CHEMISTRY

Paper 0439/13
Multiple Choice

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

Candidates performed quite well on this paper. **Questions 1, 9, 11, 23, 24, 26**, proved to be particularly straightforward with a large majority selecting the correct answer.

Questions 3, 6, 7, 17, 18, 21, 25, 32, 33, 35 and **40** 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:

<u>Comments on Specific Questions</u>

Question 2

Response **B**. Candidates clearly did not realise that a measuring cylinder would be needed to dilute the acid.

Question 5

Response **A**. Candidates opted for what they thought was an obvious response without reading t alternatives.

Question 6

Response **D**. Candidates selected a response where one number was double the other, without fully understanding the question.

Question 7

Response **C**. Candidates must have selected the first alternative where the solid did not conduct without fully reading the rest of the response.

Question 10

Response **D**. Candidates knew that graphite was the correct form of carbon but chose the wrong electrode.

Question 18

Response **C**. Candidates chose the area just before complete neutralisation when there would be no excess acid.

Question 20

Response **A**. Candidates knew that the element must be in group 0 but missed the 'denser than air' point. Candidates should know that helium is less dense than air.

Question 25

The answer to this question was clearly not understood very well, and those candidates who did not know the answer seemed to simply guess. The responses were quite evenly spread through the possible responses.

Question 30

Response **D**. Candidates clearly knew that both carbon monoxide and carbon dioxide were formed, and then guessed wrongly.

Question 33

Response **A**. Candidates presumed that an –OH group which is part of a carboxylic acid group still counted as an alcohol.

Question 35

Response **A**. Candidates did not know that fuel oil was used in central heating and did not read the rest of the question.

Question 40

Response **A**. This response was more popular than the correct response. Candidates selected it because of the carbon monoxide, not realising that hydrogen is never formed during combustion of a fuel.

CHEMISTRY

Paper 0439/23
Core Theory

Key Messages

- Questions requiring simple answers to inorganic chemistry were generally well done as were questions involving equations and calculations of formula mass.
- Answers to questions on aspects of practical procedures, e.g. finding the pH of a solution and devising a rate of reaction experiment, need to contain more focused explanations and attention to detail.
- Some candidates need more practice on answering questions requiring extended answers, e.g. **Question 7(a)**. When answering such questions, it is advisable to check the amount of available credit, as this is a good indicator of how many points are required in the answer. This should also be applied to any other question.
- It is very important that candidates read the question carefully in order to understand what exactly is being asked.
- Many candidates need more practice at answering questions on organic chemistry, especially fractional distillation and testing for alkenes. More specific revision of the uses of the elements and compounds mentioned in the syllabus would also be an advantage to many candidates.

General Comments

Many candidates tackled this paper well, showing a very good knowledge of core chemistry. Good answers were given to a number of different questions throughout the paper, however, most candidates found parts of every question challenging. Nearly all candidates were entered at the appropriate level.

The standard of English was good. Some candidates wrote their answers as short phrases or bullet points; candidates are less likely to write vague statements or contradict themselves if this is done. Candidates are beginning to become more familiar with the tests for particular gases. There has been an improvement in the writing of word equations, although the correct spelling of chemical compounds still needs to be practised. Very often chemical names will already have been mentioned in the question, so candidates should be encouraged to check this if in any doubt about the spelling.

Candidates still have a limited knowledge of organic chemistry. Many did not know that hydrocarbons with double bonds decolourise bromine water. Many candidates showed a good knowledge of inorganic chemistry and could write simple molecular formulae and balance symbol equations correctly.

Comments on specific questions

Question 1

Most candidates scored reasonably well on this question although **(b)(ii)** was found to be quite challenging with very few candidates answering correctly.

(a) Most candidates gained full credit in this part. The most common mistake was confusing oxygen and hydrogen. Very few candidates either failed to answer this question or gained minimal credit.

(b) (i) This question was answered very well by the majority of candidates. Even though the names of the reactants were given in the stem of the question, some candidates still either gave different chemicals or spelt them incorrectly. Other less frequent mistakes were giving 'h... omitting the word 'acid' from hydrochloric acid, and giving 'manganese chlorine' and '... the products. Candidates should be reminded that when writing a word equation the '+' ... the arrow should still be used, not 'plus' and 'gives'. Some candidates gave magnesium inste... manganese and therefore lost most of the available credit.

(ii) Candidates found this question one of the most challenging on the paper, and many gave the answer **B**. This was presumably down to either misinterpretation or simply not reading the information which clearly stated that chlorine is denser than air and soluble in water.

(c) (i) Most candidates knew that the correct formula for oxygen gas is O_2 and were able to balance the equation correctly. A few gave 2O instead but still managed to balance the equation successfully.

(ii) Even though the candidates had reasonable knowledge of the uses of hydrogen and water, many were not specific enough here and therefore could not be awarded credit. A few candidates stated that 'hydrogen could be used to make water', and 'water is used to keep hydrated', neither of which were creditworthy responses. Better answers were 'hydrogen is used to make ammonia, margarine or as a fuel' and 'water is used as a coolant, for drinking or washing'.

Question 2

In this question, parts **(b)** and **(d)** were generally done well. Many had problems describing the experimental technique in part **(c)**.

(a) About half the candidates circled the correct answer. Each of the incorrect answers was chosen with about the same frequency.

(b) Most candidates gave a value above 7, with none giving higher than 15. In a few cases candidates incorrectly gave values below 7, and some mentioned chemical names.

(c) A few candidates were awarded full credit for this question. Some described dipping or physically putting the indicator into the solution. Many candidates did not state where they would put the indicator, e.g. into the beaker, or into the solution, so were not awarded credit. Many candidates did not specify Universal Indicator **paper** or **solution**, or suggested litmus paper which was incorrect. Some talked about a specific indicator such as methyl orange, and even Benedict's solution was incorrectly mentioned. Very few mentioned comparing the colour with a pH colour chart and simply said 'red is acidic and blue is alkaline' with no mention of the pH scale. Those who did talked about identifying the 'colour change' of the indicator and not the specific colour. Few mentioned the use of a pH meter or that they would just read the pH from the meter.

(d) (i) Most candidates stated that the plants might die or that they would not grow. Only a few gave answers that did not relate to the growing of plants and just suggested that there would be a problem with the soil, e.g. the soil would not be good enough.

(ii) Many candidates realised that calcium carbonate 'reacts' with or 'neutralises' the soil. The most common incorrect suggestion was that calcium carbonate was an alkali. A few candidates stated that calcium carbonate 'acts as a base' rather than that it '**is** a base' and so lost credit.

Question 3

This proved to be one of the most difficult questions on the paper. Only a few candidates exhibited a good knowledge of the colours of the halogens or of the precipitates formed, and hence not many were awarded full credit in parts **(a)** and **(c)**.

(a) (i) Many candidates knew that bromine is brown, but fewer that chlorine is green. The commonest error was to give two colours for an answer, one of which was incorrect, e.g. orange-green for chlorine and yellow-brown for bromine. Some candidates wrote colourless for both.

(ii) Only a few candidates gained full credit. A number could correctly answer the first part about chlorine, but then did not answer in terms of both melting and boiling point for bromine. Most could recognise that chlorine has a low boiling point, but did not say that it is lower than room temperature; many candidates just stated the boiling point. Again, for bromine many candidates either just stated the melting point and/or the boiling point but did not compare them with room temperature. Some correctly said that the melting point is below room temperatur... mention the boiling point at all so could not be awarded credit.

(iii) About half the candidates gained credit here for giving a value for the melting point of as... Candidates needed to use the data from the other halogens to successfully work out this va... However, there were a few candidates who stated a value below that of the melting point of iodine.

(b) (i) Most candidates knew that the correct formula for iodine is I_2 and were able to balance the equation correctly. A few gave 2I instead, but then went on to balance the equation successfully. A small number of candidates incorrectly stated the elemental symbol I for the iodine; KI and KC*l* were also seen.

(ii) This question was well answered with the vast majority awarded full credit. A common error was to give potassium chlorine and iodide, although chlorine, potassium and iodine were also seen.

(iii) About half the candidates identified from the given periodic table that chlorine is in period 3. However, many candidates thought that 7 was the correct answer and some put group 7, having possibly not read the question correctly.

(c) A small number of the candidates were awarded maximum credit for this part. Many thought that hydrochloric acid could be used to acidify the solution, forgetting that it would react due to it possessing the chloride ion. Most correctly identified silver nitrate, but more revision of the colours of the halide precipitates is needed, as white was given in quite a few instances, and some thought that a solution, rather than a precipitate, was formed.

Question 4

Parts **(d)** and **(e)(ii)** were very well answered, and only a few candidates were not awarded full credit for the definition of a catalyst. Some good answers were seen for the other parts of this question.

(a) (i) About half the candidates correctly identified ammonia. The most common incorrect answer was nitrogen trichloride.

(ii) Most candidates could recognise the ionic salt, and there were few incorrect answers here.

(iii) Most candidates correctly recognised the carboxylic acid functional group from the substances given, and again there were very few wrong answers.

(b) Some candidates answered this question well, giving appropriate sources such as cars and factory emissions. However, a few candidates gave an effect, such as acid rain, rather than a source of nitrogen oxide. A few candidates wrote ‘from nitrogen’ or ‘nitrogen is 78% of the air’.

(c) Only a minority of candidates answered this question well. Many were too vague, giving ‘poisonous’, ‘harmful if breathed in’, ‘lung problems’ and ‘causes pollution’ as their answers, none of which gained any credit.

(d) This question was very well done. Many candidates have now mastered working out relative formula masses using the periodic table. Some highlighted their answers by circling or underlining them, which is to be encouraged. Only a few candidates multiplied the masses together instead of adding them up.

(e) (i) There were not many answers that gained full credit here. Some candidates recognised that it is carbon monoxide that is being oxidised and gave the correct name or formula, and then went on to state that it was gaining oxygen. However, some thought that it was carbon dioxide that had been oxidised and misinterpreted the question, hence losing credit. Quite a few candidates incorrectly thought that the answer was nitrogen dioxide and that it had lost oxygen.

(ii) Candidates found this question to be straightforward and showed their knowledge very well here. There were some excellent definitions. Only a minority of candidates lost credit.

(iii) Not many candidates realised that the correct answer here was that the amount of oxygen was reduced or that there was less oxygen. Many misinterpreted the question as stating that all the holes had been blocked, instead of ‘some of the air holes’. This led to statements such as that there would be 'no oxygen present', which could not be credited. A few candidat carbon monoxide was formed by carbon dioxide losing oxygen. Not many candidate term 'incomplete combustion', for which they would have received credit.

(iv) Over half of the candidates gained full credit for this question, with 'poisonous' and 'toxic' being most popular correct answers. Higher level answers using the combining of carbon monoxide wit haemoglobin were also good, but some candidates' answers were too vague to gain credit, with carbon monoxide combining with the red blood cells being a popular vague answer. A few candidates thought that it was the carbon that was poisonous.

Question 5

Many candidates gave good answers to parts **(a)**, **(b)(i)** and **(c)(i)**. Most gave very vague answers to the experimental question **(b)(ii)**. Some included the words 'element' or 'atom' in their definition of a compound along with 'bonded' or 'joined together' to gain full credit. Many candidates wrote about mixtures for which credit was not awarded.

(a) Some candidates correctly gave three properties of a transition element. Others had clearly misinterpreted the question and wrote about reaction with water and acids. 'Shiny' and 'solid' were given as properties in some answers, but as these had already been mentioned in the question credit could not be awarded for them. Answers such as 'stronger' and 'harder' were also not awarded credit. Another incorrect answer given by some candidates was that the transition elements are coloured, rather than that they form coloured compounds.

(b) (i) Most candidates wrote this word equation correctly and scored full credit. However, a few did not give sulfuric acid as one of the reactants, even though it was stated and spelled correctly in the question. Candidates must take care when reading the question. Other incorrect answers seen were 'iron sulfide' and 'iron sulfuric', instead of iron sulfate. A few candidates incorrectly gave ferric instead of iron.

(ii) Many candidates did not score well on this question. There were many vague answers such as 'time how long it takes for the reaction to stop' or 'for the iron to disappear' with no mention of a gas being given off. There were a couple of drawings of electrolysis experimental equipment, and a few candidates wrote about timing how long it took for a cross or shape on a piece of paper to disappear. Candidates who realised that a gas was given off and mentioned bubbles earned some credit. Some drew a collection apparatus but then did not show a closed system. When candidates did draw a syringe, some did not write about measuring the volume of the gas and just stated to 'collect the gas'. A few candidates did draw the correct apparatus, but most of these did not state to 'measure time after certain time intervals' but just said 'measure the time'. A few candidates wrote about a weight loss experiment, but again these were very vague.

(c) (i) Nearly all candidates realised that this was an exothermic reaction. Incorrect answers tended not to state that it was endothermic, but gave a totally unrelated answer. This does at least show that candidates are not getting confused between the terms *exothermic* and *endothermic*.

(ii) Very few candidates answered this question correctly. The most common incorrect answers omitted 'element' or 'atom' and used the words 'particles' and 'substances'. Candidates did not, on the whole, use the words 'bonded' or 'joined'. Some were not credited because they used the word 'react'. Many candidates gave 'mixed' or 'mixture' in their answers which also lost credit.

(iii) Many candidates did not gain any credit for this answer. Even the highest scoring candidates did not gain credit here and the correct formula of FeS was seen very infrequently. Other formulae such as Fe_2S, 2FeS and $FeSO_4$ were also seen. Some candidates wrote $Fe_{10}S_{10}$ and did not cancel down any further. The most frequent incorrect answer was Fe(II)S.

Question 6

This question was one of the least well answered on the paper. Few candidates exhibited a good kn of the fractional distillation of crude, only a minority remembering the name of the unknown fraction. uses of the two fractions were also not well known and even though most candidates seemed to know w relative molecular mass is, they struggled to remember what class of hydrocarbons decolourised aqueous bromine.

(a) Candidates found this question one of the hardest on the paper with many candidates not being able to respond at all. Many put a cross at the top of the column, some tried to put a cross between layers in the column and some even put the cross outside the column. Only a very few correctly put a cross in the bottom compartment, of those who did, some put it half outside.

(b) A minority of candidates answered this correctly. Some were nearly there but others incorrectly gave, for example, petrol, diesel or paraffin. Naphthalene was another answer used wrongly by some candidates.

(c) Some candidates gave answers which were too vague, and instead of saying 'a fuel for ....' they just wrote 'aeroplanes' and 'cooking' for kerosene and for diesel 'cars or trucks'. Some got confused between the two fractions and others suggested uses which would be suitable for other fractions, e.g. wax and candles.

(d) Not many candidates scored full credit for this part, although many only lost a small amount of credit. It was the third answer that usually cost the attainment of full credit, with many candidates writing 'higher' instead of 'lower'. Most realised that the correct answers were 'mixture' and 'heated' for the first two responses, showing some knowledge of the organic section of the syllabus. However, the fourth space produced a variety of answers, e.g. 'vaporises' instead of 'condenses'. In the last space, many candidates put 'melting' instead of 'boiling'.

(e) (i) In this question many candidates were awarded full credit for part **(i)** showing that they could work out the molecular formula of an organic compound and then work out which two had the same relative molecular mass.

(ii) Only a small number of candidates were awarded credit for this part and many incorrectly wrote down the two alkanes, **A** and **C**. This showed either a lack of knowledge of the chemical test for an alkene or a misinterpretation of the question with candidates either thinking that the question stated 'will not decolourise bromine', or that having chosen **B** and **D** already for part **(i)**, they could not use them again in part **(ii)**.

Question 7

The extended writing part **(a)** was answered very well in quite a few cases and most candidates scored at least some credit. Some candidates did not perform as well in parts **(b)(i)** and **(ii)**.

(a) The answers in this part were mainly good and candidates showed a very good knowledge of the kinetic particle theory. Many candidates talked about the particles dissolving and diffusing for which they were awarded credit. Some wrote about the movement of the particles and that they spread themselves out. A few also wrote about the random movement and collisions of the particles but these tended to be the most able ones who went on to achieve full credit. Common misconceptions were that the salt particles rose up because they were less dense and that the salt and water particles reacted with each other.

(b) (i) About half the candidates achieved full credit here. These were mainly the ones who had worked out the electronic configurations in the space below the question. The sharing of electrons was a common misconception.

(ii) Very few candidates gained full credit for this comparison question. However, many did realise that this was a comparison question and put down an answer for both solid and molten sodium chloride. Many did not use the word 'ion' so did not gain credit. Some candidates did use the term ions but did not make a comparison and just wrote that in molten sodium chloride the ions could move but did not refer to the solid. The most commonly used words were electrons and particles which gained no credit.

(iii) A common misconception in this question was that the solution was not aqueou candidates gave chlorine at the positive electrode and sodium at the negative, for which credit could be awarded. Only those who realised that it was an aqueous solution gave h as the correct answer at the negative electrode. Common errors were writing chloride a instead chlorine.

(iv) Nearly all candidates gave the correct answer here. A few thought that the negative electrode was called the anode or cation.

(v) About half the candidates realised that graphite was a suitable material for an electrode because it conducts electricity, but some answers were too vague and just said that it conducts. Some candidates wrote that graphite was not very reactive rather than inert. Other answers which gained no credit were that graphite was strong and that it was made of carbon.

CHEMISTRY

Paper 0439/33

Extended Theory

Key Messages

- Some candidates did extremely well on some questions and less well on others. It is essential that candidates revise the whole syllabus.

- Metals should not be described as corrosive or non-corrosive. The correct description is to say that metals corrode or do not corrode. When answering questions on metals, candidates are advised to remember that iron/steel is the only metal that can form rust, because rust is hydrated iron(III) oxide. Therefore, to mention rusting with reference to any metal other than iron/steel is inappropriate, although other substances can *prevent* rusting.

- It has been commented on in previous reports that if a comparison between two things is asked for in a question, **both** things must be referred to if maximum credit is to be achieved. This applied particularly to **Questions 1(a)** and **2(c)**.

- The small number of candidates who suggest using sodium, potassium and fluorine for use in chemical experiments should be aware that these are dangerous substances and would not be allowed in schools for routine class experiments.

Comments on specific questions

Question 1

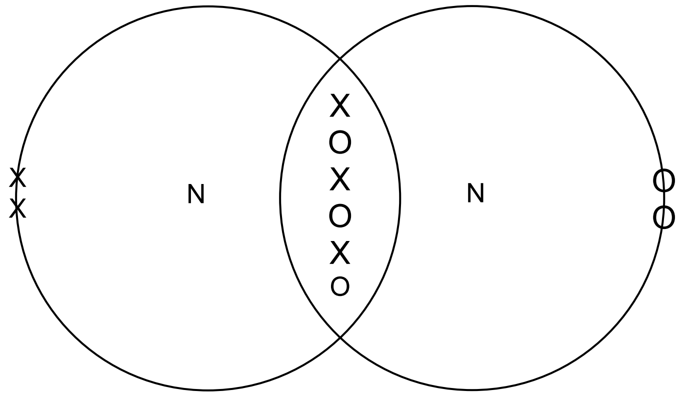
(a) This is a question about electron configuration of atoms. Quite a number of excellent answers showed awareness of the differences between neon atoms and fluorine atoms. Neon atoms have a full outer shell of electrons, but fluorine atoms do not. Thus fluorine atoms need to share a pair of electrons/form a covalent bond to achieve a full outer shell. The boiling points in the table were a distraction for many candidates in this response. Stability alone would not achieve credit without some explanation related to electron configuration or bonding. Candidates commonly mentioned that neon was a noble gas in group 0 and that fluorine was a halogen in group 7, but none of these points addressed the requirements of the question.

(b) The only correct answer to this question is the atomic number (of the element) or the number of protons (in one atom of the element). Many mentioned electrons and even electron shells.

(c) The question expected a comment about 'the bond between the atoms being very strong'. A few candidates stated that the bond between the atoms does not break. It is only the weak forces of attraction between nitrogen molecules that break when liquid nitrogen boils. The intention of this question was to discover whether candidates realised that weak intermolecular forces break when a simple molecular substance boils, but strong covalent bonds between nitrogen atoms within nitrogen molecules do not break when liquid nitrogen boils.

(d) Examiners had to be able to count the dots and crosses in order to mark this question. Thus candidates should be reminded of the necessity to draw large diagrams. Many candidates drew a nitrogen atom rather than a nitrogen molecule. There was no penalty for drawing inner shells and nuclei in addition to outer shells, but the question does ask for outer shells only. There were quite a number of candidates who used 14 instead of 7 as the atomic number of nitrogen.

The diagram below is of the type preferred.



Question 2

(a) Graphite is a giant molecule, and therefore it is not appropriate to write about ***intermolecular*** forces between layers. There are weak forces of attraction between layers which is why the layers can slide over each other. Many candidates referred either to weak forces between layers or that the layers could slide, but only a minority of candidates made both points.

(b) The correct answer to this question should have focused on the fact that **all** the bonds in diamond are strong covalent bonds, (there are no weak bonds), which is why diamond is resistant to change when forces are applied.

(c) Graphite is a good conductor of electricity because it contains electrons that can move. Diamond does not contain electrons that can move, because all the outer shell electrons in diamond are used in covalent bonding. A common misconception was that diamond has no space in the lattice for electrons to move, rather than to say that diamond did not possess moving electrons.

Question 3

(a) Plastics are flexible and can be moulded into a suitable shape to surround the cable underneath. They are unreactive and therefore offer suitable protection for the conducting metal in the cable. Many candidates repeated information about plastics being good insulators, even though this was given in the question.

(b) This is not a question about steel alloys, (such as stainless steel which contains iron alloyed with nickel and chromium), but is concerned with chromium plated steel. The chromium plating improves the appearance and prevents the rusting of steel.

(c) Candidates generally answered this question well. Aluminium is used extensively in the manufacture of aeroplanes because it is a low density metal which is strong. It has a protective layer of aluminium oxide which prevents the metal underneath from corroding.

(d) Candidates generally answered this question well. Copper is suitable for making cooking utensils because it allows heat to pass through readily (good conductor of heat), does not melt until high temperatures are reached (high melting point), it can be made into the shape required (malleable or ductile) and does not react with food or its constituents (unreactive).

(e) The question asks about (metallic) bonding in metals rather than (ionic) bonding in compounds containing metals. Attraction, or forces of attraction (as opposed to forces alone), between positive ions and electrons was required for full credit to be awarded. The question asks for a description of the bonding as opposed to a description of the structure. This is why mentioning attraction is so necessary. It was common to see reference to atoms or protons rather than positive ions.

Question 4

(a) (i) Most candidates correctly named at least one of the products formed at the anode.

(ii) Cryolite is used to lower the operating temperature at which this electrolysis occurs. This sa energy costs. Cryolite acts as a solvent because aluminium oxide (alumina) dissolves in cryolite. Cryolite also improves the conductivity of the electrolyte. It is a common misconception that cryolite is a catalyst. Many candidates referred to *aluminium* instead of aluminium oxide or alumina.

(iii) Iron(III) oxide does not react or dissolve in aqueous sodium hydroxide and therefore has to be separated from the rest of the mixture by filtration or an alternative suitable method, otherwise complete separation is not achieved. The majority of candidates did not include this and therefore were not awarded full credit.

(b) (i) Many candidates achieved full credit in this question. Half equations were almost always correct. Non-electrolytic methods were inappropriate. Sodium chloride does not react with water, but merely dissolves in it to form an aqueous solution of sodium chloride, the starting material for the electrolysis.

(ii) Candidates who knew that the two chemicals were hydrogen and chlorine were usually also able to give a use for each one.

Question 5

(a) (i) The repeat unit of starch can be represented as

-O-☐-

Any number of repeat units could have been drawn. It is important to draw extension bonds on both ends of the polymer to achieve full credit, but these were not always seen. It is unnecessary to use brackets with or without an n outside the brackets, but there was no penalty for this.

(ii) Catalysts in industrial and laboratory processes are generally specific for only one reaction. Therefore iron, nickel and vanadium(V) oxide would not catalyse the hydrolysis of starch, which is catalysed by aqueous solutions of acids. Yeast is not a catalyst. UV light only catalyses photochemical reactions.

(iii) There was a wide variety of answers to this question. Many candidates knew that carbohydrates are made from carbon, hydrogen and oxygen. 'Elements' refers to chemical elements, but some candidates gave answers that were not elements.

(b) (i) A wide variety of answers to this question were seen. Starch and yeast were often given as products. Water was often seen instead of carbon dioxide as a product in addition to ethanol. A number of candidates gave alcohol instead of ethanol.

(ii) Yeast is a source of enzymes which act as a catalyst in fermentation. Some candidates interpreted this question as asking why more yeast is added. Because yeast is a living organism it reproduces as respiration proceeds.

(iii) Enzyme catalysed reactions, such as fermentation, are sensitive to extremes of temperature. This is because enzymes are denatured at temperatures above their optimum, which leads to a decrease in reaction rate. Le Chatelier's principle cannot be applied to enzyme catalysed reactions. Yeast cannot be denatured, nor can enzymes, (which are not living), be killed. The consequences of enzyme denaturation/yeast death were required for full credit to be awarded.

(c) (i) The word 'suggest' in this part, and also in **(c)(ii)**, indicates that it was not expected that candidates were familiar with the complex chemical changes occurring in this process, but that they were expected to make a reasonable suggestion based on their knowledge of similar processes and issues.

If oxygen was present it is likely that an aerobic process would occur, rather than [...] process. This means that the product would be something other than methane, or th[...] could be produced and oxidised further by reaction with oxygen.

(ii) Phrases such as 'no pollution', 'environmentally friendly', 'eco-friendly', or 'saves money' could [...] gain any credit without further explanation. Any process in which fuels are produced from pla[...] materials result in the absorption of carbon dioxide when the plant grows. This compensates to some extent for the release of carbon dioxide into the atmosphere when the fuel burns, thus limiting the net production of a greenhouse gas. This is often expressed as carbon neutrality. Plants are renewable resources whereas fossil fuels are non-renewable. The other advantage of this process is that the waste is recycled rather than allowed to cause disposal problems.

Question 6

(a) (i) Most candidates were able to put the four experiments in order of reaction speed.

(ii) Many candidates achieved only minimal credit for stating the reason for their choice in **(a)(i)** was that as time increased rate of reaction decreased. Very little credit was achieved by merely restating the information in the question with very little explanation. The question was asking for an explanation of why the reactions with the four acidic solutions proceeded at different rates.

Some candidates calculated that if the concentration of propanoic acid doubled, the time taken would be 115 seconds, and did similar calculations for the other acids. This does not address the question.

Strength of acids relates to the degree that an acid dissociates or splits up into ions. Both hydrochloric and sulfuric acids are strong, whereas propanoic acid is weak. Concentration refers to the number of moles of acid in 1 dm^3 of solution. B and D are of equal concentration, although D is stronger than B which is why D reacts faster than B. Sulfuric acid is diprotic, whereas the other two acids are monoprotic. Thus sulfuric acid produces a greater concentration of H^+ ions than hydrochloric acid of the same concentration, which is why A reacts faster than C.

(b) Some candidates ignored the statement in the question that the concentration of the acid and the mass of magnesium were kept the same, and suggested changing the concentration. Changing the pressure in a reaction between a solid and an aqueous solution will have no effect on the rate of reaction. Increasing the pressure will affect the rate of reactions between gases, because at higher pressure gaseous molecules are closer together and will collide more often.

Question 7

(a) (i) The empirical formula represents the smallest whole number ratio of atoms of each element in a compound. The empirical formula is CH_2 in all alkenes. C_nH_{2n} was by far the most common answer.

(ii) Compounds in the same homologous series or with the same functional group or with the same general formula do not necessarily have the same empirical formula. Alkenes have the empirical formula CH_2 because the formulae of all alkenes cancel down to a smallest whole number ratio of 1C : 2H. Members of **all** homologous series (not just alkenes) differ from the preceding member by a $–CH_2–$ group of atoms.

(b) (i) Amongst the many correct answers it was fairly common to see ethanoic acid and methanoic acid, instead of propanoic acid and ethanoic acid respectively. Organic compounds are named according to the total number of carbon atoms in each molecule, and this includes the carbon atom in the functional group in the case of carboxylic acids.

(ii) Any symmetrical alkene was accepted as a correct answer. Ethene was seen fairly regularly, as well as the non-existent methene.

(c) (i)(ii) Many products of both reactions were seen to have double bonds, which is not the case in addition reactions.

In **(c)(i)** $CH_3CH_2CH_2Br_2$ was occasionally seen. In an addition reaction the two added atoms are not added to the same carbon atom.

(d) Most candidates drew polyethene (polythene), with a chain containing three carb i.e. —CH_2-CH_2-CH_2— (or more usually a fully displayed version), as opposed to poly (pr

Any number of correct repeat units could have been drawn. It is important to draw extension bo on both ends of the polymer to achieve full credit. It was unnecessary to use brackets with o without an n outside the brackets, but there was no penalty for doing so.

(e) Although the number of 'moles of O_2' (molecules) was requested, the number of moles of O (atoms) i.e. 2.4/16 = 0.15 was often seen. This error could have been rectified in subsequent steps to score full credit. Some candidates approximated the number of moles of O_2 from 0.075 to 0.08 and were unable to recover from this severe over approximation to achieve any credit.

The easiest way to deduce the formula of the alkene is to calculate the number of moles of CO_2 which is 2.2/44 = 0.05. The mole ratio between the alkene and carbon dioxide is 0.01 : 0.05 which in whole numbers is 1 : 5. Therefore it must follow that 1 molecule of the alkene must contain 5 carbon atoms and because alkenes have the general formula C_nH_{2n} the molecular formula of the alkene is C_5H_{10}.

Question 8

Candidates found **(c)** and **(d)** amongst the most difficult parts of the whole paper.

(a) Acids are defined as **proton donors**. This was the only acceptable answer.

(b) Candidates were expected to give a very brief description of an experiment, such as measure pH/add Universal Indicator, and an observation, such as ethylamine has a lower pH, rather than giving a great deal of underlying theory.

Universal Indicator produces different colours when added to strong and weak bases rather than different shades of the same colour. Litmus cannot be used to distinguish between strong and weak bases, because it changes to the same colour (blue) in both. Weak bases and strong bases do not require different volumes of acid to neutralise them, assuming that equal numbers of moles of the base are present. The reaction between aqueous solutions of ethylamine or sodium hydroxide and acids does not proceed with any visible differences, and therefore it is not possible to compare the rates of reaction.

(c) Ammon**ium** salts, such as ammon**ium** chloride, react when heated with strong bases such as sodium hydroxide to produce ammonia; therefore ethylammon**ium** salts such as ethylammon**ium** chloride would be expected to react similarly when heated with strong bases such as sodium hydroxide to produce ethylamine. Those who were aware that a strong base was required, usually omitted to mention that heat was also necessary.

(d) Some candidates recognised the fact that an aqueous solution of ethylamine behaved in a similar manner to aqueous solutions of ammonia and sodium hydroxide when added to an aqueous solution of an iron(III) salt. Candidates were aware that the precipitate indicated a positive test for iron(III) ions in aqueous solution. Although hydroxide ions are commonly used to carry out a test for iron(III) ions in aqueous solution, the converse is also true, which means that aqueous solutions containing iron(III) ions can be used to show the presence of hydroxide ions in aqueous solution.

The question asked for and explanation of the chemistry and a correct response required the knowledge that the hydroxide ions formed reacted with the iron(III) ions to produce a brown precipitate of iron(III) hydroxide.

Candidates commonly identified the brown precipitate as either iron or rust.

CHEMISTRY

Paper 0439/53
Practical Test

Key messages

It is important to read and follow the instructions in the qualitative tasks in **Question 2** to avoid using the wrong substances.

Only observations, and no conclusions, should be written in the table for **Question 2**.

General comments

The majority of candidates successfully completed both questions and there was no evidence that candidates were short of time. Supervisors' results were submitted with the candidates' scripts; few problems were reported and no candidate who followed the instructions provided would have been disadvantaged by any of the reported problems. The Examiners use Supervisors' results for both questions when marking the scripts to check comparability.

The results obtained by some Supervisors and candidates suggested that a few Centres did not use a newly purchased sample of anhydrous magnesium sulfate for solid **C** (as stated in the Confidential Instructions provided). During storage anhydrous magnesium sulfate will absorb water from the air and become hydrated. This results in the enthalpy of solution becoming less exothermic or, in cases of near complete hydration, endothermic.

Comments on specific questions

Question 1

(a) (b) All candidates completed the two tables of results. Most obtained results that showed a steady increase or decrease in temperature. A few candidates had erratic temperature changes which could have been caused by sporadic stirring.

(c) Many candidates produced inappropriate scales on the *y*-axis, for which credit could not be awarded. The plotted points should occupy a minimum of half the available grid. This can always be achieved by selecting scales that are sensible, (such as 2 cm = 1 °C), however, some candidates chose to use awkward scales, (such as 3 cm = 2 °C), which often resulted in points being plotted incorrectly or errors in reading the graphs in **(d)**. Many candidates drew excellent smooth curves of best fit, however, a curved line which goes from point to point is not a line of best fit (unless the points happen to lie on a perfect curve), and nor is a series of straight lines joining the points. Some candidates drew inappropriate straight lines which had little relationship to the points plotted.

(d) In both **(d)(i)** and **(d)(ii)** there were errors in reading the graph scales. The required working was usually shown on the graph, but sometimes in the wrong place. In **(d)(ii)** some candidates ignored the word 'initial' in the question and just measured the time taken for a 1 °C temperature change at any point during the experiment.

(e) This proved unexpectedly difficult for many candidates. Many just stated that the temperature dropped but did not relate this to the process being endothermic.

(f) This question was a good discriminator. The main error was for candidates to rela volume of water to greater dilution and so a slower reaction. The more able candidat that twice the volume of water would require twice the heat energy, and so the temperature was halved.

(g) Most candidates realised that all of the solid would have dissolved after an hour, but many though this would just mean that the temperature would stop changing. Better candidates explained clearly that the solution would gain energy from the atmosphere and so return to the initial or room temperature.

(h) Many answers referred to improved accuracy, but few commented on the increased frequency of the readings.

Question 2

Solid **E** was basic copper carbonate and liquid **F** was dilute ethanoic acid. Some candidates obtained observations that would not be possible with these reagents.

(a) The appearance of **E** was usually correctly described as green, although a number of answers stated it to be blue.

(b) The effect of heat on solid **E** produced a wide range of observations and gas test results. Some reported ‘fizzing’, but this could not be observed as the substance remains solid throughout the process. Most reported that the solid became black, but very few noted the condensation formed at the top of the test-tube. When testing the gas, a surprising number of candidates obtained positive results for gases which could not have been present.

(c) (i) Many candidates failed to report the violent effervescence that occurred and while most noticed the blue colouration obtained, they failed to note that it was a solution or liquid (rather than the solid).

(ii) The action of sodium hydroxide was familiar to the vast majority of candidates, but it must be noted that a solid formed from the reaction between two solutions should be described as a precipitate.

(iii) This part produced some excellent answers, but a few contradictions were made, such as claiming the solid dissolved to give a deep blue precipitate.

(d) It was common for candidates to report that liquid **F** was clear or transparent. Neither of these terms describes the colour of the liquid and so are not acceptable alternatives for colourless. A wide range of descriptions of the smell of dilute ethanoic acid were accepted and most candidates gained credit here. Acceptable descriptions were pungent, sharp, sour, strong or vinegar. Vague descriptions such as ‘bad’ or ‘horrible’ scored no credit.

(e) Due to the large variety of pH indicator paper available and their differing sensitivities, a wide range of pH values were accepted. However, pH values of 1 or 7 (or in some cases greater than 7) were not accepted.

(f) The reaction of copper carbonate with dilute ethanoic acid is slow, but if observations are made carefully then effervescence can be seen, as can the blue-green solution obtained. Many candidates failed to gain credit here by simply not observing carefully, or possibly not leaving the mixture to stand as instructed. Some observations made it clear that the candidates had not used solid **E** but had used the decomposition product (copper oxide).

(g) Most candidates successfully identified solid **E** as a copper carbonate.

(h) Most candidates were able to state that liquid **F** was an acid. Many correctly identified it as ethanoic acid or vinegar.