at the appropriate level.

Candidates misinterpreted what was being asked by some questions. For example, in **Question 4 (c)** writing about chemical properties or uses of tin instead of physical properties and in **8 (a) (ii)** writing about the effect of sulfur dioxide on plants and animals rather than on buildings.

Some candidates did not use the information provided by the stem of the question where answers requiring free response were required. This is designed to help candidates structure their answers and write relevant points. In **Question 4 (a)** some candidates did not mention the terms vapour, liquid, solid, condensation or freezing.

Some questions were left unanswered, especially in **3 (c) (i)** (structure of ethane), **6 (b) (i)** (equation for fermentation) and **7 (e) (i)** (polymerisation). Candidates should be encouraged to attempt every question.

Equations were well constructed by some candidates. Others did not complete symbol equations correctly, with many putting letters in place of numbers. Many candidates would have benefitted from more practice at questions involving appropriate separation techniques. For example in the chromatography **Question 7 (a)** and **(b)** the candidates should be encouraged to draw labelled diagrams including the origin line to show where the spot of dye is placed.

As in previous sessions, questions involving environmental aspects of chemistry were not done well by all candidates. For example in **Question 8 (a) (ii)** few candidates referred to the fact that sulfur dioxide forms acid rain. In organic chemistry, some candidates struggled to write the correct molecular formulae of ethane or complete the equation for cracking in 3 **(d) (i)**.

The standard of English was reasonably good. Some candidates need to analyse the questions more thoroughly since a considerable number of errors were made by not doing so. Few candidates wrote their answers in the form of short phrases or bullet points. This method is especially useful in questions involving free response answers. Candidates are less likely to contradict themselves if this is done.

Comments on specific questions

Question 1

This question was the best answered in the paper. Many of the candidates were able to identify the relevant species in part **(a)** and many candidates scored well in part **(b)**.

(a) Most candidates scored at least partial credit for this question. Part **(i)** was generally well done. In part **(ii)**, oxygen and carbon dioxide were generally seen as incorrect answers instead of hydrogen. In part **(iii)** many candidates suggested carbon dioxide instead of carbon monoxide. Parts **(iv)** and **(v)** were generally correct.

(b) Nearly three-quarters of the candidates correctly identified the members of group VII and sodium correctly. The middle two words were less commonly correctly identified with many choosing 'similarity' and 'trend' to fill the blanks.

Question 2

Few candidates scored well on this question. In part **(a)** many candidates only concentrated on one feature of the atom such as the arrangement of electrons. In part **(b)** many candidates ignored the word 'industrial' in the stem of the question. In part **(d)** **(i)** few knew the products of the reaction between lithium and water.

(a) About half the candidates identified at least one aspect of the atom. Some candidates gave answers which switched the object of the sentence between Thomson's model and the modern model and it became unclear to which model they were referring.

(b) (i) Fewer than half the candidates were able to describe the differences between the isotopes. The commonest error was to confuse relative atomic mass with mass number. A few candidates suggested that there were different numbers of protons.

(ii) Many medical uses were given rather than industrial uses. A significant minority of candidates confused isotopes with catalysts. A number of candidates also suggested that X-rays are produced using radioactive isotopes. Whilst the decay of radioactive isotopes can produce X-rays this is not the method used to produce them for industrial use.

(c) About half the candidates obtained partial credit for this question. The melting point of lithium was often predicted to be lower than the range given by the Examiners.

(d) (i) Very few candidates obtained full credit Lithium oxide was the most common incorrect answer, with water, oxygen or carbon dioxide featuring as the incorrect gaseous product.

(ii) About two-thirds of the candidates recognised that pH7 is neutral. The commonest error was to suggest pH13.

(e) Over half the candidates could draw the electronic structure for a potassium atom. The best candidates indicated the electron pairs.

Question 3

This was one of the least well answered questions on the paper. Few candidates scored well. The petroleum fractions naphtha and bitumen were not well known and few gained full credit for the dot-and - cross diagram for methane. The symbol equation in part **(d)** **(i)** was not as well done as in corresponding questions in previous sessions.

(a) Nearly three-quarters of the candidates correctly wrote about the relationship between the number of carbon atoms and the boiling points. Others wrote vague statements, such as 'it increases'.

(b) Fewer than a third of the candidates obtained full credit. A wide variety of spellings of naphtha and bitumen was seen. The commonest errors were to suggest petrol, gasoline or named alkanes.

(c) (i) Many candidates drew the structure of methane or incomplete dot-and-cross diagrams instead of drawing the structure of ethane. A few drew structures including oxygen atoms. A number of candidates did not answer this question.

(ii) Many candidates obtained partial credit for this question. The commonest error was to omit the inner electrons of the carbon atom. Another common error was to place additional electrons on the outer shell of the carbon. Some candidates drew only one bonding electron. Again, a number of candidates did not answer this question.

(d) (i) Fewer than half the candidates balanced the equation. The commonest errors were to put C or C_3.

(ii) This question was moderately well answered. There were many vague answers stating 'temperature' or 'pressure' rather than 'high temperature' or 'high pressure'.

Question 4

Most candidates did moderately well on this question. In the extended response question **(a)**, those who referred to the vapour, liquid or solid tin generally scored well. In part **(c)** many gave chemical properties of tin rather than physical properties.

(a) Many candidates scored at least partial credit. There was confusion between 'freezing' (the process) and 'being in the frozen state'. Many tried to describe freezing in terms of movement of particles, suggesting that the particles were moving in both the liquid and solid state. Similarly, many described condensation in terms of distance between particles being considerable.

(b) About half the candidates recognised that tin has 4 electrons in its outer shell. The commonest errors were to suggest 3 electrons or 6 electrons, the latter perhaps through a misreading of the Roman numeral.

(c) About half the candidates gave a suitable physical property. A considerable number either gave chemical properties or physical properties that do not apply to all metals. Some thought that because tin was in group IV that it is a non-metal and so gave answers such as ' insulator' or' poor conductor'.

(d) Most candidates were able to put the metals in their correct order of reactivity. A minority put the reverse order by just remembering the orders of the metals in the reactivity series.

(e) (i) About two-thirds of the candidates obtained full credit. A significant minority added letters to the equation and made new 'compounds' rather than balancing the equation by adding numbers.

(ii) Under half the candidates scored the mark. Many did not gain the mark because they wrote vague statements about the effects of carbon monoxide. Common amongst these errors were (i) causes cancer, (ii) causes nerve damage. Many candidates gave extensive explanations which were not required.

Question 5

About half the candidates scored well on this question, especially in parts **(b)** and **(c)**. In Part **(a)** few candidates understood where the air and waste gases entered and exited the blast furnace and in Part **(d)** few could explain how the equation shows reduction.

(a) A minority of candidates knew the position of the air blast. Many put the position in the slag hole or iron tap hole. A considerable number put the air blast where the waste gases should have come off.

(b) About two-thirds of the candidates correctly identified hematite as the ore of iron. Of the incorrect answers there was no common error.

(c) (i) Three-quarters understood the meaning of the term exothermic. Common errors included endothermic or things that were totally unrelated to heat changes.

(ii) Fewer than half the candidates knew the test for carbon dioxide. Common errors included (i) water instead of limewater (ii) a lighted splint test (iii) using litmus or other indicator. A considerable number of candidates did not respond to this question.

(d) About one-third of the candidates correctly identified that reduction is loss of oxygen. Many suggested that iron (which is on right of equation) rather than iron oxide, has the oxygen removed from it. Others gave generalised definitions of reduction.

Question 6

Many candidates obtained partial credit for this question. Part **6 (b) (i)** (word equation for fermentation) and **6 (e) (iii)** (explanation of the state of pentanol at room temperature and pressure) were least well done.

(a) Many candidates were unsure of whether to include the carbon and so gave ambiguous answers circling half the carbon atom next to the OH group. Many circled the hydrocarbon part of the molecule or put more than one circle in different parts of the molecule.

(b) (i) Few candidates could recall the word equation or fermentation. Many suggested yeast, alcohol or carbon dioxide as a reactant. Others suggested a variety of incorrect products, such as oxygen or nitrogen. A number of candidates did not respond to this question.

(ii) Most candidates identified enzymes as biological catalysts. Carbonates was the commonest incorrect answer.

(c) About one third of the candidates completed the equation correctly. Many gave impossible compounds, such as C_2H_3 or just C.

(d) Just over half the candidates described the shape of the graph correctly. The commonest error was not to refer to the peak of the graph or write vague statements, such as ‘below 20 °C the reaction is slow’.

(e) (i) About two-thirds of the candidates gave a correct correlation between density and the number of carbon atoms. Common errors included (i) just writing ‘they increase’ (ii) writing about boiling point changes rather than density changes.

(ii) Two-thirds of the candidates gave the correct answer. The commonest incorrect answers were pentanol or methanol.

(iii) Few candidates gave a suitable reason as to why pentanol is a solid. Many only stated the melting or boiling point alone and did not link these values to room temperature. A large number of candidates suggested that pentanol is a solid or a gas at r.t.p.

Question 7

This question was the least well answered on the paper. In Parts **(a)** and **(b)** few candidates could describe chromatography adequately. Few knew about polymerisation in Part **(e) (i)**. Part **(f)** was best answered, many candidates being able to extract relevant information from the table.

(a) Chromatography was not very well understood. Few scored full credit. Common errors were (i) confusing the watch glass with a magnifying glass or dish in which to place the solvent (ii) laying the paper flat across the top of the beaker (iii) filling the beaker nearly to the brim (iv) pouring the solvent onto the paper. Most scored minimal credit for the piece of paper inside the beaker.

(b) This part was marked in conjunction with Part **(a)**. Many did not mention adding dye to the paper as a drop. Another common error was to put the dye into the solvent. Many candidates did not appreciate the role of the solvent in moving the dye up the paper.

(c) About half the candidates suggested a suitable solvent, usually ethanol. Others suggested salts or unsuitable ionic compounds. A significant number of candidates did not respond to this question.

(d) (i) About half the candidates selected dyes WXY. The commonest error was to select only one or two of these.

(ii) This was moderately well answered, with a significant number giving 3 as the answer, perhaps excluding the lowest dot as the initial position of the mixture.

(e) (i) Few candidates could explain the process of polymerisation. Many could link enough together to score one mark but the idea of monomers linking together to form a longer chain was often missing. Most gained marks for statements such as 'ethene is a monomer' or 'poly(ethene) is a polymer'. A number of candidates did not respond to this question.

(ii) Fewer than half the candidates could describe an alloy. Common errors included (i) a mixture of non-metals (ii) metals added together – the word mixture is essential in answering this question.

(f) (i) Many candidates were able to extract the information from the table and so gained credit

(ii) Many candidates were able to extract the information from the table and so gained at least partial credit.

Question 8

This question was one of the least well answered on the paper. The electrolysis question in Part **(c) (ii)** was not well answered.

(a) (i) This question was well answered with about half of the candidates obtaining full credit. A few omitted the 2 in front of the sulfur dioxide and many wrote a C or S in front of the O_2.

(ii) About half of the candidates obtained only partial credit because they missed the acidic nature of the gas. Many referred to the effect of sulfur dioxide on animals and plants, rather than on buildings. A significant number of candidates did not realise that sulfur dioxide is acidic.

(b) About half the candidates realised that insoluble impurities are removed by filtration. The commonest incorrect answer was distillation.

(c) (i) Two-thirds of the candidates were able to identify the cathode. The commonest incorrect answers were anode or cation.

(ii) A quarter of the candidates recognised that zinc is formed at the negative electrode and oxygen at the positive. There was no consistent pattern in the incorrect answers.

CHEMISTRY

Paper 0620/22
Core Theory

Key Messages

- Questions requiring simple answers to practical chemistry were usually well done as were questions involving balancing equations and describing easy separation processes.
- Questions on more detailed aspects of practical procedures (e.g. fractional distillation) need to contain a more focused explanation and attention to detail. Candidates also need to think more carefully when constructing their answers.
- Some candidates need more practice on answering questions requiring extended answers. Questions involving extended writing need to contain the same number of relevant points as the number of marks available. This also should be applied to any other question that has more than one mark available.
- It is very important that candidates read the question carefully in order to understand what exactly is being asked. Practice of reading off graphical scales may also be something to emphasise to candidates, although this was done better than in the past. The drawing and plotting of graphs was also much better.

General Comments

Many candidates tackled this paper well, showing a very good knowledge of Core Chemistry. Good answers were shown throughout the paper to a number of different questions, however, most candidates found parts of every question challenging. Nearly all candidates were entered at the appropriate level, however there were still many candidates obtaining low credit. The general standard of answering was comparable with previous years. It is evident that many candidates are using past paper practice as part of their revision program but more revision is needed in some aspects of the syllabus.

Comments on specific questions

Question 1

(a) This question was reasonably well answered with most candidates achieving moderate credit. Common incorrect answers were N for **(vi)**, H for **(iii)** and K for **(iv)**

(b) This part was answered well with many candidates achieving full credit. As in previous years the most common mistake was the formula of oxygen that led to problems which then did not enable the candidates to obtain full credit.

(c) This question was not well answered, The recall of the required information seemed to present a problem for some candidates. Lots of different answers were seen and some did not relate to the 'adverse effect of lead compounds on health'. This indicated that candidates had not read the question carefully.

Question 2

This question was well answered.

(a) The vast majority of candidates were able to name the pieces of apparatus shown. Measuring tube was seen in a few instances instead of measuring cylinder.

(b) It was clear that candidates knew the salt given by hydrochloric acid and they realised that this was from a carbonate and acid general equation. Some candidates gave hydrogen instead of water.

(c) This was again well answered. However, some candidates did state that the volume was higher than expected.

(d) (i) This part was answered very well with most candidates either stating that there was no oxygen present or that the carbon dioxide does not support combustion.

(ii) This question was moderately well answered, with few candidates stating that the density was less.

(iii) Most candidates obtained at least partial credit here. Some stated that carbon dioxide had escaped and oxygen was now present in the beaker for full credit but most commented correctly on one of the acceptable answers.

Question 3

This question was answered well with the majority of candidates obtaining full credit for parts **(a)** and **(b) (i)**. In most cases the graph was plotted well and this enabled candidates to be able to work out the solubility at 25 ^{o}C successfully.

(a) A well answered question with most candidates achieving at least partial credit and many candidates obtaining full credit. If a question does mention about a labelled diagram it is important that a candidate uses a diagram and labels it carefully. There were some very well considered diagrams here. The common error was to describe industrially how the water could be screened and how chlorine could be added.

(b) (i) This was very well answered. The majority of candidates wrote the correct answer magnesium. Some candidates, however, wrongly wrote that the answer was magnesium and calcium.

(ii) Few candidates wrote the correct answer of sulfate. Sulfur dioxide was the main wrong answer that was seen.

(iii) This question was not well answered, it must be stressed that calculators may be used when taking this paper and candidates should be encouraged to use calculators when doing calculations.

(iv) Most candidates did not realise that the answer should be smaller in magnitude than their answer to the previous question Many candidates were unable to convert the 1000 cm^3 to 50 cm^3 with the majority multiplying their previous answer by 50.

(v) The most common answers for this question were chloride or sodium. A few also wrote down sodium and chloride, but few converted this into a compound and wrote the expected answer of sodium chloride and could not be credited.

(c) (i) This question was very well answered. In a few instances points were plotted using very thick pencils which made the point very hard to read. A sharpened pencil is advisable with small crosses being used for the points. Most candidates could draw a good curve through the points however, double lining and very thick curves were seen in very few cases. Straight lines were seen by a few candidates showing that again the particular candidate had not read the question sufficiently carefully as it specifically asked for a curve of best fit.

(ii) This question was well answered.

(iii) Lots of different percentages were seen right from very high to very low percentages.

Question 4

(a) The correct naming of another homologous series of hydrocarbons was very well answered here. However, there was evidence that some candidates did not read the question carefully enough and named a particular alkane or alkene like methane, ethene, propane etc. The incorrect answer, alcohol was also seen a few times.

(b) (i) Many candidates correctly stated that increasing the number of carbon atoms did generally increase the melting point, but some seem to have been confused by the negative scale and said that the melting point decreased. Few candidates stated that the increase was lower for alkanes with an odd number of carbon atoms and increase higher for alkanes with an even number of carbons.

(ii) Most candidates could draw a line to show that the melting point had increased and more candidates obtained credit here than on **(b)(i)**. Quite a few candidates drew lines showing the increase being lower between the 8^{th} and 9^{th} carbon atoms than the 9^{th} and 10^{th}. The most common mistake was lines going outside the graph space.

(c) (i) Some candidates did struggle with a natural source of methane. Pollution, greenhouse gas and burning fuels were common incorrect answers.

(ii) This question was not well answered, and many vague incorrect answers such as 'effect on breathing' were seen.

(d) This question was moderately well answered. The most common mistake was to write carbon as the other product, which resulted in the candidate being unable to balance the oxygen correctly.

Question 5

(a) Candidates did well on this part. The most common incorrect answer was from candidates who had confused oxidation and reduction.

(b) This question was not well answered; few candidates related the fact that carbon dioxide and sulfur dioxide are gases to this question.

(c) (i) The balancing of this equation was completed well by most candidates.

(ii) Few candidates obtained credit on this question. Only the best candidates wrote that phosphorus is a non-metal and therefore formed an acidic oxide. Some wrote 'basic because it is an oxide' which is not correct.

(d) This was not well understood by most candidates. Some wrote that carbon reacted with the phosphorus(V) oxide and others wrote that it was the slag that reacted with the phosphorus(V) oxide and that it did not react to form a slag.

(e) (i) This question was moderately well answered, but some candidates could not recall a use for one or both of these alloys.

(ii) This was well answered, although options C and D were selected by a minority of candidates.

(f) This data analysis question did prove challenging to a number of candidates. The most common incorrect answer was 'zinc is lower than copper'

(g) (i) This question was well answered. Some candidates did not link the names in the stem of the question to those in the equation and therefore had difficulty in naming the nitric acid and nitrogen dioxide. The most common incorrect name for the copper nitrate was copper nitrogen oxide.

(ii) Only the most able candidates obtained credit on this question. The most common error was to list the product as a dark blue precipitate rather than a dark blue solution.

(iii) This question was moderately well answered, however some answers to this question were very vague and therefore could not be credited.

Question 6

Candidates found this question challenging, however most candidates could name the salt successfully in part **(c) (ii)**, even though they struggled with the reactivity of the halogens in part **(iii)**.

(a) (i) Many candidates did not realise that they needed to answer the question using specific examples not just generalisations. Many candidates wrote that there were no groups/periods present rather than identifying that the groups/periods were different. However, the key problem was with the candidates not being specific enough. An example would be that 'hydrogen is in the same group as the Halogens in Newlands Table' etc. Being more specific would have led to candidates being able to obtain greater credit for the question.

(ii) Few candidates identified that elements like Li, Na and K were in groups already in Newlands Table and some got confused and talked about 'rows of elements'.

(b) Most candidates obtained minimal credit on this question, but very few obtained full credit. Credit could usually be awarded for the colour of astatine. The 'boiling point of bromine' was reasonably well known, but some candidates struggled with the last part of this question.

(c) (i) This question was moderately well answered.

(ii) This was very well answered in most cases.

(iii) This question was answered well by the most able candidates, but some candidates got the correct trend but then talked about 'chloride' instead of 'chlorine'.

(iv) The answer to this question was 'two atoms in the molecule', however several alternative answers were seen which could not be credited. The most common incorrect answers were 'two atoms in an element' or 'two or more atoms in a molecule'. The answer 'two atoms' was insufficiently detailed to be awarded credit.

Question 7

(a) Many candidates were not able to draw the displayed structure of ethanol. The most common incorrect structure was that of methanol.

(b) This question was moderately well answered. The question asked for the products of incomplete combustion. Many wrote carbon dioxide and ethane and ethane were quite commonly seen.

(c) (i) Water and steam were not seen very often here as candidates struggled with this question on the hydration of ethane. 'Yeast' was a relatively common incorrect answer.

(ii) Most candidates obtained partial credit here, but few correctly identified both conditions to obtain full credit.

(iii) This question was moderately well answered. Common incorrect answers included the drawing of apparatus for the fractional distillation of crude oil, and the use of gas syringes to collect the products. Those candidates who drew a diagram did seem to gain greater credit as it can be easy for candidates to miss a detail in a written description. For example, credit could be awarded for the condenser and the flask in the diagram where these had not necessarily been included in the written description. Some candidates did not state anything about the differences in boiling points which meant that they could not obtain full credit.

CHEMISTRY

Paper 0620/23
Core Theory

Key Messages

- Questions on general chemical properties and calculation of relative molecular mass were generally well done by most candidates.
- Many candidates need more practice in answering questions relating to organic chemistry, especially in the areas of organic structures and polymerisation.
- It is important that candidates read the question carefully in order to understand what is exactly being asked.
- It is important to remember the tests for ions and water in appropriate detail for the theory papers as well as for the practical paper.
- More practice is needed with questions involving electrolysis.
- Interpretation of data from graphical information and tables was generally well done.

General comments

Many candidates tackled this Paper well, showing a good knowledge of core Chemistry. Nearly all candidates were entered at the appropriate level and few candidates scored less than one quarter of the available credit.

Some of the questions were left unanswered by a number of candidates. This was especially apparent in **Questions 4 (a) (i)** (selection of apparatus for spotting in chromatography), **4 (c) (iii)** (polymerisation), **5 (c) (iii)** (titration), **8 (b)** (test for sulfate) and **8 (c)** (distillation).

Many candidates would benefit from increased knowledge of environmental chemistry. For example, in **Question 3 (b) (ii)** many gave confused answers.

Few candidates knew the tests for the sulfate ion or for water using cobalt chloride, but many had a good grasp of chromatography and analysis of the results. Most candidates, however, need more practice at explaining practical techniques such as titrations, distillation and practical aspects of electrolysis.

In organic chemistry, few candidates could write the correct displayed formulae of ethanoic acid or explain polymerisation and some struggled when answering extended questions such as 7 **(a) (i)** (comparing Periodic tables) and **8 (c)** (distillation). More practice will help them to learn how to order their ideas in a logical fashion, including specific references to relevant data or parts of apparatus. Many candidates would also have benefitted in additional practice with questions involving electrolysis and the deduction of the formulae of ionic compounds from a diagram of part of the structure.

Comments on specific questions

Question 1

Most candidates scored at least partial credit in both parts of the question. A wide variety of answers was seen in parts **(a) (i), (ii)** and **(iii)**.

(a) In part **(i)** few candidates selected copper sulfate. Calcium oxide was the most frequently seen incorrect answer. In part **(ii)** calcium carbonate was the most common incorrect answer, presumably because candidates did not read the word decomposition. In part **(iii)** a wide variety of answers was seen, potassium bromide being the commonest incorrect answer. Parts **(iv)** to **(vi)** were generally correct.

(b) This question was well answered. The commonest error was to put 'mixed' instead of 'fixed' in the last space.

Question 2

Most candidates scored at least partial credit for this question, part **(b), (d)** and **(e) (i)** being particularly well done. Part **(c)** posed problems in terms of explaining what happens in both tubes.

(a) Fewer than half the candidates could name a suitable acid and base. Common errors included **(i)** chlorine or metal chlorides instead of acids **(ii)** calcium or calcium salts as the base.

(b) Many candidates scored at least partial credit. Many did not put the 6 in front of the H_2O. Others omitted the equilibrium sign.

(c) Few candidates gained credit here. In tube A, most candidates implied that the calcium chloride covered the cotton wool and so prevented oxygen and water from entering. Very few candidates correctly suggested that the anhydrous calcium chloride absorbed water. Many thought that it was the oxygen that was being absorbed. Few candidates commented on why the nails in tube B rusted.

(d) About two-thirds of the candidates identified the oxidation state of the iron correctly. There was no commonly given incorrect answer.

(e) (i) Most candidates could be credited here. The commonest error was to reverse the order. This was probably because the candidates were thinking about the reactivity series of metals rather than comparing the reactions of the metal oxides in the table.

(ii) This question was moderately well answered. The commonest error was to write generalities rather than referring to the equation given.

Question 3

Most candidates tackled this question well, especially in parts **(a)** and **(c) (ii)**. Candidates seemed unfamiliar with the reaction between lime and ammonium salts in part **(b) (ii)**.

(a) (i) About half the candidates identified potatoes and carrots correctly. A common error was to suggest clover, presumably because the range was the greatest.

(ii) Most candidates recognised that a neutral pH is pH7.

(b) (i) Most candidates were able to explain why lime is added to acidic soils, but common errors were (i) to omit writing that lime is alkaline (ii) to state that lime is acidic (iii) to suggest that lime makes the soil more acidic.

(ii) This question was not well answered. Many candidates just repeated material in the stem of the question and referred to nitrogen gas being lost. Few seemed to know that the reaction of ammonium salts under alkaline conditions produces ammonia.

(c) (i) Common errors were (i) writing that the rate was low at low pH values, rather than referring to an increase in rate with increase in pH (ii) mentioning that the rate remains the same without referring to the pH.

(ii) Nearly all candidates identified the pH value correctly.

Question 4

This was the best answered question on the paper. The only parts which proved difficult were parts **(a) (i)** **(a) (ii)** and **(c)**.

(a) (i) Few candidates could name the correct piece of apparatus used to spot the dyes onto the paper. Common errors included 'measuring cylinder' and 'burette'. Many candidates omitted this question.

(ii) A minority of candidates gave a good reason for drawing the line in pencil.

(iii) This was usually correct.

(iv) Most candidates could be credited

(v) Most candidates could be credited

(b) (i) Most candidates gave the correct number of nitrogen atoms. The commonest error was to suggest 3 atoms.

(ii) Over three-quarters of the candidates were able to calculate the relative molecular mass correctly. The commonest error involved the use of atomic numbers instead of atomic masses.

(c) (i) Few candidates knew the meaning of the term 'polymer'. Common errors were (i) reference to short-chain molecules (ii) generalised statements about plastics

(ii) Fewer than half the candidates were able to state the name of the polymer formed from ethene. Common errors included 'polyethane' or various other organic chemicals. A number of candidates omitted this question.

Question 5

The more able candidates performed very well on this question. The organic sections in part **(a) (iii)** and **(b)** proved difficult for most candidates. Many candidates did not know how to carry out a titration in part **(c)**.

(a) (i) Most candidates were able to describe the variation in boiling point with the number of carbon atoms. The commonest error was to just write 'increased' without further qualification.

(ii) About two-thirds of the candidates gained at least partial credit. The boiling point of propanoic acid was calculated correctly less often than was the density of butanoic acid.

(iii) Few candidates explained why butanoic acid is a liquid at room temperature. Many just referred to the boiling or melting point alone. A considerable number of candidates suggested that butanoic acid was either a solid or a gas at r.t.p.

(b) Hardly any of the candidates completed the structure of ethanoic acid correctly. Common errors were (i) only one oxygen atom (ii) additional hydrogen atoms on the carboxylate carbon atom (iii) completion of the structure to make it a hydrocarbon

(c) (i) Many candidates identified the burette. Common errors include pipette and measuring cylinder.

(ii) Fewer than half the candidates identified sodium hydroxide correctly. The commonest errors were to suggest sodium chloride or calcium sulfate.

(iii) Many candidates did not appear to know the process of titration. Few suggested adding an indicator and few mentioned the controlled addition of the alkali to the acid. A large number of candidates omitted this question.

Question 6

This was the least well answered question on the paper. The only parts which were consistently well answered were **(c) (i)** (identification of the cathode and **(c) (iii)** (the relative formula mass of silver cyanide).

(a) A few candidates could deduce the simplest formula for lead(II) bromide. The commonest errors were (i) Pb_2Br (ii) Pb_6Br_{12} (iii) use of charges incorrectly

(b) (i) Few candidates could explain why heat is needed for the electrolysis. Common errors included (i) 'to warm it up' (without mentioning change of state) (ii) to make the particles move (often the wrong particles) (iii) 'to make it conduct' without further qualification.

(ii) Few candidates suggested graphite or platinum. Most suggested reactive metals such as zinc or aluminium. A considerable number of candidates even suggested liquids such as bromine or gases such as oxygen.

(iii) Very few candidates gained credit here. Common errors were (i) the bromine and lead at the incorrect electrodes (ii) writing bromide instead of bromine (iii) writing lead(II) instead of lead.

(c) (i) About half the candidates identified the cathode correctly. The commonest error was to suggest C (the anode).

(ii) Only a few candidates made correct observations about what happens at the positive and negative electrodes. Many referred just to silver or other species rather than giving observations.

(iii) A majority of the candidates calculated the relative formula mass of silver cyanide correctly. The commonest errors were (i) using one or more atomic numbers (ii) omitting one of the atoms present in silver cyanide.

Question 7

In general most candidates performed moderately well on this question. Parts **(b)** and **(d)** were low scoring, but many were able to balance the equation in part **(c)**.

(a) (i) Many of the candidates were able to compare Mendeleev's table with the modern Periodic Table. Some however focused too much on similar factors, such as presence or absence of particular elements and did not refer to Groups or Periods. Others just wrote about relative atomic masses. Many candidates would be advised to order their answers so that they do not repeat themselves which can lead to contradictory statements being made.

(ii) A number of candidates could name two elements which are diatomic molecules. Common errors included (i) iodine, which is not in Mendeleev's table (ii) germanium (iii) Group I elements.

(b) About one-third of the candidates gained partial credit here. Many did not make it clear which metal, titanium or sodium, was being considered. Many mentioned chemical properties rather than physical properties. A considerable minority reversed the properties of titanium and sodium e.g. sodium is hard and titanium is soft.

(c) Most of the candidates were able to balance the equation. Many realised that carbon dioxide is a product. Common errors included (i) sulfur dioxide or carbon as a product (ii) the addition of letters in the space before Cl_2.

(d) Few candidates scored full credit. Many realised that argon is unreactive, but few realised that it prevents oxygen or water vapour reacting with the sodium. A considerable number of candidates thought the argon reacted with the sodium or titanium.

Question 8

Many candidates did well in parts **(c)** and **(e)** of this question. Few knew the tests for sulfate ions.

(a) About half the candidates correctly identified the giant ionic structure of sodium sulfate. The commonest incorrect answer was giant covalent structure.

(b) Hardly any candidates gave the correct test for sulfate ions. Common errors included (i) addition of sodium hydroxide (ii) use of silver nitrate (iii) use of lime water (iv) use of litmus. A considerable number of candidates omitted this question.

(c) Many candidates gained their credit from a suitable diagram. Descriptions of distillation were very often muddled and not specific enough. Many candidates suggested that it was the sodium sulfate which vaporised first and not the water. The most able candidates mentioned the idea of the lower boiling point water vaporising first and then condensing in the condenser. A number of candidates omitted this question.

(d) A minority of the candidates gave a correct observation. Many suggested that the cobalt chloride paper coloured the water blue or that the paper bleached.

(e) About half the candidates gained at least partial credit, usually for filtration.

CHEMISTRY

Paper 0620/31
Extended Theory

Key Message

Candidates should be reminded to read each question thoroughly before attempting to answer the question. **Questions 2(b)**, **3(a)(ii)** and **4(a)(iii)** all had significant numbers of candidates who had not read the question sufficiently carefully.

Candidates should also be reminded that if a given number of uses of a substance are asked for, then no more than this number of uses should appear in the answer as any incorrect uses given will be viewed as a contradictory to correct uses.

Candidates should look to make answers concise and keep to the space available. Use of bullet points can help candidates hit the key points of an answer.

General Comments

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

Comments upon specific questions

Questions 1

The whole question was welcomed as a gentle introductory question by the vast majority of the candidates and many took advantage and secured full credit. In **1(c)**, candidates were only asked for the identity of the particles, but many went on to explain why particles B and F were positive ions. There was no credit available for this.

Questions 2

(a) (i) In most cases candidates scored full credit, where candidates were not awarded full credit, commonly filtration was omitted.

(ii) Very few candidates produced the expected examples of using water within industry (i.e. hydration of ethene in the manufacture ethanol; addition to oleum; as a source of hydrogen for the Haber process) Instead this question produced a wide range of answers, many were creditworthy but some, e.g. 'to wash things', were too vague to gain credit.

(iii) The majority of candidates obtained credit for two domestic uses of water. Some candidates listed two very similar uses, for example, 'showering' and 'having a bath'. Candidates should be encouraged to write two more diverse uses, so as to ensure that both uses can be credited.

(b) Many candidates assumed that the question was asking how to separate salt from sea-water and gave good accounts of this but earned no credit. Those who read the question more carefully scored both marks by referring to boiling followed by condensing.

Questions 3

(a) (i) This definition was well known.

(ii) Once again, it was evident that some candidates had not read the question sufficiently carefully. The question asked 'What property of a gas molecule affects the speed at which it diffuses?' Many assumed the questions asked 'What property of a gas affects the speed at which it diffuses?' and gave the answer 'Density', which gained no credit.

(b) (i) Only a small minority of candidates realised that all the gases in the air were capable of diffusing and therefore the critical factor was the relative rate of diffusion of helium in comparison to the other gases present in the air.

(ii) Most knew that a higher temperature here produced a higher rate of diffusion. Many wrote 'higher temperature so higher rate of reaction' which was inapplicable here.

(c) (i) This question was not well answered. Common errors were 'CH_3', 'C_2H_6' and even 'Me' as the formula of methane; decomposition equations forming $C + 2H_2$; the formation of $CO_2 + H_2$ as products; and by far the most common error, the writing of a (correct) word equation. At this level candidates must assume that if an equation is asked for, then a (balanced) symbol equation is expected.

(ii) Few candidates realised that if methane was combusted this would not isolate helium as the carbon dioxide formed would still be present, mixed with the helium.

(iii) Most candidate knew that fractional distillation was the best method for separating this mixture. Many wrote correctly; 'fractional distillation of liquid natural gas'. Other candidates were incorrect in writing 'fractional distillation of liquid air'

Questions 4

The idea of valency was not well known.

(a) (i) Most knew how many valency electrons these elements had but were less sure about the valency of the elements and gave ionic charges or oxidation numbers. Weaker candidates assumed valency electrons meant the total number of electrons.

(ii) Few candidates could work out that these terms were identical numbers.

(iii) This was poorly attempted. The question asked for the relationship between valency electrons and valency. The vast majority tried to answer the question without any reference to the term valency and gave weak responses such as 'Na loses its valency electrons', rather than the expected 'For Na to A*l* the number of valency electrons is the same as the valency, because this is the *number* of electrons lost'

Only the better candidates knew that for P to C*l*, the number of valency electrons + valency added up to eight because valency was the number of electrons gained.

(b) (i) Nearly all candidates confidently answered that oxides go from basic to acidic as a period is crossed but most omitted that this was via amphoteric. Weaker candidates often got the order reversed and 'neutral oxides' was also occasionally seen.

(ii) Most knew that the bonding in chlorides changed from ionic to covalent as a period is crossed, although a small minority suggested that metallic bonding was present.

Questions 5

(a) The extraction of zinc from zinc blende was poorly known and many rambling answers including several attempted equations were seen.

Weaker candidates simply replaced ZnS for Fe_2O_3 in a blast furnace and went on to write at length about blast furnace processes or attempted to use an electrolytic method based upon extraction of aluminium from bauxite.

This was a response which would have benefitted from the use of bullet points. The points looked for were

- Roasting the ore in air
- Forming zinc oxide
- Adding coke
- The coke reduces ZnO
- One equation

Several gave more than one equation and could not be credited when an incorrect equation accompanied a correct equation.

(b) Two uses of zinc were well known, although incorrect additional responses were often seen. The inclusion of additional incorrect responses meant that full credit could not be gained.

Questions 6

(a) (i) Many candidates simply wrote about how the volume of oxygen changed as the experiment proceeded and no mention was made as to how the rate of production of oxygen changed. Of those who focused their answers upon the rate of reaction many did not realise that the reaction had stopped at t_3.

(ii) Weaker candidates produced a simple description of how the rate of reaction changed, often producing answers which would have gained credit for **(a)(i)**, rather than an attempted explanation of the trend of change. Very few candidates were able to relate the idea of decreasing concentration of H_2O_2 being responsible for decreasing rate of production of O_2.

(b) (i) Most candidates appreciated that a steeper curve was necessary and that this curve had a maximum identical to the original curve. Some wobbly lines were seen, candidates should be reminded that these lines must not go higher than the expected maximum prior to setting on the maximum.

(ii) The explanation for the new graph was poorly attempted. Most candidates were given credit for stating that an increased surface area of MnO_2 would give rise to a higher rate of reaction but few were able to relate this to a steeper curve on their graph. A small minority were able to gain credit for realising that the final volume would be the same for both graphs as the same number of moles of H_2O_2 were used in both experiments.

(c) This question was not well answered on the whole.

The key stages were:
- Filter
- Dry the residue
- Weigh the (dried) residue
- The mass would be 0.1 g (or the same as the starting mass)

Weaker candidate tended to get only minimal credit, if any at all.

Even the best candidates frequently omitted the drying stage.
Many candidates used loose phrases such as ‘check the mass’ and lost the third mark. In the absence of ‘weigh’ the residue, we needed to see ‘use a balance to find the mass of’ the residue’

(d) This calculation proved problematic, but better candidates secured full credit. Many were unable to calculate the initial number of moles of O_2 produced but were able to secure partial credit as a result of their error being carried forward.

Questions 7

(a) (i) The idea of displacement reactions and reactivity was well known and the table was on the whole completed correctly.

(ii) The majority of the better candidates identified Zn as the reducing agent but did not draw an arrow showing the oxidation process. Many small arrows appeared pointing towards the Zn^{2+} ion but these arrows originated from a blank space rather than from the Zn atom.

Many weaker candidates left this question blank. One piece of exam room advice would have been to have guessed which species to circle, even if they were unsure.

(iii) This one mark question proved difficult. Many formed Zn^{+} ions with 2 Ag atoms and many others formed a Zn^{2+} ion but gave diatomic Ag_2.

(b) (i) Well over half the candidates scored credit in this question for the direction of electron flow. Weaker candidates assumed electrons could flow through the electrolyte.

(ii) This question was poorly answered. Weaker candidates assumed electrolysis was occurring and spoke of ions of reactive metals being attracted to the cathode. Relatively few realised that current flowed as a result of metals giving up electrons and forming positive ions at one electrode and that positive ions were accepting electrons at the other electrode.

The idea of metals losing electrons at the cathode was given credit and further credit was given for the idea that it is the more reactive metal which gives up its electrons most easily.

(iii) The idea of polarity of a cell being used to determine the relative reactivity of metals was not understood although better candidates were able to deduce reactivity based upon their knowledge of the electrochemical series. Many knew that copper was less reactive than lead so realised that the less reactive metal always assumed the positive electrode. This enabled them to realise that lead was less reactive than manganese and zinc. Many used their knowledge and stated that zinc was more reactive than manganese. This however, could not be concluded from the table.

(iv) Very few could be credited in this question. Many stated ‘use manganese and zinc’ but failed to include ‘find the polarity of a Zn/Mn cell’.

Questions 8

(a) (i) There were a lot of scripts with this question not attempted but many candidates derived their answer directly from the structure given and sensibly inserted a double bond between carbon 2 and carbon 3. Unfortunately many left the continuation bonds in position so could only gain partial credit.

(ii) It was clear that many candidates did not have much knowledge of polyamides and answers were generally poor. Even better candidates failed to fully address the question and went on to draw more than the one repeat unit asked for.

(iii) Although one answer was required many candidates insisted on giving more than one response and consequently lost credit for incorrect responses seen in addition to ‘protein’

(iv) These definitions were not known. Many weak candidates focused upon the monomers used. Very few succinct correct responses were seen and the expected ‘addition polymerisation produces one polymer *only*’ was hardly ever seen.

(b) (i) Most knew that non-biodegradable referred to inability to be broken down but seldom went on to relate this to idea that it is stable to attack by organisms such as bacteria.

(ii) The question asked for **three** problems and the three lines given for this response should prompt any *three* succinct statements from the list below.

- Visual polution
- Landfills become full
- Combustion would release toxic gases
- Danger to wildlife

(c) Most were able to give **two** correct advantages (other than cost) although frequently more than two responses were given.

CHEMISTRY

Paper 0620/32
Extended Theory

Key Messages

- If a question asks for a certain number of answers, e.g. **Question 4 (a)(ii)** 'state **three** characteristics of a homologous series' candidates are advised to give only the number requested.

- Names of chemical substances must be spelt correctly and written clearly.

- Several questions ask for a comparison between two things. This should involve either referring to both things in the answer e.g. as in **Question 4 (d)(iii)**, propanoic acid is weak and hydrochloric acid is strong or by using comparative words such as hydrochloric acid is stronger than propanoic acid.

General Comments

If a question requests a candidate to **name** something, this means *give the name of*. It is better not to give a formula as well as or instead of the name. 'Identify' or 'give an example' of or 'suggest the products' means give the name or formula. It is better to give either the name or the formula. If both are given they must **both** be correct.

Comments on Specific Questions

Question 1

Most candidates scored very highly on all parts of this question. B (silicon) was seen occasionally in part **(g)**. Metals such as potassium (C) are much better conductors of electricity than silicon, which is a semiconductor.

Question 2

(a) (i) Most candidates were aware that a fuel is a source of energy, although a small number explained what was meant by a *fossil* fuel.

(ii) Many candidates gained partial credit, although rather fewer obtained full credit. Oil could refer to vegetable oil and is not as specific as crude oil.

(iii) Coal and bitumen were very common incorrect answers. Coal was sometimes given in both **(a)(ii)** and **(a)(iii)**. Candidates who choose a radioactive fuel are advised to give the name or symbol and the mass number of the isotope that they choose e.g. Uranium 235 or Plutonium 239. A wide range of erroneous answers was seen.

(b) (i) The statement 'suggest the products' means that either names or formulae are acceptable as answers. This question was answered well by large numbers of candidates.

(ii) Not reusable is different to non-renewable. Pollution is a generic term, as is harmful. More specific types of pollution were required.

Question 3

(a) (i) There were some excellent answers to this question, which obtained full credit.

Some candidates went into unnecessary detail about the production of nitrogen and hydrogen. Units of pressure should be expressed as atmospheres or atm as opposed to atp and other incorrect abbreviations. ^{Oc} instead of $^{\circ}C$ was sometimes seen as units of temperature. 2N was occasionally seen in the equation as the formula of nitrogen in place of N_2. Vanadium(V) oxide was occasionally seen as the catalyst.

(ii) Many candidates gave phosphorus and potassium as correct answers, although phosphorous was seen regularly. 'Phosphates' was occasionally seen instead of phosphorus. Calcium was seen occasionally.

(b) (i) Most candidates gave the cause of acid rain as being due to sulfur dioxide rather than oxides of nitrogen. This is perfectly acceptable in this particular question. The first marking point i.e. the production of the acidic oxides was least commonly given in either case. Sulfur is not burnt, unless it is the source of sulfur dioxide for the contact process, in which case the sulfur dioxide would not escape into the air. Statements that oxides of nitrogen and sulfur dioxide come from factories and /or cars are regarded as having insufficient detail to gain credit. An acid present when the acidic oxide dissolved/reacted with rain water needed to be identified.

(ii) The correct calcium compounds used to increase soil pH were known by a significant number of candidates. Strong bases such as sodium hydroxide are not added to soil, because although they would neutralise soil acidity, their corrosive nature would do damage to plants.

Question 4

(a) (i) C_3H_7COOH provides insufficient information about how the atoms are arranged to be classified as a structural formula.

(ii) 'Characteristics' refers to properties that members of a homologous series have in common or show gradual changes in, as opposed to names and particularly name endings(e.g. –ane, -ene) which were mentioned occasionally.

Trend/gradual change in physical properties is correct, as opposed to same physical properties and different physical properties.

A small but significant number of candidates answered the question assuming that it asked about *this* homologous series i.e. carboxylic acids.

Candidates need to ensure that they know the difference between general, structural, molecular and empirical formulae. Chemical formula or formula (unqualified) is non-specific.

Some candidates were under the impression that the same type of (chemical) reaction was different to 'very similar chemical properties'.

(b) (i) Show all atoms and bonds includes the O-H bond which is just as important to show as all the other bonds. Because candidates are asked to 'Draw the structural formula' it is not advised that they write an equation. Either too few or too many carbon atoms were commonly seen.

(ii) The name potassium manganate(VII) must contain the oxidation state (although potassium permanganate is acceptable). The oxidation state of manganese was occasionally attributed to potassium e.g. potassium(VII) manganate. $KM\mathbf{NO}_4$ was also quite a common error. Candidates rarely mentioned that an acid (specifically sulfuric acid) had to be present for the oxidising agent to function.

Water was occasionally seen as the reagent.

(c) (i) and **(ii)** The information in the question i.e. 'salts of this acid are called propanoates' was included as assistance to candidates in answering all three parts. Propanoates is a plural word. Propanate/propanote/propenoate/proponate are all incorrect.

Candidates must make *all* spellings clear. If a candidate decides to change an answer, it is advisable to cross out words and replace them rather than alter them, which usually makes them illegible. This applies to this and to all other questions, but the word propanoate was often illegible. In **(c)(ii)** oxygen and (less so) hydrogen were sometimes seen as the other product instead of water. Hydroxides and carbonates were often seen as the metallic compounds that were produced instead of propanoates.

(iii) Many candidates gave names instead of formulae. $CH_3CH_2COO\mathbf{H}Li$ was commonly seen from those candidates who attempted to write the formula of lithium propanoate. Many gave word equations instead of the required symbol equations.

(d) (i) (ii) and **(iii)** There was a reluctance to mention more/less (frequency of) collisions three times, which could have scored three marks if stated appropriately. The question does ask candidates to 'Explain the following *in terms of collision theory*' and this does apply to all three parts of **(d)**.

The questions all used comparative statements which is an indication that the candidates were expected to do the same in their answers.

(d) (iii) More acidic/more reactive/lower pH were all quoted more often than stronger which is more explicit. Higher concentration of H^+ was very rarely mentioned.

Question 5

(a) (i) Incomplete combustion or similar statements were often seen as correct answers.

(ii) A number of responses stated incorrectly that there were more moles/molecules in the forward reaction or less moles/molecules in the backward reaction rather than more moles/molecules *as products* in the forward reaction or less moles/molecules *as products* in the backward reaction or less moles/molecules on the left hand side or more moles/molecules on the right hand side of the equation.

(b) The best answers, of which there were many, were the most concise. Such answers gave two ionic equations which made the identity of the products at the two electrodes clear and also named sodium hydroxide as the sodium compound formed. Many answers contained far too much written prose which was often difficult to decipher.

Sodium was occasionally seen as the product at the cathode. Electrons were often placed on the wrong side of ionic half equations.

(c) Bonding diagrams should be clear and large, using the majority of the space available. There should be no doubt as to whether electrons are shared as in this case, or transferred. Some diagrams were obscured by being partially drawn over the written part of the question. This was un-necessary.

The double bond was often absent. The oxygen atom often had three (as opposed to two) non-bonding pairs of electrons.

It is essential that Examiners can count the number of electrons, which must be drawn clearly.

Candidates are advised to check that they have used the correct number of outer shell electrons for all four atoms, and that all four atoms have a full outer shell of electrons.

Question 6

(a) Titanium has a high or higher density scored very highly. Titanium forms coloured compounds or coloured ions is the preferred response concerning colour. 'Do not form colourless solutions/compounds' could mean that the compounds are black and/or they do not dissolve in water, and is different to the preferred positive statement i.e. that the solutions/compounds are coloured. Some responses suggested that titanium itself is coloured.

(b) If atoms **and** ions are drawn, it should be made clear which ones should be marked e.g. by crossing out the atoms (working out) and also crossing out arrows showing the movement of electrons. It is essential that Examiners can count the number of electrons, which must be drawn clearly.

Covalent molecules were occasionally seen and F*l* was frequently incorrectly seen as the symbol for fluorine.

(c) The phrase 'describe how you could show' means give very brief experimental details including observations, namely dissolving (in both acid and alkali), which was hardly ever mentioned. Some candidates referred to formation of precipitates of insoluble hydroxides or effervescence rather than the formation of a solution (of a salt) in the reaction with acids and alkalis. Candidates were expected to make a positive statement e.g. that scandium oxide reacts with both an acid and an alkali as opposed to 'we should see if scandium oxide reacts with acids and alkalis'.

Question 7

(a) There were some excellent answers that obtained full credit.

The process of drying should be described briefly. The question says dry crystals, so there is no credit for repeating part of the question. The same applies for using the word crystallisation without mentioning how it is carried out.

Filtration was often described inappropriately. It is unnecessary to filter a liquid that does not contain an undissolved substance. Some candidates were under the impression that the indicator could be removed by filtration.

Some misunderstanding was evident concerning the use of the words dry and hydrated. This was also apparent in **(c)(i)**. Candidates should be aware that hydrated crystals can be dry and dry crystals can be hydrated.

(b) Many candidates interpreted 'Number of moles of $Li_2SO_4.H_2O$ which *could be* formed' to mean number of moles of $Li_2SO_4.H_2O$ which *were* formed and used the figure of 2.20g instead of dividing the moles of LiOH by 2. Answers to the second marking point were commonly given as 0.017, 0.020 or 0.052. The fourth marking point was not always given to one decimal place as requested.

(c) (i) Candidates should be aware that the only way of being certain that all the water has been driven off is to heat until the mass is constant. To carry out a fair test was a common answer, as were to get a reliable, precise or accurate result. These answers miss the point. Candidates should be aware that crystals can be dry even if they contain water of crystallisation.

(ii) There were several excellent methods used by candidates that obtained full credit.

$m_2 - m_1$ was sometimes given rather than $m_1 - m_2$.

Any successful calculation had to include the number of moles of water. To show that the mole ratio between the anhydrous salt and the hydrated salt is 1:1 is not proof that the value of x = 1. The 1:1 ratio applies in *all* cases when hydrated salts are heated, irrespective of the number of moles of water present in one mole of the hydrated salt.

Candidates were expected to explain how the experimental results (i.e. masses m_1 and m_2) could lead to the conclusion, rather than devise another experimental method.

CHEMISTRY

Paper 0620/33
Extended Theory

Key Message

The candidates should be reminded they should read the question carefully and then ensure that the answer they give answers the question presented in the paper.

General Comments

The allocated space is normally sufficient to answer the question and to be awarded full credit. There is no advantage in reducing handwriting size in order to include a greater content; this increases the likelihood of contradiction or ambiguity.

Many examples of illegible handwriting were encountered. Candidates should be reminded that credit cannot be awarded where the work cannot be read.

It is essential to use the correct scientific term in the context of the question. Atom and ion are not interchangeable and the use of the wrong alternative can result in no credit being obtained. Similarly you cannot have intermolecular forces in a metal or an ionic compound.

Amount formed in a reversible reaction is not the same as the yield. Assuming the change in conditions favours product C in the following equilibria:

$$A + B \rightleftharpoons C + D$$

then one ought to comment that the yield of C increases or the position of equilibrium moves to or favours the products side. The amount produced can be determined by the scale of the reaction.

Specific Questions

Question 1

(a) to (g) It was rare for a candidate not to be awarded any marks for this question, equally full marks were not common. Part **(f)** proved to be the most challenging with the popular, but incorrect, suggestions of fluorine and ammonia.

Question 2

(a) This was generally well answered with the majority of the candidates realising that the important points were an increase in energy, molecules moved faster and there was a higher collision rate or more successful collisions or more molecules had sufficient energy to react. Although not required by the syllabus arguments based on activation energy were acceptable.

(b) The question required an explanation of the two phases, liquid and gas, in terms of particles e.g. a liquid has intermolecular forces which prevents the particles moving apart whereas in the gaseous phase these forces are virtually absent. The particles can move apart and fill any volume.

The question required an explanation of the two phases, liquid and gas, in terms of particles and not in terms of macroscopic characteristics e.g. a liquid has a finite volume.

Question 3

(a) (i) Enzymes are the biological catalysts, not bacteria, micro-organisms, microbes or fungi.

(ii) Appropriate suggestions were accepted. Slower reaction rate, microbes have a lower rate of reproduction, microbes become dormant, enzymes less efficient at low temperatures.

(b) Many could not recall the structure of the polymer and a proportion of those who could did not indicate continuation. The popular choice for the product other than the polymer was glucose not water.

(c) One of the best answered questions on the paper with many candidates obtaining full credit.

Question 4

(a) (i) A majority thought that calcium oxide was made by reacting calcium and oxygen instead of the thermal decomposition of limestone and that oxygen was made by photosynthesis. A minority could recall that it was obtained by the fractional distillation of liquid air.

(ii) The four impurities formed their oxides. Carbon dioxide and sulfur dioxide are gases and leave the furnace. The other two oxides are acidic and react with the basic oxide, calcium oxide, to form a slag which can be separated from the molten iron. Few accounts gave the above detail.

Many responses described the Chemistry of the Blast Furnace rather than the removal of the impurities from the pig iron produced by this furnace.

(b) (i), (ii) and **(iii)** All three parts required familiarity with the model of the structure of a metal as a regular array(lattice, rows or layers) of cations surrounded by delocalised electrons. Malleability can be explained in terms of the movement of the layers without the metal breaking. The increase in hardness of mild steel relative to pure iron the layers moving past each other or as a candidate wrote" the layers are locked together".

Common errors included stating that the iron is present as atoms, that carbon forms a hard covalent compound. Many candidates gave the general characteristics of metals and did not mention cations and delocalised electrons. This could not be credited.

Question 5

(a) This question was generally well answered with candidates aware that the faster reaction rate is as a result of the higher collision rate and that the shift in the position of equilibrium to the right hand side is a result of there being fewer moles on this side.

(b) Some candidates found it difficult to formulate a coherent explanation even when they seemed to have the correct idea.

(c) (i) The advantage of using a fine powder that is a greater surface area and consequently a higher collision rate was widely understood.

(ii) The majority were awarded partial credit for increase in reaction rate but were unable to obtain full credit. Having a faster rate without increasing the temperature, which would reduce the yield, is an advantage.

(d) The most able candidates stated that water should be added and only the ammonia would dissolve, cool so that the ammonia will liquefy first, or increase the pressure only the ammonia will liquefy. The majority of the candidates suggested fractional distillation without any additional comment. This received only partial credit, as did fractional distillation followed by a statement that ammonia would distil over first.

(e) The reaction is exothermic. A mark was only awarded for the correct thermicity if calculation was complete and there is evidence that the reaction is exothermic. For example changes labelled exothermic/endothermic **or** bond breaking/forming mentioned **or** the correct use of signs.

Most of the candidates made a good attempt at this calculation.

Question 6

(a) (i) A compound which contains carbon and hydrogen only. "Only" is essential but it was omitted by many of the candidates.

(ii) Either only single bonds or no double bonds. The former was more popular. The comment that all carbon hydrogen bonds are single bonds could not be credited.

(b) (i) The majority could recall this formula C_nH_{2n+2}.

(ii) This was well answered, with a considerable number obtaining the correct formula and being awarded full credit. Some did this using the formula in **(b)(i)**, but others drew the structural formula in full across the page, presumably a line of 14 carbon atoms, allocating one each four bonds and then counting the hydrogen atoms. The only frequent error was to omit the hydrogen atoms and give 168.

(c) (i) A high portion of the candidates were able to write and balance this equation, the common problem was in balancing the oxygen atoms.

(ii) Only the most able candidates scored full credit on this question. Virtually all the candidates chose the more challenging method that is to convert volumes into number of moles rather than usual method which uses the relationship that the mole ratio is the same as volume ratio.

(d) (i) This question was generally well answered.

(ii) Correct equations for the cracking of decane to form two different alkenes and hydrogen were frequently encountered. The typical errors were to include alkanes, the equation could not be balanced, and to include two moles of the same alkene.

(e) (i) Candidates were awarded credit for referring to the presence of light and high temperature. References to pressure were ignored and just "catalyst" did not suffice, a catalyst had to be specified.

(ii) The structural formula of 2-chloropropane or any dichloropropane were required. The latter was the more common choice. An important point to be addressed is that chlorine cannot be part of the chain. It is not divalent. Many attempts to draw the structural formula of 2-chloropropane included this error.

Question 7

(a) Many could not recall the name of this ore, attempts ranged from haematite to aluminite.

(b) A significant number did not attempt this part question on the electrolytic extraction of aluminium from pure alumina.

(c) (i) Correct suggestions included soda cans, windows, roofing, foil, containers for food, construction of boats etc The reason for the widespread use of aluminium in the construction of aeroplanes is not because of its resistance to corrosion but due to its very high strength to mass ratio. Low density is acceptable as an approximation of this characteristic.

(ii) Candidates should be reminded of the rules of balancing equations – they must balance by atoms and by charge. The formula of a species cannot altered to facilitate balancing. A frequent example of this was to write oxygen as O_3.

CHEMISTRY

Paper 0620/04
Coursework

General comments

The centres more experienced in entering candidates for the coursework option generally presented work of high quality which was generally accurately marked. Some centres which are new to the assessment of coursework had problems. Some tasks were unsuitable for the assessment of the skills they were used to assess and marks were sometimes overgenerous.

Tasks set should be based on the Chemistry in the 0620 syllabus. This also aids candidates as they are more likely to understand the principles involved if they have studied them as part of the course. The tasks should be testing the candidates' skills which they have developed during their course. In other words they should have some knowledge of the techniques involved in the task before they attempt it.

Candidates are expected to score well in skills C1 and C2 since they are relatively straightforward once candidates have had practice in their use. Skills C3 and C4 are more testing and high marks are more difficult to score. Skill C1 cannot be assessed by the same task as skill C4. In C1 detailed instructions must be provided and in C4 they are not provided.

The marks given must be based on the criteria provided in the syllabus it will not always be the case that the best candidate in the Centre will score a very high credit or that the weakest candidate will score a low credit.

The comments on each skill below are designed to help centres who have found the setting of appropriate tasks or applying the correct narking standards difficult. It is the job of a Moderator to ensure that the standards applied by each Centre are in line with the standards applied by other Centres throughout the world.

Comments on specific skills

Skill C1 Using and Organising Techniques, Apparatus and Materials.

Since this task assesses the ability of the candidate to follow instructions, it is essential that the instructions provided by the Centre are appropriate. To gain the highest credit the instructions should include a number of separate steps which the candidates must follow in sequence. In addition there should be a point in the investigation where the candidate has to make a decision of what to do next as a result of an observation made.

This instruction sheet must be included in the sample of work sent to the Moderator together with a mark scheme explaining how the candidate is to be assessed. This mark scheme should not simply be a copy of the assessment criteria but must be linked to them.

Skill C2 Observing Measuring and Recording.

The tasks set should allow candidates both to take measurements and to make other observations, though not necessarily in the same task. Visual observation should be detailed and complete. Measurements should be as accurate as is feasible using the apparatus available to the candidate. Simple single observations or measurement do not give sufficient justification for high credit. There should always be a range of data values or a number of observations as part of the task.

Observations and measurements should be recorded appropriately (usually in a table) in a manner designed by the candidate. The provision of an outline table or detailed instruction on how to record results limits the maximum mark available.

Again the instruction sheet given to the candidates should be included with the sample along with a mark scheme.

Skill C3 Handling Experimental Observations and Data.

In this skill processing is important. This is easier to assess where the tasks include some numerical data. The most straightforward way to assess this skill is by incorporating a graph into the assessment. Simple arithmetical processes do not usually provide sufficient evidence though more complex calculations can do so. Graphs should be accurately drawn and fill over half of an A4 sheet of 2 mm graph paper.

If the candidate has only undertaken tasks which involve observation rather than data measurements it is difficult to justify the highest marks.

Where calculations are involved (e.g. in titration exercises) any assistance given decreases the mark available.

Conclusions given in answer to leading questions are rarely worth high marks although a question prompting the candidate to give a conclusion is fair.

At the highest level conclusions should describe and explain patterns/trends found in the results and should comment on any results which do not fit the pattern.

Skill C4 Planning, Carrying Out and Evaluating Investigations.

This is the skill where the selection of an appropriate task is most important. To gain access to the higher credit it is essential that a number of variables are involved as part of the skill is the ability to control variables. Very simple investigations are will not give access to the highest credit.

The most obvious examples are concerned with rate of reaction where a number of variables could affect the rate. Explaining how these variables will be controlled, varied or measured is the key to performing well. Another good example would be comparing the amount of heat produced by different fuels.

It is also essential that candidates perform the investigation which they have planned as indicated in the title for this skill. A candidate who does not carry out the investigation has not fully complied with the criteria for minimal credit.

Another part of the assessment criteria is the evaluation of the method and suggestion of improvements. This clearly cannot be done if the investigation has not been attempted.

This is the most difficult skill to score well on. It is not recommended that C4 tasks should be the only way of assessing C2 and C3 as a poor plan can adversely affect these marks.

CHEMISTRY

Paper 0620/51

Practical

Key messages

All burette readings should be recorded to one decimal place and it is not possible for the initial reading on the burette to be greater than the final reading.

In qualitative exercises, candidates must read and follow the instructions given. All observations should be noted. There is still a tendency to test for a gas but forget to note effervescence or bubbles formed.

General comments

The majority of candidates successfully attempted and completed both questions and there was no evidence that candidates were short of time.

Supervisors' results were submitted with most of the candidates' scripts. These results were used when marking to compare with the candidates' responses, particularly in **Question 1**. Centres reported no problems with regard to obtaining the requirements for both questions.

Candidates should be encouraged to read the question before starting any practical work and follow the instructions carefully.

Comments on specific questions

Question 1

(a) and **(b)**

The tables of results were completed by all of the candidates. A minority of candidates recorded initial burette readings greater than the final burette readings. Some candidates recorded volumes to the nearest whole number only and could not be credited. Burette readings should be recorded to one decimal place. The titre differences were compared with the Supervisor's results.

(c) Observations varied from Centre to Centre. Some candidates within the same Centre noted effervescence or bubbles while others noted no visible change.

(d) (i) The colour changes were often correctly recorded. Pink to colourless was the expected response. A significant number of candidates gave the colours in the wrong order. Credit was not given for descriptions such as red, purple or clear.

(ii) This question was generally well answered with orange or pink scoring credit.

(e) (i) A number of candidates understood that S and T were alkaline solutions. References to bases or basic were not credited. In **(ii)** good answers referred to the presence of a carbonate or carbon dioxide from the effervescence recognised in **(c).**

(f) (i) and (ii)

The majority of candidates were unable to use their results to determine the volume of hydrochloric acid that reacted with substances S and T. Many candidates ignored the guidance and made up their own methods, frequently giving the values from differences obtained in **(a)** and **(b).** The unit was also frequently omitted.

(iii) This was well answered with the majority of candidates using their results in **(i)** to state that more or less acid was used as appropriate.

(g) (i) A number of candidates realised that using four times of the volume of solution R if the experiments were repeated, would require four times the volume recorded in the differences in the tables in **(a)** and **(b).** Candidates often multiplied their values obtained in **(f)** and misunderstood what was required. The explanation was often vague and reference to more or double the amount of acid would be needed instead of four times as much was common.

(g) (ii) A number of candidates realised that the repeat experiments would involve using volumes of acid greater than one burette could contain. Consequently this practical problem could be solved by using more than one burette or refilling the burette. Some confused responses referred to accuracy as the problem of using a measuring cylinder and did not answer the question.

Vague references to parallax errors and spillage of chemicals were common and were not credited.

Question 2

Solid **U** was hydrated manganese(II) sulfate.

(a) Most candidates were able to describe the appearance of solid **U** as a powder or crystalline. The pale pink colour of the salt was often missed.

(b) Detailed observations were rare. The presence of condensation was often not noticed. Credit was given for recognising that the colour of the solid darkened or turned brown after strong heating. It was apparent that many candidates had not followed the instruction to heat the solid more strongly.

(c) Some responses showed that candidates did not follow the instructions given and therefore observations were missed. A brown precipitate which turned black when hydrogen peroxide was added was expected. The description of effervescence or bubbles was rarely given. Despite this the gas was usually tested by a glowing splint relighting, or glowing brighter which scored credit. Some candidates just wrote 'oxygen is produced' giving no test whatsoever and scored no credit. Many yellow or white colourations were recorded and a surprising number of candidates used a lighted splint to test the gas which they then reported 'popped'.

(d) Generally well answered with the recognition of a brown precipitate. Many candidates noted the formation of the precipitate but failed to describe the colour appropriately.

(e) The formation of a white precipitate was often recognised

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

(g) The majority of candidates correctly surmised that halide ions such as chloride and iodide were absent. Other answers referred to halogens.

(h) The gas was generally correctly identified as oxygen though carbon dioxide and hydrogen were frequently mentioned.

(i) Many candidates scored credit by referring to the presence of sulfate ions in solid **U** from the white precipitate recorded in **(e).** Very few candidates deduced that the formation of condensation in **(b)** indicated that a hydrated solid was present. Only a minority realised that the coloured nature of the solid indicated the presence of transition metal ions. Guesses such as iron(III) ions and iodide ions were common.

CHEMISTRY

Paper 0620/52

Practical

Key Messages

Where a qualitative test asks for a reagent to be added drop-wise and then in excess, it is important that candidates first give an observation for what happens when a few drops of reagent have been added and then an observation for what happens when an excess of the reagent is added.

Candidates should make full use of the "Notes for use in qualitative analysis" page of the examination paper. This gives the formulae of many ions and gases and will help avoid confusion between, for example, ammonia and ammonium

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. Few problems were reported with carrying out the experiments. The Examiners use Supervisors' results when marking the scripts to check comparability.

The results obtained by some Supervisors and candidates suggested that some Centres did not use solutions of the concentrations specified in the Confidential Instructions. The expected formation / redissolving of precipitates in qualitative exercises may not occur if the solutions used are of too low a concentration. Ammonia solution in particular can become less concentrated when it is stored, and so its concentration should be checked shortly before the examination.

Comments on Specific Questions

Question 1

(a) to **(e)** Almost all candidates completed the table of results. Errors in calculating the temperature change occurred most often where a candidate had altered their recorded initial or final temperatures but then failed to alter their calculated temperature change. Good results were obtained by the majority of candidates, with longer lengths of magnesium giving a larger temperature increase and temperature increases of candidates agreeing well with those obtained by the Supervisors.

(f) While most candidates plotted all points correctly, the scale on the vertical axis of the graph resulted in some mis-plotting. It is important for candidates to look back at the instructions for the practical to see the length of magnesium used in each experiment.

(g) Most candidates showed clearly where they had read from the graph, but again candidates need to carefully read the scale on the y-axis to avoid errors in recording values from the graph.

(h) Having done the experiment, the majority of candidates were able to state they saw bubbling. It should be noted that 'gas made' is not an observation, it is a conclusion based on the fact that bubbles are seen and that the magnesium did not 'dissolve', it disappeared as it reacted.

(i) The majority of candidates identified the experiment with the greatest temperature change. The most common error was to attribute this to the magnesium having a larger surface area rather than there being more magnesium reacting.

(j) While many candidates gave good answers linking rate and surface area, some candidates did not understand the link between particle size and surface area, stating that the powder would have a smaller surface area and so would react more slowly.

(k) Some excellent diagrams were seen, but some candidates were clearly unsure of how to collect gases produced in reactions. Balloons are not appropriate and sealed apparatus with a fixed volume would not work.

(l) This question part produced a wide variety of answers. While there were many correct answers seen, some candidates need to remember that if they are going to use a more accurate item of apparatus then they need to give the name of that apparatus.

Question 2

Mixture **E** was a mixture of ammonium chloride, **F**, and zinc carbonate, **G**.

(a) Most candidates stated that the mixture was white.

(b) While it was common for candidates to report a correct pH or colour of pH paper, relatively few commented on the white smoke, the solid deposited on the sides of the tube or the pungent smell. The results reported by some candidates suggested that they heated the tube for more than the one minute stated in the instructions.

(c) In **(c)(i)** while many correctly noted the correct pH or colour of pH paper, some claimed observations (such as the pH paper becoming red) that were not possible. In **(c)(ii)**, while most candidates saw a white precipitate, impossible results such as the precipitate redissolving were reported, as well as results for tests with pH paper, which were not required in this part of the examination.

(d) Candidates need to observe carefully during the qualitative analysis section, most candidates missed the fact that bubbles are formed. Again, impossible results were reported with positive test results being seen for all five gases listed on the notes page on the back of the question paper.

(e) Many well set out answers with fully correct observations were seen. Some candidates needed to read the instructions more carefully as they did not report the result of adding excess sodium hydroxide in either **(e)(i)** or **(e)(ii)**

(f) It was not uncommon for candidates to just repeat their test results here rather than explain them. While many noted that there was a alkaline gas, or identified the gas as ammonia, relatively few stated that decomposition or sublimation had occurred, possibly because they had not observed the white solid on the walls of the test tube after heating.

(g) Many candidates correctly identified solid **F**, but there was some confusion between ammonia**a** and ammoni**um**

(h) Candidates who made correct observations in **(d)** and **(e)** usually correctly identified **G**. Problems arose when candidates had supposedly identified a gas that could not have been made in **(d)** as they then had to try and suggest a possible cation that would produce that particular gas.

CHEMISTRY

Paper 0620/53
Practical

Key Messages

Where a qualitative test asks for a reagent to be added until there is no further change, it is important that candidates first give an observation for what happens when a small amount of reagent have been added and then an observation for what happens when an excess of the reagent is added.

It is essential for candidates to follow the instructions in the qualitative analysis experiments carefully. If an instruction says a mixture should be left to settle then it should be left until there is a clear solution in the test tube. If an instruction then tells a candidate to decant the solution, then they should pour the clear solution off from the solid, leaving the solid in the original tube.

General Comments

The majority of candidates successfully completed both questions and there was no evidence that candidates were short of time. The number of candidates entered for this component was low compared to the other two components.

Supervisors' results were submitted with the candidates' scripts; the results for experiment 2 for some Centres suggested that the sodium carbonate used was not the decahydrate and that some efflorescence had occurred.

Comments on Specific Questions

Question 1

(a) Almost all candidates completed the table of results and gained results which showed an increase in temperature in good agreement with that gained by the Supervisor for that Centre.

(b) Almost all candidates completed the table of results. Most Centres reported an increase in temperature rather than the decrease that would be obtained with $Na_2CO_3.10H_2O$. This did not disadvantage candidates and caused no problems with answering any other questions on the examination paper.

(c) Most candidates noted the appearance of bubbles. It should be noted that 'gas made' is not an observation. As is often the case, some candidates reported impossible observations given the chemicals used, such as 'white precipitate formed '.

(d) Having done the experiment, the majority of candidates were able to state they saw bubbling. It should be noted that 'gas made' is not an observation, it is a conclusion based on the fact that bubbles are seen and that the magnesium 'did not dissolve', it disappeared as it reacted.

(e) Some candidates were unable to obtain full credit as a result of misreading the graph scale or by failing to show from where on the graph they had read the value.

(f) This was well answered. A minority of candidates ignored the fact that the only information they had from Experiment 2 was the temperature change and suggested reaction types for which there was no evidence.

(g) Many candidates realised that the observed bubbles would mean that the white solid used was a carbonate. Some suggested it was a metal; while some metals would give bubbles with an acid, no metals would appear as a white solid at the start and no metals would form aqueous solutions containing metal atoms.

(h) Many answers focused on the process being either faster or slower. The results of experiment 1 were temperature changes and only a small number of candidates realised that with a larger volume of water to heat, the temperature change would be smaller.

(i) This was well answered, with most candidates stating that the reaction would have stopped and so it would return to room temperature.

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

Question 2

Solid **P** was copper(II) oxide and solid **Q** was copper(I) oxide.

(a) Note: there was no mark for **(a)** alone, a correct description was also required in **(d)** to gain a mark. A few candidates did not state a colour, just saying the solid was "dark". Colours should be stated in descriptions.

(b) If the instructions in **(b)(i)** had been followed and candidates had allowed their reaction mixtures to settle, then blue colour of the resulting solution would be obvious. Some candidates stated the solution was black – this is only the case if it is not allowed to settle. It was clear in some answers to **(b)(ii)** and **(b)(iii)** that candidates had not decanted the solutions, but simply split the mixture, complete with back solid, into two portions. In **(b)(ii)** most candidates reported the expected blue precipitate, but in **(b)(iii)** candidates were less successful in reporting the correct colours as they once more failed to let the mixture stand for the specified 10 minutes.

(c) Once more there were difficulties in identifying the colour of the solution if the solution was not allowed to settle. Many reported the expected blue precipitate followed by a dark blue solution, but some answers were in an illogical order, giving the excess result before the results seen for a few drops.

(d) Almost all candidates stated a suitable colour for solid **Q**

(e) Copper(I) oxide undergoes disproportion nation when it reacts with dilute acid, giving a solution containing copper(II) ions and solid copper metal. There were again problems caused by candidates not allowing the original reaction mixture to settle before decanting it. Failure to follow the instruction would result in solid copper being seen in both **(e)(ii)** and **(e)(iii)** rather than the expected blue precipitate followed by a dark blue solution.

(f) Many candidates were able to identify that solid **P** contained copper

(g) Solid **Q** caused candidates considerable difficulty and very few were able to state that the results obtained showed it to contain a copper compound.

CHEMISTRY

Paper 0620/61
Alternative to Practical

Key message

Questions requiring candidates to plan an investigation should be answered with details of apparatus to be used, quantities of substances involved, practical procedures clearly specified with some idea of a conclusion. Preliminary notes are advisable before writing the plan.

General comments

The majority of candidates attempted all of the questions.

Candidates found **Questions 4** 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 3**.

Comments on specific questions

Question 1

(a) Most candidates obtained credit for identifying the thermometer. Identifying the condenser caused more problems. There were references to cooling tubes which were ignored.

(b) Many candidates got the idea of water passing through the apparatus. There were incorrect references to oxygen, gas and air and even ethanol moving through the condenser.

(c) Generally correct with fractional distillation scoring full credit. A minority of candidates stated simple distillation which scored partial credit.

(d) (i) Ethanol would be the first liquid to collect and this was identified by the majority of candidates. Many confused responses referred to butanol and water Responses such as 'the one with the lowest boiling point' were ignored.

(ii) This was less well answered, with the idea that the temperature reading on the thermometer would rise. Many thought that the liquid would stop dripping into the beaker or that the flask would be empty.

(e) Many answers ignored the fact that a hazard had been asked for, giving instead a problem with the experiment resulting in the non separation of the alcohols. Many candidates seemed to think that heat would break the glass, or melt it or that the whole assembly was about to collapse and fall down. Others discussed the toxicity of alcohols at length and the need for a fume cupboard. Only a small minority realised that the problem lay in the flammability of alcohols although there were some excellent answers that described the use of a water bath to heat the flask instead of a Bunsen burner.

Question 2

(a) Precipitation and double decomposition scored credit. Many claimed that the reaction was a displacement, double displacement or a neutralisation.

(b) Some candidates incorrectly made references to rate. Other guessed that both were soluble or both insoluble.

(c) Filtration was realised by many but crystallisation and evaporation were common incorrect answers.

Question 3

(a) The volumes of gas were almost always correctly recorded from the gas syringe diagrams.

(b) The points were usually correctly plotted with the exception of the origin which was omitted by some. Some lines were not smooth lines and many included the anomalous point. A number, despite drawing mainly a curve, used a ruler to draw a straight line for the left hand section of the graph.

(c) (i) The inaccurate point was often correctly identified. There were some ambiguous answers stating just'5' without making it clear if that was the fifth point or 5 cm^3 of acid.

(ii) A number of responses focused on the actual process of reading the volume of the gas with errors such as parallax error or just misreading the gas volume, despite the syringe diagram being there for them so they could have checked it. Correct answers referred to possible leakage or escape of gas, wrong quantities of reactants or the syringe sticking.

(iii) Despite having correctly identified the anomalous point some were unable to complete this question, instead giving a gas volume for some other point on the graph with 48 cm^3 being a common answer.

(d) Many just said that the reaction was over or that all the reactants were used up. A significant number of candidates thought that the acid was all used up. Good candidates understood that the acid was in excess and that the zinc had fully reacted and was the reactant that had been used up.

(e) Many candidates showed confusion with different rates of reaction so many answers gave the same gas volume but were less steep. Only the more able candidates worked out that using the same mass of zinc granules would give an identical graph to the original.

Question 4

Completing the tables of burette readings in **(a)** and **(b)** caused problems despite this style of question having been asked before on several occasions.

(a) This table was completed by most candidates. Common errors were

- not having readings to one decimal place
- misreading the burette diagram giving 17.2
- having the wrong start volume, 25 and 50 being the most common errors

(b) This table was completed slightly better than **(a)**. The final reading was often wrongly read as 26.8 instead of 25.2. Some candidates did not transfer their answer from **(a)** as the initial volume and used 0 or some other number. This showed that they had not read the information in the stem of the question carefully.

(d) Responses showed that most candidates could specify the colour change from pink to colourless. Other guesses such as green, red and blue were prevalent.

(e) Some good answers described the masking of the phenolphthalein colour by the methyl orange or discussed the fact that the reaction was over and that the solution would be acidic.

(f) The majority scored credit for specifying the presence of a carbonate or carbon dioxide. Vague answers just stated 'it made a gas' and some claimed wrong gases such a hydrogen.

(g) (i) The more able candidates followed the guidance in the stem of the question to give a value from the readings, but many did not give a value. The unit scored credit.

(ii) Commonly the volume was halved instead of doubled as advised.

(iii) Many scored credit using their answers in **(i)** and **(ii)** but non quantitative answers were common.

(h) (i) Generally well answered but a significant number chose the wrong numbers to multiply by four or could not do the calculation. Others could not give a correct explanation despite having the correct answers.

(ii) Badly attempted suggesting that some candidates had never used a burette to do a titration. References to pipettes and measuring cylinders and parallax errors showed a lack of knowledge and understanding. Only the better candidates surmised that measuring larger volumes of acid would require more than one burette or that the burette would need refilling. Partial credit was given for references to the need to clean out or rinse the apparatus to remove previous chemicals.

Question 5

Answers to this qualitative analysis question were centre dependent. It was evident that some candidates had no knowledge of the tests required to complete the observations in table for **(d)** and **(e).**

(d) The appearance of a white precipitate was common. Credit could not be obtained where the candidate stated that the precipitate was soluble or that effervescence was seen.

(e) There was some confusion by those candidates who thought that a white precipitate would be formed, despite the fact that this halide test should produce no reaction/change.

(f) Some ignored the fact that that they should be using the result in **(e)** and used other information. There was confusion between the terms halogens and halides.

(g) Well answered with oxygen being recognised by most candidates. A minority gave hydrogen and carbon dioxide.

(h) Conclusions gaining full credit were rare. Credit was awarded for understanding that a hydrated transition metal salt was present that possibly behaved as a catalyst. The mention of various iron compounds was common.

Question 6

Most candidates scored partial credit for mentioning using the three different types of nut of equal mass.

Confused answers discussed weighing the nut or measuring the initial temperature once the experiment was over. This type of question benefits from having the answer planned out first, which some candidates clearly did.

The most common error was to heat the nut in some way while measuring the temperature change of the water instead of igniting the nut. In answers scoring credit a mark was often lost for not saying how long to heat the water or let the nut burn completely. Some complex answers ignored the apparatus shown and involved extraction of the oil from the nuts and resultant methods which would not work.

Well planned answers from more able candidates gave essential experimental detail with a clear practical method and a means of measuring the amount of energy produced by the nuts.

Marks were awarded for:

- measuring the volume of water
- noting the initial temperature of the water
- measuring mass of nut(s)
- ignite/burn the nut(s)
- for suitable time
- noting the final temperature of water
- repeat procedure with other nuts
- idea of comparing results/conclusion

CHEMISTRY

Paper 0620/62

Alternative to Practical

Key Messages

Candidates should use a sharp pencil for plotting points and for drawing their lines of best fit on their graphs. This allows them to correct any errors. The question might require the line of best fit to be a curve or a straight line, as appropriate. Straight lines, as in **Question 4** on this paper, should be drawn with a ruler, but rulers should not be used to join the points on a curve. Lines of best fit should avoid anomalous points. When requested to draw two straight intersecting lines, then not only should a ruler be used, but there should only be two lines.

When candidates are asked to compare volumes, they should look for simple quantitative relationships, such as twice as much" or "half as much".

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

General comments

The vast majority of candidates successfully attempted all of the questions. The full range of marks was seen.

No question, other than **Question 6**, proved to be more demanding than the others, all discriminated equally well. **Question 6** was a planning task involving the extraction of a metal from its ore. There were many possible routes and candidates do find this type of question to be challenging.

The majority of candidates were able to complete 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) The beaker was well known.

(b) The process, electrolysis, was well known and most realised that the carbon rods were electrodes, or successfully described the purpose of electrodes.

(c) There were a lot of correct answers for the test for both chlorine and hydrogen. A few responses suggested that carbon dioxide or oxygen would be produced. There was no credit awarded for this.

(d) Although there were some excellent diagrams, most candidates could not answer this question.

Question 2

(a) Answers were split about evenly between the correct pipette/burette and measuring cylinders, which are not accurate enough to measure to a precision of 25.0 cm^3.

(b) Most knew that an indicator was needed, but only about half realised that it had to be a pH indicator.

(c) Nearly everyone stated, in one way or another, that the pH increased. Only about half mentioned the rapid increase.

(d) A large majority gave neutralisation at 12.5 cm^3, but far less could explain quantitatively the difference in concentrations (see Key Messages).

(e) This was not well understood. Many answers were in terms of rate or pH rather than evaporation/crystallisation.

Question 3

(a) Nearly all candidates knew that a Bunsen (or spirit) burner was required. There were a few “heaters”, which was not specific enough to gain credit, and several clamps, syringes, etc.

(b) A pleasing number of candidates knew that there would be air in the first tube. Others worked out that, for one reason or another that the first tube of ethene would not be pure.

(c) Many candidates knew that aluminium oxide was a catalyst. Others suggested various reasons for its presence.

(d) The bromine test was very well known.

Question 4

(c) The table of results was often completed correctly. A few omitted the first line.

(d) This was also well answered, with the majority correctly using a ruler to draw a single straight line (see Key Messages). There were a minority who plotted the experiment number rather than the length of the magnesium ribbon.

(e) Again, most could extrapolate the straight line and take a reading for 8 cm.

(f) Most candidates gave fizzing or similar. Any correct observation was credited. However, there were many non-observations such as “hydrogen is given off”, which would not get a mark (see Key Messages).

(g) Nearly everyone knew that it was Experiment 5, because the magnesium ribbon was the longest.

(h) The vast majority could explain that it would be faster because of the increased surface area. The temperature rise, theoretically, would not change as the mass of magnesium is not changed. In practice, however, because the reaction is faster, there would be less cooling, so the temperature rise might be greater. Therefore all comments about the temperature rise were ignored.

(i) Few suggested the “temperature change”, 3°C.

(j) There were many correct, labelled diagrams of syringes. Collection over water was also correct, but a more difficult diagram, so fewer of these were seen.

(k) There were many correct suggestions, such as the use of a burette or insulation, but also many suggestions that were not credited, such as timing or parallax issues.

Question 5

(b) There was a roughly even split between ammonia and chlorine being the gas evolved.

(c) Nearly everyone realised that in this case the gas was ammonia. However, few gave enough observations for two marks. A white precipitate with silver nitrate solution was correctly given by nearly everyone.

(f) Most answers identified zinc carbonate.

Question 6

This proved, as always, to be a question that differentiated well. Whilst nearly everyone could make an attempt, fewer scored full credit. Initial credit could be obtained for crushing the "lump" with either an explanation of how or why. Then there were many acceptable methods either starting by heating the cerussite (with or without a reducing agent such as carbon or iron) or by dissolving the cerussite in an acid. This could be followed by further reduction or by displacement or by electrolysis. If a method worked, then it could gain full credit. Detailed knowledge of the solubility of lead compounds is not required in the Core syllabus, so, for example, using sulfuric acid to dissolve the cerussite was accepted. However, the easier route of dissolving the cerussite in water limited the candidate to only partial credit.

CHEMISTRY

Paper 0620/63
Alternative to Practical

Key messages

Questions requiring candidates to plan an investigation should be answered with details of apparatus to be used, reactants/substances involved and quantitative information clearly specified.

Questions asking for expected observations require information as to what candidates would be expected to actually see. Naming the substances formed is not an observation.

General comments

The majority of candidates attempted all of the questions.

Candidates found **Questions 1**, **3** 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) Few candidates scored full credit. The most common error in part **(i)** was to name the substance absorbed by the ceramic wool as magnesium, magnesium oxide or steam. A minority of candidates understood that water was needed to produce the steam. In part **(ii)** the arrows were required under the wool and under the magnesium. Arrows were often only in one of these positions. Many guesses were evident with arrows shown at point Y or under the tube connecting the syringes.

(b) (i) Very few candidates were able to describe the change in the appearance of the magnesium from silver or grey to a white ash or recognise that it would burn. Common references to the magnesium melting, turning black or darkening scored no credit. Vague answers such as 'changes colour' were prevalent.

(ii) Able candidates realised that the product formed would be alkaline and turn the Universal Indicator blue or purple. References to the formation of an acid and colour changes to red or yellow were seen and scored no credit.

(c) Generally well answered. Many candidates identified the formation of hydrogen and a positive test for the gas. Credit was awarded for the gas catching fire, exploding or popping with the lighted splint.

Question 2

(a) Most candidates labelled the lines correctly and realised that twice as much gas was formed in Experiment 2.

(b)(i) Most candidates stated that water should be added to dilute the acid further. However, many candidates did not specify the relative amounts of acid and water to be mixed and only scored partial credit. Good answers specified equal volumes of acid and water to be mixed.

(ii) The sketch curve for Experiment 3 showed good differentiation. Able candidates realised that the curve would be less steep and level out at 15 cm^3.

(c) Many diagrams were left blank or completed so that they would not work. More able candidates used a measuring cylinder filled with water or a gas syringe. References to distillation and condensers, and test-tubes in closed systems were common and it was apparent that many candidates had never experienced this practical procedure.

(d) Well answered. Most answers referred to heating or using a catalyst. Full credit was rarely given as explanations were often missing.

Question 3

(a) Electroplating was often recognised and credit was given for electrolysis.

(b) The idea of removing impurities was common but the reason for doing so was often omitted. Candidates often did not state that the key was rubbed with sandpaper so that an even coating of nickel on the key would result.

(c) More able learners named a nickel salt and used an aqueous solution of the salt. A range of incorrect answers such as copper sulfate, silver nitrate, acids and water showed a lack of knowledge and understanding.

(d) Observations scoring no credit referred to the key getting bigger or smaller, gases evolved or colour changes. The bulb lighting up or a silver deposit on the key were specific expected observations.

(e) The majority of responses scored credit for using water and some form of heat or absorbent e.g. a paper towel.

Question 4

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

(d) Most candidates plotted the points on the grid correctly. The majority of candidates drew smooth line graphs but others joined the points with straight lines drawn with a ruler. Some graphs were not labelled.

(e) (i) Most candidates identified the temperature after 45 seconds and scored full credit. Some errors in reading the scale were evident. The question asked candidates to show clearly on the graph how they worked out their answer. A minority of candidates did not follow this instruction and could not be credited

(e) (ii) The scale on the *x*-axis was sometimes misread and tie lines were often not evident.

(f) The type of chemical process was usually correctly identified as endothermic. Some confused responses mentioned exothermic.

(g) More able candidates concluded that a carbonate was present or referred to carbon dioxide gas. Many candidates missed the point and made vague references to reactions happening or metals being involved.

(h) Most candidates erroneously thought that a larger volume of water would result in a faster reaction and/or larger temperature change. Better candidates realised that the temperature changes would be lower because of the larger volume of water.

(i) Many candidates realised that the temperature of the solution would return to the initial temperature of 25°C or room temperature. Many failed to explain that this was because the reaction would be finished. Vague answers were seen such as 'the temperature will decrease' or 'heat would be lost to the environment'.

(j) Most candidates scored credit for realising that more results, readings or points on the graph would result. Reference to accuracy was allowed as an advantage.

Question 5

Answers to this qualitative analysis question were centre dependent. It was evident that some candidates had no knowledge of the tests required to complete the observations in the table.

(c) (i) A white precipitate insoluble in excess aqueous sodium hydroxide was generally well known. Some candidates thought that the precipitate would be soluble. Additional incorrect observations such as effervescence meant credit could not always be given.

(c) (ii) The incorrect observation that a white precipitate formed was frequently seen.

(c) (iii) Some candidates realised that a yellow precipitate would be formed.

(d) Meaningful conclusions were variable. The presence of copper oxide was given by the more able candidates for full credit though other named copper compound was a common response.

Question 6

The quality of answers spanned the entire spectrum. Many candidates scored partial credit for measuring a known volume of vinegar or aqueous sodium hydroxide and adding it to a beaker or flask.

A lack of knowledge and understanding was often then evident with answers mentioning the addition of the sodium hydroxide to the vinegar and noting the time for the reaction to stop or gas to evolve or colour to change. None of these methods would work as there is no visible reaction between these reactants.

The more able candidates realised that an indicator would be needed and that the volume of sodium hydroxide should be recorded when the indicator changed colour.

Methods involving measuring the temperature when the sodium hydroxide was mixed with the vinegar scored credit.

Some answers which could be awarded no credit involved not using aqueous sodium hydroxide and just boiling or heating the samples of vinegar which would not work

Marks were awarded for

- A measured volume of vinegar
- in named container
- use of a named indicator
- adding aqueous sodium hydroxide until colour change
- record volume added
- repeat with other brand of vinegar
- compare results

Some candidates did not attempt this question.