CHEMISTRY

Paper 0439/11
Multiple Choice

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

General comments

Candidates performed quite well on this paper. **Questions 1**, **2**, **7**, **12**, **15**, **24**, **25**, **28**, **35** and **37** proved particularly straightforward with the vast majority of candidates choosing the correct response. **Questions 26**, **30** and **34** proved to be difficult with only a minority of candidates choosing the correct response.

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

Comments on specific questions

Question 5

Response **D**. Candidates chose the total number of electrons rather than the number in the outer shell.

Question 6

Response **C**. Candidates chose the alternative where only one atom of each element was presumably assuming that this meant that all electrons were used.

Question 9

Response **B**. Candidates did not fully understand electrolysis assuming that sodium would be produced from an aqueous solution.

Question 10

Response **B**. Candidates appreciated that a copper salt needed to be used but chose the wrong electrode for its deposition.

Question 18

Response **C**. This response was more popular than the correct answer. Candidates knew that the pH would rise as an alkali was added, but did not read the question fully and realise that an excess of alkali was added.

Question 23

Response **B**. Candidates considered the density of helium rather than its reactivity and incorrectly thought that helium was less dense that hydrogen.

Question 30

Response **B**. This response was more popular than the correct answer. Candidates did not realise how little carbon dioxide is in the air. This is a common error.

Question 32

Response **A**. Candidates partially remembered the test for ammonium salts but opted to add acid rather than alkali.

Question 34

Response **B**. This response was more popular than the correct answer. Candidates did not know that limestone is heated to make lime.

Question 36

Response **B**. Candidates knew that boiling point was important but did not realise that this was, in turn, dependant on chain length.

CHEMISTRY

Paper 0439/21

Core Theory

Key Messages

- More practice is needed in writing the correct formulae for diatomic gases such as O_2 and Cl_2.
- Questions on general chemical properties were fairly well done by most candidates.
- Candidates need more practice in answering questions relating to qualitative analysis.
- It is important that candidates read the questions carefully in order to understand exactly what is being asked.
- In questions involving free response answers it is important to use the information provided in the bullet points.
- More practice is needed in questions involving atomic structure.

General comments

A few candidates tackled this paper well, showing a good knowledge of core chemistry. Good answers were seen to some parts of particular questions. Nearly all candidates were entered at the appropriate level. Some candidates misinterpreted what was being asked by some questions. For example, in **Question 2(b)(ii)** some candidates wrote about acidity and alkalinity rather than referring to pH values. Many candidates did not use the information provided by the bullet points or the stem of the question where answers requiring free response were required (**Questions 6(a)** and **7(c)**). These are designed to help candidates to structure their answers and write relevant points. A significant minority of candidates left blank spaces, especially in **Questions 2(c)**, **3(c)**, **3(d)**, **4(a)**, **4(b)**, and **7(c)**. Equations were well constructed by some candidates. Others did not complete symbol equations correctly, especially when diatomic molecules had to be included. The nature of the solid state was not well known in **Question 3(c)(i)**. Many candidates believed that the particles in a solid are moving slightly. Definitions were not always as precise as they might have been, for example, the definitions of an element in **Question 1(c)** were often vague, as were the definitions of isotopes in **Question 4(a)**. Some candidates need more practice at questions involving appropriate separation techniques. For example, in **Question 3(c)(ii)** the candidates should first have considered the state of each of the components to be separated, and then what the most appropriate technique would be. As in previous sessions, questions involving environmental aspects of chemistry were not done well by many candidates. For example in **Question 7(c)** many candidates did not use the help provided by the bullet points, and did not mention a fuel containing sulfur or the reactions leading to acid rain. One misconception was that sulfur dissolves in water in the atmosphere to form acid rain. The question on diffusion, **Question 6(a)**, which also involved free response writing, was often not answered in terms of particles, and there were many vague statements. Candidate answers should be structured to include the essential details required. In organic chemistry, many candidates could write the correct molecular formulae of ethane, identify particular hydrocarbons and link the uses of petroleum fractions to their names. The standard of English was reasonably good. Some candidates need to analyse the questions more thoroughly; a considerable number of errors were made by those who did not do 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, and candidates are less likely to contradict themselves if this is done.

Comments on specific questions

Question 1

This question was fairly well answered. Many candidates gave the correct molecular formula of ethene part **(b)**. The terms in part **(c)** were not always well known, especially the definition of a compound.

(a) Few candidates scored full credit, although many scored the majority of the available credit. In part **(i)** most candidates correctly identified ethene as an unsaturated hydrocarbon. The most common errors was to suggest methane or ethanol. In part **(ii)** most candidates recognised that carbon dioxide was the combustion product. Others did not read the question carefully enough and suggested a hydrocarbon or ethanol. In part **(iii)** half of the candidates recognised ethanol as belonging to the alcohol homologous series. In part **(iv)** no candidates correctly identified methane as being an alkane. Carbon dioxide was a common error here. Many candidates scored full credit for parts **(v)** and **(vi)**, the commonest error in part **(vi)** being to suggest methane.

(b) The majority of candidates gave the correct molecular formula for ethane. The main errors were to suggest CH_2 or write the names of a number of species.

(c) A minority of candidates correctly defined the term 'compound'. Many candidates gave vague answers or omitted the idea of the atoms bonding or joining together. Many realised that 'inert' means 'does not react' or similar. Nearly all candidates gave a suitable definition of a catalyst. A few misinterpreted the question and wrote about enzymes without further qualification, or suggested that 'the reactant was never used up'.

Question 2

Few candidates scored well in this question, parts **(a)**, **(b)(ii)** and **(c)** proving to be the most demanding. The details of the test for copper ions were not generally known. The dot and cross diagram for hydrogen chloride in part **(a)** caused particular problems for some candidates. Some candidates omitted part **(a)**.

(a) Fewer candidates were able to draw the correct dot and cross diagram for hydrogen chloride. Some drew the structure as a single circle, i.e. without the hydrogen. Others put too many electrons in the outer electron shell.

(b) (i) Many candidates were able to identify the burette and flask correctly. The commonest errors were to suggest pipette instead of burette, and beaker instead of flask. Other errors for the burette were 'graduated cylinder' and 'fractionating column'.

(ii) Very few candidates were awarded full credit. The commonest error was to omit pH values at the start or at the end of the titration. Most candidates scored credit for the idea that the pH decreased. Many did not mention pH at all, and just mentioned acidity and alkalinity.

(iii) Some candidates were able to correctly name ammonium chloride but fewer were able to give the correct formula of ammonia. Ammonium chloride was often incorrectly named as 'ammonia chloride' or 'ammonia hydrochloride'. Common errors in the formula for ammonia were NH_4 and NH.

(c) Few candidates scored any credit in this question. Common errors included: the omission of the word 'precipitate'; mention of bubbles; not mentioning what happens when excess ammonia is used; lack of reference to the colour or statement of incorrect colours.

Question 3

Most candidates scored about half of the available credit on this question. Parts **(a)(i)** and **(a)(ii)** were not always well explained, and many vague statements were seen. Parts **(b)** and **(d)** were particularly well done. Several candidates omitted parts **(c)** and **(d)**.

(a) (i) Many candidates thought that magnesium was the least reactive of the metals. Most candidates made additional errors, so did not score any credit. Common errors included writing down the name of the oxides of the metals and giving the name of a metal which was not on the list.

(ii) In general, candidates were not able to explain why iron does not react with zinc oxi errors included a considerable proportion of answers suggesting that iron does react statements such as 'they are both metals'.

(b) This was well answered by about half of the candidates. The commonest error was to suggest all metals have a high density.

(c) (i) Many candidates scored full credit. A number of candidates did not score credit for their descriptions of the 'arrangement' because they wrote vague statements such as 'the arrangement is random' or gave irrelevant statements. Fewer candidates successfully described the 'movement', common errors indicating movement from place to place, or random movement.

(ii) The majority scored minimal credit, generally for the suggestion that the mixture should be filtered. Some candidates implied that the solid mixture of salt and sand was filtered. Those who wrote about sodium chloride 'going through the filter paper' often omitted to state that the sodium chloride was in solution. A minority of candidates suggested, incorrectly, that fractional distillation should be used.

(d) Most candidates had a good grasp of the terms used in distillation. Errors were most commonly observed in the second gap (where 'heavy' was given instead of 'lower') and in the fourth gap (where 'flask' was chosen instead of 'condenser').

Question 4

Candidates generally answered **(c)** and **(d)(i)** well but few scored well on this question overall. Many candidates did not draw the lithium atom in sufficient detail, and many did not label their diagrams. Some candidates omitted the labelling of the anode and electrolyte in part **(d)(i)**. The explanation of why aqueous lithium chloride conducts electricity was not well known.

(a) A minority of candidates gave a convincing explanation of the term 'isotope'. There were many vague answers which did not refer to neutrons at all, e.g. more than one compound of elements occurring naturally on earth'. Some referred to amounts of the element.

(b) Few candidates drew good labelled diagrams of a lithium atom. The best showed the nucleus surrounded by electrons. Candidates generally did not gain credit, either because they did not draw or label the protons and neutrons in the nucleus, or did not show the correct number of electrons or the correct number of shells.

(c) Some candidates were able to balance the equation for the reaction of lithium with oxygen. The main error was to write oxygen as O instead of O_2.

(d) (i) Some candidates successfully identified the anode as the positive electrode and the electrolyte as the liquid. The commonest error was to label the anode as the electrolyte.

(ii) Some of the candidates realised that an aqueous solution involved water. Many definitions were rather vague. The commonest error was to refer to liquid instead of water.

(iii) Candidates did not refer to ions. Incorrect answers were vague and included 'even distribution of molecules', and 'if a liquid conducts electricity it's aqueous'.

Question 5

Some candidates scored well on this question, especially in parts **(a)**, **(b)(ii)** and **(d)(ii)**. Few candidates knew that argon is unreactive.

(a) Many candidates could link the fuels to their correct use. The commonest errors were to suggest that hydrogen is present in natural gas, that methane is used as a fuel for ships, or that kerosene has a relative molecular mass of 2.

(b) (i) The majority of candidates were able to suggest a correct factor that should be kept the same in each experiment. The commonest correct answer was to refer to the same amount of water. Common incorrect answers included time of burning and the temperature of the water at the start.

(ii) Candidates gave suitable reasons for keeping the water stirred. The best answe keeping all the water at the same temperature.

(iii) The majority of candidates realised that the petroleum spirit gave the most energy on bu Fewer calculated the temperature differences and gave the incorrect answer referring to highest temperature reached. The best candidates showed their calculations clearly on the table. A significant minority chose propanol as the (incorrect) fuel because the final temperature of the water was the highest.

(c) About half the candidates correctly identified nitrogen and oxygen in their correct proportions as the major gases in the air. The commonest error was to suggest that hydrogen is present in the air.

(d) (i) Some candidates stated a correct use for argon. Others gave vague statements such as 'the manufacture of products'.

(ii) Most candidates correctly identified argon as belonging to period 3 of the Periodic Table. The commonest error was to give a Group name such as noble gases.

(iii) A minority of the candidates realised that argon is inert or unreactive. Many candidates gave answers which did not relate to chemical reactivity, e.g. 'it is a gas' or 'it conducts electricity'.

Question 6

The extended writing in part **(a)** of this question did not provide much credit for most candidates. Many vague answers were seen without reference to the particle theory. The equation in part **(b)** was often balanced correctly although the formula for a chlorine molecule was known by only a few.

(a) Most candidates scored minimal credit. Only a few scored higher. The majority of the candidates did not mention particles and were awarded the credit for the idea of dissolving or diffusion. Many thought that the ions were reacting with water. Only the better candidates wrote about movement of ions or particles. Many candidates disadvantaged themselves by writing incorrect statements about the precipitation. Many repeated the information in the question by stating that 'a yellow precipitate is formed'.

(b) Many candidates correctly balanced the equation. Few scored full credit because 2Cl was written instead of Cl_2. Others did not gain credit because they did not balance the (incorrect) Cl.

Question 7

This question was the least well answered on the paper. The calculation in part **(b)** provided only a minority of candidates with credit as did the extended writing about acid rain in part **(c)**. The test for sulfate ions in part **(e)** was generally not known. Several candidates left this part unanswered.

(a) Most of the candidates calculated the number of atoms in three molecules of sulfur correctly. The commonest incorrect answers were multiples or fractions of 24, e.g. 48, 420, 8.

(b) Few candidates calculated the relative molecular mass of S_8 correctly. Common incorrect answers were 32 (the atomic mass) or 128 (multiplying the atomic number by 8).

(c) Most candidates scored some credit. Many answers were unstructured and many candidates did not appear to use the bulleted phrases to help them structure their answers. The commonest errors were to omit the name of a fuel containing sulfur, to suggest that sulfur dissolves in water in the atmosphere, or to make no mention of sulfur oxides dissolving in water.

(d) A minority of candidates realised that the other two elements present in (NPK) fertilisers were nitrogen and phosphorus. Common errors were to give the names of compounds or compound ions such as KNO_3 or nitrate, or incorrect elements such as hydrogen.

(e) The test for the sulfate ion was not generally known. Most candidates did not mention that a precipitate was formed, or suggested electrolysis. Copper sulfate was also seen as a test reagent, even though it contains a sulfate.