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. However, Centres should note that when internal moderation has taken place, the internally moderated mark should be the one entered on the MS1.

There is a tendency in some Centres to give high marks where they are not justified by the criteria provided by Cambridge. These Centres seem to give their best candidate the maximum credit available and then rank other candidates accordingly. This practice should be avoided and judgements should be made against the set criteria.

The tasks used are now all chemistry tasks and are mostly from the IGCSE syllabus but they are not always the most appropriate tasks for assessing the skills for which they are used. Tasks should be considered carefully to ensure that candidates can access the full mark range available.

Comments on specific tasks

Skill C1

Tasks used for this skill were largely satisfactory though care should be taken not to use tasks that are too straightforward. Candidates should have a sense of branched instructions to follow. Branched instructions are those which require the candidate to choose between two possible routes at some points. This could be as simple as deciding when to stop adding acid during a titration.

Skill C2

This skill presented few difficulties. Candidates must be given the opportunity to design their own method of displaying results and observations. It is important that there is a range of results to display. It is best if the candidates have opportunities to display both quantitative and qualitative information in the range of tasks they attempt.

Skill C3

To gain the highest marks in this skill, candidates must process results and analyse them to come to conclusions. It is usually easiest to do this if numerical data are generated by the task. If this is the case, a graph can be drawn and any trends in the data can be observed, stated and explained. Accessing the top of the mark range is more challenging where only qualitative observations are obtained.

When designing a task which will generate a graph, it is important to ensure that there are two continuous variables to be plotted. It is not appropriate to plot as a line graph the temperatures produced when a metal reacts with acid against the names of the metals (this would generate a bar chart). The same task could be used to generate graphs if the change in temperature over time were plotted for two or more metals.

Skill C4

High marks cannot be attained for this skill on a simple straightforward task. There must be a detailed plan stating what is to be investigated and how. There must be discussion of the idea of a fair test. This should include which two variables are to be investigated (the effect of one on another) and which variables, relevant to the task, are to be controlled. The plan must then be carried out and evaluated by the candidate. Any necessary improvements should be suggested.

It is best if a candidate is asked to plan an investigation which is similar to one which they have already carried out. Rate of reaction tasks are easily the most popular way of assessing this skill.

CHEMISTRY (US)

Paper 0439/13
Multiple Choice (Core)

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

General comments

Questions 1, 2, 4, 9 and **13** proved to be particularly straightforward for candidates.

Candidates found **Questions 14**, **15**, **30**, **32**, **35**, **38** and **40** the most challenging.

Questions 14 and **30** all had an approximately equal number of candidates choosing each alternative suggesting that a high proportion of candidates were guessing the answers.

Comments on specific questions

Question 5 – Response C

Some candidates did not read the definitions carefully.

Question 10 – Response C

Very few candidates knew the products of electrolysis for concentrated aqueous sodium chloride.

Question 11 – Response A

Many candidates did not read the question properly, missing the word “hydrocarbons”.

Question 15 – Response B

Many candidates possibly read the heading of the third column as *size*, not *surface area*.

Question 16 – Response C

Some candidates confused oxidation and reduction.

Question 18 – Response A

Many candidates knew that lime contains calcium but did not understand neutralisation.

Question 22 – Response C

Candidates clearly knew the reactivity trend in Group I but were unsure about the trend in Group VII.

Question 24 – Response B

The inertness of noble gases was not well understood.

Question 31 – Response D

Most candidates knew that the gas produced was ammonia but not how it was formed.

Question 32 – Response B

Very few candidates knew about fermentation and many other candidates read *lime* as *limestone*.

CHEMISTRY (US)

Paper 0439/23
Multiple Choice (Extended)

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

General comments

Questions 1, **2**, **5**, **7**, **14**, **25**, **26**, and **30** proved to be particularly straightforward for candidates.

Candidates found **Question 9** the most challenging.

Question 9 had an approximately equal number of candidates choosing each alternative suggesting that a high proportion of candidates were guessing the answer.

Comments on specific questions

Question 10 – Response C

Many candidates chose the two most reactive metals rather than the two furthest apart in reactivity.

Question 11 – Response A

Many candidates did not read the question properly, missing the word “hydrocarbons”.

Question 15 – Response B

Many candidates possibly read the heading of the third column as *size*, not *surface area*.

Question 16 – Response A

Many candidates did not realise that, because the number of molecules of gas increases in the forward reaction, the equilibrium is favoured by low pressure.

Question 22 – Response C

Candidates clearly knew the reactivity trend in Group I but were unsure about the trend in Group VII.

Question 24 – Response B

The inertness of noble gases was not well understood.

Question 31 – Response C

The wrong catalyst was frequently selected.

Question 33 – Response B

Many candidates did not realising that copper is below hydrogen in the reactivity series.

Question 38 – Response C

Some candidates perhaps did not realise that hydration of ethene is a rapid reaction.

Question 39 – Response C

Many candidates got the acid and alcohol the wrong way round.

CHEMISTRY (US)

Paper 0439/33
Theory (Core)

Key messages

- Many candidates need more practice in answering questions relating to practical procedures including tests for specific ions and molecules.
- Greater accuracy is required in using the correct chemical terminology when answering questions involving structure, bonding, rates of reaction and the particulate nature of gases.
- Candidates should be reminded to read through the questions carefully and to make use of the Periodic Table, where appropriate.
- Candidates should clearly distinguish between rate and time taken in questions involving the effect of concentration on rate of reaction.

General comments

Many candidates answered the majority of questions well, showing a good knowledge of chemistry. A number of questions were left unanswered by some candidates. These commonly included **Question 2(b)** (test for ammonia), **Question 4(a)(i)** (naming an ore of iron), **Question 4(a)(ii)** (explanation of how carbon monoxide is formed in a blast furnace), **Question 5(c)** (extraction of material from a plant) and **Question 7(e)** (crystallisation and purification).

Many candidates need more practice in distinguishing between molecular, ionic and giant structures and understanding the difference between the arrangement and the proximity of particles. Other candidates need to be able to select relevant information from tables of data.

Many candidates need more practice in carrying out simple chemical tests, e.g. the test for ammonia and iron(II) ions. Other candidates need practice in questions involving practical procedures such as determining rates of reaction, the use of solvents to extract materials, and crystallisation to produce a sample of a pure dry crystalline salt.

Most candidates need further practice in questions requiring extended answers, in particular, the inclusion and organisation of specific details (which could be in bullet point form). Some candidates need further practice in using the Periodic Table to answer questions about atomic structure.

Many candidates were able to balance symbol equations and calculate relative formula mass. Other candidates need practice in using the equations given to answer questions about particular reactions. Some candidates also need more practice in calculating relative formula masses.

Comments on specific questions

Question 1

(a) (i) Many candidates were able to identify a noble gas electronic structure. **A** or **D** were the most common incorrect answers.

(ii) A majority of the candidates recognised the electronic structure of a chlorine atom.

(iii) This was almost always answered correctly. A few candidates incorrectly gave **A** or **B**, however.

(iv) Most candidates identified the Group IV element. **A** was the most common incorrect answer.

(v) Many candidates identified the atom of a metallic element. The most frequently seen incorrect answers showed a lack of understanding that most metallic elements are on the left-hand side of the Periodic Table so have 1, 2 or 3 electrons in their outer shells. The most common incorrect answer was **E**. Better-performing candidates referred to the Periodic Table to check that the number of protons and therefore the number of electrons fitted with the metallic or non-metallic nature.

(b) Most candidates calculated the correct number of neutrons in magnesium but few candidates took note of the positive charge on the calcium ion and therefore gave the incorrect answer of 20 electrons. Other candidates added electrons and gave the answer 22. A few candidates gave the mass number, 44. Many candidates worked out the correct number of protons in the two species. Other candidates wrote down the mass number instead of the atomic number.

Question 2

(a) (i) Many candidates calculated the mass of magnesium ions correctly. Other candidates made simple errors in addition or subtraction. The most common errors were to suggest 20 mg or 24 mg.

(ii) A majority of the candidates identified the hydrogencarbonate ion as the negative ion present in the highest concentration. The most frequently seen error was to ignore the word "negative" in the question and suggest the calcium ion.

(iii) Some candidates gave the correct name for the NO_3^- ion. Common errors included nitrogen oxide, nitroxide or nitrate oxide.

(iv) Many candidates were able to calculate the mass of hydrogencarbonate ions present in 250 cm^3 of solution. The most common error was to suggest 5 mg through dividing 250 (cm^3) by 50 (mg) (the mass of hydrogencarbonate present in 1000 cm^3).

(b) Only the better-performing candidates described a correct test for ammonia. Some candidates who did mention litmus suggested, incorrectly, that blue litmus turns red. Many candidates suggested smelling the gas, which is neither a failsafe method nor sensible in terms of safety. Some candidates paraphrased the stem of the question and suggested the addition of sodium hydroxide but added the formation of a precipitate.

(c) Many candidates deduced the correct formula of calcium bromide. Other candidates did not appear to refer to the Periodic Table to find the relationship between group number and formula and so many formulae, such as $CaBr_4$ and $CaBr_6$, were given. The most common error was to suggest CaBr.

(d) (i) Many candidates realised that calcium was produced at the anode and bromine at the cathode. Some responses gave bromide as a cathode product. Some candidates reversed the anode and cathode products. Other candidates incorrectly suggested products such as hydrogen because of confusion with electrolysis of a solution.

(ii) Very few candidates identified a suitable inert substance which could be used as an electrode, other than graphite. Copper and zinc were often suggested as were more reactive metals such as lithium and magnesium. A significant number of candidates suggested that diamond should be used.

Question 3

(a) Many candidates gained full credit for this question. Most candidates gained at least partial credit for the motion of the particles in the three structures. Fewer candidates recognised the type of bonding present the common suggestion that **P** was covalent or metallic. A significant number of candidates focused on the strength of the bonding rather than the type of bonding. Many candidates did not understand the meaning of the term *arrangement* and wrote about the proximity of the particles instead.

(b) Only the better-performing candidates realised that at a higher temperature, the volume increases. Many candidates only wrote about particles and did not consider what happened to the volume.

Other candidates thought that the volume decreased. A considerable proportion of those candidates who suggested that the particles moved further apart thought that the volume decreased. Other common errors included giving kinetic particle theory answers referring to changes in pressure or concentration, or writing vague statements about the change in force of each individual particle on the walls of the syringe.

(c) Many candidates selected **C** and **D**. Other candidates gave one of these, occasionally selecting **B** as a physical change. Few candidates gained credit for the explanation, either because they wrote "it can be reversed" without any qualification, or did not refer to the fact that "no new substance is formed".

(d) Many candidates gave a correct use of graphite with pencil (leads) being the most frequently seen correct answer. A significant number of candidates suggested "conductor of electricity" despite the fact that a use other than electrical conduction was required. Few candidates made reference to the layers, which appeared in the stem of the question to give candidates a clue. Many candidates gave explanations which were too vague such as "it slides", or "easy to work". A few candidates suggested that graphite is hard.

Question 4

(a)(i) Some candidates correctly identified hematite as the major iron ore. The most common error was to suggest bauxite. A few candidates suggested steel.

(ii) Few candidates gave strong arguments to explain how carbon monoxide is formed in the blast furnace. Many candidates obtained partial credit for the idea that carbon burns in air but few candidates realised how the carbon monoxide forms either by reaction of carbon with carbon dioxide or by incomplete combustion of carbon. Many candidates confused their arguments by including statements about limestone or the addition of pure oxygen.

(iii) Most candidates were able to balance the equation. The most common error was to give $6CO_2$.

(iv) Few candidates gave a clear explanation of how the equation shows the reduction of iron(III) oxide. Many candidates incorrectly referred to the iron and not the iron(III) oxide. The best responses either referred to iron(III) oxide losing oxygen or the iron ions gaining electrons.

(v) Many candidates calculated the molar mass of iron(III) oxide correctly. A few candidates tried to do mole calculations. One common error was to calculate the formula mass of Fe_2O instead of Fe_2O_3.

(b)(i) Many candidates identified hydrogen. The most common error was to suggest either carbon dioxide or oxygen.

(ii) Some candidates gained partial credit for a well-labelled diagram or a suitable explanation but only a minority of candidates referred to timing the reaction. Many candidates did not gain credit because they drew diagrams showing apparatus which would leak or did not show the graduations on an unlabelled gas collector. Many drawings of syringes looked rather like test-tubes or balloons. Other candidates drew connecting tubing as a single line. Other common errors included an absence of a stopper in the flask; the use of a beaker or test-tube open to the air with no collecting apparatus; and imprecise or incorrect labelling.

(c) A minority of the candidates were able to describe a suitable test for iron(II) ions. Those who suggested a suitable test reagent often gained full credit for the green precipitate. The most common errors were to describe a flame test, the addition of a halogen or the addition of nitric acid.

(d) Many candidates did not recognise that recycling is different from reusing. Many candidates selected alternative uses for the steel rather than advantages in terms of conservation of materials or energy. There were many vague answers such as "keeps the same form" or "easier to obtain". Many candidates who did understand that answers about the conservation were required did not give sufficiently precise answers, e.g. "saves the environment" or "you don't have to extract the iron".

Question 5

(a) Many candidates identified the COOH group but some candidates included the adjoining CH_2 group. The most common incorrect answer was to circle the C=O group.

(b) Some candidates deduced the correct molecular formula. Other candidates made simple errors in counting the atoms. $C_2H_3O_3$ was a common incorrect answer. Some candidates did not gain credit because they wrote partial molecular formulae, e.g. CH_2COOH_2.

(c) Very few candidates understood how to extract materials from a plant by grinding/using a mortar and pestle. Only the better-performing candidates suggested adding a solvent to extract the chemicals and very few candidates mentioned filtration. The most frequently seen errors were to suggest direct distillation of the plant material, evaporating the plants or heating the plants.

(d) Some candidates gave a simple definition of the term oxidation by referring to the addition of oxygen. Other candidates gave a definition in terms of electron loss. A significant number of candidates suggested electron gain or made vague statements such as "increases in number".

(e) (i) Most candidates described the trend correctly. However, some incorrect answers either did not refer to the number of carbon atoms or suggested that the density decreases when the number of carbon atoms decreases.

(ii) Most candidates gave a suitable prediction. Those candidates who did not often gave predictions which were in the range of 170–190 °C.

(iii) Many candidates correctly deduced that butanoic acid is a solid at –10 °C but a significant number of candidates suggested that it is a liquid. Many candidates made errors because of the negative temperatures, thinking that –10 °C is higher than –5 °C. Other candidates gave answers which were too vague, e.g. "it only melts at –5 °C".

Question 6

(a) (i) Most candidates chose the correct metal. Fewer candidates gave two reasons for the use of iron; high strength was the most common correct answer. Some candidates just quoted figures or gave an imprecise answer such as "its relative strength" rather than stating that iron is strong. The most common incorrect answers usually referred to density.

(ii) Few candidates gave a suitable reason for the use of **M** in the tips of high-speed drills. The most common incorrect answers referred to high strength or high density. Alloy **J** was often incorrectly chosen.

(iii) Few candidates gave a suitable reason for the use of **K** for aircraft bodies. The most frequently seen incorrect answers referred to strength or density. Alloys **J** or **K** were often incorrectly chosen.

(b) (i) Many candidates drew a suitable line of steeper gradient and ending at the same volume as **W** and **X**. Some candidates did not complete the line, showing it decreasing in gradient but not levelling off. Other candidates drew a line that went well above the 80 cm^3 level and then returned to this level. More candidates drew the line finishing at a volume above 80 cm^3. Fewer candidates drew the line finishing below this value.

(ii) Most candidates identified alloy **Y**. The most common incorrect answer was to choose alloy **W**.

(iii) A majority of the candidates were able to deduce how long it took for alloy **X** to lose 40% of its mass. The most common incorrect answer was 1.1 days.

(iv) Most candidates realised that increasing the temperature would increase the rate of mass loss. Better-performing candidates gave a correct answer for the relationship between increased concentration and the rate of mass loss. The most common errors were either to suggest that there would be a lower mass loss or to refer to time rather than rate.

(c) Many candidates selected the correct pH. The most common error was to suggest pH 3.

Question 7

(a) Some candidates completed the electronic structure of water correctly. Other candidates did not draw the electrons in the overlap area. The most common errors included the addition of extra unpaired electrons on the hydrogen or oxygen atoms, or drawing either one or three bonding electrons in the overlap area.

(b) Few candidates gave two suitable physical properties which help distinguish between covalent and ionic compounds. The most common error was to describe covalent and ionic bonding rather than giving suitable properties. Many candidates wrote about malleability or hardness rather than focusing on melting points, electrical conductivity or solubility.

(c) Only the better-performing candidates gained full credit but many candidates gained partial credit from the inversion of one of the pairs of metals.

(d) (i) Many candidates knew the conditions for rusting. Oxygen or air was more commonly given than water. A significant number of candidates suggested that heat was necessary. Many candidates suggested humid conditions, which was an acceptable answer.

(ii) Some candidates gave one suitable way of preventing rust. Others suggested using an alloy or electrolysis, which were not accepted. Many candidates wrote vague statements about coating with an unreactive substance without mentioning the type of substance involved. Another common error was to write about rust avoidance rather than rust prevention, e.g. “store away from oxygen” or “don’t let water touch it”.

(e) Better-performing candidates could describe in detail how to obtain a pure dry sample of copper(II) sulfate from aqueous copper(II) sulfate. Credit was most frequently awarded for the idea of heating to the crystallisation point. Many candidates however just wrote “evaporate” or gave an incorrect answer such as “evaporate to dryness”. A significant number of candidates suggested freezing or placing in a water bath. A few candidates mentioned how the crystals could be washed or dried.

(f) Many candidates balanced the equation correctly. The most common error was to write the incorrect number of water molecules. Attempts to balance with 2, 6 and 8 water molecules were occasionally seen.

CHEMISTRY (US)

Paper 0439/43
Theory (Extended)

Key Messages

- Candidates should be reminded to read questions carefully to ensure that they answer the question as it has been set.
- Candidates are expected to know that some commonly encountered elements are diatomic (chlorine, bromine, iodine, nitrogen, oxygen and hydrogen being the most commonly encountered).
- Working should be clearly shown. This allows method marks to be awarded in calculations even if the final answer is incorrect.
- If candidates use technical terms, such as filtrate or intermolecular, then they need to ensure that they do not then contradict the term used.
- When calculating the number of moles of a gas, candidates are expected to use the molar volume of gas at r.t.p. (24 dm^3), as stated on page 16 of the Question Paper. Candidates should not be using the ideal gas equation.

General Comments

There were many good answers to the questions set. Some candidates provided answers which were too general.

Comments on Specific Questions

Question 1

(a) All parts of **(a)** were well answered, although **(vi)** proved more challenging than the other parts.

(b) (i) This question was generally well answered, although some candidates mixed up protons and neutrons. Correct statements about electrons were ignored, but some candidates stated that the number of electrons was different. There was some confusion in a few answers between the terms *isomers* and *isotopes*.

(ii) Most candidates could identify the two isotopes.

(iii) While most candidates gave a correct answer, some answers lacked the required information and simply stated that isomers have identical chemical properties because they are the same element.

Question 2

(a) (i) A large number of candidates gave the molecular formula of cyclopropane rather than the empirical formula requested. A few answers included “Br”, suggesting the candidates had not read the question carefully and were giving a formula of the product.

(ii) Although candidates were not expected to have knowledge of cyclopropane, they were expected to use the information provided in the question and their knowledge of the colour of aqueous bromine and the reaction of bromine with alkenes to answer this question. Despite the information in the question, a significant number of candidates insisted that cyclopropane would not react with aqueous bromine and so the colour would not change.

(b) (i) This was generally only answered well by the better-performing candidates. While most candidates were able to draw a suitable line to represent the energy of the products in this exothermic reaction, the labelling of the energy change, ΔH, was often inaccurate. Even those candidates who knew it was the energy difference between the reactants and products often failed to put an arrow pointing in the correct direction on the line.

(ii) While many fully correct answers were seen there were a number of common errors. The most common errors were reversing the subtraction or failing to include one (or more) of the C–C bonds in the calculation. There were also a number of simple arithmetical or transcription errors. Candidates should be encouraged to check their working when they have completed each question. Where a final answer was incorrect, credit was awarded for the method used in the calculation where the working was clearly shown.

(c) The most common error was to compare the strength of the covalent bonds. Of those candidates who referred to intermolecular forces, some then contradicted themselves by saying that the intermolecular forces were between atoms. When explaining why something is bigger or smaller than something else, the language used in the answer needed to be comparative, such as saying “the intermolecular forces are stronger” rather than “the intermolecular forces are strong”.

Question 3

(a) Most candidates gained credit for stating there was a “sea of delocalised electrons”. However, relatively few candidates described the attraction between the electrons and the positive ions or the fact that the positive ions were arranged in a lattice. It was not uncommon for the bonding to be described as “ionic” or “covalent”. Some candidates wrote at length about various properties of magnesium that were not asked for in the question.

(b) While the majority of candidates could relate the electrical conductivity to being due to the electrons, fewer candidates could state that the electrons were mobile and could move throughout the structure. Many candidates limited their answer to the electrons being delocalised which was insufficient, as many organic compounds contain delocalised electrons but are not conductors of electricity. Some candidates seemed confused by the nature of an electric current and described how electrons pass charge from one electron to another and so enable the material to conduct. This was incorrect as the electrons are charged and their movement in a given direction is the electric current. They do not pass charge on.

(c) This was well answered with the majority of candidates referring to layers of suitable particles being able to slide over each other.

(d) (i) The two most common errors were to omit the charges of the two ions formed or not to show the two electrons gained by sulfur as being derived from the magnesium (shown as “×” since the magnesium’s electrons were shown using this symbol in the diagram given).

(ii) Most candidates knew that the magnesium sulfide would have to be molten to conduct electricity but few candidates went on to answer the second part of the question correctly. The most common error was to state that the electrons were able to move.

Question 4

(a) This question proved challenging to many candidates. Common incorrect answers were “petrol” (not the same as petroleum) and “oil” (not the same as “crude oil”).

(b) (i) While most candidates gained some credit, common errors included saying that a hydrocarbon was a mixture or omitting the fact that hydrocarbons contain *only* carbon and hydrogen.

The meaning of “saturated” caused problems for some candidates. A common error was to say that “each carbon has as many bonds as possible” or that “each carbon is bonded to as many hydrogen atoms as possible”. The required definition was that all carbon to carbon bonds are single bonds.

(ii) This question was very well answered.

(iii) While many fully correct answers were seen, it was not uncommon for candidates to mix up physical and chemical properties. It should be noted that members of a homologous series have the same general formula but not the same chemical, molecular or empirical formula.

(iv) Most candidates who identified carbon dioxide and water as the products gained full credit by also correctly balancing the equation. The most common error in balancing was to have 22 as the stoichiometric coefficient for oxygen. Presumably these candidates had not noticed that oxygen was diatomic.

(c) (i) This question was well answered. Most candidates selected acid rain as the environmental problem but many candidates also knew about photochemical smog.

(ii) Most candidates were able to state that incomplete combustion formed carbon monoxide. However, there were a number of answers stating that the nitrogen involved in the formation of oxides of nitrogen came from the fuel rather than from the air.

(iii) Most candidates were aware that carbon monoxide was toxic and some excellent answers based on the formation of carboxyhaemoglobin were seen. However, some candidates incorrectly claimed that carbon monoxide prevented blood flowing or gave unacceptable vague answers such as "causes respiratory problems".

(iv) Some clearly set out and detailed answers were seen, complete with fully correct equations. However, there were many less detailed and less precise answers. It was common in the equation to show nitrogen as monatomic and some candidates suggested that nitrogen reacted with oxygen in the catalytic converter to form oxides of nitrogen.

(d) (i) Most candidates were able to recognise and name butane.

(ii) This definition was not well known. It was common to see incorrect terminology to describe the formula such as "empirical", "chemical" or "general", rather than the correct "molecular formula".

(iii) This was only answered well by the better-performing candidates. Most candidates were able to give the conditions required for the reaction. However "light" on its own was insufficient. The structures of the products were very often incorrect. Incorrect numbers of bonds from each atom were common, as were structures based on **A**, rather than **B**. It was clear that many candidates did not understand the terms "organic" and "not organic" since they drew two organic products. Where an inorganic product was attempted this was often incorrectly shown as a hydrogen molecule.

Question 5

(a) (i) The definition of oxidation in terms of electrons was well known.

(ii) There were relatively few fully correct ionic equations. It was common to see equations with Ni^{2+} on the left, despite the question asking for the oxidation of nickel. In some equations the number of electrons was unbalanced, while in others the electrons were being added rather than taken away. A common error was the use of "N" as the symbol for nickel.

(iii) While the majority of candidates could state that the mass of the nickel electrode would decrease, some candidates gave a reason for their answer, which was not required. A significant number of candidates incorrectly attributed the mass loss to the loss of electrons.

(b) (i) Better-performing candidates gave correct answers with clear explanations relating to the data in the table. The most common error was to identify vanadium as the most reactive based on the fact it produced the most positive potential difference.

(ii) This question was very well answered.

(iii) Most candidates realised that beryllium was more reactive than silver and so predicted a negative voltage. Relatively few candidates could work out the value using the data in the table. The most common prediction was a value between –1.6 V and –0.7 V, presumably because these were the numbers either side of the blank in the table.

(c) This question was very well answered by better-performing candidates. The most common approach was to set up a cell using magnesium as one electrode and beryllium as the other and then to look at the sign of the potential difference.

Question 6

(a) (i) It was not unusual to see oxygen given incorrectly as one of the products of this thermal decomposition.

(ii) While candidates were not expected to recall the actual pH of the solution formed when barium oxide is added to water, they needed to realise that, as this is the oxide of a Group II metal, the solution formed will be alkaline. However, the pH scale in water does not continue to infinity and so answers that were unlimited (such as "greater than 7") did not gain credit.

(iii) While the majority of candidates named oxygen as a product, very few candidates were able to identify nitrogen dioxide as the other gaseous product. Common incorrect products included nitrogen and various ionic compounds of barium.

(b) (i) This question was generally not well answered. Only a minority of responses correctly showed the formula of sodium nitrate.

(ii) This type of practical procedure should be familiar to candidates. However, two common errors were: ignoring the information at the start of the question and treating barium carbonate as soluble, thereby trying to crystallise it from a filtrate; and confusing the terms *residue* and *filtrate* and so trying to wash and dry the filtrate, which would not work.

(c) (i) If a candidate calculated the relative formula mass (M_r) of barium carbonate incorrectly, then the error they had made was carried forward and credit could still be awarded for the use of this incorrect M_r in calculating the number of moles subsequently. However, this could only be done if the candidates' working could be followed. The use of words to support the steps taken in calculations is strongly recommended. This could be as little as "The M_r $BaCO_3$ = …".

(ii) Most of the better-performing candidates used the ratio in the equation correctly and so could correctly give the number of moles of carbon dioxide.

(iii) This question was well answered by the better-performing candidates.

(iv) Most candidates who made progress with the calculation did not use the 1:2 ratio in the equation and so simply subtracted the moles of barium carbonate in **(i)** from the moles of hydrochloric acid used and so got the answer 0.20, rather than 0.15.

CHEMISTRY (US)

Paper 0439/53
Practical Test

Key messages

- Candidates should be reminded that when there is an instruction to label graph lines, all lines should be labelled and not just one of them.
- Graph lines will normally be either straight lines or curves with either an increasing or decreasing gradient or curves that level off. "Best fit" lines are not wavelike curves that both increase and decrease in gradient depending on where the next datum point is.
- Candidates should be reminded that precipitates are specifically solids that have been formed in the reaction between two solutions. It is incorrect to describe a substance as a precipitate just because it is a solid.
- Where a test in is two (or more) parts, it is best to give observations after each part, rather than just an observation pertaining to the final product.
- Centres should ensure that they use starch solution that gives an obvious blue-black colour when added to a solution containing iodine.

General comments

There were some very strong answers to questions and candidates appeared to be well prepared for the planning question, **Question 3** which was generally well answered.

Parallax errors in reading the scale from apparatus means that the user is not using the apparatus correctly; it is not a fault or problem with the apparatus. Parallax errors are not regarded as a source of error in chemistry experiments.

Comments on specific questions

Question 1

(a) Almost all candidates correctly completed the gas volumes in the table with the gas volume increasing as time increased. A small minority of candidates had an incorrect non-zero value at zero seconds and so could not gain full credit. Many candidates reported gas volumes of equal to or greater than 100 cm^3 before the 180 seconds had elapsed. This was perfectly acceptable and full credit could still be awarded.

(b) As in **(a)**, this question was very often fully correct, although again a small minority of candidates had an incorrect non-zero value at zero seconds. Almost all candidates reported the expected slower increase in gas volume than in the first experiment.

(c) The accuracy of plotting of the points was generally good with relatively few errors made. However, the smooth lines were, on the whole, very poorly drawn.

(d) All most all candidates could identify Experiment 1 as having the faster rate. However, while most candidates could suggest a reason why this was the case, some candidates did not read the question with enough care and did not explain how they knew that the selected experiment had the faster rate.

(e) A common error was to read the volume of gas incorrectly from the graph. The calculation was normally completed correctly and, in many instances, correct units were seen.

(f) Some candidates either did not read the introduction to **Question 1** with sufficient care, or they had forgotten the information they were given. Despite being told that the acid was in excess in both experiments, many candidates suggested that the acid had all been used up.

(g) The majority of candidates realised that the reaction would be faster with magnesium powder and could give a correct explanation for this. However, some candidates suggested that the magnesium powder would have a smaller surface area.

(h) A number of candidates thought that an advantage of a measuring cylinder was its high degree of accuracy. Candidates should be aware of the use of volumetric pipettes and burettes for the accurate measurement of volumes of solutions.

(i) The most commonly suggested improvement was to repeat the experiment and take averages.

Question 2

(a) The most common error here was to describe solid **J** as a liquid, solution or precipitate. Solids should not be described as precipitates unless they have been formed in a reaction between two solutions.

(b) (i) While many candidates reported the expected result of the litmus paper being bleached, some candidates seemed to stop testing the gas as soon as the litmus became red, and so missed the required observation. A few candidates reported that the litmus became blue which was an unexpected result given the reagents used.

(ii) While the correct colour of product was often seen, the term *precipitate* was less common. The product was often described as being cloudy. If two solutions are combined and the resulting mixture is not clear, then it is probable that a precipitate has been formed.

In some cases “no change” was recorded. This suggests that insufficient sodium hydroxide had been added to neutralise the remaining hydrochloric acid and that the candidates had not followed the instruction to add an excess of aqueous sodium hydroxide

(c) Despite the fact that the *Tests for gases* on page 8 of the Question Paper lists only two gases that are tested for using damp litmus paper (chlorine and ammonia) and that damp litmus paper was the only test carried out on the gas produced, answers such as carbon dioxide, oxygen or hydrogen were seen. These gases could not have been identified given the test carried out.

(d) There were two parts to this test. The first part involved the addition of iron(II) sulfate to solution **K** and the second part involved the addition of sodium hydroxide to the resulting mixture. Candidates who gave observations after each part usually gave clearer and more accurate answers than candidates who just gave a final observation.

(e) As in **(d)**, there were two parts to this test. Many candidates just gave a final observation after the addition of the starch and did not record any observation after the addition of the aqueous potassium iodide. Most candidates who gave two observations scored full credit.

(f) Some candidates reported the solution becoming pink or purple. This is probably due to a failure to follow the instruction to add a few drops of potassium manganate(VII) solution.

(g) The *Tests for gases* on page 8 of the Question Paper lists only two gas tests involving a splint. Hydrogen is tested for using a lighted splint and oxygen requires the use of a glowing splint. However, it was not uncommon to see answers referring to “a lighted splint relights”. If the splint is already alight then it cannot relight. Some candidates reported the gas as “popping” with a lighted splint which is an unexpected result, given the reagents used.

(h) Many candidates correctly identified the gas as oxygen, although carbon dioxide was frequently also seen, despite this gas not having been tested for.

Question 3

This question produced some excellent answers as well as some rather inventive ones. Some candidates who performed less well opted for fractional distillation, which is not appropriate in a laboratory given the high boiling points of ionic compounds and metals. A common omission was not stating that the cassiterite (which was provided as a large lump) would need breaking down using a pestle and mortar before use.

Better-performing candidates made good use of the information provided on the reactivity of tin and used a displacement reaction to obtain a sample of tin.

For the final part of the answer, candidates were expected to explain how they would use the results obtained to calculate the required percentage of tin. While many candidates did this, some just stated "calculate the percentage of tin" which could not be credited.