CHEMISTRY

Paper 0620/11
Multiple Choice

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

Candidates performed well on this paper. Questions **1**, **3**, **8**, **10**, **12**, **14**, **15**, **16**, **21**, **27** and **28** proved to be the most straightforward, with a high proportion of candidates selecting the correct response.

Questions **13**, **17**, **25**, **26**, **30**, **34** and **38** were the most difficult for candidates.

The following responses were common incorrect responses to the questions listed:

Question 13

Response **A**. Candidates knew the colour change but did not account for the information regarding the temperature change.

Question 17

Response **C**. Candidates did not appreciate that it is necessary to filter out the excess oxide before proceeding to crystallisation.

Question 25

Response **C**. Candidates did not realise that lime is added in the manufacture of steel to remove acidic impurities.

Question 26

Response **A**. This question posed difficulties for some candidates, possibly because metal Y was not directly referred to in the numbered list. Response **A** was commonly chosen because the positions of X and Z were clear. It is necessary to use all of the information given to work out the correct relative reactivity of Y. More than half of candidates managed to do this successfully.

Question 30

Response **B**. Candidates did not realise that nitrogen has a monoxide, NO. They should also have noted that CO_2 exists.

Question 34

Response **A**. Candidates realised that limestone is calcium carbonate but were not familiar with what happens when it is heated in a lime kiln.

Question 38

Response **A**. Candidates did not realise that the –COOH group of a carboxylic acid contains an –OH group.

CHEMISTRY

Paper 0620/12
Multiple Choice

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

Candidates performed well on this paper. Questions **3**, **5**, **8**, **15**, **19**, **26**, **27**, **28** and **35** proved to be the most straightforward, with a high proportion of candidates selecting the correct response.

Questions **12**, **13**, **17**, **24**, **25**, **30**, **38** were the most difficult for candidates.

The following were common incorrect responses to the questions listed:

Question 12

Response **C**. Candidates were not clear of the meaning of the term oxidation and chose a response in which the underlined compound was already in an oxidised state.

Question 13

Response **A**. Candidates knew the colour change but did not account for the information regarding the temperature change.

Question 17

Response **C**. Candidates did not realise that copper does not react with dilute acids.

Question 24

Response **D**. Candidates were not familiar with the uses of mild and stainless steel stated in the syllabus.

Question 25

Response **C**. Candidates did not realise that lime is added in the manufacture of steel to remove acidic impurities.

Question 30

Response **D**. Candidates realised that carbon monoxide is toxic but thought that it is acidic like carbon dioxide.

Question 38

Response **C**. Candidates did not realise that ethanoic acid, like most acids, is soluble in water.

CHEMISTRY

Paper 0620/13
Multiple Choice

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

Candidates performed quite well on this paper. Questions **1**, **14**, **19**, **27** and **31** proved to be the most straightforward.

Questions **4**, **13**, **17**, **21**, **25**, **28**, **37**, **38** and **40** were the most difficult for candidates.

The following were common incorrect responses to the questions listed:

Question 4

Response **C**. Candidates assumed that the question was about isotopes although it was stated that the atoms in question had *different* chemical properties.

Question 13

Response **A**. Candidates knew the colour change but did not account for the information regarding the temperature change.

Question 17

Responses **A**, **C** and **D**. All responses had a significant number of candidates opting for them, indicating that the topic was generally not well understood.

Question 21

Response **A**. Candidates found this question difficult as there was more than one piece of information to take into account. Candidates choosing response **A** identified a Group I metal but did not take into account the displacement reaction.

Question 25

Response **C**. Candidates did not realise that lime is added in the manufacture of steel to remove acidic impurities.

Question 28

Response **D**. Candidates chose two processes which use oxygen without taking into account whether or not they are useful. They also did not realise that oxygen is used in steel manufacture.

Question 37

Response **C**. Candidates chose an answer which did apply to all of the compounds but did not sufficiently explain their chemical similarity.

Question 38

Response **B**. Candidates thought that the C=O double bond decolourises bromine water in the same way as the C=C double bond in alkenes.

Question 40

Response **B**. Candidates did not realise that the reaction of ethene with steam is an addition reaction.

CHEMISTRY

Paper 0620/21

Core Theory

Key Messages

- It is important that candidates read questions carefully in order to understand what is exactly being asked.
- Many candidates would benefit from more practice in answering questions about the properties of Group I elements and the conversion of iron into steel.
- Greater exactitude is required in explaining and using particular chemical terms, such as isotopes and electrolysis.
- Interpretation of data from tables and completing balanced equations were generally done well.

General Comments

Many candidates showed a good knowledge of core Chemistry. Nearly all candidates were entered at the appropriate level. The standard of English was generally good. Some of the questions were left unanswered by a minority of candidates. This was especially apparent in **Questions 2(d)** (purification of ethanol), **5(b)(i)** (calculation of relative molecular mass) and **6(a)(iv)** (conversion of iron into steel).

Some questions were misread or the rubric was misinterpreted by a minority of candidates. For example, in **Question 2(d)** some candidates wrote about chromatography, in **4(c)(i)** most gave the electronic structure of a hydrogen atom rather than a hydrogen molecule, whilst in **6(b)** some did not state the differences of the reactions of lithium and potassium with water.

Many candidates were unable to distinguish between atoms, molecules and ions and between compounds and elements. Chemical definitions such as those for isotopes and electrolysis were recalled by few candidates.

Some candidates would benefit from more practice in recalling simple chemical tests e.g. bromine water test for unsaturation and limewater test for carbon dioxide.

Many candidates were able to calculate relative atomic masses and identify functional groups.

Questions involving general chemistry including electrolysis and rates of reaction were well tackled by many candidates.

Comments on specific questions

Question 1

Most candidates identified at least three of the structures correctly in part **(a)**. Fewer completed the equation correctly in part **(b)** or knew the limewater test for carbon dioxide in part **(c)**.

(a) In part **(i)** many candidates correctly identified **D** as being an element. The commonest error was to suggest **C** (ethane). In part **(ii)** many could not distinguish a saturated from an unsaturated hydrocarbon; the commonest incorrect answer being **E** (ethene). In part **(iv)**, many candidates chose the ionic giant structures rather than the covalent structure, **D**. In part **(vi)** some candidates did not check the atomic masses of Ca and Zn and hence chose the incorrect giant structures. Others appeared not to understand the word ‘ion’ and chose covalent structures. There were no consistently common errors in parts **(iii)** and **(v)**.

(b) Many candidates recognised **B** as being calcium carbonate. Fewer identified the product of the thermal decomposition. The commonest errors were to suggest compounds containing atoms which were not on the left hand side of the equation e.g. hydrogen, water, compounds of metals other than calcium. Oxygen or carbon monoxide were other common errors.

(c) Some candidates knew the test for carbon dioxide. Others incorrectly suggested testing with litmus or sodium hydroxide.

Question 2

Nearly all candidates recognised the exothermic reaction in part **(a)** and a considerable number could construct the word equation and select the conditions for the synthesis of ethanol by hydration of ethene. Few could complete the structure of ethanol in part **(b)** or suggest how ethanol can be purified from a fermentation mixture in part **(c)**.

(a) Nearly all the candidates recognised the temperature rise indicates an exothermic reaction. The commonest error was to refer to the bubbles.

(b) A minority of candidates completed the structure of ethanol correctly. The commonest errors were: drawing the structure of methanol; drawing the structure of ethane; omitting hydrogen atoms or joining the H to the carbon e.g. C – H – O.

(c)(i) Many candidates wrote the correct word equation for the synthesis of ethanol. The most common errors were: writing the steam/ water over the arrow or giving extra products e.g. oxygen or hydrogen. A few wrote ethane instead of ethene.

(ii) Many candidates selected the correct conditions for the hydration of ethene. The commonest errors were to suggest presence of light or enzyme catalyst.

(iii) Few candidates knew the test for an unsaturated compound using bromine water. Many gave the answer that 'the bromine water stays orange/ brown'. Others suggested that there would be a precipitate or gave colours such as blue or green.

(d) A minority of the candidates suggested filtering the mixture first. Most realised that distillation was required although most stated 'simple distillation' rather than the correct 'fractional distillation'. A number of candidates did not respond to this question.

Question 3

A majority of the candidates were able to identify the cathode from a diagram and complete the word equation for the electrolysis of sodium bromide. Few could explain the meaning of the terms *electrolysis* or *isotopes*. Some were able to interpret the diagram in part **(d)** correctly. Others gave answers which were vague or contradictory.

(a)(i) Few candidates gave a correct definition of electrolysis. Some did not mention an electric current or include the important words 'breakdown' or 'decomposition' in their answers. A common error was to suggest that electrolysis is a way of separating elements or compounds. A minority of candidates incorrectly suggested 'the breakdown of elements'.

(ii) Many candidates identified the cathode correctly. The commonest error was to suggest **S**.

(b) Most candidates were able to deduce at least one of the electrolysis products. The commonest error was to suggest 'bromide' instead of bromine. A considerable minority suggested elements other than those present in sodium bromide e.g. zinc.

(c) Nearly all candidates recognised that a neutral solution has a pH value of 7. The commonest error was to suggest pH 0.

(d)(i) Few candidates recognised that the charged particles in sodium bromide were ions. Many suggested 'atoms'.

(ii) Many candidates recognised that the diagram represented a solid but very few gave two reasons. The commonest error was to write about how the particles moved. Most responses included the idea of the particles being close together or touching. Others gave vague statements such as 'they are closer together than in a liquid'. Only a minority of candidates recognised that the ions were regularly arranged.

(e) Many candidates balanced the equation successfully. The commonest error was to put Br or 2Br instead of Br_2.

(f) Few candidates gave a good definition of the term 'isotope'. The most common errors were to write about substances or molecules rather than atoms or elements. Many wrote vague statements such as 'they have different numbers of neutrons'.

Question 4

This question was generally well answered. The extraction of information from the graph and the construction of a line to show how the volume of gas changed at a lower temperature in part **(b)** was not always well done. Few candidates were able to draw the electronic arrangement in a hydrogen molecule in part **(c)(i)** and even fewer could give the names of two compounds which react together to form magnesium sulfate in part **(d)**. Nearly all recognised that powdered magnesium reacts faster than magnesium ribbon with hydrochloric acid.

(a) Many candidates recognised that the evolution of a gas was responsible for the mass loss in the reaction between magnesium and hydrochloric acid. The commonest errors were: suggesting that the hydrochloric acid evaporated; suggesting that the products were 'lighter' than the reactants or that the cotton wool was somehow involved in the reaction. Some candidates compromised their answers by writing that the 'gas is absorbed by the cotton wool'.

(b)(i) Many candidates misread the graph and gave a time of 40 seconds.

(ii) Some candidates read the time from the graph accurately. Others assumed that the line went through the 40 cm^3 rather than 41 cm^3. A considerable number did not respond to the question.

(iii) Many candidates realised that they had to draw a line with a lower initial gradient. Fewer recognised that the line should reach the same final volume. A considerable minority did not start their curve at the origin.

(iv) Nearly all candidates realised that the reaction with magnesium powder would be faster than that with magnesium ribbon. Some tried to write explanations but this was not necessary.

(c)(i) Most candidates drew a diagram of a hydrogen atom rather than a hydrogen molecule, sometimes without an electron.

(ii) Many recognised that the bonding in a hydrogen molecule is covalent. The commonest errors were to suggest ionic or to write answers which were not related to bonding.

(d) A majority of the candidates did not acknowledge the word 'compound' in the stem of the question and suggested adding magnesium to sulfur. Only a few suggested suitable magnesium compounds, magnesium salts being the commonest suggestions. A greater number of candidates suggested correctly, that the acid should be 'sulfuric acid'. Some incorrectly suggested 'hydrochloric acid'.

Question 5

Some parts of this question were reasonably well done especially most of part **(b)**. Part **(d)** was considered by most candidates to be a question about chromatography rather than about the extraction of colour from grape skins. Many did not recognise the carboxylic acid group in part **(a)**.

(a) A minority of candidates recognised the carboxylic acid group. Common errors included: ringing the carbonyl group or the alcohol group. Others ringed several parts of the structure.

(b)(i) A considerable number of candidates did not respond to this question. Those who did often calculated the relative molecular mass correctly. The commonest errors were the use of atomic masses or not including both hydrogen atoms in the calculation.

(ii) Nearly all the candidates could describe the function of a catalyst.

(iii) The effect of carbon monoxide on human health was well recognised. The commonest errors were to suggest that it caused lung diseases or cancer. Many candidates wrote answers relating to haemoglobin which were acceptable.

(c)(i) Candidates who performed less well gave responses that were too vague or confusing e.g. 'it reduces the oxygen'. A considerable minority wrote about atoms being taken away.

(ii) Some candidates chose carbon as the correct reducing agent. The commonest error was to suggest copper and a few candidates suggested carbon dioxide.

(d) Most candidates misunderstood the question and described the process of chromatography rather than the extraction of pigments. Many gave a method of crushing the grapes but fewer mentioned the addition of a liquid. Common errors included 'squeezing the grapes to get the juice' or 'putting the grape skins on chromatography paper'. A considerable number of candidates did not respond to this question.

(e) Many candidates gave the correct monomer. The common errors were to suggest the catalyst or 'poly(ethene)'.

(f)(i) Most candidates realised that a high temperature is needed for cracking. Only a minortiy went on to mention use of a catalyst.

(ii) The equation for the cracking of hexadecane was generally completed well. There were no consistent errors.

Question 6

This was the least well answered question on the paper. Part **(a)(iii)** (the conversion of iron into steel) and part **(b)** (comparison of lithium and potassium with water) were not always well answered. Most other parts were well done.

(a)(i) Many candidates were able to extract relevant information from the table. The most common error was to confuse the properties of the Group I elements with those of other metals. Some thought that Group I metals were transition elements.

(ii) The properties of transition elements were not very well known. Some candidates described the general properties of metals rather than those of the transition elements.

(iii) The most common error was to give '$2H_2$'.

(iv) This was the least well answered question on the paper. Many candidates confused steelmaking with the extraction of iron in the blast furnace. Most realised that oxygen was involved and a few mentioned the addition of calcium oxide or adding other metals to make the steel. A few of the better performing candidates mentioned oxidation of impurities but few mentioned the nature of the impurities in the iron.

(b) Some candidates wrote statements such as 'potassium produces bubbles' rather than 'potassium produces more bubbles'. Few candidates knew both products of the reaction. 'Hydrogen' was frequently suggested but 'potassium oxide' or 'lithium oxide' were common incorrect answers.

Question 7

This was the highest scoring question on the paper for many candidates. Parts **(a)** and **(b)(iii)** were the least well done. Many could extract information for the table in part **(b)(i)** and deduce the numbers of electrons, protons and neutrons from given information in part **(c)**.

(a) Better preforming candidates gave a good description of the compressibility and an explanation in terms of the proximity of the particles. Others either did not mention the change in volume of the syringes or write vague statements about the proximity of the particles in water e.g. 'they are further apart in gases than in water' or 'the particles in water are not very far apart'.

(b)(i) A majority of the candidates correctly identified the trend in density.

(ii) A majority of the candidates were able to deduce the electron arrangement of neon. The commonest error was to suggest 2,8,8.

(iii) Many candidates suggested, incorrectly, that argon is a solid at -188^{o}C. A minority suggested that it is a gas at this temperature.

(iv) The correct gas (krypton) was chosen by many candidates. Others generally chose helium. Very few chose other gases.

(b) Most candidates identified the number of neutrons in helium and the number of electrons in argon from the data given in the table. The commonest error was to suggest that neon has a mass number of 20.

CHEMISTRY

Paper 0620/22

Core Theory

Key Messages

- Questions requiring simple answers to structure and bonding were usually answered well, as were questions involving balancing equations and reaction rates.
- Questions on more detailed aspects of practical procedures (e.g. crystallisation) need to contain a more focused explanation and attention to detail.
- Some candidates need more practice on answering questions requiring extended answers e.g. **Question 6(f)**. Questions involving extended writing need to contain the same number of relevant points as the number of marks available.
- It is very important that candidates read the question carefully in order to understand what exactly is being asked.
- Candidates would benefit from further practice of reading graphical scales.
- Candidates need more practice answering questions on organic chemistry (e.g. polymers) and practical techniques, especially crystallisation and chromatography.
- More specific revision of the chemical tests mentioned in the syllabus would also be useful to many candidates.
- Comparison questions were much better.

General Comments

Many candidates showed a very good knowledge of Core Chemistry. Good responses were shown throughout the paper. Nearly all candidates were entered at the appropriate level. The general standard of answering was comparable with previous years.

Some candidates misinterpreted the rubric or misread the questions. A typical example is in **Question 2(b)**, where the question asked for the candidates to 'Describe how you could prepare pure dry crystals of sodium citrate from citric acid and sodium hydroxide', with many candidates talking about 'adding sodium hydroxide to sodium citrate'. In **Question 2(a)**e candidates wrote 'heat is taken in', rather than looking at the evidence from the experiment. In **Question 1(a)(i)**, many candidates did not use the Periodic Table provided to check which element was a noble gas. In **Question 1(a)(v)**, many candidates did not identify ions to show that a compound is ionic. The completion of word equations was much better this year, with **Question 5(c)** being completed reasonably well. Balancing and completing formula equations was also much better.

Quite a few candidates did not know the meaning of the organic term 'unsaturated' in **Question 5(b)(i)** and did not know the 'test for an unsaturated compound' in **Question 5(b)(ii)**. Some candidates were able to 'calculate the relative molecular mass of bromine trifluoride' in **Question 7(d)** Quite a few candidates used atomic numbers, instead of mass numbers in this question. Most candidates could label the apparatus in **Question 4(a)**. Some candidates in **Question 4(b)(i)**, found it difficult to interpret the graph. Where there are two marks it is very likely that two separate points are needed. Candidates also need to be more conscientious when reading data from graphs, as in **Question 4(b)(ii)** and **(iii)**. Many candidates were imprecise on both these questions. Drawing chemical structures such as ethanol in **Question 2(d)** was better this year. Some candidates were unable to identify a 'carboxylic acid functional group' in **Question 5(a)**. Candidates knew the pH scale in **Question 3(b)**. The general equation in **Question 3(c)(i)** was often only partially correct. Most candidates were able to get the 'water' part of the answer. Candidates found **Question 3(c)(ii)** and **(iii)** challenging, suggesting that they need to practice questions that require discussion rather than recall. The standard of answering 'kinetic particle theory' questions as in **Questions 3(d)** and **7(a)** was better than in previous years.

Candidates performed reasonably well on **Question 4(d)**. Candidates found **Question 5(d)** to be the most challenging question on the paper. Although many used the words needed, they were often muddled leading to an incorrect answer. A similar question was **Question 6(f)**, although candidates seemed to have a stronger understanding of 'alloys' than 'polymers'. **Question 5(e)(i)** was poorly answered. Candidates were often unable to describe how 'pigments from balsam flowers' could be obtained and many irrelevantly described how 'chromatography' was carried out. Candidates' knowledge of metals was much better and many were able to extract data from the table presented as in **Question 6(a)**. In **Question 6(b)(i)** and **(ii)**, better performing candidates avoided using the words 'it' and 'they' to answer questions, especially when there is more than one substance mentioned in the question. These better performing candidates named the element or substance that they were describing. Many candidates found determining the 'state of fluorine' in **Question 7(b)(i)** to be difficult. More practice on these types of questions would be beneficial. Candidates found the reactivity of the halogens challenging in **Question 7(c)(i)** and **(ii)**.

The standard of English was reasonably good. Some candidates wrote their answers as short phases or bullet points. Candidates are less likely to write vague statements or contradict themselves if this is done. In **Question 6(f)** candidates answered well, using the correct chemical terms. For one of the other longer questions, **Question 2(b)**, candidates struggled to 'describe how to prepare pure dry crystals of sodium citrate'. The writing and balancing of chemical equations was excellent, as in **Question 1(b)** and **3(a)(i)**.

Candidates were often unable to give 'an example of the use of an alloy of iron' as in **Question 6(f)**. It is most important that candidates know at least one use of all compounds.

Candidates would benefit from using past papers to reinforce their revision.

Comments on specific questions

Question 1

Candidates tackled this question reasonably well. They found part **(a)** the most challenging. Parts **(b)** and **(c)** were very well done.

(a) This question was well answered. Candidates need to make better use of the Periodic Table provided. Some candidates did not realise that Xenon was a noble gas in part **(i)** and some struggled with the compound that is used to neutralise acidic soil. Most recognised that carbon dioxide is a greenhouse gas but many could not recognise the ionic compounds.

(b) This part was answered really well. The most common mistake was using the formula of hydrogen instead of water.

(c) This part was answered really well. Candidates should be encouraged to re-read the sentence or paragraph again after fitting in the words to check that the sentence makes sense.

Question 2

Parts of this question were attempted to a high standard; however the responses to part **(b)** were less well answered.

(a) Most candidates gave the correct answer for this part. Some candidates did not use the diagrams and preferred to say the 'energy was taken in'. Candidates were explicitly asked to use the experiment shown and not just the definition.

(b) This part showed that many candidates did not know how to make pure dry crystals. Few candidates started by adding one substance to another from a burette and using an indicator. Most chose to start from 'heating the substances together'. This led to many candidates describing evaporating all the water away, which would leaving a powder rather than crystals.

(c) Most candidates knew something about fermentation. There were a few candidates who did not appreciate that yeast will be denatured at higher temperatures.

(d) There were some candidates who drew 'methanol' and 'propanol' instead of 'ethanol' and some missed out hydrogens and bonds completely.

(e) Most candidates identified at least one of the two answers for this part.

Question 3

This question was answered reasonably well in parts **(a)** and **(b)**. In part **(c)(i)** many candidates missed that it was a 'salt' that was formed. In part **(d)** candidates often did not identify the correct state of matter.

(a)(i) This part was answered very well.

(ii) This was well answered for most candidates. The common error was to suggest 'neutralisation'.

(b) This part was very well done. The candidates knew the pH scale.

(c)(i) Few candidates did well with this part. Most mentionedr 'water' but few identified the second word 'salt' and chose a chemical substance instead.

(ii) Not many correct answers were seen here. Some candidates misinterpreted the question and many talked about 'yeast' instead of baking powder.

(iii) The majority of candidates did not realise that if the sodium hydrogen carbonate was impure it could cause us harm.

(d) Some candidates knew that carbon dioxide is a gas under normal conditions and gave this as their answer. Many candidates did not read the question properly and so did not use the 'kinetic particle theory' as required.

Question 4

This question was answered successfully in most cases. Part **(a)** was very well answered and showed that candidates knew their apparatus. Most candidates could interpret the graph in part **(b)(i)**. Many candidates did not read the graph in part **(ii)** or were not precise enough. Many candidates could draw the correct line on the graph for a higher temperature in part **(b)(iv)**. The electrolysis in part **(d)** was answered well and showed the candidates were comfortable with this part of the syllabus.

(a) The vast majority of candidates answered this part correctly.

(b)(i) Some candidates did not realise that they needed to talk about the 'volume of gas remaining constant' as well.

(ii) Most answers to this part were not specific enough. The most common incorrect answer was '5 minutes'.

(iii) This part was answered very well.

(iv) Most candidates answered this part well and could draw the correct line on to the graph for a higher temperature. A few candidates drew the line above or below this.

(c) Many candidiates were unable to decide whether 'larger pieces of zinc' would have a 'higher' or 'lower' surface area.

(d)(i) Some answers for this showed that candidates understood 'electrolysis' and especially the electrolysis of 'molten ionic compounds'. Some candidates dot the answers the wrong way round and others gave 'chloride' rather than 'chlorine'.

(ii) This was a very poorly answered question, with many candidates forgetting that graphite is used because it is 'inert'.

Question 5

Candidates found some of the parts in this question the most challenging, particularly parts **(b)(i), (ii)** and especially **(d) and (e)(i)**. Many candidates could not draw 'a ring around the carboxylic acid functional group' and so did not attempt it at all in part **(a).** Many also suggested that Na_2CO_3 was sodium carbon oxide in part **(c)**. The longer answers of parts **(d)** and **(e)(i)** were found to be very challenging.

(a) Many candidates struggled with this answer and could not identify the 'carboxylic acid functional group' and so did not attempt to answer the question at all. Some candidates thought that it also had a 'carbon-carbon double bond' in its structure.

(b)(i) Candidates misunderstood the term 'unsaturated' and so not many correct answers were seen here. A few candidates described 'unsaturated' in terms of solutes and solutions which was not appropriate in this question.

(ii) Generally chemical tests were not well recalled. Few candidates knew that 'bromine water' was the correct reagent and that it went 'colourless'. Some thought that it became 'orange'.

(c) Most candidates gave 'water' but did not give 'sodium carbonate' for a completely correct answer. The incorrect answer 'sodium carbon oxide' was common.

(d) Many candidates struggled to use the words in the correct context. Many thought that 'ethene joined with a monomer' instead of it being the monomer and few used 'polymerisation' in the correct context.

(e)(i) This was a very challenging question for most candidates. Many candidates did not read the question correctly and talked about chromatography instead of obtaining 'a solution of this mixture of pigments from balsam flowers'. Some candidates incorrectly suggested 'distillation'.

(ii) Candidates were able to read the chromatogram successfully in this question. Some thought one pigment was present instead of two.

Question 6

Candidates did well on this question, particularly on parts **(a)**, **(b)(ii)** and **(e)(i)**. They did well on questions where they were using information from the table. Candidates were often unable to recall properties of transition metal compounds in part **(c)** and the chemical test in part **(e)(ii)**. Most candidates knew some information about alloys for the longer part **(f)**.

(a) This question was answered very well. If it is stated as 'very good' in the table, it is best to use these words in the answer and not just 'good'.

(b)(i) Lots of candidates talked about 'it' or 'they' and did not name 'aluminium' or 'steel' which led to confused responses.

(ii) This part was very well answered. Most candidates could interpret the information in the table and gave correct answers.

(c) Candidates did not recall the properties of transition metals and many talked about density and conductivity of the compounds instead of comparing the colours of them.

(d) Most could get 'silver' and 'lithium' as the 'least' and 'most' reactive respectively but got 'aluminium' and 'magnesium' confused.

(e)(i) This was probably the best answered question on the paper. Most candidates gave 'reversible' as the correct answer here.

(ii) The chemical tests were poorly recalled and the 'test for hydrogen' was no exception. Some candidates thought that a 'glowing splint' went 'pop' and many did not know or attempt the question.

(f) Many candidates knew what an alloy was. Some incorrectly said that 'metals bonded' or 'joined' together. 'Why alloys are used instead of pure iron' was answered very well and many candidates were able to state one 'use of an alloy of iron'.

Question 7

In part **(b)(i)** candidates were often unable to give the correct state. Parts **(b)(ii) and (iv)** were not well answered. There were many good answers for part **(a)** and most were able to quote 'the density of bromine' successfully in part **(b)(iii)**..

(a) This question was successfully attempted. Some candidates did not mention 'particles'.

(b)(i) Many candidates could not deduce that the state would be a 'liquid'.

(ii) Quite a few candidates correctly stated 'increases down the group' here. There were some answers that described density and numbers of electrons so did not answer this specific question.

(iii) This question was well answered and most candidates wrote down a correct figure for the density of bromine that was inside the range needed.

(iv) Most candidates wrote down the electronic configuration of chlorine which does not answer the question.

(c)(i) Most candidates remembered that iodine is diatomic. '2I' was still seen as a common error.

(ii) Many candidates incorrectly talked about the reactivity of potassium instead of bromine.

(d) There were quite a few candidates that did not attempt this part and some candidates used atomic numbers instead of mass numbers.

CHEMISTRY

Paper 0620/23

Core Theory

Key Messages

- It is important that candidates read questions carefully in order to understand what is exactly being asked.
- Many candidates need more practice in answering questions about the reactions of the halogens with halide ions.
- More practice is needed in drawing diagrams of apparatus involved in practical procedures and in answering questions about qualitative tests for particular compounds.
- Interpretation of data from tables and answering simple questions about structure, electron arrangement and diffusion were generally done well.

General Comments

Many candidates tackled this paper well, showing a good knowledge of Core Chemistry. Nearly all candidates were entered at the appropriate level. The standard of English was generally good. Some of the questions were left unanswered by a minority of candidates. This was especially apparent in **Questions 2(a)(ii)** (formula of ethanoic acid), **5(c)(ii)** (use of the naphtha fraction) and **5(d)(i)** (source of methane).

Some candidates need more practice in reading and interpreting questions. For example in **Question 4(c)(i)** many candidates selected zinc rather than a zinc compound, whilst in **6(b)** some wrote about the reaction of chlorine with potassium bromide and potassium iodide.

Many candidates were unable to distinguish between atoms, molecules and ions and between compounds and elements. Chemical definitions such as those for isotopes and electrolysis were recalled by few candidates.

Some candidates need more practice in recalling the results of simple chemical tests e.g. the test for water using anhydrous copper sulfate and the tests for halide ions and nitrates.

Some candidates need more practice in drawing the apparatus used for filtration (**Question 3(c)**) and in interpreting the results of practical procedures (**Question 4(a)**)

Many candidates were able to extract information from tables and complete word equations. Some were able to draw the arrangement of electrons in a molecule of chlorine, identify functional groups and complete the structure of ethanoic acid.

Questions involving general chemistry including rates of reaction and the particulate nature of matter were well tackled by many candidates.

Comments on specific questions

Question 1

Most candidates identified at least three of the structures correctly in part **(a)**. Fewer could give the correct name of compound B in part **(b)(i)**.

(a) In part **(i)** many candidates identified **C** as being an element. In part **(ii)** most candidates recognised **A** as being a substance that turns red litmus blue. The most common incorrect answer was **B** (sodium nitrate). In part **(iii)** the most common incorrect answer was **A** (ammonia) or **E**

(sodium chloride). In part **(iv)**, many candidates chose **D** rather than **E**. A variety of answers were seen in response to part **(v)**, where many candidates chose one of the other ionic structures or **A**.

(b)(i) Some candidates gave the correct name for **B** (sodium nitrate). Others tried to create names such as 'sodium nitroxide' or 'sodium nitric acid'.

(ii) Common errors included, 'liquid' in the first answer space and 'atoms' in the last answer space. There were no consistent errors for the other spaces.

Question 2

Nearly all candidates recognised the exothermic reaction in part **(a)** and a considerable number could recognise the characteristic properties of a homologous series in part **(b)**. A minority of the candidates were successful in completing the structure of ethanoic acid in part **(a)(ii)**. In part **(c)** some candidates appeared to misunderstand the word 'observations'.

(a)(i) Most candidates recognised the temperature rise as indicating an exothermic reaction. A few candidates incorrectly referred to the bubbles.

(ii) Few candidates were successful in completing the structure of ethanoic acid. The most common errors were: omission of one of the oxygen atoms; five bonds to the carboxyl carbon atom; double bonds between oxygen and hydrogen atoms and structures with too many hydrogen atoms. A significant number of candidates did not respond to this question.

(iii) Some candidates gave vague answers for this part, which did not explain the crystallisation process well enough. Many candidates just suggested heating the crystals to dryness. Few mentioned drying the crystals with filter paper.

(b) Most candidates were able to describe the characteristics of a homologous series. The most common error was to suggest that they have the same physical properties.

(c) Many candidates were able to suggest at least one observation when ethanoic acid is added to magnesium. Others did not give observations but wrote about 'gas given off', 'a magnesium compound is formed' or 'there is a change in the pH'.

Question 3

Many candidates performed well on this question especially in parts **(a)** and **(b)(ii)**. The interpretation of the diagram in part **(a)(iii)** and the drawing of a labelled diagram to show filtration were poorly attempted.

(a)(i) Many candidates identified the change from copper sulfate to copper oxide as thermal decomposition. The most common error was to suggest oxidation.

(ii) Many candidates chose appropriate safety procedures for dealing with sulfur trioxide but few mentioned using a fume cupboard. Some candidates gave vague statements about 'keeping away from the reaction' or 'don't breathe in the gas'.

(iii) Some candidates realised that the sulfur trioxide was a liquid; others thought it was a solid. Many misinterpreted the diagram and suggested that the particles were 'a little away from each other' or that there are 'large spaces between the particles'. Many wrote about the movement of the particles, even though the diagram did not show that. Some candidates incorrectly suggested that the particles were regularly arranged.

(b)(i) Some candidates wrote the formula for sulfuric acid correctly. Others missed off a hydrogen atom or added other atoms.

(ii) Nearly all the candidates recognised the pH value which was strongly acidic. The most common error was to suggest pH 13.

(c) A few candidates drew neat, well-labelled diagrams to show filtration. Common errors were: placing a sheet of filter paper flat across the top of the filter funnel; not using any filter paper or not labelling the apparatus. A considerable minority of candidates incorrectly drew apparatus with condensers, burettes or other pieces of glassware.

(d)(i) Many candidates recognised the symbol for a reversible or equilibrium reaction. Those who did not, often referred to 'equality'.

(ii) Some candidates recognised the test for water involving anhydrous copper(II) sulfate. Others muddled it with the litmus test and wrote red and blue instead of white and blue. A wide range of other colours were seen.

Question 4

This question was generally well answered, with many candidates giving good answers for the questions involving reaction rate. Fewer candidates could explain the loss in mass of the flask in part **(a)** and in part **(c)(i)** few candidates could name a suitable zinc compound which reacts with hydrochloric acid to form zinc chloride.

(a) Some candidates recognised that the evolution of a gas was responsible for the mass loss in the reaction between zinc carbonate and hydrochloric acid. The most common errors were: suggesting that the hydrochloric acid evaporates; suggesting that solids are lost from the flask or implicating the cotton wool in the reaction.

(b)(i) Many candidates recognised that the mass decreases with time. Fewer wrote about the mass staying the same after about 40 seconds.

(ii) The reaction time was deduced correctly by some candidates. Others misread the graph and gave values for reaction time which were considerably outside the allowed range.

(iii) Many candidates calculated the decrease in mass correctly. The most common errors were to suggest 135 g or 196 g.

(iv) Some candidates drew good graphs to show how the mass of the reaction mixture changes when the experiment is carried out at a higher temperature. Others drew a line with a steeper initial gradient but ended the line at a lower volume, rather than reaching the same final volume. A considerable minority drew the line with a shallower initial gradient or drew a straight line cutting the curve already drawn on the graph.

(v) Many candidates realised that the reaction with large pieces of zinc would be slower than that with smaller pieces.

(c)(i) A considerable number of candidates did not appear to read the stem of the question carefully enough and suggested the element zinc rather than a compound of zinc. Those who did suggest the name of a compound tended to suggest a chloride or other salt rather than an oxide, hydroxide or carbonate. A considerable minority of candidates did not respond to this question.

(ii) The products of the electrolysis of zinc chloride were not always recognised. Some candidates gave the names or formulae of the ions rather than the elements. Others wrote the products at the incorrect electrodes. A considerable minority gave elements which were not present such as copper.

Question 5

This was generally the least well answered question on the paper. Few candidates realised the link between petroleum fractions and the boiling points of the molecules. Many could not give a suitable use for the naphtha fraction. In part **(a)** some candidates responded well to the questions referring to the formula of linalool.

(a)(i) Some candidates were able to identify the alcohol functional group. Others drew a circle around the double bond or included a carbon atom attached to the OH group. Another common error was to put a ring around the $(CH_3)_2C=$ group.

(ii) Most candidates deduced the number of different elements present in linalool. The most common error was to suggest '4'. Some candidates suggested '10' or higher numbers.

(iii) Many candidates counted the number of carbon atoms correctly. The most common error was to suggest 9 carbon atoms.

(iv) Some candidates recognised that the compound was unsaturated. Many incorrectly thought that the CH_3 groups or the OH group were responsible for unsaturation.

(b)(i) Most candidates gave a nearly correct sequence for the purification procedure. Few got the sequence completely correct.

(ii) Few candidates realised that fractional distillation depends on boiling points. Most gave vague answers relating to other physical properties such as density.

(c)(i) The main errors in this part were to place **H** in the next compartment from the bottom or to place **X** either at the bottom of the column or somewhere in the middle.

(ii) A minority of candidates gave a suitable use for the naphtha fraction, usually for making chemicals. A wide variety of incorrect answers were seen ranging from roofs to natural gas. A considerable minority of candidates did not respond to this question.

(d)(i) Some candidates gave a correct source of methane often from animal sources. Others referred to other petroleum fractions or from particular chemicals. A considerable minority of candidates did not respond to this question.

(ii) Many candidates referred to global warming or the effects of global warming. The most common error was to suggest that methane is responsible for depleting the ozone layer.

(iii) Many candidates suggested, incorrectly, that methane belongs to the alkene or alcohol homologous series. Others gave answers which did not relate to any homologous series.

Question 6

This was the best answered question on the paper. The exception was in part **(b)** (reactions of the halogens with the halides) where very few candidates answered this part well.

(a)(i) Most candidates were able to extract relevant information from the table and deduce which elements are giant covalent structures. The most common error was to suggest that they have low melting points or to try to relate the structure to their colour.

(ii) Some candidates were able to link the structure of graphite with its electrical conduction. A considerable number of candidates suggested that either **C** or **D** was graphite because it did not conduct.

(iii) Most candidates correctly identified chlorine from its colour. The most common error was to suggest **D**.

(b) Many candidates gave statements that encompassed both reactions at the same time and hence the answers were confused. Most candidates thought that there would be a reaction of bromine with both potassium chloride and potassium iodide. Only the better performing candidates commented on the relative reactivity of the halogens. A considerable minority of candidates wrote about the reaction of chlorine with potassium bromide and potassium iodide.

(c) Many candidates commented on the ability of chlorine to kill bacteria or other microorganisms. The most common error was to write vague answers such as ‘it purifies the water’ or ‘the water is cleaned’.

(d) The electron arrangement of chlorine was well known. The most common error was to omit the bonding pair of electrons.

(e)(i) Many candidates were able to deduce the molecular formula for indium chloride. The most common errors were either to reduce the formula to $InCl_3$ or to miscount the atoms to give In_2Cl_4 as a common example.

(ii) Most candidates deduced the number of protons correctly.

Question 7

Parts of this question were well answered by the majority of the candidates e.g. **(c)(i)** and **(d)(ii)**. Few could explain the term *volatile* in part **(a)** or suggest why it is difficult to predict the melting point of butane from the data given in part **(c)**. The question on diffusion in part **(b)** was answered well by many candidates.

(a) Very few candidates understood the meaning of the term *volatile*. Many gave answers relating to the smell of the perfume or thought that it meant poisonous.

(b) The best candidates gave a good description of diffusion in terms of particles moving down a concentration gradient and moving randomly. Common errors were: not to mention particles at all (just reference to the smell); not mentioning the term diffusion or to suggest that the particles move in a direction from low to high concentration.

(c)(i) Many candidates were able to deduce the pattern of change in boiling points from the information in the table. The most common error was to suggest that boiling point decreases as the number of carbon atoms increases. A minority of candidates tried to relate the pattern to the melting points rather than the number of carbon atoms.

(ii) Better performing candidates commented on the irregularity of the pattern in the melting points of the alkenes as the number of carbon atoms increases. The most common errors were to either write about 'not knowing the state' or suggesting that it had something to do with the formulae.

(iii) Many candidates identified the CH_2 group as having a relative mass of 14. The commonest error was to suggest CH_3.

(iv) The word equation for the combustion of ethene was not well known. Many candidates omitted oxygen as a reactant and a variety of incorrect hydrogen-containing products was seen including hydrocarbons and hydrogen. Many candidates gave products which did not contain hydrogen.

(d)(i) Some candidates gave a good definition of the term isotopes mentioning atoms or elements. Others gave answers which were far too vague involving molecules or compounds. Some candidates confused atomic number and mass number. A minority of candidates wrote about radioactivity.

(ii) Most candidates were able to write a symbol for carbon-12 showing the mass number and proton number. The commonest error was to suggest that there are 4 protons.

CHEMISTRY

Paper 0620/31
Extended Theory

Key Messages

Candidates need to be reminded to read each question thoroughly before attempting to answer the question.

If **one** use of a substance is asked for, then no more than *one* use should appear in the answer.

Candidates need to be reminded that a word equation is not acceptable in place of a correct symbol chemical equation.

Some good examination techniques were seen by underlining of command words in the questions. However, some responses were a rewriting of the question. Better performing candidates kept their answers concise and within the space available. These candidates often made use of bullet points rather than long paragraphs.

General Comments

Candidates seemed well prepared for the question paper. There was no evidence of insufficient time to complete the paper and there was little evidence of problems in understanding the questions.

Comments on Specific Questions

Question 1

(a) Many responses erroneously included coal as one of the *other* fossil fuels. Candidates need to be aware that vague answers such as 'oil' or 'gas' were not acceptable. A few candidates were unaware that crude oil and petroleum are the same thing.

(b) Many candidates did not read the question, which asked for three *other* elements. Carbon and sulphur, which were given in the question, were frequently seen in responses.

(c) (i) Better performing candidates were able to realise that oxides of nitrogen formed inside an internal combustion engine and reacted with or dissolved into atmospheric water to form acid rain.

Many candidates wasted time by describing the formation of sulfur dioxide and sulfuric acid again, rather than *another* cause of acid rain.

Dissolution/reaction with water of the gas was frequently omitted.

(c) (ii) Most candidates knew two harmful effects of acid rain, although contradictory answers such as 'acidifies lakes and increases the pH levels' were frequently seen.

(d) Candidates found this question challenging. A common error was to state that wood does not contain any carbon and would not produce any CO_2 on burning, or any other gases. Very few candidates realised the relevance of photosynthesis leading towards carbon neutrality.

Question 2

(a) Some candidates knew that the oxide of all four elements would form and that carbon dioxide and sulfur dioxide would be removed as gases. The removal of the solid acidic oxides depended needed their reaction with calcium oxide.

It was evident that many candidates were unaware of how steel is manufactured and there was some confusion with the blast furnace reactions. A common error was to assume calcium oxide reacted directly with silicon or phosphorus in order to remove these elements as slag.

(b) (i)(ii) Most candidates could provide a use for mild steel but found a use of hard steel more challenging.

(iii) Some candidates confused electrical conductivity and melting points. Better performing candidates realised that a simple phrase such as 'layers of ions slide over each other' would succinctly answer the question.

(iv) Better performing candidates realised that in hard steel, the sliding was restricted but only a minority stated that the reason for this was that the carbon atoms are a different size.

Candidates who performed less well produced responses with a lot of repetition of the question and with figures for the percentages of carbon contained in both types of steel but no explanation offered for the malleability differences.

Question 3

(a) (i)(ii) These parts were well answered but some candidates just gave 'hydrogen'/'H' rather than the 'hydrogen ion'/'H^+' as the oxidising agent.

(b) (i) A large proportion of candidates wrongly assumed the question meant 'copper chloride' when it asked for 'copper'. Other candidates chose to write irrelevant statements about copper being a catalyst and speeding up the reaction. Where equations were given, it was extremely rare to see the expected equation for the displacement reaction between zinc and copper chloride.

(ii) Candidates did not explain how graph 2 showed copper to be a catalyst (i.e. steeper gradient suggesting an increased rate of reaction but producing the same volume of hydrogen).

(c) Some candidates assumed ethanoic acid to be stronger.

(d) Candidates found this a challenging question. Candidates are advised that they do need to state what their calculation is attempting to determine and to include as many words as possible amongst their figures, even if this is just units. In that way 'method marks' for an 'error carried forward' can be awarded. It was evident that there was confusion with the molar gas volume, as the number '24' featured amongst many other figures.

Question 4

It was clear that some candidates had little knowledge of the organic section of the syllabus.

(a) (i) Most candidates could give at least one characteristic of a homologous series. Many candidates erroneously assumed that members of a homologous series share similar physical properties. Some candidates gave more than the three characteristics asked for.

(ii) Most candidates were aware that propanol was the third member of the alcohol homologous series.

(iii) Candidates coped well with this calculation and most were able to determine that the alcohol had 10 carbon atoms, 22 hydrogen atoms as well as the one oxygen atom.

(b) Most knew why the two structures were isomers.

(c) (i) The dehydration reaction of alcohols was not widely known and many candidates assumed that a silicon based organic compound was formed .Candidates are advised to check that they are not drawing structures with pentavalent C atoms.

(ii) There were a lot of blank responses to this question. Where candidates knew about esters, then butyl ethanoate was identified as the ester. Occasionally, 'ethyl butanoate' was seen.

(iii) The oxidation product from butan-1-ol was not well known. Candidates are advised to check that they are not drawing structures with pentavalent C atoms.

Question 5

(a) It was clear that many candidates were not familiar with this displacement experiment, as many blank responses were seen.

(b) Candidates coped well with this calculation to determine the formula as being IF_5, although a significant number assumed fluorine to have the symbol 'Fℓ.

(c) (i) It was expected that candidates would use their knowledge of the syllabus and come up with a reversible reaction, such as heating hydrated copper(II) sulfate crystals or the Haber process. Many opted for physical changes.

(ii) Candidates realised that an equilibrium is a reaction which can occur in both directions and at the point of equilibrium the macroscopic properties, such as concentration do not change as the rates of forward and backward reactions are equal. A significant number wrongly stated that the concentration of the products was equal to the concentration of the reactants.

(d) Many candidates did not refer to shift in equilibrium or gave unclear explanations of shift in equilibrium. Many candidates who performed less well re-stated the colour changes rather than why they occurred. These candidates gave contradictory statements about equilibrium shifts, e.g. 'the equilibrium shifts to the left hand side, towards the products'.

(e) Candidates generally understood that the forward reaction was exothermic but could not relate this to the forward shift in equilibrium.

Question 6

(a) (i) Many candidates did not address the question and omitted any mention of protons.

(ii) Many candidates made good attempts at this and sensible uses and outcomes of suitable indicators (such as pH paper and universal indicator) were frequently seen. Although many irrelevant 'fair test' conditions such as temperature and volume of base were given, only a minority of candidates realised that it was essential to keep concentration constant in order for the comparison to be 'fair'.

(b) (i) This equation was completed successfully by better performing candidates. A significant number of candidates were able to work out the name of the salt produced. The most frequent error was to assume the sulfate group had a charge of minus one.

(ii) A minority of candidates could name a strong base, with sodium hydroxide being the preferred choice. Some candidates opted for sodium chloride.

(c) (i) The process of diffusion was reasonably well understood.

(ii) There were many good answers to this question but often candidates assumed the molecule with the larger number of atoms must be 'heavier' and gave the answer the wrong way round. It was expected that candidates would refer to ethylamine having a lower relative molecular mass or lower density. This would mean that ethylamine would diffuse quicker or its *molecules* would travel faster.

Candidates incorrectly wrote about ethylamine being 'lighter' and 'ethylamine moving quicker'.

CHEMISTRY

Paper 0620/32

Extended Theory

Key Messages

If candidates are asked to write equations, this refers to balanced equations using symbols and formulae as opposed to word equations.

There are several questions on this paper which ask for observations. In such cases, it is necessary to describe the appearance and physical state of reactants and products as opposed to the theory behind any chemical reactions that take place. It is only necessary to give names of substances, or comment on the type of reaction that is taking place in answer to such questions if this is specifically asked for as well as observations.

Spelling and presentation is an important part of any examination. It is important that candidates are aware that if a word or a number cannot be read, marks cannot be awarded for such words or numbers.

Comments on Specific Questions

Question 1

This question was answered very well in general. Many candidates achieved all eight marks. The most common omissions were the charges on lithium and selenium ions. Candidates should be aware that particles in which the number of electrons and the number of protons are not equal are charged ions.

Question 2

All parts of this question were usually answered very well. In a small number of cases candidates quoted values of melting point and/or boiling point without commenting on the significance of such values.

(a) This was well known by most candidates.

(b) This was also well known by candidates.

(c) Melting point was almost always mentioned; boiling point was seen less often.

(d) Conduction of electricity in the liquid state was seen often and a reference to lack of conduction in the solid state was also required. Reference to melting point and/or boiling point was also required.

Question 3

(a) A minority of candidates answered this question correctly. It was common to see atoms drawn before the transfer of electrons, as well as the ions asked for in the question. It is acceptable to draw both, but candidates must make it clear which answer should be marked, preferably by crossing out the atoms (working out).

Diagrams should be large, using all the available space, and clearly drawn. It is preferable to draw electrons in pairs.

(b) (i) There were several good answers to this question, although the wording could often have been more coherent.

(ii) The phrase 'in terms of ionic charges' was usually ignored. Answers were usually in terms of electrons as opposed to ionic charges. References to valencies and oxidation states were also common.

Better performing candidates stated that the overall charge on a chemical substance has to be zero. This means that the number of positive charges must be equal to the number of negative charges. These candidates also stated how this applies to calcium nitride.

(c) This was answered quite well by the majority of candidates. The phrase 'in terms of electron transfer' was usually used to answer the question as requested. However, there was occasional inappropriate reference to loss and gain of oxygen. Loss of electrons by calcium ions and gain of electrons by nitride ions was occasionally seen.

Phrases such as 'calcium oxidises' are ambiguous and could mean that calcium is oxidised (correct) or calcium carries out oxidation (incorrect). Thus such phrases should be avoided.

Question 4

(a) This was usually answered very well. Comparisons such as great**er** surface area and fast**er** reaction were required.

(b) The question required reference to changes in conditions which would cause the equilibrium to shift to the right, thereby increasing the percentage of ammonia. Again two comparisons, i.e. high**er** pressure and low**er** temperature were required. Low**er**/low pressure and (particularly) high**er**/high temperature were sometimes seen.

(c) Candidates who did not achieve marks in **(b)** found it difficult to achieve marks here.

Question 5

It was apparent that many candidates were unfamiliar with the word reagent, giving an incorrect answer to the reagent in all three parts, although using a correct reagent in the equation.

(a) This was answered reasonably well by many candidates. The spelling of hydrochloric acid should be emphasised to candidates.

Some made the question unnecessarily difficult by attempting a symbol equation instead of the word equation that was requested. In some cases candidates unadvisedly gave a combination of words and formulae. Carbonic acid was occasionally seen as a product.

(b) Although silver bromide is a bromide that candidates are familiar with, it is unsuitable as a reagent because it is insoluble. Bromine was also seen very often. It would be useful for candidates to remember that all sodium and potassium salts (as well as all nitrates) are soluble. This should facilitate the choice of a soluble bromide for ionic precipitation reactions.

Writing ionic equations is an area that the majority of candidates are advised to improve on. The 'ionic equations' given by candidates rarely contained any ions. The small number who had the correct ionic species on the left hand side usually ignored the requirement to balance the equation.

(c) Word equations were seen very often. The spelling of sulfuric acid was sometimes given as sulfric acid. Some candidates found the formula of lithium sulfate to be challenging and $LiSO_4$ was often seen.

Question 6

(a) (i) The fact that ammonia was produced by the Haber process was known by many candidates, but the significance of ammonia being a source of fertilisers which were alternatives to sodium nitrate was appreciated by less. Some attempted an answer in terms of economic reasons.

(ii) Several candidates realised that the solubility of sodium nitrate in water meant that it would be washed away by rainfall but not in desert areas. The reactivity of sodium was sometimes mentioned. There were some references to acid rain.

(iii) Many candidates realised that the potassium in potassium nitrate was an important component of fertilisers. The reactivity of potassium was sometimes referred to. Some candidates used the symbol P to refer to potassium.

(b) (i) Although the formula of sodium nitrite was given, and sodium nitrite was described as a product of the decomposition, candidates did not always put the formula of sodium nitrite on the right hand side of the equation. In some cases, sodium nitrite did not appear anywhere in the equation. 'O' was commonly seen as the formula of oxygen gas. There were a wide variety of products and reactants. Candidates should realise that in a decomposition reaction, nothing is added to the substance that is decomposing. Word equations (both correct and incorrect) were very common.

(ii) The original and final colours were given by some candidates as required by the question. Many candidates tried to give an explanation of the theory behind the reaction, or to name the products, rather than to give the observations. A colour change of orange to green was occasionally described.

(iii) Some excellent answers were seen, which described reactive metals as decomposing into their nitrites and oxygen, whereas unreactive metals produced an oxide, nitrogen dioxide and oxygen. Other candidates found it very difficult to produce coherent answers to this question. It was often strongly implied that the answer was describing the decomposition of the metal itself rather than the nitrate.

(c) (i) Only a very small number of candidates described the copper(II) nitrate as a blue (crystalline) solid before it was heated. If copper oxide was described as black, this was not often accompanied by solid. The products were very rarely described correctly. Several candidates described a test for oxygen gas with a glowing splint, although there was no requirement in the question for this. It was common to see references to a solution, even though candidates should know that the copper(II) nitrate is a solid. Precipitates were often incorrectly referred to. Colourless gases cannot be observed. Names of substances are not required in a question of this type.

(ii) The definition of a mole should be known to candidates. Some candidates gave a method of how to calculate moles as opposed to the meaning of what a mole is. The Avogadro constant was occasionally correctly quoted to three decimal places.

(iii) A minority of candidates answered this question well. The number of moles of the hydrate was often calculated using 7.26 ÷ 206 = 0.0352, instead of using a 1:1 mole ratio.

Question 7

(a) (i) A minority of candidates knew respiration involved the use of glucose as a source of energy in a reaction occurring in living organisms. There was occasional confusion with photosynthesis. Candidates often scored some, as opposed to all three, of the available marks.

(ii) A variety of substances were seen in answer to this question. The question asks for product**s**, although it was not uncommon for candidates to name just one.

(iii) The majority of candidates knew that enzymes are biological catalysts.

(iv) To measure the rate of any reaction it is essential to measure time as well as the amount of one of the reactants or products. Time was the most likely to be missing.

(b) (i) Although several candidates knew that more collisions were occurring, possible reasons for more collisions such as an increase in temperature (the stem of the question refers to the mixture getting warmer) and /or the yeast reproducing were often missing. Yeast being added, even though there was no reference to this, was a common answer. Some mentioned that the enzymes started to work, but there was no reason given for the delay.

(ii) Cloudiness was often thought to be connected to the production of carbon dioxide and in some cases due to the reaction of carbon dioxide with lime water (although it was never made clear where the lime water came from). Very few knew that the cloudiness was due to the increase in the amount of yeast by reproduction.

(iii) Many correct answers were seen, as well as references to yeast being used up, enzymes being killed (they are not living things) or yeast being denatured (only enzymes can be denatured).

(c) Most candidates gave two uses of ethanol, particularly as a fuel or a solvent. Some repeated a use in alcoholic drinks. Cleaning was sometimes mentioned which showed confusion between detergency and sterilisation. Medicine was often given as an answer, but without explanation.

(d) Some excellent answers were seen. Many candidates ignored the instruction to manufacture ethanol and described the production of hexanol from hexane. The type of reaction with water/steam was often missing or incorrect. Hydrolysis and hydrogenation were sometimes seen as types of reaction, as well as occasional references to polymerisation. Word equations were seen instead of chemical equations.

CHEMISTRY

Paper 0620/33
Extended Theory

Key Messages

Candidates need to read questions fully and with care to ensure they are in possession of all the information provided and that they are trying to answer all aspects of the question asked.

General Comments

A number of answer spaces were left blank. The overall quality of answers was very variable.

Comments on Specific Questions

Question 1

(a) Candidates found this opening question challenging. Common errors were in the valencies of the elements concerned, using incorrect symbols, superscripts rather than subscripts and inserting stoichiometric coefficients before the formulae.

(b) A number of candidates ignored the word 'ions' in the question and wrote species without a charge.

(c) Many fully correct answers were seen. Common errors included having only single bonds (one shared pair of electrons) between each oxygen atom and the carbon atom, missing out the non-bonding electrons on the oxygen atoms and adding extra non-bonding electrons on the carbon atom.

Question 2

(a) This was not well known by candidates. Aluminium, copper or silicon oxides were common errors.

(b) The alkaline nature of sodium oxide was well known.

(c) The use of sulfur dioxide as a bleach was well known.

(d) Aluminium oxide was seen more commonly than zinc oxide. A common error was carbon monoxide.

(e) A significant number of candidates incorrectly wrote carbon monoxide.

(f) The acid nature of sulfur dioxide was well known.

Question 3

(a) Candidates found this question challenging. Very few referred back to the equation and noted that a gas was made, which would escape. Many stated that the reaction is not reversible, despite the use of $\rightleftharpoons$ in the equation.

(b) Many candidates did not start with calcium oxide and did not make calcium hydroxide. Some wrote word equations.

(c) A good number of fully correct answers were seen. Some candidates' responses lacked clear working and some appeared to not know where to start this calculation. A common error was to use the conversion factor for tonnes into grams as the mass of one of the species.

(d) In **(d)(i)** most candidates were able to state that the calcium carbonate is insoluble as one advantage. Some gave excellent explanations of its resistance to being washed away by rain. A number of candidates gave answers which suggested they thought calcium carbonate was a fertiliser and provided the plant with substances required for growth.

Candidates found **(d)(ii)** challenging and this was not attempted by a significant number. Some responses were confused, stating that the sulfur in the gas was removed by calcium carbonate by converting it into sulfur dioxide.

The best answered section of this question was **(d)(iii)**. Many candidates could correctly state a use of calcium carbonate, the most common use given being in the making of steel or in the extraction of iron.

Question 4

(a) In **(a)(i)** the majority of candidates could name another fossil fuel, but in **(a)(ii)** many explained either what a fossil was or what a fuel was, but rarely both.

(b) Some confused answers were seen in **(b)(i)**, with candidates stating that there is sulfur in the air or with carbon dioxide reacting to form sulfuric acid.

The chemistry in **(b)(ii)** was not well known by many candidates. Some responses involved hydrogen from the air reacting with nitrogen and water to make nitric acid.

The test for nitrate ions in **(b)(iii)** was not well known.

Some interesting and innovative answers were seen in **(b)(iv)**. Unfortunately, some candidates contradicted themselves by stating that the pH could be measured and that the acid with the higher concentration of hydrogen ions would be more acidic; having the *higher* pH.

Question 5

(a) Many candidates did not write equations that gave copper(II) oxide as a product.

Part **(a)(i)** was most commonly correctly answered. In **(a)(ii)** hydrogen was sometimes seen as a product. Very few candidates gave correct products and a balanced equation in **(a)(iii)**.

(b) In **(b)(i)** a small number of candidates knew the colour of copper oxide. A common error was to state that the starting colour would be blue. When a question asks for a colour change both the start and finish colour should be stated.

Part **(b)(ii)** was well answered, with many candidates realising that the copper would react with the oxygen in the air; however, some candidates suggested answers such as 'it will explode'.

In **(b)(iii)** many candidates gave hydrogen as the answer (the gas used in the question rather than another gas) or gave the name of a substance which was not a gas.

Part **(b)(iv)** was well answered, with most candidates selecting a more reactive metal.

(c) Most candidates were able to correctly complete the table in **(c)(i)**, but very few fully correct answers were seen in **(c)(ii)**.Most candidates could identify which sample was impure, but could not then relate this to how the sample of copper(II) oxide had been made.

Question 6

(a) While many candidates were able to give the correct formula for the aluminium ion in **(a)(i)**, fewer were able to construct a correctly balanced equation. Triatomic aluminium or three moles of aluminium were seen as products.

Few fully correct equations were seen in **(a)(ii)**. Some candidates did not make diatomic oxygen molecules or had half the required number of electrons.

In **(a)(iii)** the answer 'exothermic' was very common and some candidates did not give an explanation.

(b) In **(b)(i)** some candidates did not give an explanation.

In **(b)(ii)**, while a good proportion of candidates could give a reason why the magnesium electrode lost mass, fewer could explain why the copper electrode gained mass. The most common error being that copper gains electrons rather than copper *ions* gain electrons and are so deposited as copper atoms.

In **(b)(iii)** many candidates did not use the cell in the question; instead they described a displacement reaction.

(c) While some fully correct equations were seen, some candidates did not balance their equations. A number of candidates made products other than carbon dioxide and water.

(d) The source of energy for photosynthesis was well known in **(d)(i)** and many correct equations were seen in **(d)(ii)**. Some candidates tried to write balanced symbol equations.

Question 7

(a) This was the best answered section of the examination paper. The majority of candidates completed parts **(a)(i)** and **(a)(ii)** correctly.

Part **(a)(iii)** was poorly answered; those candidates who knew the test reagent (bromine) often did not state the starting colour of the bromine.

(b) Many candidates were able to go from the structure of the monomer in **(b)(i)** to the polymer structure. Common errors were to not show the structure repeated.

In **(b)(ii)** candidates typically drew the structure of the repeat unit of the polymer rather than the structure of the monomer.

In part **(b)(iii)**, few candidates confidently used the term 'addition' and 'condensation' in relation to polymers.

Part **(b)(iv)**, was not attempted by the majority of candidates.

CHEMISTRY

Paper 0620/04

Coursework

General Comments

This is the final June series for this paper and the vast majority of Centres submitted samples of work that required no adjustment.

The tasks chosen were usually appropriate and the standards applied by the Teachers at the Centres were also appropriate.

Much excellent work was read by Moderators which reflects well on the Teachers and candidates in the Centres.

Where there were occasional problems, it was usually due to the tasks chosen by the Centre not being entirely suited to the assessment of the skill concerned. Over generous marking by the Teachers at Centres was relatively rare.

CHEMISTRY

Paper 0620/51

Practical Test

Key Messages

Candidates should use a sharp pencil for plotting points and for drawing their lines of best fit on their graphs. This allows them to correct any errors. The question might require the line of best fit to be a curve or a straight line, as appropriate. Straight lines should be drawn with a ruler, but rulers should not be used to join the points on a curve. Lines of best fit should avoid anomalous points.

In qualitative exercises, candidates must read and follow the instructions given. All observations should be noted. If candidates test for a gas, they should note effervescence or bubbles formed.

General Comments

The majority of candidates successfully attempted and completed both questions and there was no evidence that candidates were short of time.

Supervisors' results were submitted with all of the candidates' scripts. Centres reported no problems with regard to obtaining the requirements for both questions.

A number of candidates did not follow the instructions as detailed in certain parts of **Question 2**.

Comments on Specific Questions

Question 1

(a) and (b) The tables of results were completed by all of the candidates. The majority of candidates recorded temperature readings that were comparable to the Supervisor for both experiments.

Some candidates recorded temperatures which did not show an increase as acid was added, while others had results that levelled out and did not decrease.

(c) Most candidates plotted the points for both experiments on the grid correctly. The majority of candidates drew smooth line graphs. A number included obvious anomalous points and while others joined the points with straight lines drawn with a ruler. Some graphs were unlabelled.

(d) Most candidates worked out the temperature of the reaction mixture after 8 cm^3 of acid **B** were added in Experiment 2 and showed clearly how they had used their graph. Some errors in reading the scale of the *x*-axis were evident and a significant number of responses chose the wrong curve.

(e) The reaction was correctly identified as exothermic by the majority of candidates. A few answers mentioned endothermic. Displacement and reduction were common errors.

(f) Most candidates noted the idea of removal of acid **A** from the first experiment, often expressed in terms of cleaning or removing contamination. Only the better performing candidates understood that the burette was rinsed with acid **B** to remove the water and avoid subsequent dilution.

(g) (i) This question was well answered, with Experiment 2 given.

(ii) Better performing candidates were able to communicate the idea that acid **B** was stronger, often in terms of a lower pH or more acidic/more hydrogen ions.

(h) Most correct responses referred to accuracy as the problem when using a measuring cylinder and suggested replacing it with a burette or pipette. References to heat losses and not washing out the polystyrene cup were also creditworthy.

Some vague references to parallax errors, thermometer reading errors, not using more than one burette or using a dirty burette and using the thermometer as a stirrer were also seen.

Question 2

Solid **C** was hydrated aluminium ammonium sulfate (ammonium alum).

(a) Most candidates were able to describe the appearance of solid **C** as a white or colourless powder or crystalline. The colour of the salt was sometimes missed and a few answers referred to the presence of a precipitate.

(b) Detailed observations were rare. The presence of condensation was often not noticed. It was apparent that many candidates had not followed the instruction to heat the solid more strongly. A number of positive tests for chlorine and acidic gases were recorded, when in practice ammonia is evolved.

(c) Some responses showed that candidates did not follow the instructions given and therefore observations were missed. A white precipitate which dissolved when excess sodium hydroxide was added was expected. Despite the final instruction, the gas was often not tested. Only better performing candidates recorded the presence of a gas that had a pH > 7 or turned red litmus blue. Some candidates just wrote 'ammonia is produced' giving no test whatsoever. A number of candidates used a lighted splint to test the gas, which then supposedly popped or used a glowing splint and got the splint relighting.

(d) Generally well answered with the recognition of a white precipitate. Many candidates noted the formation of a cloudy or milky solution but did not describe the colour appropriately.

(e) A significant number of candidates obtained a white precipitate when there should have been no reaction for this halide test. Other candidates described effervescence and precipitates dissolving.

(f) This was generally well answered. Vague references to milky, cloudy and bubbles were prevalent.

(g) Better performing candidates realised that the formation of condensation indicated that the solid was hydrated or that water was present. Some confused answers discussed the nature of an alkaline solid.

(h) The majority of candidates correctly surmised that halide ions such as chloride and iodide were absent. Confused answers referred to halogens or the fact that halides were indeed present.

(i) Many candidates referred to the presence of sulfate ions in solid **C** from the white precipitate recorded in **(f).** Only a minority realised that the tests on the solid indicated the presence of aluminium and ammonium ions. Common errors such as transition metal, calcium or zinc ions and nitrate or chloride ions were prevalent.

CHEMISTRY

Paper 0620/52

Practical

Key Messages

Where a qualitative test asks for observations, it is important that candidates state their observations and not just their conclusions.

General Comments

The majority of candidates successfully completed both questions and there was no evidence that candidates were short of time. Most Centres submitted Supervisors' results with the candidates' scripts. Few problems were reported with carrying out the experiments. The Examiners use Supervisors' results when marking the scripts to check comparability. Some Centres submitted two sets of Supervisors' results without stating which set applied to which candidates. If more than one set of Supervisors' results are submitted (as may be the case if, for example, the examination is carried out over two sessions) then it is important that it is clear which should be used for each candidate. It is important that Centres use the correct reagents at the specified concentrations in the Confidential Instructions.

Comments on Specific Questions

Question 1

(a) – (f) Almost all candidates fully completed the table of results. Quoting a '–' is not a suitable alternative to stating a volume of 0 cm^3. A small minority of candidates gave one or more of the times in minutes. Good results were obtained by the majority of candidates, with more dilute solutions giving longer times.

(g) While most candidates plotted all points correctly, some candidates selected scales for the *y*-axis that made plotting difficult. It was common in these cases for points to be plotted incorrectly.

(h) A colour was required in the description of the contents of the conical flask: simply stating 'cloudy' was insufficient.

(i) In **(i)(i)** most candidates could correctly read a value from their graphs. The most common error was the omission of units from answers. A large number of candidates did not attempt **(i)(ii)**. Most of those who did attempt the question realised that the reaction would be slower and so the times longer. It was common for the sketch line to incorrectly meet the plotted line at one (or both) ends.

(j) Almost all candidates could identify the fastest experiment in **(j)(i)** and relate it to having the highest concentration in **(j)(ii)**.

(k) While some excellent answers were seen, some candidates incorrectly thought that as the volume of sodium thiosulfate solution was being reduced from experiments 1 to 5, it could not then be increased.

(l) In **(l)(i)** most candidates realised that a burette would increase accuracy, but could not explain why this occurred by making a comparison to the measuring cylinder used. Better performing candidates explained that while the volume of hydrochloric acid added would become more accurate, the acid would be slow to add to the reaction mixture and so the times obtained may be less accurate.

Candidates found part **(l)(ii)** challenging, with some candidates thinking the conical flask was used for measuring volume. Many others thought that the solution would come out of the flask during mixing or that the changed surface area of the flask changed the collision frequency. Better performing candidates gave very good answers, relating depth of solution to how quickly the text would be obscured.

Question 2

J was ammonium iodide and **K** was barium carbonate.

(a) Most candidates stated that the mixture was white.

(b) It was common for candidates to report a correct pH or colour of pH paper. Relatively few commented on the smell of the gas produced.

(c) The most common error was the omission of the fact that a precipitate was formed; stating 'cloudy' is not sufficient for the formation of a precipitate. Some candidates could not decide on the colour of the precipitate so stated two (or even three) colours.

(d) Candidates were expected to give an observation for each instruction. However, many did not state the initial colour after adding the hydrogen peroxide or missed the effervescence. A significant number stated the gas given off was oxygen but gave neither the test nor observed result.

(e) Candidates were expected to give an observation for each instruction. Some gave the identity of the gas rather than the test and result.

(f) Many fully correct responses were seen, although a few candidates got **J** and **K** mixed up. There was some confusion between the ammonium and nitrate ion tests, leading some candidates to conclude that since an alkaline gas was made in **(b)** that the salt must be a nitrate.

(g) The majority could identify **K** as a carbonate, but the use of the sulfate test the other way round (adding a sulfate ion to identify barium ions or any other ion with an insoluble sulfate) in **(e)** was missed by most candidates.

CHEMISTRY

Paper 0620/53

Practical

Key Messages

Where a qualitative test is split into a number of steps, then observations should be recorded for each step in the order the steps are carried out.

General Comments

The majority of candidates successfully completed both questions and there was no evidence that candidates were short of time. All Centres submitted Supervisors' results with the candidates' scripts. Not all Centres used the specified reagents but used a substitute. If Centres are concerned that one of the specified reagents will not be available for the examination then they should contact CIE at the earliest opportunity to seek advice.

Comments on Specific Questions

Question 1

(a) Almost all candidates correctly recorded effervescence.

(d) Some candidates recorded only one colour, rather than the colour before and after the addition.

(e) Most candidates recorded their results from all four experiments; a small minority incorrectly calculated one or more temperature difference. A relatively common error was to record temperatures to differing numbers of decimal places.

(f) Almost all candidates drew a bar chart as instructed, with only a very few attempting to draw a line graph. There were few errors in drawing bars to the correct heights.

(g) (i) While many correct responses were seen, there were many incorrect reaction types stated, such as precipitation, displacement or redox. Some candidates gave two answers; this almost invariably meant that one of their answers was wrong.

(ii) Better performing candidates could relate the effervescence to the production of carbon dioxide from the reaction between a carbonate and an acid. Some candidates thought that the gas was hydrogen and that the white solid **D** must be a metal.

(h) Most candidates were able to correctly identify the experiment with the largest temperature change.

(i) While many candidates recognised that the pH increased or that it was a neutralisation reaction, only a small fraction of those continued their answer to state that **G** was a base.

(j) A number of candidates did not realise that because the reaction would be over, the temperature would return to room temperature. Some candidates thought the temperature would continue to increase at the same rate and so predicted temperatures which should have been identified as implausible.

(k) The most common error was for candidates to think that a larger volume of acid meant a faster reaction and so a larger temperature change.

Question 2

Solid **H** was ammonium iron(III) sulfate.

(a) Most candidates gave an acceptable description of the appearance of solid **H**. Descriptions of appearance should include colour.

(b) The recorded observations suggest that many candidates did not heat gently at first as required. Relatively few candidates noted the initial formation of a liquid or the condensation in the upper reaches of the test-tube.

(c) Some candidates incorrectly reported that solid **H** was insoluble.

(d) Better performing candidates gave an observation for each instruction. Others just gave one set of observations for all three instructions together. Although the gas produced was ammonia, few commented on the smell and some reported the production of an acidic gas.

(e) Despite the fact that the precipitate formed in this test is the same precipitate as the one formed in **(d)** candidates often reported different colours from those reported in **(d)**.

(f) Some candidates reported positive halide ion tests. Negative tests are helpful in identifying ions in a salt.

(g) Most candidates reported the formation of a precipitate, but some reported results such as the precipitate re-dissolving or being coloured.

(h) As many candidates missed the formation of condensation, they did not state that solid **H** was hydrated. The identification of ammonia gas being given off was more common, although some mistakenly stated that solid **H** itself was alkaline.

(i) This was well answered by those candidates who correctly reported no reaction in **(f)**, although some mixed up halogens with halide ions.

(j) Candidates found identifying the three ions in solid **H** challenging. Candidates should include the oxidation state when identifying iron ions, such as iron(III) or iron(II).

CHEMISTRY

Paper 0620/61
Alternative to Practical

Key Message

Questions requiring candidates to plan an investigation should be answered with details of apparatus to be used, quantities of substances involved, practical procedures clearly specified with some idea of a conclusion. Preliminary notes are advisable before writing the plan.

General Comments

The majority of candidates attempted all of the questions

Candidates found **Questions 1, 2(c)(ii), and 6** to be the most challenging.

The majority of candidates were able to complete the tables of results from readings on diagrams and plot points successfully on a grid as in **Question 4**.

Comments on Specific Questions

Question 1

(a) Most candidates identified the flask, which was often described as distillation, condensing or conical. Not all candidates labelled the arrows on the condenser. The condenser often had air, gas, ethanol or ethanoic acid flowing through it instead of water.

(b) (i) Many candidates referred to safety or controlled heat distribution. Reference to the flammability of ethanol was less common with some describing ethanol as volatile or explosive. There were incorrect references to the Bunsen burner not being hot enough.

(ii) Many answers just repeated the question and said ‘to condense’ while others tried to condense liquids or referred to distillation.

(c) The smells were not well known. Many incorrect responses suggested that neither of the substances had a smell and the terms strong and weak were prevalent. The description of the ethanoic acid was more successfully attempted. Correct answers for ethanol were few and often confused, with vinegar and pungent common.

Question 2

(a) This was generally well answered, with the bulb lighting and bubbles being the most common correct answers. The most common error was to state that lead was formed at the cathode instead of describing the formation of a silver-grey substance.

(b) (i) The majority of candidates correctly suggested carbon or graphite as a non metal for the electrodes. Others specified a metal such as platinum or copper, while inappropriate non metals such as oxygen showed a lack of understanding.

(ii) This was well answered, with the idea that iron would react. Some candidates thought that iron did not conduct electricity or conducted too well or would melt.

(c) (i) Well answered. Common errors included bromide, chlorine, iron or lead oxide.

(ii) Common errors were that the litmus paper would turn red or not change colour. Only better performing candidates understood that the paper would probably bleach.

(d) Generally well answered, with lead given.

(e) Better performing candidates recognised that a fume cupboard or well-ventilated room was necessary.

Question 3

(a) Some candidates did not attempt this question, which required putting a label on the diagram provided. Attempts were usually correct, though some drew an extra line.

(b) Some candidates did not read the question stem and suggested water. Mineral acids and sodium hydroxide were other incorrect answers. The most common correct response was ethanol.

(c) This was well answered, with three the expected answer. Wrong answers were commonly 2, 4 and 6.

(d) Many candidates understood that the mixture contained dyes 1 and 3 and an unknown dye. Only the better performing candidates realised that dye 2 was absent.

A significant number of candidates made reference to the differing solubility or different boiling points of the dyes.

(e) Many candidates suggested repeating the experiment to check the reliability of the results or the use of R_f values and a different solvent.

Question 4

Completing the tables of temperature readings in **(a)** and **(b)** caused very few problems.

(c) The points were usually correctly plotted, although a few got the *y*-axis scale wrong and some missed points out.

Some lines were not smooth lines and some drew straight lines through the points. A number, despite drawing mainly a curve, used a ruler to draw straight lines to join up some of the points. A minority failed to label the graphs.

(d) Often well answered. Errors included misreading the value from the *y*-axis, starting from the wrong value on the *x*-axis or taking the construction line to the wrong curve.

(e) Responses showed that most candidates could specify the type of reaction as exothermic. A minority wrote ‘enothermic’ or ‘exdothermic’, with ‘endothermic’ also common. Other errors included redox, precipitation, displacement and oxidation.

(f) Most candidates knew the idea of removal of acid **A** from the first experiment, often expressed in terms of cleaning or removing contamination. Only the better performing candidates understood that the burette was rinsed with acid **B** to remove the water and avoid subsequent dilution.

(g) (i) This was well answered, with Experiment 2 given.

(ii) Better performing candidates were able to communicate the idea that acid **B** was stronger, often in terms of a lower pH or more acidic/more hydrogen ions.

Vague references to the greater reactivity of acid **B** were ignored.

(h) Most correct responses referred to accuracy as the problem when using a measuring cylinder and suggested replacing it with a burette or pipette. References to heat losses and not washing out the polystyrene cup were also seen.

Vague references to parallax errors, errors reading the thermometer, not using more than one burette or using a dirty burette and using the thermometer as a stirrer were common.

Question 5

Answers to this qualitative analysis question were Centre dependent. It was evident that some candidates had no knowledge of the tests required to complete the observations in the table for **(c), (d), (e)** and **(f).** Blank spaces were seen.

(c) The appearance of a white precipitate was common. Candidates who performed less well stated that the precipitate was insoluble or that effervescence was seen.

(d) A large number of incomplete answers such as ' insoluble' or 'precipitate remains' were evident, while 'no reaction' was also common.

(e) There was some confusion by those candidates who thought that a white precipitate would be formed, despite the fact that this halide test should produce no reaction/change.

(f) Yellow, green and brown precipitates were seen.

(g) Better performing candidates realised that the formation of condensation indicated that the solid was hydrated or that water was present.

(h) Some candidates ignored the fact that they should be using the result in **(e)** and used other information. There was confusion between the terms halogens and halides.

(i) (i) This was well answered, with ammonia being recognised by most candidates. A minority gave hydrogen and carbon dioxide.

(ii) The mention of various transition metals, iron compounds and nitrate was common.

Question 6

The quality of answers spanned the entire spectrum. Candidates who performed less well did not describe an experiment or only one experiment was performed between hydrogen peroxide and copper oxide and this did not compare with hydrogen peroxide on its own. Others discussed measuring rate without explaining the measurements to be taken such as volume of gas and time. Some proposed investigations involved heating the hydrogen peroxide and/ or measuring temperature changes.

Very few tested the gas.

In Step 2, a lot of chemical tests were suggested rather than simply measuring the mass of copper oxide before and after the reaction. Some forgot to filter or dry the recovered solid.

Well planned answers from better performing candidates gave essential experimental detail, with a clear practical method and a means of showing that the catalyst was unchanged.

Some candidates did not attempt this question.

CHEMISTRY

Paper 0620/62
Alternative to Practical

Key Messages

Candidates should use a sharp pencil for plotting points and for drawing their lines of best fit on their graphs. This allows them to correct any errors. The question might require the line of best fit to be a curve or a straight line, as appropriate. Straight lines should be drawn with a ruler, but rulers should not be used to join the points on a curve. Lines of best fit should avoid anomalous points.

Observations are those which you can see. For example, “fizzing” is an observation; “a gas was given off” is not. Smells, such as the pungent smell of ammonia and the bleach or swimming pool smell of chlorine, were acceptable as observations on this paper.

When a question asks for the name of a chemical, a correct formula is acceptable. However, if a candidate answers with an incorrect formula, then the mark will not be awarded.

General Comments

The vast majority of candidates successfully attempted all of the questions. The full range of marks was seen. The paper was generally well answered, with very few blank spaces

Question 7 was a planning task, testing the acidity of two samples of tonic water. There were many possible routes. Candidates find this type of question to be challenging.

The majority of candidates were able to complete tables of results from readings on diagrams and plot points successfully on a grid as in **Question 4**.

Comments on Specific Questions

Question 1

(a) The majority of candidates answered this correctly.

(b) Many candidates made vague comments about temperature and volume of ethanol, without using the information given in the question or appreciating how these measurements would be obtained.

(c) Answers were expressed poorly for this question. Many stated that the temperature would decrease, when they clearly meant that the increase would be less.

(d) Most candidates knew that copper was a better conductor of heat than glass. Often this was expressed as the idea that less heat would be lost or that the temperature rise would be greater; both of which were accepted.

Question 2

(a) Nitric acid was correctly identified by the majority of candidates.

(b) Spatula and stirring rod were both well known, although a significant minority explained why the process was needed rather than what apparatus was used.

(c) Nearly everyone knew that the process was filtration, although crystallisation and evaporation were often seen.

(d) Candidates found this question challenging. Whilst most said what would remain in the evaporating basin; many could not go on to explain how pure, dry crystals could be obtained, partly because many thought that the original process would achieve that.

Question 3

This question required three tests, each of which would give a result that neither of the other liquids would give.

Potassium hydroxide: Many candidates appreciated that an indicator could be used to identify potassium hydroxide, although a wide range of tests were mentioned. Some candidates correctly mentioned the use of the flame test, or precipitation of metal hydroxides when a metal compound such as copper(II) sulfate was added. Some responses mentioned the addition of an acid, and while it is a possible test, the candidates rarely had a suitable observation.

Octane: Most candidates went for the negative test with bromine water. While this may be useful when comparing saturated and unsaturated hydrocarbons, it did not distinguish octane from the other two chemicals. The most common answer was a simple ignition test, with some candidates mentioning the formation and testing of the product carbon dioxide.

Pure water: A large percentage of candidates used cobalt chloride or copper(II) sulfate to test for water. Unfortunately, although it is a recognised test for water it does not distinguish pure water from potassium hydroxide solution. The most commonly creditworthy test was the boiling point test.

Question 4

(f) The table of results was often completed correctly. A few recorded times in minutes and seconds.

(g) This was also well answered, with the majority correctly drawing a smooth curve. A few joined the points with straight lines.

(h) Most could deduce the time for 25 cm^3, although fewer could sketch the correct curve for a lower temperature. It was either missed altogether or drawn below the original.

(i) This was well answered, with a large majority identifying the first experiment and stating that it was because the sodium thiosulfate was the most concentrated.

(j) A minority of candidates answered that changing the total volume would make the test unfair. Whilst many did realise that the total volume would no longer be 60 cm^3, few went on to mention that it would make a comparison with the other results invalid. Common incorrect answers discussed overflow and the size of the measuring cylinder.

(k) Most understood that using a burette as a measuring device would be more accurate. A few good responses compared it to the use of a measuring cylinder or went on to mention that the time taken to add the solution from a burette would make the timing of the experiment less accurate. In the second part, many candidates treated the 100 cm^3 conical flask as another measuring device, rather than a container for the reaction that would give a greater depth of solution and therefore a shorter time.

Question 5

(b) The most common correct response was the colour of the indicator paper, with fewer mentioning the pungent odour. Many candidates gave the pH or identified the gas as ammonia, but these are not observations.

(c) The correct answer, a yellow precipitate, was seen often, but with a significant number of white precipitates.

(e) Most realised that the pH would be above 7.

(f) Carbon dioxide was correctly identified as the gas by most candidates.

(g) Many candidates realised that it was a carbonate, with many also correctly identifying the cation as barium, calcium, lead or silver.

Question 6

(a) Platinum was rarely seen. Carbon or graphite was the most common, incorrect answer.

(b) A number of candidates realised that hydrogen ions have a positive charge.

(c) Chlorine was commonly identified as the gas, with a correct test being given.

(d) Few candidates realised that chlorine is slightly soluble in water.

Question 7

Nearly all the candidates made an attempt at this question. Some candidates suggested testing equal volumes of both tonic waters with the potassium hydroxide solution mentioned in the question (or another suitable reagent). Many went on to correctly use a titration. Others measured temperature changes. However, some went on to incorrectly measure volume of gases, time to form a precipitate or for an unspecified reaction to finish, all of which limited the quality of their answer. A very small number attempted to use chromatography, electrolysis, or a similar method.

CHEMISTRY

Paper 0620/63

Alternative to Practical

Key Messages

Questions requiring candidates to plan an investigation should be answered with details of apparatus to be used, method involved and quantitative information clearly specified.

Questions asking for expected observations require information as to what candidates would be expected to actually see e.g. fizzing, bubbles or effervescence. Naming the substances formed is not an observation e.g. ammonia or a gas is given off.

General Comments

The majority of candidates attempted all of the questions. The full range of marks was seen.

Candidates found **Questions 1**, **4** and **6** to be the most challenging.

The majority of candidates were able to complete the tables of results from readings on diagrams and plot points successfully on a grid as in **Questions 2** and **4**.

Comments on Specific Questions

Question 1

(a) Most candidates labelled the apparatus as a tube. The correct term is a delivery tube which was given by some candidates. Answers such as a gas syringe, condenser or burette showed a lack of understanding and familiarisation with common laboratory apparatus.

(b) Most responses placed an arrow under the liquid paraffin or the broken tile. Better performing candidates realised that both the paraffin and the tile needed to be heated. Arrows were often only in one of these positions. A significant number of arrows were wrongly placed under the trough of water and the delivery tube.

(c) The most common error in part **(i)** was to discuss the role of the small pieces of tile as allowing only the gas to pass and acting as a filter. The idea that small pieces of tile provided a larger surface area was only understood by a minority of candidates. Some candidates stated there would be an increase in the rate of the reaction. In **(ii)** the purpose of the mineral wool was to absorb or contain the paraffin. A number of responses referred to its effect on reaction rate which was ignored.

(d) A minority of candidates correctly identified the process as cracking. Incorrect responses included fractional distillation, condensation and evaporation.

(e) Very few candidates were able to describe the change in the appearance of the bromine water from orange/yellow to a colourless or recognise that it would react with alkenes. Common errors included references to the hydrogen reacting. Vague answers such as ‘changes colour’ were prevalent.

Question 2

(a) The vast majority of candidates successfully completed the volumes of hydrogen from the gas syringe diagrams.

(b) Most candidates plotted the points on the grid correctly and drew smooth line graphs. A large number included the anomalous point, while others joined the points with straight lines drawn with a ruler.

(c) (i) This was well answered, with the point at 150 s being correctly identified as inaccurate.

(ii) Most candidates identified the expected volume of gas after 150 seconds. Some errors in reading the scale were evident and a significant number of responses omitted the unit.

(d) (i) The most common methods to cool the acid involved the use of a freezer, refrigerator or ice. Vague answers referring to cold water and condensers were also seen.

(ii) Better performing candidates realised that the graph would level out at the same height.

Question 3

(a) The colour of the iron after one week was often correctly described as brown, red-brown, orange or black. Red, white and blue were common incorrect answers.

(b) The idea of the water rising up the tube as rusting had removed oxygen/air was common. References to pressure were ignored. In **(ii)** the majority of responses worked out the decrease in the volume of air as 17%.

(c) Better performing candidates realised that using boiled distilled water instead of tap water would have no effect on the experiment and that the same results would be obtained.

A range of incorrect answers such as increasing or decreasing the amount or rate of rusting and effects on the water level in the tube showed a lack of knowledge and understanding.

Question 4

(e) The table of results was completed correctly by the vast majority of candidates. A number of candidates did not record the temperature change for Experiment 3 as $-3^{\circ}C$.

(f) Most candidates chose an appropriate scale for the *y*-axis and plotted the temperature changes on the grid correctly. The majority of candidates drew correct bars and labelled them clearly. Some candidates mistakenly drew all of the bars from the base of the *x*-axis, while others joined the points with straight lines drawn with a ruler. Some bars were not labelled.

(g) (i) The type of chemical process was usually correctly identified as exothermic. Some confused responses mentioned endothermic. A large number of responses gave vague reference to effervescence or decomposition.

(ii) Better performing candidates concluded that a carbonate was present or referred to carbon dioxide gas. Many candidates missed the point and made vague references to reactions happening or metals being involved.

(h) This was well answered with the majority correctly identifying Experiment 2.

(i) Most candidates realised that the acid was neutralised but only the more able deduced that solid G was a base/alkali.

(j) Many candidates realised that the temperature of the solution would return to the initial temperature of 23°C or room temperature. Many did not explain that this was because the reaction would be finished. Vague answers were seen such as 'the temperature will decrease' or 'heat would be lost to the environment'.

(k) Most candidates erroneously thought that a larger volume of hydrochloric acid would result in a faster reaction and/or larger temperature change. Better performing candidates realised that the temperature changes would be lower because of the larger volume of acid.

(l) The most common source of error identified was the use of a measuring cylinder, rectified by using a burette or pipette. Other creditable answers specified heat losses or an unclean polystyrene cup. Many answers thought that using a polystyrene cup was a source of error because it would melt and suggested using a beaker instead.

Question 5

Answers to this qualitative analysis question were Centre dependent. It was evident that some candidates had little knowledge of the tests required to complete the observations in the table.

(c) (i) A red-brown precipitate, insoluble in excess aqueous sodium hydroxide was seldom known. Some candidates thought that the precipitate would be white and soluble.

(d) The correct observation that a red-brown precipitate formed was rarely seen.

(e) Candidates generally did not realise that this test for a halide would be negative, having been told that the anion present was a sulfate. A large number of answers gave the formation of coloured precipitates as white.

(f) Some candidates realised that a white precipitate would be formed.

(g) Only better performing candidates surmised that the solid was hydrated or that water was present.

(h) Many answers incorrectly referred to the presence of halides, when in fact the test would have shown that halides were absent.

(g) (i) This was well answered, with ammonia being recognised by many. Common incorrect responses included chlorine, hydrogen and carbon dioxide.

(ii) Meaningful conclusions were variable. The presence of ammonium ions was given by better performing candidates. Zinc, transition metals and nitrate were common incorrect responses.

Question 6

The quality of answers spanned the entire spectrum. Many candidates noted the need for collecting and measuring a sample of methane gas.

A lack of knowledge and understanding was apparent, with answers mentioning weighing a sample of the ice in a beaker and then letting it melt. The beaker and contents were the reweighed and the difference would be the mass of methane liberated. In practice this method would not work, as there would be little measurable difference between the initial and final weights using a laboratory balance.

Other incorrect responses involved using 1 kg of ice and leaving the ice to melt in an open system, which would not work. Candidates did not read the question which informed them, ' You are provided with a lump of ice weighing between 100 g and 200 g'.

Some candidates did not attempt this question.