CHEMISTRY (US)

Paper 0439/13
Multiple Choice (Core)

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

General comments

Questions 2, **15**, **32** and **37** proved to be of lower demand.

Questions 10, **16**, **18**, **22**, **23**, **24**, **30** and **31** proved to be particularly challenging.

Comments on specific questions

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

Question 6

Response **B**. Candidates realised that Q was a metal but did not know the bonding in hydrogen.

Question 7

Response **B**. Candidates elected an option which, whilst true, does not answer the question.

Question 8

Response **B**. Candidates did not understand the mathematical process involved and simply divided 120 by 12.

Question 9

Response **A**. Candidates missed the term *molten* in the stem of the question.

Question 10

Response **A**. This response was more popular than the correct response. Hydrogen, a fuel, does not release carbon dioxide whereas all fuels release heat.

Question 11

Response **D**. This response was more popular than the correct response. Candidates were confused by the two prefixes ‘exo’ and ‘endo’.

Question 16

This had an approximately equal number of candidates choosing each alternative. This indicates that a high proportion of candidates were guessing the answer.

Question 18

Response **D**. This was more popular than the correct response. Candidates rejected the three previous options, not realising that a carbonate would have fizzed producing carbon dioxide.

Question 22

Response **A**. This response was more popular than the correct one. Candidates did not consult their Periodic Table and assumed all noble gases have eight electrons in their outer shell.

Question 23

Response **A**. This was more popular than the correct response. Candidates did not know that an alloy shows a random distribution of the atoms of the second metal.

Question 24

Response **D**. This response was more popular than the correct response. The least reactive metals have oxides which react with carbon.

Question 31

Response **B**. This response was more popular than the correct response. Candidates knew that greenhouse gases absorb heat but did not think their answer through.

Question 39

Response **B**. Candidates knew about fermentation but did not remember the ethene process as an addition reaction.

CHEMISTRY

Paper 0439/23
Multiple Choice (Extended)

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

General comments

Questions 2, **3**, **4**, **7**, **21**, **22**, **27**, **29**, **32** and **33** proved to be of lower demand.

Questions 9, **20** and **30** proved to be particularly challenging.

Comments on specific questions

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

Question 1

Response **B**. Candidates knew that the answer involved diffusion but did not understand the reason for this.

Question 5

Response **D** is true but does not answer the question. It is electrons which determine chemical properties.

Question 6

Response **D**. Candidates did not fully understand the structure of solid silicon dioxide, only knowing that it was similar to diamond.

Question 9

Response **B**. This response was more popular than the correct response. Candidates got part of the way with the calculation but added less water instead of more.

Question 10

Response **A**. Candidates did not take into account the copper electrodes.

Question 15

Response **C**. Candidates may have been thinking of rate of production rather than yield.

Question 18

This had an approximately equal number of candidates choosing each alternative. This indicates that a high proportion of candidates were guessing the answer.

Question 24

Response **A**. Candidates should realise that the second metal atoms are randomly distributed through the metallic structure.

Question 28

Response **C**. Candidates knew it must be higher but selected wrongly, possibly without doing the maths.

Question 30

Responses **A** and **D** were both more popular than the correct response. Candidates missed the term *solubl*e in option 2 and then found the question challenging.

Question 34

Response **D**. Candidates confused lime with slaked lime.

Question 35

Response **B**. Candidates did not know the names of the fractions that are given in the syllabus.

CHEMISTRY

Paper 0439/33
Theory (Core)

Key messages

- Many candidates needed more practice in questions involving qualitative analysis.
- It is important that candidates read questions carefully in order to understand what is exactly being asked.
- Many candidates needed more practice in memorising the meaning of chemical terms such as *compound* or *hydrocarbon*.
- The balancing of simple equations and extraction of data from 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. Most candidates attempted all parts of each question. The exceptions were **Questions 4(a)(ii)**, **5(d)**, **7(a)(i)**, **7(a)(i)**, **7(b)**, **7(c)** and **(8)(e)** where a significant number of candidates did not respond.

Many candidates needed more practice in questions involving qualitative analysis. For example, very few candidates knew the test for water using cobalt chloride (**Question 3(b)(ii)**), the test for an unsaturated hydrocarbon (**Question 4(a)(ii)**) or the test for bromide ions (**Question 5(f)**).

Some candidates needed more practice in reading and interpreting questions. The rubric was misinterpreted or ignored by some candidates. In **Question 2(a)(i)** the words 'on health' were ignored. In **Question 3(g)**, many candidates did not refer to the equation as instructed in the stem of the question, whilst in **Question 4(b)(iii)** some candidates did not choose a 'use in industry' as asked for by the question. In **Question 6(a)** a considerable number of candidates did not write about the position of the sub-atomic particles in the atom.

Many candidates needed more practice in answering questions involving chemical terms without contradicting themselves. For example, in **Question 1(b)(ii)**, many candidates wrote about single atoms or compounds rather than elements and in **Question 6(c)** some candidates suggested that nucleons were only protons or the mass of the element.

Some candidates needed more practice in answering extended questions such as **3(a)** (diffusion) and **6(a)** (position and number of sub-atomic particles).

Questions involving general chemistry, including organic chemistry, were generally tackled well by many candidates. Many candidates were able to balance simple equations and extract relevant information from tables of data. Others needed more practice in naming salts, describing how a soluble salt can be separated from an insoluble salt and in understanding the reactions of halogens with halide ions.

Comments on specific questions

Question 1

Most candidates identified two of the gases correctly in part **(a)** but only a minority of the candidates identified the gas that forms an acidic solution in part **(i)** or identified the monatomic gas in part **(ii)**. In part **(b)** most candidates identified two elements in **(b)(i)**; fewer gave a convincing explanation of the term *element* in **(b)(ii)**. The dot-and-cross diagram in part **(c)** was generally well answered.

(a) (i) A minority of the candidates identified hydrogen chloride. The commonest error was to suggest ammonia. The next most common error was to suggest ethene.

(ii) A minority of the candidates correctly identified helium as being monatomic. The commonest error was to suggest hydrogen. Other common errors were ammonia or methane.

(iii) Some candidates correctly identified nitrogen as forming 78% of dry air. Hydrogen was the commonest incorrect answer. The next most common error was methane.

(iv) Some candidates correctly identified methane as the main constituent of natural gas. Hydrogen was the commonest incorrect answer. Hydrogen chloride or ammonia were other errors seen.

(v) Many candidates were able to identify the molecule containing 14 protons. The commonest error was to suggest hydrogen chloride.

(b) (i) Nearly all the candidates were able to identify two elements from the list.

(ii) A minority of the candidates gave a good definition of the term *element*. Many answers were too vague to give credit, e.g. ‘a set of one atom’, ‘two or more atoms together’, ‘a product in the Periodic Table’. Better performing candidates wrote about substance containing only one sort of atom. A significant number of candidates wrote ‘the same type of molecule’, which could apply to ammonia or hydrogen chloride’.

(c) Many candidates drew a correct dot-and-cross diagram for hydrogen chloride. Some only gave a bonding pair of electrons. Common errors included: too many electrons on the chlorine atom; one or no bonding electrons or addition of extra non-bonding electrons on the hydrogen atom.

Question 2

This question was generally the best-answered on the paper. Many candidates gained full credit for parts **(a)(i)**, **(b)** and **(c).** Fewer gained full credit for comparing the composition of the exhaust gases in part **(a)(ii)** or for giving one adverse effect of sulfur dioxide on health in part **(a)(ii)**.

(a) (i) Most candidates gave the correct answer. The commonest errors arose from not including all the figures in the addition.

(ii) Many candidates gave at least two differences in the composition of the exhaust gases. Others wrote statements that were too vague, e.g. ‘there is a greater volume of gases, which are not harmful in petrol’ or ‘there is more volume of gases in the petrol engine than the diesel’.

(iii) Some candidates gave a correct effect of sulfur dioxide on health. Others did not focus on the word ‘health’ in the stem of the question and gave answers such as ‘hazardous for the environment’ or ‘acid rain’. Some answers were incorrect because they either referred to disease or cancer. A significant number of candidates appeared to muddle the effect of sulfur dioxide with that of carbon monoxide.

(b) Nearly all the candidates filled in the gaps in the sentences correctly. The commonest errors were ‘density’ or ‘crystallisation’ (instead of distillation), ‘poly(ethene)’ (instead of kerosene) and ‘poly(ethene)’ (instead of boiling).

(c) Most candidates were able to balance the equation. The commonest errors were $3(H_2O)$ and $2(CO_2)$. Those who made errors, generally gave an incorrect balance for the carbon dioxide. A significant number of candidates gave a balance of $2(H_2O)$ and $2(CO_2)$.

Question 3

Parts **(b)(i)**, **(d)** and **(f)** were answered well by many candidates. Many did not give detailed enough answers to part **(a)** (diffusion) and **(g)** (reduction). Few knew the test for water using anhydrous cobalt chloride (part **(b)(ii)**). Some candidates were able to give three differences between cobalt and lithium in part **(e)**. Others wrote answers that were too vague.

(a) Some candidates recognised that diffusion was occurring. Few explained diffusion in terms of the particles moving randomly from areas of higher concentration to areas of lower concentration. Many just described the cobalt chloride moving or the colour moving. A minority of the candidates did not recognise the physical process of diffusion and described chemical reactions in the solution.

(b) (i) Many candidates recognised the symbol for a reversible reaction. Common errors included: 'balanced equation'; 'same reactants and products' or 'turns into products'.

(ii) Few candidates knew the test for water using anhydrous cobalt chloride. Many confused it with the test for water using anhydrous copper sulfate, often giving the colours the wrong way round. Others confused it with the bromine water test for unsaturation. Common incorrect colours for the anhydrous cobalt chloride included orange, red and white. Common incorrect colours for the hydrated cobalt chloride included brown, blue and colourless.

(c) Some candidates wrote the correct molecular formula. Others disadvantaged themselves by writing the formula as $CO_2C_8O_8$. Other common errors were: $2CoC_8O_8$, CO28CO or 2Co8C8O.

(d) Some candidates gave the correct order of reactivity but many reversed the order completely. Others seemed to rely on their existing knowledge of the reactivity series rather than using the information in the table. This was obvious from those candidates who wrote down lists of relative reactivity either next to the question or on one of the blank pages.

(e) Some candidates gained credit for correct comparisons of the properties of cobalt and lithium but few gained full credit. Many described properties that were common to both metals, e.g. conductivity. Some thought that one was a metal and the other was a non-metal or described their relative positions in the Periodic Table. A significant number of candidates did not mention which metal they were writing about. It was assumed that if no name was mentioned, that the answer referred to cobalt. Many candidates did not score because they wrote about electronic structure, number of protons or physical state or did not compare properties sufficiently well, e.g. cobalt is malleable (rather than less malleable than lithium). Others wrote statements that were too vague, e.g. cobalt is heavier than lithium.

(f) Many candidates balanced the equation correctly. The commonest incorrect answer was to suggest 2(CoO).

(g) Many candidates gave a definition of reduction but did not apply the concept of reduction to the equation. Others described the equation without explaining how it was a reduction. Many candidates described the cobalt losing oxygen rather than the cobalt oxide losing oxygen. Others wrote answers that were too vague, e.g. 'the oxygen and cobalt split apart'.

Question 4

Parts **(a)(i)**, and **(b)(ii)** were answered well by many candidates. Many did not know the test for an unsaturated compound in part **(a)(ii)** and many candidates did not respond to this part. Better performing candidates were able to draw the structure of ethanol in part **(b)**. A minority of the candidates gave a suitable use of ethanol in industry in part **(b)(iii)** and few could explain the energy level diagram in part **(b)(iv)** or state the name of two products formed when ethanol burns in a limited supply of air in part **(b)(v)**.

(a) (i) Many candidates identified the C=C bond as being responsible for unsaturation. The commonest errors were to refer to either the OH or CH_2 group or to suggest that there were 'missing bonds'.

(ii) A minority of the candidates knew the correct colour change when aqueous bromine reacts with an unsaturated compound. Others either reversed the colours (colourless to orange) or guessed the colour of the product, green, white, orange or blue being commonly seen. Common incorrect colours for aqueous bromine were red or blue. A few candidates suggested white or transparent for the colour of the product, which was not accurate enough.

(iii) Some candidates gave good answers relating the temperature of –120°C to its position between the melting point and the boiling point. Most candidates who chose the correct state (liquid) only wrote about one of the fixed points, e.g. 'liquid because it is above the melting point'. Others gave vague answers such as: 'the melting point is 9 degrees away' or 'it's about to reach its boiling point'.

(b) (i) A minority of the candidates drew the correct structure of ethanol. The commonest errors were to show the presence of a double bond, to draw the structure of ethane or to draw the carbon attached to the OH group with five bonds.

(ii) Most candidates gained at least two marks. The commonest errors were salt (instead of sugar), 300°C (instead of 30°C), sugar (instead of enzymes) and electrolysis (instead of distillation).

(iii) Very few candidates gave a suitable use of ethanol in industry. Many suggested its use as a fuel or oil despite the word 'fuel' being in the stem of the question. Others gave non-industrial uses such as 'rubbing alcohol', 'for drinking' or 'preservatives'. A significant number of candidates thought that ethanol is used in fertilisers.

(iv) Many candidates did not gain credit because they did not refer to the diagram and only gave a definition of an endothermic reaction. Others gave vague answers such as 'energy goes from top to bottom' or just referred to the equation.

(v) Many candidates gained only one mark because one of the products suggested was water, which is in the stem of the question. Other common errors included hydrogen or oxygen. A few suggested methane.

Question 5

Some candidates responded well to this question, especially in parts **(a)** and **(f)**. Others suggested that gases were given off during the electrolysis in part **(b)** or that elements other than those present in the electrolyte were formed. Few gave correct descriptions of the salt preparation in part **(c)** or identified the orange-brown substance in part **(d)**. The colour of silver bromide in part **(e)** was known by very few.

(a) Many candidates were able to give the name of the positive electrode. Common incorrect answers included 'cnathode, pathode, anion and graphite'.

(b) Some candidates gained one mark but few gained both marks. Some wrote lead(II) (equivalent to Pb^{2+}) instead of lead. Others suggested that gases such as hydrogen and oxygen were produced, perhaps thinking that the electrolyte was an aqueous solution. A significant number of candidates either gave electrode products that did not relate to the electrolyte, e.g. copper, or gave the names of compounds, e.g. lead bromide.

(c) A minority of the candidates gave a suitable method for getting crystals of lead bromide from the mixture. Many either did not add water or added acids instead of water. The process of filtration was absent from many answers. Many suggested evaporating the solids formed. Others did not explain the process of crystallisation sufficiently and wrote vague answers such as 'let the solution rest'.

(d) Some candidates identified bromine as the element responsible for the orange-brown colour. Others suggested sodium bromide, sodium, an inter-halogen compound or sodium chloride plus bromine.

Very few candidates gave a suitable reason and some referred to chlorine being reactive instead of comparing the reactivity with bromine. The most common error was to compare the reactivity of chlorine with sodium or bromide ions. A significant number of candidates wrote vague statements about electrons or the balance of the equation.

(e) Few candidates knew the colour of silver bromide. The commonest incorrect answers were white or yellow.

(f) A majority of the candidates recognised that an electron is gained when a chloride ion is formed from a chlorine atom. The commonest incorrect answer was to suggest a proton.

Question 6

Some candidates gave good answers to part **(a)** (atomic structure). Others did not respond to the part of the question asking about the position of the subatomic particles. Many candidates gained at least one of the two marks available in part (**b)**. Fewer could describe the term *nucleon number* satisfactorily in part **(c)**.

(a) The location of electrons was not made clear by many candidates. Statements such as 'they are in energy levels' or 'in shells' were not sufficient to gain the mark. Many candidates suggested that 'the electrons are outside the atom', rather than outside or surrounding the nucleus. Many gained only three marks because they identified the correct number of electrons, protons and neutrons but did not describe their position. Others described the position by trying to relate it to the isotopic symbol, e.g. 'the proton number is lower' or 'the neutrons plus protons are up'.

(b) Many candidates gained at least one mark for a correct statement about isotopes. The commonest error was to tick the top box (isotopes of the same element have different numbers of protons).

(c) A minority of the candidates realised that the term *nucleon* refers to both neutrons and protons. The commonest errors were: 'the number of neutrons', 'the mass of the atom', 'the number that the element has' or 'the number in the nucleon'.

Question 7

Many candidates performed reasonably well in this question, especially in parts **(a)(i)** and **(d)**. In part **(b)** some candidates could write the electronic structure of sodium correctly. Others did not appear to understand the meaning of this term. Part **(c)** was least well answered, with many candidates writing vague answers for the explanation of alkalinity and the use of indicators to show that a solution is alkaline.

(a) (i) Most candidates gave suitable figures within the ranges so that a trend was followed. More candidates made errors with the values for melting point than with the values for relative hardness.

(ii) Many candidates gave suitable observations mentioning slow bubbling. The commonest incorrect answer was 'no reaction'. Others wrote 'bubbling' (unqualified) or wrote general comments about reactivity instead of giving observations.

(b) Few candidates were able to deduce the electronic structure of sodium. Many just wrote Na or gave the total number of electrons. A few candidates wrote structures in the form $1s^2 2s^2$, etc. These candidates almost invariably gave the incorrect electronic structure.

(c) (i) Some candidates focussed on the sodium hydroxide or hydroxide ions being responsible for the alkalinity. The commonest error was to suggest that the hydrogen is alkaline in nature. Many candidates wrote answers about neutralisation or the loss of atoms or electrons.

(ii) Many candidates were able to select a suitable indicator, Universal Indicator generally being the indicator of choice. Fewer were able to give a correct colour in alkaline solution, yellow, green or red being the colours most often suggested.

(d) Most candidates calculated the relative formula mass correctly. The commonest incorrect answers were 20 (using atomic numbers) or 35 (not multiplying the number of hydrogen atoms by 4).

Question 8

Many candidates gave good answers to part **(a)** and **(c)**. Fewer were able to describe fully how the apparatus was used in part **(b)** or to relate the size of the pieces of calcium carbonate to the rate of reaction in part **(d)**. In part **(e)** many candidates either named the salt incorrectly or gave products other than carbon dioxide and water.

(a) Many candidates identified the measuring cylinder. The commonest incorrect answer was 'test-tube'. References to beakers or flasks were not uncommon.

(b) Few candidates gave convincing descriptions about how the apparatus could be used to measure the rate of reaction. A common error was to state 'measure the volume of the substance' without referring to which volume was to be measured. A significant minority thought that it was the volume of the acid and zinc that should be measured. Many just referred to liquid levels without reference to the volume of gas. Others suggested counting bubbles or gave answers that were irrelevant to the question, e.g. 'the more the gas, the higher the rate of reaction'. Most candidates that gained a mark did so for a reference to time rather than measuring the volume of gas.

(c) Many candidates recognised that the reaction rate would be less or the reaction would be slower. Others did not gain the mark because their answers were not comparative, e.g. the reaction is slow. A significant number of candidates wrote about the reaction decreasing, rather than the reaction rate decreasing.

(d) Some candidates were able to relate the size of the pieces of calcium carbonate to the rate of reaction. The commonest error was to suggest small pieces (medium rate of reaction), powder (slowest reaction) and large pieces (fastest reaction). Some candidates wrote numbers in the left hand column instead of sizes.

(e) Very few candidates gained two marks for this question. The commonest errors were to write 'calcium hydroxide' or 'salt' instead of calcium chloride. Hydrogen was often written instead of carbon dioxide or water. A few candidates wrote sulfur instead of sodium. Others suggested organic compounds.

CHEMISTRY

Paper 0439/43
Theory (Extended)

Key messages

- Candidates need to take care when using technical terms, such as *filtrate* or *residue* and ensure they are using them in the correct context.
- Electrolysis and the chemistry of esters proved to be weaker areas. These topic areas do contain some demanding content and additional time should be spent covering these areas with students.

General comments

Working should be shown in calculations and this working should be set out so that it can be followed. This will allow method marks to be awarded in calculations even if the final answer is incorrect.

When a question asks for a *chemical equation* a word equation will not be accepted. Where a *word equation* is asked for, candidates should refrain from writing a chemical equation as these are more difficult and increase the likelihood that an error will be made.

Comments on specific questions

Question 1

(a) The majority of candidates could identify chlorine as the substance used to kill bacteria in drinking water.

(b) Most candidates gave the correct answer of sulfur dioxide; a number suggested argon or calcium hydroxide or chlorine could be used.

(c) Almost all candidates correctly identified copper as the electrical conductor used in cables.

(d) Most answers seen were correct; an appreciable number of candidates suggested substances that were not gases.

(e) Carbon dioxide and sulfur dioxide were common errors.

(f) A very common answer was iron, showing some confusion between the contact process and the Haber process.

Question 2

(a) (i) Despite the question asking for a description in terms of protons, neutrons and electrons, an appreciable number of candidates ignored this and tried to answer the question in terms of only two of the three particles. Candidates need to read questions with care – some candidates ignored the instruction regarding the three subatomic particles and answered in terms of atomic number and mass number.

(ii) Some candidates missed the fact that the species in the question was an aluminium ion rather than an atom and so stated there were 13 electrons.

(b) (i) The name of the main ore of aluminium proved was not well known. A common error was to give 'aluminium oxide' or 'alumina' as the ore – these are not correct, they are both Al_2O_3 and are obtained from the ore.

(ii) An answer comparing the reactivity of aluminium with that of carbon was required. Vague answers such as 'aluminium is reactive' were not sufficient to be awarded the mark.

(iii) Cryolite is used in the extraction of aluminium oxide since it is a solvent for aluminium oxide. The solution has a far lower melting point than aluminium oxide alone and is a better conductor of electricity. Many candidates claimed that the cryolite changed the boiling (rather than melting) point or that it was the melting point of aluminium that was very high. It should be noted that cryolite is not a catalyst.

(iv) Some candidates thought that because there was a '+ $4e^-$' that electrons had been gained and so this was reduction. Of those who realised this was electron loss and so oxidation often then went on to say that oxygen had been oxidised; this is incorrect, oxygen is formed in this reaction, the species being oxidised is oxide ions.

(v) Better performing candidates gave clear explanations of how oxygen formed at the anode reacted with the graphite from which the anode was made to form carbon dioxide. Common weaker answers referred to the carbon coming from the electrolyte or the oxygen from the air.

(c) (i) The answer needed to include a comparison of the reactivity of zinc and copper. While 'zinc is more reactive than copper' was an acceptable answer, 'zinc is more reactive' was not, since we are not told what zinc is more reactive than; given the wording of the question 'zinc is more reactive' actually means zinc is more reactive than copper(II) sulfate.

(ii) Most candidates were able to identify this correctly as a redox or displacement reaction.

(iii) The existence of an inert coating of aluminium oxide on the surface of aluminium was not well known. A common error was for candidates to claim that aluminium was unreactive.

Question 3

(a) Better performing candidates generally had no difficulty in selecting a property that was common to all metals – such as the ability to conduct electricity.

(b) (i) Better performing candidates generally had no difficulty in selecting a property that was different for the two metals. A common error was to identify a property common to all metals, which should have been given as the answer to **(a)**.

(ii) A number of candidates gave the answer to this part in **(b)(i)**.

(c) Most candidates gave two correct observations. Some candidates repeated the observations given in the question and so did not gain credit, or gave the same observation twice, such as 'fizzes' and 'bubbles' thinking they were two different observations. In this reaction, it is the hydrogen gas that is made that catches fire, not the potassium.

(d) (i) The test for hydrogen should be known by almost all candidates and while most had some idea about the test there was also some confusion – a burning and not a glowing splint is required in order to ignite the hydrogen.

(ii) Some candidates did not read the question and stated that increasing the temperature would increase the rate, which, while true, did not gain credit since that information was in the question. The most common correct answer was to increase the concentration. A few candidates stated that the pressure should be increased – this will not work as the substances involved were a solid and an aqueous solution, neither of which are compressible.

(iii) Better performing candidates included the following key points:

1. Increasing the temperature gives the particles more energy, this results in them moving faster.
2. As a result of moving faster the particles have more collisions per second. (Note: the reference to time or frequency is essential).
3. As the particles have more energy, a bigger proportion of particles have energy greater than the activation energy and so a greater percentage of collisions are successful.

(e) (i) Candidates were expected to realise that the equilibrium would move right and so become (more) pink. However, many candidates did not refer to the equilibrium and just gave a colour. Some candidates confused themselves and having worked out the equilibrium moved right and formed more $(Co(H_2O)_6)^{2+}$ they then thought that this would shift the equilibrium left to make the blue species.

(ii) This was well answered.

(f) Some excellent answers were seen, although some candidates incorrectly chose to give the charge shown on a species other than Co, such as $Co(OH)_3^{3+}$.

Question 4

(a) The characteristics of a homologous series were well known. Common errors were to mix up chemical and physical properties (giving incorrect answers such as 'a trend in chemical properties') and confusion between general and molecular formulae (giving answers such as 'have the same molecular formula').

(b) Many fully correct answers were seen. The two most common errors were to omit the non-bonding electrons on the oxygen or to omit the bonding pair between the two carbon atoms.

(c) (i) This was not well answered; equations often had incorrect formulae for ethanol and ethene or additional incorrect products.

(ii) Very few candidates could recall the equation for fermentation, a number of candidates tried to write an equation for aerobic respiration.

(iii) Both the greater speed and greater purity of the product were well known advantages. Some candidates mixed up the advantages of each method and stated that catalytic hydration used renewable materials.

(iv) The most common answer given was based on the renewable nature of the raw materials used. Those who mixed the two methods up often incorrectly stated the product was purer.

(d) Very few candidates could identify the reagent used to oxidise ethanol.

(e) (i) Few fully correct structures were seen. Only a minority of candidates could draw an ester group. Structures showing trivalent or pentavalent carbon atoms were common.

(ii) Better performing candidates could correctly name the ester formed.

(iii) The name of the homologous series was known by some but polyester was a common incorrect answer.

(f) (i) This was not well answered. The difference between a strong and weak acid is not based on pH; a very dilute strong acid can have a pH higher than a more concentrated weak acid. Candidates are expected to refer to the fact that weak acids ionise only partially in aqueous solution.

(ii) Candidates are expected to be familiar with the preparation of soluble salts from acids. There are three steps to the process:

1. Add excess copper carbonate to the acid. Most candidates did not state the copper carbonate should be in excess.
2. Filter the solution to remove unreacted copper carbonate. The copper ethanoate solution is the filtrate. There was some confusion between the terms 'filtrate' and 'residue'.
3. The filtrate should be heated to the point of crystallisation and then allowed to cool so that crystals form. It should not be evaporated to dryness.

(iii) Correct word equations were not common; often carbon dioxide or water were omitted as products. Some candidates decided to attempt a chemical equation rather than a word equation. This made the question much more difficult.

Question 5

(a) Many fully correct answers to the empirical formula calculation were seen. A common error was to divide the percentages given in the question by the smallest percentage, so missing out the first step of calculating a number of moles of each element. Some candidates mixed up Ni and N, and so divided by the relative atomic mass of nitrogen. A significant number of candidates attempted to guess a formula and made no attempt at showing any working; in these cases, the answer given was invariably incorrect.

(b) (i) The movement of electrons in the wires was well known.

(ii) Both anions and cations transfer charge through the solution. It was a common error to specify just one of these two as the answer.

(iii) Many candidates were able to correctly identify the electrolysis products. Some candidates thought a solution was being electrolysed and so stated hydrogen would be made; this is despite the nickel(II) iodide being identified as molten in both the diagram and the stem to **(b)**. It was expected that candidates would write the equation for the formation of nickel (since ionic half-equations for the cathode reactions are on the syllabus) but many attempted the equation for anodic reaction and were often successful.

(c) (i) While many candidates were able to correctly state that copper was deposited on the negative electrodes, a number of candidates simply stated that copper ions go the negative electrode without any mention of copper being formed and coating the electrode.

(ii) This was often correct with hydrogen as the most common incorrect gas formed.

(iii) The fact that copper atoms lose electrons and form copper ions which pass into the solution was not well known. Some answers put the mass loss down to just the loss of electrons.

(iv) Some fully correct answers were seen with clear explanations of the colour changes seen in both sets of apparatus. Other candidates clearly did not understand the difference in electrolysis products when using an inert cathode compared to using a reactive cathode.

Question 6

(a) (i) This part involved two stages; the calculation of the relative formula mass of calcium hydroxide and using this value to calculate the number of moles of calcium hydroxide. There were some common errors in the calculation of the relative formula mass – having just one hydroxide ion being the most common. Where candidates set their work out so that it could be followed, the error could be carried forward and credit given for the correct use of the incorrect relative formula mass. Consequential marks can only be awarded if candidates set out their working in a clear and logical manner.

(ii) A common error was to use the value as 24 dm^3 rather than 24 000 cm^3. Candidates needed to consider the units used for volume in the question.

(iii) Better performing candidates were able to use the 6:1 ratio in the equation to obtain a correct value. A common error was to not use the limiting reagent identified from the values in **(a)(i)** and **(a)(ii)**.

(iv) This two-step calculation firstly required the relative formula mass to be determined and then using that figure to work out the mass of the number of moles stated in **(a)(iii)**. An error in the calculation of the relative formula mass could be carried forward, but only if the working was presented in a clear and logical manner by the candidate.

(v) The percentage yield calculation was often correct.

(b) (i) Most candidates were able to state that heating was required to bring about thermal decomposition.

(ii) This question part was generally very well answered. Many candidates identified oxygen as the colourless gas and were able to construct a fully correct equation.

(c) (i) The colour of methyl orange in an acid was well known.

(ii) There were many errors in the definition of an acid; many candidates incorrectly stated it was a proton receiver.

(iii) Candidates found this part challenging and few were able to complete the equation to show the transfer of a proton from $HCIO_3$ (the acid) to H_2O (the base).

CHEMISTRY

Paper 0439/53
Practical Test

Key messages

- If, when two solutions are added together, the product is cloudy this will be because a solid has formed. The solid formed should be called a *precipitate*.
- In the planning question (**Question 3**) there is no need to write a list of apparatus at the start of the answer. Any apparatus used should be referred to in the description of the experiment so that it is clear for what purpose that apparatus has been used.
- Candidates should be familiar with the technique of a flame test. A flame test involves placing a small amount of an ionic solid (normally on a wire) into a roaring Bunsen flame. The colour of the Bunsen flame then changes. Flame tests do not involve using a lighted splint and the result cannot be 'squeaky pop' or 'flame goes out'.

General comments

Almost all centres were able to gain the expected results in **Question 1**, with *Experiment 1* and *Experiment 2* showing an increase in temperature followed by a decrease.

Candidates should complete graph work in pencil so that errors can be erased.

Comments on specific questions

Question 1

(a) Almost all candidates were able to obtain the expected results showing an increase in temperature followed by a decrease.

(b) A number of errors in plotting were noted. Most candidates followed the instruction to draw two intersecting straight lines. Some candidates did 'dot to dot' lines or curves. Some candidates are plotted points or drew graph lines in ink – this means that if an error is made the point/line that is wrong cannot be erased.

(c) Almost all candidates were able to obtain the expected results showing an increase in temperature followed by a decrease.

(d) A number of errors in plotting were found and some candidates ignored the instruction to draw two intersecting straight lines.

(e) (i) A number of candidates misread their graph scales despite having just successfully plotted the graph. A small number of answers stated the temperature rather than the volume.

(ii) Most candidates worked out that a smaller volume would be required; they did not go on to give a quantitative answer and reason.

(f) Candidates need to ensure that when writing *exothermic* that the 'x' does not look like an 'n' as the intended answer must be unambiguous.

(g) (i) Almost all candidates realised that the burette needed to be cleaned, with most candidates focussing on the acid left from the previous experiment.

(ii) Many candidates focused on removing the acid from the previous experiment despite having already removed it with water. Only the better performing candidates realised the water would dilute the acid used in the second experiment and so had to be removed.

(h) Many candidates did not realise that a source of error is not removed by repeating an experiment – if the same method and apparatus is used then that source of error in still there. Better responses identified heat loss or using a measuring cylinder as a source of error.

Question 2

(a) (i) A number of candidates confused flame test with testing a gas with a lighted splint. The result of a flame test should be a colour, not 'the flame went out'.

(ii) Most candidates gave an acceptable pH value.

(b) By this stage candidates could have identified solution **T** as aqueous sodium hydroxide. The results given by some candidates suggested that having worked out this was the reaction between an aqueous zinc salt and aqueous sodium hydroxide all that they needed to do was give observations similar to those in the *Notes for use in qualitative analysis*. However, in this instance the tests were reversed, with the zinc salt being added to the sodium hydroxide. Almost all candidates missed the initial formation of a white precipitate, which then quickly dissolves before any more of the zinc salt is added.

(c) The gas given off should have been ammonia. Some candidates reported positive tests for chlorine, presumably thinking that because ammonium chloride was used that chlorine would be made, it is not possible for chlorine to be made in this way. The expected test and result was that for ammonia.

(d) Many candidates missed the initial green precipitate, which rapidly dissolves giving a green solution. The final green precipitate that should have been formed when excess was added was often reported as being a green solution.

(e) Most candidates could correctly identify solution **T**.

(f) Most candidates stated that liquid **U** was colourless. It should be noted that 'clear' is not accepted as an alternative to colourless; coloured solutions, such as aqueous copper(II) sulfate, are coloured and clear.

(g) Many candidates noted the formation of a yellow precipitate.

(h) Most candidates reported that liquid **U** caught fire, some incorrectly stated that it extinguished the lighted splint.

(i) A common error was to state that liquid **U** contained iodide ions; this was presumably because of the yellow precipitate seen in **Question 2(g)**, despite the fact that silver nitrate had not been used.

Question 3

This question required candidates to extract the mixture of pigments from the leaves and then to analyse the pigments. Unfortunately, most answers seen concentrated on either extracting the pigment from the leaves or on conducting chromatography rather than addressing both aspects; relatively few answers described how to obtain the pigment from the leaves and then conduct chromatography. It was not uncommon for candidates who missed out the pigment extraction stage to place the leaf directly on chromatography paper. Some candidates were not sure what to do with the sand and so used it as a filtration medium or even the stationary phase in chromatography.

CHEMISTRY (US)

Paper 0439/07
Coursework

General comments

The work from centres is improving steadily and fewer require any significant adjustment to their marks. Samples submitted for moderation are usually good and well presented.

There is still a tendency in some centres to give high marks where they are not justified by the criteria. These centres seem to give their best candidate a mark of 48 and rank other candidates accordingly.

The tasks provided were all chemistry tasks and were mostly from the IGCSE syllabus. Some tasks were not the most appropriate for assessing the skills for which they were used.