CHEMISTRY (US)

Paper 0439/11
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 (US)

Paper 0439/13
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 (US)

Paper 0439/21

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 ºC 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 (US)

Paper 0439/23
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 (US)

Paper 0439/31

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 (US)

Paper 0439/33
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 0439/04
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.