CHEMISTRY

Paper 0620/11
Multiple Choice

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

Candidates performed well on this paper. **Questions 1**, **3**, **5**, **9**, **10**, **15**, **19**, **22**, **27** and **30** proved to be the most straightforward with a high proportion of candidates selecting the correct response.

Questions 13, **20**, **21**, **23**, **25**, **32** and **36** were the most difficult for candidates.

The following were common incorrect responses to the questions listed:

Question 13

Response **A**. Candidates did not read the alternative statement (2) carefully and so thought it to be correct.

Question 20

Response **B**. Candidates correctly selected elements “W” and “X” but did not identify that “Y” would also form a basic oxide because it is a transition metal.

Question 21

Response **D**. Candidates did not realise that copper would not react with the two acids.

Question 23

Response **D**. Candidates did not identify that hydroxides, not oxides, are formed when Group I metals react with water.

Question 25

Response **C**. Candidates correctly identified the structure of an inert gas but did not realise that the question specifically referred to helium.

Question 32

Responses **A**, **C** and **D**. This question was not well answered and all responses had a significant number of candidates opting for them.

Question 36

Response **C**. The difference between ethane and ethene was not taken into account correctly.

CHEMISTRY

Paper 0620/12
Multiple Choice

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

Candidates performed very well on this paper. **Questions 1**, **2**, **4**, **6**, **7**, **8**, **9**, **12**, **16**, **18**, **23**, **28, 35, 36, 38** and **40** proved to be the most straightforward with a high proportion of candidates selecting the correct response.

Questions 3, 11, 20, 21, **24**, **25**, **27**, **32**, **33** and **37** were the most difficult for candidates.

The following were common incorrect responses to the questions listed:

Question 3

Response **B**. Candidates were perhaps misled by the related practical task involving the separation of sodium chloride and sand.

Question 11

Response **C**. Candidates selected the correct products for the electrolysis of molten sodium chloride.

Question 20

Response **B**. Candidates correctly selected elements “W” and “X” but did not identify that “Y” would also form a basic oxide because it is a transition metal.

Question 21

Response **D**. Candidates did not realise that copper would not react with the two acids.

Question 24

Response **B**. Candidates did not put “vigorously” and “violently” in the correct order.

Question 25

Response **C**. Candidates correctly identified the structure of an inert gas but did not realise that the question specifically referred to helium.

Question 27

Response **B**. Candidates selected their response from the information in the first part of the question only.

Question 32

Responses **A**, **C** and **D**. This question was not well answered and all responses had a significant number of candidates opting for them.

Question 33

Response **D**. Candidates did not realise than sulfur dioxide causes respiratory problems.

Question 37

Response **C**. The difference between ethane and ethene was not taken into account correctly.

CHEMISTRY

Paper 0620/13
Multiple Choice

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

Candidates performed very well on this paper. **Questions 1**, **2**, **4**, **5**, **9**, **13**, **14**, **18**, **22**, **27**, **30**, **31**, **33**, **37** and **40** proved to be the most straightforward with a high proportion of candidates selecting the correct response.

Questions 8, 12, **15**, **19**, **23**, **25**, **35**, **36** and **38** were the most difficult for candidates.

The following were common incorrect responses to the questions listed:

Question 8

Response **D**. Candidates did not know the meaning of the word “volatility”.

Question 12

Response **B**. Candidates selected aqueous sodium chloride instead of molten (liquid) sodium chloride.

Question 15

Response **B**. Candidates realised that rate would increase but did not fully understand the meaning of the plateau in graph **B**.

Question 19

Response **C**. Candidates did not realise that copper oxide would react to form a blue copper salt in solution.

Question 23

Response **A**. Candidates may have confused density with hardness.

Question 25

Response **C**. Candidates correctly identified the structure of an inert gas but did not realise that the question specifically referred to helium.

Question 35

Response **A**. Candidates referred to the composition of air but did not account for the word “exhaled” in the question.

Question 36

Response **C**. The difference between ethane and ethene was not taken into account correctly.

Question 38

Response **A**. Steps “X” and “Y” were correctly identified but step “Z” should have been combustion.

CHEMISTRY

Paper 0620/21
Core Theory

Key Messages

- Some candidates would benefit from more practice answering questions requiring extended answers especially those about the reaction of acids with metals and metal oxides, acid-base titrations and diffusion.
- Many candidates would benefit from more practice at answering questions on specific tests for ions and unsaturated compounds.
- Candidates should be reminded to read the stem of the question carefully and not repeat or paraphrase the stem as well as to take note of phrases such as 'one other use'.

General comments

Some candidates tackled this Paper well, showing a good knowledge of core Chemistry. The standard of English was generally good. Nearly all candidates were entered at the appropriate level. And responses were seen to all the questions.

The extraction of information from tables of data was generally fairly well done. Many candidates did less well when extracting information from graphs.

As in previous sessions, quantitative tests were not well known.

In organic chemistry, some candidates could answer simple questions about carbon compounds but fewer could identify the OH functional group of alcohols or write the formula of ethanol showing all atoms and bonds.

Many candidates would have benefitted from more revision of practical procedures such as chromatography, acid-base titrations and comparing the energy released when different fuels are burned.

Some candidates performed well on questions involving free response. Others would benefit from more practice in answering this type of question in terms of remembering basic chemical facts and organising their ideas.

Comments on specific questions

Question 1

This was the best answered question in the Paper. Some candidates scored well in **(a)**. Others scored only partial credit. Fewer were able to write the correct molecular formula in **(b)**. In **(c)** some candidates got full credit for balancing the equation. Many others did not score.

(a) Most candidates gave the correct answers to **(a)(i)** and **(a)(vi)**. In **(a)(ii)** a significant number of candidates chose the unsaturated hydrocarbon, B, instead of the saturated hydrocarbons A and D. A wide range of incorrect answers were seen in **(a)(iii)** and **(a)(iv)**. In **(a)(v)** many candidates suggested that compound C is a greenhouse gas. Although many compounds can act as greenhouse gases, release of methane into the atmosphere is far more important in terms of global warming than the other compounds given in the question.

(b) Some candidates were able to deduce the molecular formula of dibromoethane correctly. Others wrote the numbers of atoms in front of the symbols e.g. 2Br4H2C, sometimes with a plus sign between them. Other common errors were CH_4Br_2, $C_2H_2Br_2$ or writing the word 'bromine'.

(c) Some candidates balanced the equation correctly. The commonest error was to balance the oxygen incorrectly, $3O_2$ often being seen. Other errors were to suggest 6 water molecules or to balance the oxygen and water in the correct ratio 10:8 but to forget to double the other species.

Question 2

Many candidates recognised the correct ion in **(a)(i)**. Fewer were successful in gaining credit in the rest of **(a)**. Very few candidates knew the test for chloride ions in **(b)**. In **(c)** most candidates recognised that poly(ethene) is a polymer but few were able select the correct word for the second gap in the sentence.

(a) (i) Many candidates recognised that the sodium ion was present at the highest concentration. The commonest error was to suggest potassium ions. A significant minority suggested chloride ions.

(ii) Few candidates recognised the correct names for the fluoride and nitrate ions. The fluoride ion was usually called the fluorine ion and the nitrate ion was given a variety of names, the commonest incorrect ones being 'nitrogen oxide' or 'nitroxide'.

(iii) Some candidates were able to calculate the mass of sodium ions in 200 cm^3 of mineral water correctly. Others either gave values which were significantly different e.g. 198 or made simple errors in their calculations.

(iv) Many candidates did not refer to the pH value of 6.8 in the table and suggested 'neutral', possibly assuming that the water would be pure water. A significant minority of the candidates suggested that the pH would be 'strongly acidic'.

(b) Very few candidates knew the test for aqueous chloride ions. Most either suggested adding ammonia or sodium hydroxide. Others suggested electrolysis or adding litmus. A significant number of candidates did not respond to this question.

(c) Most candidates correctly identified poly(ethene) as a polymer but few were able select the correct word for the second gap in the sentence. The commonest error was to suggest 'saturated' instead of 'monomer'. A few candidates wrote monomer in the first gap and polymer in the second gap.

Question 3

This question was one of the least well done on the Paper. Many candidates could identify the alcohol functional group in **(a)** but few could give the correct test for an unsaturated compound in **(b)**. Few candidates scored more than minimal credit for **(c)** whilst in the chromatography question only the higher scoring candidates obtained credit in **(d)(ii)** and **(d)(iii)**.

(a) Many candidates identified the alcohol functional group correctly. Common errors included putting a circle around the CH_2-CH_2OH group or the C-OH group.

(b) Few candidates knew the test for an unsaturated compound using aqueous bromine. Many did not realise that a chemical test was required and wrote about heating, burning, diluting with water or using steam. Many candidates did not respond to this question.

(c) (i) A few candidates obtained credit for suggesting that maceration extracts the pigment or that the solvent dissolves the pigments. Others gave vague answers such as 'shows the colours', 'so that you can use chromatography' or 'so as to separate the pigment'.

(ii) A minority of the candidates realised that a lot of pigment would be absorbed onto the filter paper. Others gave vague answers such as 'so you can see the colour change', so there is no residue to separate' or 'because there is no need to filter'. Many candidates did not respond to this question.

(d) (i) Many candidates identified the procedure as chromatography. The commonest incorrect answer was 'filtration'. Other common incorrect answers included 'diffusion' or 'distillation'.

(ii) Some candidates placed the spot of pigment just above the solvent level. The commonest incorrect answer was to place the spot half in and half out of the solvent. A significant number of candidates placed the spot either below the solvent level or near the top of the paper.

(iii) Few candidates realised that the solvent might evaporate or that the atmosphere in the jar should be saturated with solvent vapour. Some candidates gave vague answers such as 'so the experiment doesn't get contaminated' or 'so the solution (rather than the solvent) doesn't get out'. A significant number of candidates suggested that there might be a reaction between the air and the solvent or the spots.

(iv) Many candidates gave identified the spots correctly. Others gave only A or C as the answer rather than both. A significant number of candidates chose D.

(e) A few candidates drew the structure of ethanol correctly showing all atoms and all bonds. Others drew the structures of ethene, ethane or other hydrocarbons. Other common errors included joining a hydrogen to the carbon atom (C – H – O) or missing out hydrogen atoms altogether.

Question 4

Many candidates gave good answers to **(a)**, **(e)** and **(f)(iii)**. Fewer could describe in **(c)** why the water in the can needs to be stirred. Others wrote too vague a definition of an alloy in **(f)(i)** and could not explain why tin prevents the steel from rusting in **(f)(ii)**.

(a) Many candidates realised that the thermometer was the essential piece of apparatus missing from the diagram. The commonest answer which was not accepted was 'stirrer'.

(b) Many candidates suggested one factor which should be kept the same in the experiment. Few suggested two correct factors. Others gave vague statements relating to 'the same solvents', the 'same room temperature' or 'the same top pan balance'.

(c) Few candidates could describe why the water in the can needs to be stirred. Common incorrect answers included 'to speed up the reaction', 'so the reaction can occur' or 'to make the molecules attract each other'.

(d) Many candidates realised that the mass of the burner would decrease. Few gained the second mark for the idea that on combustion, gases were formed. The commonest error was to suggest that the liquid evaporated. Others suggested that the mass decrease was due to the 'energy given out' or 'the product being used'.

(e) Many candidates calculated the greatest temperature change correctly. The commonest error was to suggest G, which had the highest final temperature but a relatively high starting temperature.

(f) (i) A minority of the candidates gave a suitable definition of an alloy. Many did not gain credit because they suggested that an alloy is a compound or referred to the properties of an alloy rather than its structure.

(ii) Few candidates gave a satisfactory explanation why tin prevent steel from rusting. Many candidates just paraphrased the stem of the question by writing statements such as 'it protects the steel from rusting'. Few candidates referred to a layer covering the steel. Many suggested that tin rusts. Others referred to irrelevant properties such as thermal conductivity or strength. A significant proportion of the candidates did not respond to this question.

(iii) Many candidates identified silicon dioxide as a giant covalent structure. The commonest error was to suggest a giant ionic structure.

Question 5

Some candidates could describe the reaction of acids with metals and metal oxides in sufficient detail to obtain full credit in **(a)**. Others appeared not to have learnt this section of the syllabus. A greater number of candidates could identify an exothermic reaction in **(b)**. Many candidates were able to deduce the number of protons, neutrons and electrons in two isotopes of uranium in **(d)**. In **(c)**, fewer could give a use of a radioactive isotope which did not involve the production of energy.

(a) Many candidates did not respond to this question. A minority of candidates obtained more than half the available credit. Others wrote vague statements such as 'acids corrode the metal'. Many did not read the stem of the question properly and gave neither word equations nor the names of specific acids, metals or metal oxides.

(b) Some candidates could identify an exothermic reaction from the temperature change. The commonest error was to suggest ‘endothermic’.

(c) A minority of candidates gave a suitable use of radioactive isotopes not involving energy production. Many did not read the stem of the question carefully enough and suggested ‘nuclear fuels’ or ‘nuclear bombs’. Others gave the names of radioactive elements such as plutonium or neptunium.

(d) Many candidates deduced the number of protons, neutrons and electrons in the two isotopes of uranium correctly. The commonest error was to suggest 235 and 238 electrons. A minority of the candidates suggested 92 neutrons in both isotopes.

Question 6

Some candidates scored well on this question, especially in **(a)(i)**, **(a)(iii)** and **(a)(v)** (all relating to rate of reaction). Many did not score well in **(a)(iv)** (graphical interpretation of reaction rate) or **(b)** (carrying out a titration).

(a) (i) Many candidates obtained partial credit for this question. A significant number of candidates did not refer to the horizontal part of the curve where the concentration remained constant and so did not obtain full credit.

(ii) Some candidates deduced the time taken for the concentration of sodium hydroxide to fall to 0.15 mol/dm^3 correctly. Others gave inaccurate values, 3 minutes 45 seconds and 3 minutes 50 seconds being common errors. Some did not do the calculation properly and gave an approximate value of 4 hours.

(iii) Many candidates deduced the time correctly. Others gave values which were far too low e.g. 8 hrs 25 minutes or far too high e.g. 12 hours.

(iv) Few candidates obtained full credit for drawing the line when the concentration of bromobutane is increased. Common errors included: drawing a line parallel to the original line; drawing a line starting at zero and levelling off at about 0.2 mol/dm^3 or drawing a line above the original.

(v) Many candidates identified one other correct method of increasing the rate of reaction. The commonest errors were to suggest increase in pressure or changing the temperature (instead of increasing the temperature).

(b) Few candidates knew the procedure for an acid-base titration. Credit was most often given for the careful addition of acid to alkali. Many candidates ignored the burette and suggested that the titration be carried out in the volumetric pipette. Few mentioned the use of the indicator. Those did often placed the indicator in the burette or pipette. A considerable number of candidates did not respond to this question.

(c) A minority of the candidates drew the electronic structure of hydrogen chloride completely correctly. Others either added extra non-bonding electrons to the hydrogen or drew an ionic structure not showing the hydrogen atom. A small number of candidates drew the structure as H_2Cl or H_4Cl.

Question 7

This question was the least well done on the Paper. Some candidates gained credit for **(a)** (fertilisers) and two out of the three marks for **(f)** (electrolysis). Few candidates obtained credit in **(b)**, **(c)**, **(d)** and **(e)** (mainly inorganic chemistry).

(a) Some candidates gave correct answers relating to increase growth of crops. Others gave answers which were too vague e.g. ‘to make crops healthy’, ‘to make soils better’ or ‘to give the earth more minerals’.

(b) Few candidates identified the reaction as neutralisation. The commonest errors were to suggest ‘addition’, ‘displacement’, ‘exothermic’ or ‘endothermic’. Others gave answer which did not refer to types of reaction e.g. ‘covalent’.

(c) Many candidates did not read the question properly and suggested 'ammonium sulfate'. The commonest errors were to combine nitrogen compounds with sulfates e.g. sulfate of nitrate' or 'sulfur nitrogen'.

(d) Few candidates deduced the correct simplest ratio of ammonium to sulfate ions. A common error was to write sulfate 6: ammonium 12. A significant minority of the candidates did not count the ions correctly or reversed the ratio (1 ammonium to 2 sulfate).

(e) A minority of candidates obtained partial credit. Very few obtained full credit. Many candidates wrote vaguely about 'slaked lime removes the nitrogen' or 'nitrogen can be taken in'. Many just repeated the information given in the equation and wrote 'sodium sulfate is formed'. A significant number of candidates did not respond to this question.

(f) Some candidates obtained full credit. Others did not identify the anode or cathode and wrote potassium and chlorine in both columns or gave the substance that the anode and cathode could be made from (graphite). Many candidates gave chloride instead of chlorine at the anode. Others gave chlorine at the cathode and potassium at the anode.

Question 8

A few candidates performed well on this question. Many candidates used the information in the table in **(b)(i)** to predict the state of astatine. Others did not score many marks because they did not understand the process of diffusion in **(a)** or give convincing arguments in **(b)(ii)** or gave the incorrect formula for astatine in **(b)(iii)**.

(a) Some candidates explained the process of diffusion well. Others did not use the word diffusion or could not explain it in terms of movement of particles. The credit given most often was for the idea of iodine crystals dissolving in the solvent. A significant number of candidates did not respond to this question.

(b) (i) Many candidates suggested that astatine should be solid at room temperature. The commonest error was not to use the trend in the table and suggest gas or liquid.

(ii) Many candidates repeated information in the stem of the table e.g. 'heat is given off by astatine'. The few candidates who suggested that the heat or energy was sufficient to melt the solid gained the mark. Many wrote vague statements such as 'because of the heat' or 'because of the melting point'.

(iii) The commonest error was not to recognise that the halogens are diatomic molecules. Most wrote 2At or At in the space in the right. Many candidates ignored astatine and wrote I or I_2 in the space on the right.

CHEMISTRY

Paper 0620/22
Core Theory

Key Messages

- Some candidates would benefit from more practice answering questions requiring extended answers especially those about chemical structures and kinetic particle theory.
- Many candidates would benefit from more practice at answering questions on specific test for ions and unsaturated compounds.
- Most candidates would benefit from more revision of environmental chemistry such as flue-gas desulfurisation and the uses of compounds such as calcium oxide.

General comments

Many candidates tackled this Paper well, showing a very good knowledge of core Chemistry. The standard of English was generally good. Nearly all candidates were entered at the appropriate level and few candidates scored less than one fifth of the available credit. Most candidates responded to all questions

The extraction of information from tables of data was generally well done but many candidates did less well when extracting information from graphs.

As in previous sessions, quantitative tests were not well known.

Some candidates showed a good ability at doing calculations. Others would benefit from more practice at this type of question. Many candidates could balance equations when given appropriate formulae. Some did not succeed in balancing equations where a product had to be inserted. Generally only high-scoring candidates could write a simple symbol equation when given minimal information.

In organic chemistry, many candidates could deduce the formula of a simple hydrocarbon and recognise a carboxylic acid functional group. Few could describe the simple characteristics of a homologous series or relate the various parts of a fractional distillation column to where the temperature is lowest, where the petroleum enters and where the heaviest fraction exits the column.

Some candidates exhibited a sound knowledge of inorganic structures such as graphite and sodium chloride. Others would benefit from more revision in this aspect of chemistry, especially as regards the correct terminology for ions. atoms and molecules.

Comments on specific questions

Question 1

This was the best answered question on the paper. Most candidates were able to interpret the electronic structures in **(a)** and many obtained full credit.

(a) Most candidates gave the correct answers for **(a)(i) - (a)(iv)**. Fewer candidates identified the element in Period 4 of the Periodic Table in **(a)(v)**, the commonest errors being to suggest C or D. The commonest errors in **(a)(vi)** were to suggest A or B.

(b) Most candidates identified the correct words to fill the spaces. The commonest errors were: reversing neutrons and protons; suggesting that isotopes have different numbers of nuclei and writing ‘molecules’ instead of atoms.

Question 2

Many candidates were able to extract the information from the table. Others did not name the ion, **X**, correctly in **(a)(ii)** or made errors in calculating the mass of sugars in 250 cm^3 of apple juice in **(a)(iv)**. Few candidates knew the test to distinguish between saturated and unsaturated compounds. A majority of the candidates were able to identify the correct pH and the carboxylic acid functional group in **(c)**.

(a) (i) Most candidates identified the chloride ion correctly. The commonest error was to suggest sugars.

(ii) Many candidates knew the name of the SO_4^{2-} ion. Others made guesses and incorrect names such as sulfur oxide, sulfur ions and sodium oxide were not uncommonly seen.

(iii) A majority of the candidates wrote the formula of magnesium chloride correctly. The commonest error was to suggest $MgC\mathit{l}$. A minority of candidates suggested $Mg_2C\mathit{l}$.

(iv) Many candidates were able to calculate the mass of sugars in 250 cm^3 of apple juice. Others did not understand proportion and gave incorrect answers such as 4.16. Many others made mathematical slips resulting in incorrect answers such as 24 or 27.

(b) A minority of candidates gave the correct test to distinguish between unsaturated and saturated compounds. Some of those who identified the reagent (aqueous bromine) correctly went on to suggest that the solution was decolourised by the saturated compound. The commonest incorrect test reagents were litmus or Benedict's solution. A significant number of candidates did not respond to this question.

(c) (i) Most candidates identified the pH of a weakly acidic solution correctly. The commonest error was to suggest pH 1. Few candidates chose the pH values 7, 9 or 14.

(ii) Many candidates identified the carboxylic acid group correctly. The commonest errors were: to circle a C=O group; to circle the H–C–O–H group or to include a C or CH_2 in addition to the COOH group.

Question 3

Some candidates scored well on this question, especially in **(a)**, **(c)(i)** and **(c)(ii)**. Others did not know the test for chloride ions in **(b)(ii)** or had difficulty in interpreting the information about metals in the table in **(e)**.

(a) Some candidates were able to write the word equation correctly including the words sulfuric acid and hydrogen chloride. Others wrote hydrogen sulfate instead of sulfuric acid and hydrochloric acid instead of hydrogen chloride, even though these were in the stem of the question. Many candidates did not use the information in the stem of the question: sulfuric acid was often called hydrogen sulfate oxide or hydrogen sulfuric acid or sulfur oxide hydrogen, A significant minority of the candidates omitted one of the products, usually sodium sulfate.

(b) (i) Many candidates drew good dot and cross diagrams for water. The commonest errors were: to put additional electrons in the hydrogen shell; to give the oxygen atom three lone pairs of electrons or to have only one bonding electron between the oxygen atom and each hydrogen atom.

(ii) A minority of the candidates knew the correct test for chloride ions. Many candidates suggested 'fizzing' or 'solution going colourless'. Others gained one mark of the two available because they only gave the precipitate or the correct colour. A few candidates gave the incorrect colour, the commonest errors being blue, green or yellow.

(c)(i) Most candidates deduced the correct pH at the start of the experiment. The commonest errors arose through not reading the graph carefully enough. The commonest errors were to suggest pH 10 or pH 10.6.

(ii) Many candidates deduced the volume of hydrochloric acid correctly. The commonest errors were to suggest 1.9 (misreading from the graph) and 0.15 (factor of 10 out in misreading graph). Another common incorrect answer was 0.3.

(iii) Many candidates read the volume of hydrochloric acid from the graph correctly. Others did not understand how to deal with the scale and incorrect answers such as 10.4, 10.6, 7.5 and 11 were frequently given.

(d) Some candidates gave good answers referring to the loss of oxygen from the magnesium oxide. Others gave vague or contradictory answers referring to the chlorine rather than the oxygen.

(e) Few candidates obtained full credit. Many just focused on properties of transition elements such as high boiling point or high density. Some candidates seemed to choose the transition element randomly, focusing on one or more of the correct properties but then choosing the wrong letter (generally A). A significant number of candidates stated that transition elements form compounds which are white in colour.

Question 4

Some candidates gave good answers to **(a), (b)(i) and (c)(iii)**. In **(b)(ii)** only the higher scoring candidates could explain why the mass of the flask and contents decreased. In **(c)(i)** and **(c)(ii)** many candidates did not extract information from the graph with sufficient precision. Many candidates knew how different factors affect the rate of reaction in **(c)(iii)**. Others did not obtain credit for this part because they did not answer the question directly. In **(d)** few candidates recognised thermal decomposition and in **(e)** few candidates understood the process of flue-gas desulfurisation or knew other uses of calcium oxide.

(a) Many candidates were able to balance the equation correctly. The main errors arose from writing an incorrect product, usually H_2 or HCl.

(b) (i) Most candidates named the apparatus correctly. The main errors were to suggest that the flask was a beaker and that the balance was a timing device.

(ii) Few candidates could explain that the escape of gas resulted in a decrease in the mass of the flask and contents. The commonest errors were: calcium carbonate dissolving; the reaction is exothermic; evaporation of the reaction mixture.

(c) (i) Many candidates were able to deduce the correct time for the completion of the reaction. Others did not look at the graph carefully enough and gave values below the acccepted range. Few candidates gave values above the acccepted range..

(ii) Many candidates calculated the loss of mass correctly. Others were not precise or accurate enough in their calculations. Many candidates calculated the value to two decimal places rather than three e.g. 0.17 / 0.18 / 0.19 g. Others gave values which differed by a factor of 10 e.g. 1.75 g or more rarely 0.0175.

(iii) Many candidates obtained full credit for describing how the rate varies with particles size, temperature and concentration. Most gave the correct relationship between rate and particle size but fewer candidates described the effect of decreasing the temperature correctly. Some candidates answered the question in terms of time rather than rate. Others tried to give explanations in terms of the kinetic particle theory or the amount of product formed.

(d) Few candidates obtained full credit for naming thermal decomposition. The credit most commonly given was for 'decomposition' (second box down ticked). The commonest incorrect answers were to tick boxes 1 and 4 combustion and exothermic) or boxes 1 and 5.(combustion and oxidation).

(e) (i) Very few candidates understood the neutralisation process in flue-gas desulfurisation. Many thought that calcium oxide is acidic. Others wrote completely off the point e.g. about other atmospheric pollutants or the absorption of carbon dioxide. A few candidates obtained credit for suggesting a reaction of sulfur dioxide or acidic gases with calcium oxide. A considerable number of candidates did not respond to this question.

(ii) Few candidates knew a suitable use for calcium oxide. Common errors were: as a slag; making medicines; limestone; air balloons. A considerable number of candidates did not respond to this question.

Question 5

This question was one of the least well answered on the Paper. Many candidates wrote conflicting or inaccurate statements in the extended question describing the similarity and differences between graphite and sodium chloride. Few candidates gave a convincing definition of the term 'element' in **(b)(i)** and only a minority of candidates were able to construct the symbol equation in **(b)(ii)**. The identification of the structures in **(c)** was well done by many candidates.

(a) Some candidates described the structures in sufficient detail to obtain full credit. Others referred to bonding rather than structure and tried to relate the structures to their uses. This was not required. Many candidates wrote conflicting statements about sodium and chlorine atoms or molecules. Many candidates mentioned van der Waals' forces in relation to both graphite and sodium chloride. Candidates at this level should be reminded that van der Waals' forces are not part of the syllabus and their inclusion in answers often serves only to confuse. Few candidates included the concept of giant structures in their answers. A significant number of candidates suggested that carbon is present in sodium chloride - a clear indication that they did not take any notice of the letter *l* in the chloride ion.

(b) (i) Some candidates gave a good description of the term 'element'. Most, however, gave definitions that were far too vague. Many candidates contradicted themselves by using the term, 'compound' or writing statements which referred to different atoms. Other candidates referred to 'a single atom'.

(ii) Some candidates wrote a balanced equation for the complete combustion of carbon and included state symbols (which was unnecessary). Most others did not write the correct species. For example, CO or C_2 were both commonly given as reactants. Other common errors included: writing the equation the wrong way round; making CO a product; writing a word equation instead of a symbol equation.

(c) Many candidates obtained full credit for identifying the structures of four substances from a table of their properties. Most candidates correctly identified the liquid in **(c)(i)** and the giant ionic structure in **(c)(ii)**. The commonest error in **(c)(iii)** was to suggest substance D whilst the commonest error in **(c)(iv)** was to suggest substance B.

Question 6

This question was one of the least well answered in the Paper. Many candidates scored the marks for **parts (a)(ii)**, **(a)(iii)** and **(a)(iv)**. Few candidates could describe the meaning of the term 'homologous series in **(a)**. A minority of candidates scored well in the questions about fuels and cracking (**(b)** and **(c)**).

(a) (i) Few candidates gave a convincing definition of the term 'homologous series'. Many just referred to alkanes or muddled the definition of homologous series with the definition of hydrocarbons. Many wrote statements which were far too vague e.g. 'they have the same characteristics'. Many suggested that the members of the same homologous series have 'similar physical properties' or 'different chemical properties'.

(ii) Most candidates were able to deduce the molecular formula of pentane correctly.

(iii) Most candidates described the increase in boiling point correctly.

(iv) Many candidates were able to deduce the density of liquid ethane correctly. The commonest error was to give too low a value. Very few candidates gave too high a value.

(b) Many candidates could not give the name of a solid fuel. More were able to identify a liquid fuel, petrol and diesel being the commonest correct answers. Many candidates chose substances which were not fuels e.g. bromine and iodine. Others chose petroleum, which was not accepted. Many candidates chose two hydrocarbons from the table, often butane and pentane.

(c) (i) Few candidates identified all three parts of the distillation column correctly. The place where the petroleum enters was most often correct. The place where the temperature was lowest was rarely correct, many candidates placing the X, half way down the column, near the bottom of the column or outside the uppermost tube.

(ii) Few candidates wrote a correctly balanced equation although many gave the correct formula for either hydrogen or ethane but rarely both. Common errors were: C_2H_6 as the formula for ethene; CH_3 + CH_3; C_2H_5 + H; CH_2 as the formula for ethene.

(iii) Few candidates obtained full credit for describing the conditions needed for cracking. Those who obtained credit usually mentioned high temperature. A significant minority did not obtain this credit because they wrote 'temperature' without qualification. Many candidates did not read the stem of the question properly and wrote about large hydrocarbons being converted to small hydrocarbons rather than stating the conditions. A considerable minority thought that water or air was required for the reaction.

Question 7

Many candidates scored well on this question, especially in **(b)** (balancing the equation), and **(d)** (aspects of the chemistry of aluminium and aluminium chloride). The extended question about the melting of gallium in **(a)** was well done by some candidates. Others were confused about the arrangement and motion of particles in the liquid state. A few candidates could explain why aluminium is used in food containers **(c)**. Others gave properties that were not relevant.

(a) Some candidates understood the change of state from solid to liquid in terms of the arrangement and motion of the particles and gained full marks. Others gave confused accounts, especially when describing the liquid state. For example many suggested that the atoms moved a long way apart and moved rapidly. The commonest marking point scored was for the idea of melting. Many candidates suggested that the particles in liquids moved from place to place. Others tried to answer the question using idea of diffusion of the metal particles throughout the water.

(b) Many candidates balanced the equation successfully. The commonest errors were to leave the Ga_2O_3 product unbalanced or to balance $2Ga_2O_3$ with 2Ga rather than 4Ga.

(c) A minority of the candidates gave two good reasons why aluminium is used in food containers. The commonest correct answers referred to the lack of reactivity of aluminium (oxide). Few went on to refer to the oxide layer. Many thought that aluminium was corrosive. Many candidates gained a mark by referring to less important reasons such as low density or malleability. The commonest errors were to suggest that the electrical conductivity of aluminium was important or that aluminium is a good insulator.

(d) (i) A majority of the candidates placed the arrow under the aluminium foil. The commonest errors were: arrow in the vent tube; under the receiver; arrow at the chlorine inlet.

(ii) Many candidates deduced the structure of Al_2Cl_6 correctly. The main errors were to suggest $AlCl_3$ or Al_2Cl_3.

(iii) Most candidates obtained full credit. A minority of the candidates did not look at the information in the table carefully enough and suggested that aluminium is cheap (rather than cheaper). Others referred to the melting points or suggested that silver was better because it had better conductivity – this despite the fact that the question asked why aluminium was better than silver.

CHEMISTRY

Paper 0620/23
Core Theory

Key Messages

- Many candidates would benefit from more revision on the properties of the halogens (especially their colours and states at room temperature) and in naming halides.
- Some candidates would benefit from more practice answering questions involving balancing equations and deducing chemical formulae.
- Many candidates would benefit from more revision on areas of environmental chemistry such as global warming and the effect of sulfur dioxide on buildings made of limestone.

General comments

Many candidates tackled this Paper well, showing a very good knowledge of core Chemistry. The standard of English was generally good. Nearly all Candidates were entered at the appropriate level. Most candidates responded to all the questions.

Some candidates did not read the stem of the question carefully enough. For example, in **4(b)(iii)** a significant number of candidates chose negative ions with a double charge whereas in **6(a)(ii)** many candidates wrote about the effect of sulfur dioxide on human health instead of its effect on limestone. Some candidates gave vague answers especially in questions involving environmental chemistry.

The extraction of information from tables of data was often well done. Some candidates did less well on questions involving graphs.

Most candidates showed a good ability at doing calculations. Many candidates could balance equations when given appropriate formulae. Others did not succeed in balancing equations where a product had to be inserted. A significant minority of candidates had difficulty in converting a symbol equation into a word equation, especially with the naming of halides.

Some candidates had a good grasp of general inorganic chemistry but a significant number of candidates would have benefitted from revising the properties of the halogens more thoroughly.

In organic chemistry, some candidates could complete the formula of an alcohol, give the correct name to the homologous series of alcohols and identify the carboxylic acid functional group. Fewer were able to deduce the molecular formula for ethanedioic acid.

Comments on specific questions

Question 1

This was one of the highest scoring questions on the Paper. Most candidates scored well in **(a)**, many obtaining full credit. A majority of the candidates could deduce a simple formula in **(b)** and calculate the relative molecular mass sulfur hexafluoride in **(c)**.

(a) Many candidates had a good understanding of chemical structures. Many candidates obtained the mark for **(a)(i)**, the commonest errors being to suggest structures A or structure C. The commonest error in **(a)(ii)** was to suggest structure D. In **(a)(iii)** nearly all the candidates recognised that carbon dioxide is formed when a hydrocarbon burns. In **(a)(iv)** the commonest error was to suggest structure E. A few also suggested structure A. Most candidates scored the mark in **(a)(v)** for linking the structure of graphite to its lubricating properties.

(b) Most candidates were able to deduce the formula of potassium bromide. The commonest errors were: to write irrelevant equations, sometimes including sulfur; K_6Br_6; K + Br.

(c) Many candidates were able to calculate the relative molecular mass of sulfur hexafluoride correctly. The commonest errors were 70 (using atomic numbers) and 51 (using only one fluoride atom). A small number of candidates tried to divide relevant figures e.g. (6 x 19) ÷ 32 rather than adding them.

Question 2

This question was generally well done. Many candidates could describe the arrangement and motion of particles in solid, liquids and gases in **(a)(i)**. In **(a)(ii)** many candidates were able to relate structures to properties. A majority of the candidates knew the composition of the gases in the air in **(b)(i)** but few could explain the use of argon in welding in **(b)(ii)**.

(a) Many candidates scored at least partial credit for understanding the arrangement and motion of the particles in solids, liquids and gases. The liquid state was least well explained, many candidates suggesting that the particles are some distance apart and move fast. Others implied that the particles in solids are able to move from place to place rather than only vibrating about a fixed point.

(b) Many candidates could relate the structures to the properties given in the table. The commonest error in **(b)(i)** was to suggest substance C whist the commonest error in **(b)(ii)** was to suggest either substance C or D. Fewer candidates gained credit for **(b)(iii)** and **(b)(iv)**. In **(b)(iii)** substance A was often chosen incorrectly as a metal perhaps because of its high melting point whilst in **(b)(iv)** a variety of incorrect answers were seen.

(c) (i) Most candidates identified the composition of the gases in the air correctly. The commonest error was to tick the second box down (oxygen 78%, nitrogen 1% and noble gases 21%).

(ii) Few candidates were able to suggest why welding is carried out in the presence of argon. Some recognised that argon is inert / unreactive. Others suggested that argons reacts with the metals or helps to join the metals by acting as a catalyst. Other common incorrect statements were: 'high boiling point of argon', 'the electrical conductivity of argon' and 'argon can withstand high temperatures'. Very few candidates obtained the credit for the idea of argon preventing the air oxidising the metals.

Question 3

This question was the least well done on the Paper. Many candidates could name the mortar in **(a)(i)** and describe the process of chromatography in **(b)(ii)**. A majority of the candidates recognised the carboxylic acid functional group in **(c)(i)** but fewer gave convincing answers to **(c)(ii)** or **(d)**. Few could explain in **(d)(iv)** why carbon dioxide may be harmful to the environment.

(a) (i) Many named either the mortar or the pestle correctly. Common errors included: 'evaporating dish', 'cup' and 'bowl'.

(ii) Some candidates named a correct solvent such as ethanol. A considerable number suggested 'water' through not reading the question properly. Other common errors were 'salt' and 'methane'.

(iii) A minority of the candidates gave a suitable answer. Many wrote vaguely about 'adding more pigment'. A significant number of candidates suggested adding hydrochloric acid or adding more solvent.

(b) (i) Some candidates gave a suitable reason to explain why the spot of dye was not placed too far down the chromatography paper. Others gave very vague answers such as 'to observe the chromatography better', 'must start at the same place', 'wouldn't give an accurate result' or 'to see the difference'.

(ii) Many candidates were able to select two points related to the procedure for carrying out chromatography. The commonest marks obtained were either for placing the paper in the solvent or for putting the lid on the chromatography jar. Fewer candidates mentioned allowing the solvent to run up the paper. Most candidates just referred to the spots separating.

(c) (i) Many candidates were able to identify the carboxylic acid functional group. Common errors were putting rings around: the C–O–H group; the O–C=O group or the C=O group.

(ii) A minority of the candidates gave the correct molecular formula for ethanedioic acid. Many candidates did not appear to understand the term 'molecular formula'. Common errors included 2COOH, COOH, $(COOH)_2$, $C_2H_2O_6$ and 4O + 2C + 2H.

(d) (i) Some candidates were able to deduce the formula of X (H_2O) by counting atoms in the reactants and products. Others appeared to guess the answer and suggested C or H_2. The commonest error, however, was to suggest H_2SO_4. Candidates should realise that species over the arrow are not included when an equation is balanced.

(ii) This was the least well done part of **3**. High scoring candidates usually recognised that the gaseous products escaped, leaving only the product water which diluted the sulfuric acid. Others only mentioned one of the gases escaping. Many vague or incorrect statements were seen, for example: 'the reaction is finished', 'the acid has been reduced', 'the reactant is too strong' or 'the sulfuric acid is in excess'.

(iii) Some candidates gave a suitable source of carbon dioxide. The commonest correct answers were 'respiration' or burning fossil fuels'. Others wrote answers which were too vague e.g. 'burning' or 'fossil fuels' without further qualification. Many answers were far too vague e.g. 'from cars', 'from factories', 'photosynthesis' or 'plants'.

(iv) A minority of candidates were able to identify global warming or greenhouse gas to score partial credit. Very few candidates obtained full credit and only a minority referred to the effects of global warming. Many did not gain credit because they suggested that the 'heat from the sun is trapped in the atmosphere' or that 'the Earth warms up' rather than 'he atmosphere warms up'. Many gave vague answers such as 'bad for health' or 'the gases are harmful'.

Question 4

This question was the highest scoring in the Paper, most candidates obtaining credit for **(b)(i)**, **(b)(iv)** and **(c)(i)**. Some candidates omitted the filter paper in **(a)** and / or made errors in writing the formulae of the ions in **(b)(ii)**. **Question (b)(iii)**, which required interpretation of information from the table, proved to be the most difficult part of **Question 4**.

(a) Many candidates obtained full credit for drawing a good labelled diagram of filtration apparatus. Some candidates did not include the filter paper in their diagrams or placed the filter paper unfolded over the top of the funnel. Others did not read the instructions carefully enough and did not label their diagrams. A few candidates drew diagrams of distillation apparatus rather than filtration apparatus.

(b) (i) Most candidates named the salt potassium nitrate correctly. The commonest error was to add an oxygen to the name e.g. 'potassium nitrate oxide' or 'potassium nitroxide'. A significant number of candidates suggested 'potassium carbonate'.

(ii) Many candidates were able to write the symbols for the ions present in sodium carbonate correctly. The commonest incorrect answer was to give the sodium ion a 2+ charge. Another common error was to give the carbonate ion a single negative charge.

(iii) This was the least well done part of **Question 4**. Many candidates ignored the instruction in the stem of the question about a singly charged ion and suggested calcium sulfate. A minority of candidates suggested other substances containing ions with a double negative charge e.g. sodium carbonate or potassium sulfate.

(iv) Nearly all candidates were able to calculate the total mass of the compounds present in the mixture and calculate the percentage by mass of magnesium sulfate. The commonest errors involved the percentage by mass calculations where 10% and 13.5% were occasionally seen.

(c) (i) Many candidates completed the equation correctly. The commonest errors were to suggest oxygen, or occasionally water.

(ii) Most candidates chose the correct pH value. The commonest error was to suggest pH 7.

Question 5

Some candidates scored well on this question. Others found many parts difficult, especially **(b)** (structure of methanol), **(c)(ii)**, (hazards associated with reaction products) and **(d)(iii)** and **(d)(iv)** (aspects of graphical interpretation).

(a) Some candidates identified the homologous series of alcohols correctly. Others gave the names of specific alcohols such as ethanol. 'Methane' or 'hydrocarbons' were other common errors. A few candidates suggested 'carboxylic acids'.

(b) Some candidates completed the formula of methanol correctly. Others knew that an OH group was involved but either placed the H next to the carbon atom or drew the formula for ethanol. The commonest errors were to draw the structures of methane or ethane.

(c) (i) Many candidates completed the symbol equation correctly. The commonest errors were to use 2 or 4 to balance the hydrogen molecules.

(ii) This was the least well done part of **Question 5**. Many candidates focused on just one of the products. Many gave vague answers such as 'harmful', 'dangerous', 'causes air pollution' or 'is bad for your health'.

(d) (i) Many candidates realised that the concentration decreases with time. Fewer gained the credit available for stating that the concentration then remains constant. Some candidates seemed to think that the question was about how concentration affects rate of reaction and gave answers such as 'the higher the concentration of acid, the faster the rate'.

(ii) Many candidates deduced the concentration of hydrochloric acid correctly. Common errors were to suggest 2.8 (factor 10 difference) or 0.26 (misreading from the graph).

(iii) Some candidates gave values within the correct range. Others gave values which were too low, 40 (hours) being a common error. Few candidates gave values which were above the accepted range.

(iv) Many candidates obtained partial credit for a steeper curve at the start. Fewer obtained the full credit for stating the same final volume. A significant number of candidates started the curve lower than 0.9 (mol/ dm^3) and drew a line parallel to the original.

(e) Many candidates drew the electronic structure of hydrogen chloride correctly. Others either added extra non-bonding electrons to the hydrogen or drew an ionic structure not showing the hydrogen atom. A small number of candidates drew the structure as H_2Cl or H_4Cl.

Question 6

Some candidates scored well on this question. Others found some parts difficult, especially **(a)(i)** and **(a)(ii)** (about sulfur dioxide), and **(d)** (absorption of water by sulfuric acid). Many candidates scored well in **(b)(ii)** (purpose of a catalyst) and **(b)(v)** (calculation of mass of sulfur trioxide).

(a) (i) A minority of candidates gave a good explanation relating the acidic nature of sulfur dioxide to the position of sulfur in the Periodic Table. A significant number of candidates thought that sulfur dioxide is basic and gave a reason related to high reactivity rather than non-metallic character of sulfur. Other candidates gave vague answers such as 'it is acidic because it dissolves to form sulfuric acid'.

(ii) Many candidates obtained credit for suggesting that sulfur dioxide is acidic. Some obtained further credit for the idea of an acidic solution reacting with limestone. Few mentioned that limestone is a carbonate or that carbon dioxide is given off. Many candidates wrote vague or inaccurate statements such as 'sulfur reacts with water to form an acid'. Others did not read the question properly wrote about the effect of sulfur dioxide on humans.

(b) (i) Many candidates gained a mark for suggesting a suitable safety precaution. Others gave precautions of lesser importance such as 'wear a lab coat'. Credit was given for those precautions which prevent exposure to the skin, eyes or nose.

(ii) Most candidates understood the purpose of the catalyst. Some candidates were not awarded the mark because they wrote vague statements such as 'it increases the reaction' or 'to get sulfur trioxide'.

(iii) Some candidates completed the equation correctly. Others wrote CO_2 or H_2O in the space on the left instead of O_2. Other common errors were $3SO_3$ on the right and / or $2O_2$ on the left.

(iv) Some candidates wrote good answers referring to stopping a vapour (or liquid) being formed. Others wrote vaguely about 'cooling the flask down', that 'the melting point is 17°C' or 'the sulfur trioxide is too hot'.

(v) Many candidates did the calculation successfully. Common incorrect answers were 128 or 144. Some candidates tried to do mole calculations instead of simple proportion. Candidates should be reminded that the use of moles is not required in this paper.

(c) (i) Some candidates suggested, correctly, that a volumetric pipette should be used to place 25.0 cm^3 of sodium hydroxide solution into the flask. The commonest error was to suggest that a measuring cylinder be used

(ii) Some candidates gave a good reason for the determination of the neutralisation point, involving a colour change of the indicator. Others suggested using a pH meter, which was not mentioned in the stem of the question. Many candidates gave vague answers such as 'when it reaches pH 7', 'when a salt is produced' or 'when there is no more fizzing'.

(d) Some candidates realised that water vapour in the air had been absorbed by the sulfuric acid and so diluted it. Other candidates just referred to gases being absorbed by the acid or the solution reacting with the air. A number of candidates ignored the statement in the stem of the question that the sulfuric acid becomes diluted and suggested that the solution evaporates.

Question 7

Many candidates gave good answers to **(b)**, (identification of diatomic molecule), **(c)** (electronic structure of the fluorine atom) and **(d)** (construction of a word equation from a symbol equation). A few candidates obtained full credit for **(a)** but most obtained only partial credit because they did not have sufficient knowledge of the properties of the halogens.

(a) Few candidates obtained more than partial credit. Many candidates gave incorrect states for bromine (often suggested to be a solid) and iodine (usually suggested to be a liquid). The colour of bromine was best known. The colour of chlorine was often given as colourless and the colour of iodine was almost invariably given as brown. Many candidates did not comment on the reactivity of the halogens. Many of those that did suggested that iodine was the most reactive.

(b) Most candidates recognised that chlorine is diatomic. The commonest incorrect answer was ionic. A small number of candidates suggested monatomic.

(c) Many candidates drew the correct electronic structure of fluorine. The commonest errors were to draw one electron in the outer shell (often as 2,8,8,1) or to draw too many inner shells of electrons. A few candidates drew a fluorine molecule instead of a fluorine atom.

(d) Many candidates answered this question correctly. Others named the halides incorrectly as potassium iodine and / or potassium bromine. A few candidates wrote incorrect oxidation numbers. The use of oxidation numbers to name compounds is not required for the core paper.

CHEMISTRY

Paper 0620/31
Extended Theory

Key messages

Where a question asks for an equation the requirement is for a balanced symbol equation. Word equations are appropriate only when the question specifically asks for a word equation.

The halogens, nitrogen, oxygen and hydrogen all form diatomic molecules – hence they should be shown as such in equations (N_2 for example).

The terms ion, atom and molecule are not interchangeable

General comments

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

Comments on specific questions

Question 1

(a) The majority of candidates obtained full credit on this question. A very small minority reversed the pH scale (so low numbers were alkaline) but still obtained credit for the pH of water.

(b) Very few candidates obtained full credit – but many obtained partial credit by stating that one of the acids was strong or fully ionised but not linking that to the concentration of hydrogen ions in the solution.

(c) Despite the question asking for a another method other than measuring the pH, a very large number of candidates suggested the use of universal indicator. Of those that selected to look at the rate of a reaction a significant number could not be credited as they were vague about the substance with which the acid was to be reacted – just stating "metal" is insufficient as some metals do not react with acids. A number of candidates suggested doing a titration – despite having already been told the acids were of the same concentration.

Question 2

(a) While some excellent answers were seen there were also many answers which indicated a very poor understanding of how the properties of graphite are related to its structure. The two most common errors were stating that the gaps between the layers left space for electricity to flow or that the bonds were weak so the atoms could move. It should be noted that to conduct electricity the electrons have to be free to move throughout the structure, electrons being delocalised does not mean a substance will conduct electricity – benzene has delocalised electrons yet benzene is a non-conductor.

(b) Most candidates correctly stated that graphite was used as lubricant or in pencils. However, many candidates were vague in the use they stated based on graphite's electrical conductivity; simply stating "electrolysis" – this is insufficient since there are a number of components in an electrolysis circuit while only the electrodes can be made of graphite

(c) In **(c)(i)** a few clear descriptions of the structure of silicon(IV) oxide were seen, but many answers described structures with incorrect valencies for silicon or oxygen or, rather carelessly, described structures containing carbon. In **(c)(ii)** many candidates were able to predict correctly two properties of both silicon dioxide and graphite.

Question 3

(a) Despite the question asking for two uses other than making sulfuric acid, one of the most common answers was to state sulfur dioxide was used to make sulfuric acid. Other common errors included giving uses of sulfuric acid or an environmental problem caused by sulfur dioxide. Candidates must ensure they answer the question that has been asked rather than the question asked in a previous year or the question they wanted to be asked.

(b) Some very good answers were seen but again vague answers or ones that did not fully address the question were common. A surprising number of candidates thought electrolysis would be a suitable method.

(c) In **(c)(i)** only a minority of candidates could correctly state the formula of vanadium(V) oxide, many thought that the (V) indicated five vanadium atoms should be included in the formula. In **(c)(ii)** it was common to gain partial credit for a correct reference either to yield or energy – few candidates commented on both aspects. In **(c)(iii)** relatively few candidates gave correct explanations, although most could state that the yield and rate would be higher. It was a common misconception that increasing the pressure gave the particles more energy and there were many answers with contradictory statements regarding the position of the quilibrium – stating that the yield of sulfur trioxide increased and the position of equilibrium moved left. It should be noted that while there are fewer gaseous moles on the right of the equilibrium there are not fewer gaseous moles in the forward reaction.

(d) This was clearly not very well known or understood. Although some answers were correct, some thought that the problem was that the sulfur trioxide would not react or would make a product other than sulfuric acid.

Question 4

(a) In **(a)(i)** only a minority of candidates stated that there would be insufficient oxygen higher up in the Blast Furnace and so the carbon dioxide (formed lower down) would react with carbon. Many gave answers based on the relative densities of the gases – this cannot be a valid argument as there is a flow of gas through the furnace from the bottom (where hot air enters) to the top (where waste gases exit). Many of the equations seen in answer to **(a)(ii)** did not have iron as a product (although oxides of iron were commonly seen – despite the act that the Blast Furnace is used to obtain iron), a significant number who did have iron as a product failed to score as they had iron as being diatomic; equations are not balanced by changing formulae – the stoichiometric coefficients must be changed.

(b) Most candidates obtained credit in **(b)(i)** but in **(b)(ii)** many candidates gave an incorrect formula for silicon(IV) oxide. The majority of candidates obtained full credit in **(b)(iii)** but a number of odd reasons were given in **(b)(iv),** including a common error in thinking that molten iron was unreactive.

(c) Most candidates obtained credit in **(c)(i)** although a few thought that hydrogen was required. Many answers seen to **(c)(ii)** were very poor – candidates had not read the question carefully. The question stated that aluminium coated with aluminium oxide is protected from further corrosion, hence answers that just stated the aluminium oxide formed a protective coating were merely repeating the information in the question that they should have been explaining and so could not be credited.

(d) In **(d)(i)** the credit was awarded most commonly for stating that zinc is more reactive than iron. Many candidates obtained no further credit. Very few answers considered that when the zinc reacts it loses electrons and that these electrons flow through the wire to the steel and prevent the atoms in steel from losing electrons. A common error was to state that zinc rusts (only iron or steel can rust). It was very common in **(d)(ii)** to see arrows in the sea-water (the electrolyte) – electrons are responsible for the conduction of electricity only in metals and graphite, in aqueous solutions it is the movement of ions. Few correct equations were seen in **(d)(iii)**, only a minority of candidates gave hydrogen as being a diatomic molecule and many had the charge on the hydrogen ions wrong.

Question 5

(a) Most candidates cited the reaction between nitrogen and oxygen, but far fewer linked the reaction to the high temperatures in the engine. Some candidates incorrectly stated that the oxides of nitrogen were products of complete (or incomplete) combustion of the fuel.

(b) Some excellent and highly detailed answers were seen, the very best of which included correct equations for the reactions. Some candidates did not fully answer the question and did not consider all of the pollutants. A common misconception was that the catalytic converter acted as a filter and trapped the pollutant gases in some way.

(c) While many correct answers were seen, many candidates appeared to have guessed – resulting in lead compounds being blamed many environmental problems including global warming, acid rain and damaging the ozone layer. A common error was to state that they prevented the blood carrying oxygen – some confusion with carbon monoxide being evident.

Question 6

(a) In **(a)(i)** only a minority of candidates managed to name both of the acid and alcohol required, of those candidates that obtained partial credit more were able to name the alcohol than the acid. Most candidates were able to obtain partial credit for two of the first three points in **(a)(ii)**, a common error was to add together the moles of each reagent to determine the number of moles of product formed.

(b) Some excellent answers were seen, although many candidates seemed to have little idea of what an ester linkage was – despite one being shown in the structure towards the top of the page. Some candidates managed to correctly draw the ester link correctly, but did not realise that the monomer units needed to alternate or that being a polymer there needed to be an indication that the structure continued to each side.

(c) In **(c)(i)** many candidates scored well on this part although a significant number mixed up the results for saturated and unsaturated compounds or failed to state the starting colour of bromine somewhere in their answers. Most candidates who correctly identified "ester 1" were also able to explain why. It was common for candidates to score just partial credit in **(c)(iii)** with salt and alcohol being the common correct answers.

Question 7

(a) Part **(a)(i)** was poorly answered, the most common errors being incorrect formulae – monatomic nitrogen or triatomic lithium were often seen. While some excellent diagrams were seen in **(a)(ii)** candidates should be reminded that diagrams should be drawn large enough so that the "x" and "o" symbols can be seen clearly.

(b) Many fully correct diagrams were seen, the most common error being the omission of one or more of the non-bonding pairs of electrons.

(c) Many candidates incorrectly stated that covalent bonds were weak – they are not. Substances with simple molecular substances have relatively low melting/boiling points due to weak intermolecular forces. Some candidates referred to intermolecular forces in the ionic compound – this shows a clear lack of understanding between the types of particles involved in different structures.

CHEMISTRY

Paper 0620/32
Extended Theory

Key Messages

If candidates are asked to give a specified number of answers e.g. **one** use, **two** reasons and so on, it is not advisable, nor is it in the candidate's interest to give more than the specific number of answers requested.

Knowledge of all parts of the syllabus is very important.

Each question should be read carefully and the point of the question should be directly addressed.

General Comments

Make handwriting legible. This particularly applies to names of an alkene or an alkane is written where it is very important to show whether the ending is –ane or –ene.

Organic diagrams should be drawn so the bonds connect to the correct atoms.

Candidates should try to avoid using long sentences which can make understanding less clear or even introduce contradictions. The use of short phrases or bullet points is acceptable.

Comments on Specific Questions

Question 1

(a) This was a recall question. The two expected responses were either 'foodstuffs' or 'drugs'. Many candidates assumed erroneously that in everyday life, water must be pure.

(b) (i) Candidates were able to score well here and many secured full credit. Some candidates were confused over when to use simple and fractional distillation. Also the question was also not always read carefully enough to identify correctly which part of the mixture was required so the sea water was often evaporated.

(ii) It was evident that the practical skills of some candidates are not as strong as might be expected. Many candidates assumed the mixture was already in water so very few gained credit for dissolving part of the mixture of solids. Workable methods often wrote about 'heating to crystallisation' but they missed cooling/crystallisation at the end and then explained at great length that the crystals should be washed and dried

Question 2

(a) This question was answered well. Most were aware that aluminium exists as an Al^{3+} ion, although the occasional Al^{2+} ion was seen. One common error was to remove three electrons from this positive ion to form an atom.

(b) (i) Most candidates scored full credit here. Several obtained partial credit for the correct formulae of the products but omitted to balance the equation. Some candidates were distracted by the reactant formula, $AlCl_3$ and assumed the product must be $NaCl_3$.

(ii) Most candidates knew that the procedure to extract sodium metal was 'electrolysis' but a large majority of these did not state that the sodium chloride must be molten. A significant minority of candidates stated 'electrolysis of aqueous sodium chloride' clearly indicating that due thought had not been given to the question or suggesting that they had not seen the action of sodium in water.

(c) **(i)** All but a few knew 'bauxite' was the major ore of aluminium.

(ii) This was not a familiar process to many candidates and they struggled to apply their knowledge to the information given in the question. A very wide range of improbable reactions were suggested, some of which seemed to produce aluminium. Occasionally candidates drew on their knowledge of qualitative analysis and gave precipitate colours. Very few mentioned filtering the mixture after reaction.

(iii) This is a typical type of question in which **two** reasons were asked for yet many candidates chose to give three (or more) reasons which often compromised some correct answers. Cryolite was often stated to be reducing the melting point of *aluminium* rather than the alumina in the electrolyte. A few responses gave creditworthy mentions of increasing conductivity seen but reduced melting temperature was more frequently correctly linked to reduced cost or energy reduction. Responses stating that cryolite was a solvent received no credit as this information formed part of the question. Many of the candidates who gave more than two reasons referred to cryolite being added as a catalyst. This incorrect answer would contradict an earlier correct answer.

(iv) A question of this nature does require a little planning, in order to ensure that all points are covered.

Some candidates confused the electrolytic extraction of aluminium with the Blast Furnace and thought carbon was directly reducing the ore and CO_2 and CO were produced as waste gases.

Candidates need to be aware that reference to *oxygen* ions and *fluorine* ions rather than ox*ide* and fluor*ide* is incorrect chemistry.

(d) **(i)** Most candidates were aware that there was an oxide layer (although some described an oxygen coating) but some then failed to qualify it as being protective.

(ii) It was expected that aluminium's good thermal conductivity, high melting point and unreactivity towards the food being cooked were particular properties of aluminium which would make it suitable for making pots and pans. A range of properties were seen including non-(thermal) conductivity and good electrical conductivity.

Question 3

(a) **(i)** Molecular formula was better known than empirical formula. Many confused general formula with empirical formula.

(ii) Good candidates latched on to the fact CH_2 is the empirical formula of alkenes and many drew correct structures of alkene isomers of C_4H_8. The occasional candidate gained credit for a correct structure of methylcyclopropane.

Many 'impossible' structures were seen in which carbon atoms were not tetravalent. Both trivalent and pentavalent carbon atoms were often seen in the same alkene structure.

(iii) In most cases candidates had learnt this definition and responses generally earned full credit. Occasionally the term general formula was confused with the term molecular formula.

(iv) This question required more than the stock answer for justification of organic substances being in the same (or different) homologous series. 'They have the same (or different) functional groups does not apply here as the alkane structure given in the question does not have a functional group. Better candidates were able to explain that one was saturated and the other unsaturated.

(b) (i) Many described the idea of breaking down long-chained (alkane) hydrocarbons to shorter chained (alkene) molecules but frequently omitted to state that heat or a catalyst was required.

(ii) Better candidates used the information given in the question and were able to determine that the original alkane must have been $C_{10}H_{22}$. Several assumed only one mole of ethene was produced and thus C_8H_{18} was frequently seen as an incorrect response.

(c) (i) The question was well answered by most candidates. It was apparent that a minority of candidates had not met this simple addition polymer, but nearly all knew that the two alkeno-carbon atoms lost the double bond between them. A few candidates did not insert the continuation bond either side of the polymer structure and the use of a subscript 'n' was omitted by a significant minority of candidates which meant that they could not be given partial credit.

Connections to methyl groups were often quite poorly drawn. Candidates are advised to be accurate in their drawing of bonds between atoms.

(ii) Candidates need to be certain that the last three letters of a named alkane are clearly '–*a*ne' and do not read as '–*e*ne'.

Some candidates opted to draw a polymer structure, possibly influenced by the content of the previous question.

Question 4

(a) Most candidates were able to state that brass was an alloy of zinc and that copper was the other metal in the alloy.

(b) (i) The majority of candidates secured the partial credit for identifying the correct species in the equation and a high proportion of these candidates obtained full credit by correctly balancing the equation.

A significant number wrote a word equation for the reaction. Candidates need to be aware that in the rare cases where a word equation is required, the question will specifically ask for one.

(ii) Bleaching, sterilising, preserving food and making sulfuric acid were the most frequent responses although some candidates thought sulfur dioxide was manufactured in order to produce acid rain.

(c) (i) The majority of candidates knew that sulfuric acid should be used to convert zinc oxide to zinc sulfate although copper sulfate was a frequently seen incorrect response.

(ii) Achievement in this section seemed to vary across groups of candidates which perhaps represented the result of different teaching in different centres.

Often the positive zinc ion was incorrectly losing electrons or was univalent.

Many misread the second part and produced an equation instead of naming oxygen or water – although credit was given if oxygen and water were seen as the (only) products of an equation.

The third part was the part which was answered most successfully although zinc sulfate often appeared as an incorrect response.

(d) (i) The responses to this question suggested that candidates did not carefully read the question for it told them that the graphite was the positive electrode and the zinc casing was the negative electrode. In some cases candidates did not attempt the question.

(ii) The idea that a paste was needed to facilitate the flow of ions stumped many candidates and frequently no response was given.

(iii) The majority of candidates obtained full credit. A significant minority misread the question and simply (correctly) stated 'Oxidation' and 'Reduction' but failed to give a reason for their choice. Various explanations of the redox changes were accepted.

Question 5

(a) (i) Once again a question which asked for **two** responses was often answered by three (or more) responses and consequently candidates lost credit by supplying incorrect answers alongside correct answers.

Most candidates secured the partial credit for carbohydrates consisting of carbon, hydrogen and oxygen atoms but it was only a minority who knew that the ratio of hydrogen to oxygen atoms is 2:1.

(ii) Nearly all candidates achieved partial credit for showing the correct oxygen bridge linkage but full credit eluded many as the question specifically asked for **three** glucose units in the part structure of starch. The vast majority of candidates gave three units but then included an extra oxygen atom suggesting that their knowledge of what consists of a monomer unit within a polymer is a little hazy.

(b) The phrase 'biological catalyst' frequently secured full credit for nearly all candidates.

(c) (i) This data handling question was well answered and nearly all secured full credit although the inverse order of B, A, C was not uncommon suggesting once again that the question had not been read with care.

(ii) The application of kinetic theory was not well done. For an increased temperature candidates need to be aware that particles have increased energy. This leads to a higher frequency of collisions as well as a higher proportion of collisions occurring above activation energy. Alternative phrasing for each of these points was allowed such as particles move faster, collide more often and more collisions are successful.

(iii) The idea of the enzyme being denatured was appreciated by nearly all candidates.

Question 6

(a) The uses of sulfuric acid were confused with uses of sulfur dioxide and many candidates repeated responses seen in their answer to **4(b)(ii)**. Candidates need to realise that laboratory uses are not considered to be major uses and also that sulfuric acid is not 'a fertiliser' or 'paint' but is used in the *manufacture* of either.

(b) (i) Some rambling responses to a simple question were seen. All that was required was the addition of water (to the product) to turn the mixture green for full credit.

(ii) Most candidates secured at least partial credit. The idea of sulfur dioxide coverting to sulfur trioxide was often omitted and many candidates were unaware that simple addition of water to sulfur trioxide would form sulfuric acid. The second conversion was achieved by many through the method of converting sulfur trioxide first to oleum before (careful) addition of water to form the acid.

(iii) This step-wise calculation proved difficult and sloppy mathematical techniques caused candidates to not gain full credit.

In the first step, the sum 37.2/18 was frequently seen but the answer of 2.07 was frequently left unrounded as 2.06.

The simple subtraction sum of 100g – 37.2g = 62.8g in the next step was not spotted by many candidates and various calculation attempts were seen.

Some were able to carry their error forward in the next step by dividing the answer to step 2 by 152g.

The final step was achieved by dividing the answer to step 1 by the answer to step 3 and rounding to the nearest *whole number* in order to determine the number of waters of crystallisation present.

(c) **(i)** Nearly all knew that nitric acid was the other acid present although there were many alternatives seen.

(ii) This is a difficult equation and the fact that a nitrite forms eluded many. However a significant number of candidates were able to secure partial credit for the correct species and of these, nearly all went on to correctly balance the equation.

Once again, a significant number wrote a word equation for the reaction. Candidates need to be aware that in the rare cases where a word equation is required, the question will specifically ask for one.

CHEMISTRY

Paper 0620/33
Extended Theory

Key Messages

- Candidates should know the differences between the terms 'physical property' and 'chemical property' and be able to quote appropriate examples for types of substance and specific substances referred to on the syllabus.

- Solid compounds such as those made in **6(b)(i)** by precipitation and in **8(b)** by crystallisation will be contaminated by liquid after they are filtered off or left to crystallise. Therefore to make the solid pure, it should be washed using distilled water to remove the contaminants, and dried, for example by pressing between filter papers, to remove the water that was used to wash them.

- Fractions can be used to balance equations, as in **7(c)(i)** i.e.:-

$$3C_4H_{10} + \mathbf{5\ ½}\ O_2 \rightarrow 4C_2H_5COOH + 3\ H_2O$$

- If question asks for a certain number of answers, e.g. as in **Question 7 (a)(ii)** 'state **three** characteristics of a homologous series' candidates are advised to give only the number requested

- Handwriting and presentation continue to be a problem. Names of chemical substances must be spelt correctly and written clearly.

- If a question requests a candidate to name something, this means give the name of. It is advisable not to give a formula as well as, or instead of, the name.

Comments on Specific Questions

Question 1

Melting point and boiling point were often included as chemical properties instead of physical properties in all three sections, as was conduction of electricity. There were several other instances in which chemical properties and physical properties were seen in the wrong places.

(a) Candidates are expected to know that bromine is a brown volatile liquid (physical property) and will displace iodine from an aqueous solution containing iodide ions (chemical property).

(b) Candidates are expected to know that graphite is a good conductor of electricity and is a lubricant (physical properties) and as a form of carbon it would show the chemical properties expected from carbon, such as reduction of certain metal oxides and reaction with oxygen.

(c) Candidates should know that because manganese is a transition metal it is a solid with a high density and high melting point (physical properties) and would form coloured compounds and behave as a catalyst (chemical properties).

Question 2

(a) (i) This was answered correctly by the majority of candidates.

(ii) This was answered correctly by the majority of candidates.

(iii) This was answered correctly by the majority of candidates.

(iv) There were a variety of answers to this question. Many candidates knew that the presence of an impurity would cause a decrease in the melting point although some thought that the melting point would increase. Some candidates referred to change of melting point without mentioning decrease or increase.

(b) (i) This was answered correctly by almost all of the candidates.

(ii) There were many correct answers to this question, although C_6H_{12} was occasionally seen.

(iii) There were many correct answers to this question.

Question 3

(a) (i) There were many correct answers to this question, although, despite the evidence in the diagram, some candidates thought that each carbon atom was bonded to four other atoms in the C_{60} fullerene.

(ii) There were many correct answers, although 840 ÷ 60 = 14 was another common answer as were other factors of 840. A small number of candidates used the Avogadro constant in the calculation.

(b) Water was occasionally suggested as a solvent instead of octane or a liquid hydrocarbon, despite the information provided in the question. Distillation and fractional distillation were occasionally mentioned, despite the fact that they are both used to separate liquids rather than form crystals from a solution. Filtration was sometimes suggested, even though the candidate had not referred to forming a solution first.

(c) (i) This was answered correctly by the majority of candidates. Diamond was occasionally seen, as were metallic elements.

(ii) The mobile sea of delocalised electrons was often mentioned, as was the movement of electrons. It was necessary to refer to both points to achieve full credit.

(iii) Many candidates named two correct potassium compounds that could be formed when potassium is exposed to air. Potassium oxide, hydroxide and carbonate were the most common correct answers. Some candidates gave formulae, even though names were asked for in the question.

Question 4

(a) This was answered correctly by the majority of candidates.

(b) Candidates should be aware that the (overall) reaction occurring in any fuel cell is exactly the same as the reaction that would occur if the fuel was burnt in air/oxygen. A wide variety of formulae of atoms, ions and molecules was seen in answer to this question.

(c) (i) Those who correctly chose the anode needed to mention that movement of electrons from the anode is loss of electrons (which is oxidation). In a cell the anode is the negative electrode from which electrons are released. This is the other way round to electrolysis in which electron gain occurs at the negative electrode (reduction). It is sometimes evident from candidates' answers that they need to recognise the distinction between cells (which convert chemical energy to electrical energy) and electrolysis (in which electrical energy is converted into chemical energy).

(ii) There were a wide variety of answers to this question, many of which involved oxygen or oxide ions instead of hydrogen. A small number of candidates gave a correct ionic equation for the reaction at the anode in an alkaline fuel cell. Since it was not specified whether this fuel cell was acidic or alkaline, this was perfectly acceptable.

(d) Answers to this type of question continue to be vague. Advantages are environmental and economic but statements need to be more specific than 'less pollution', 'no harmful gases', 'cheaper' and 'environmentally friendly'. Those who referred to the lack of production of toxic gases, greenhouse gases, gases causing acid rain and/gave suitable examples of such gases gained credit along with those who commented that fuel cells were more efficient as far as energy was concerned. Others successfully commented that fuel cells used renewable fuels as well as conserving fossil fuels which are non-renewable.

Question 5

(a) (i) Many candidates chose to comment on the fact that the reaction had stopped when the graph levelled off, rather than to explain why the gradient of the graph decreased as requested by the question. The relationship between gradient and rate were only mentioned occasionally. The word concentration was rarely used, although the syllabus does refer to concentration being a factor which affects rate (speed) of reaction. There were several comments made about the catalyst being used up.

(ii) The majority of candidates obtained full credit for this question.

(iii) The reaction in question is a photochemical reaction. Many candidates stated the opposite.

Enzymes and their denaturation were also occasionally mentioned.

(iv) Large numbers of candidates answered this question very well and scored all three marks.

(b) (i) Many candidates scored three marks out of four. Sodium ions and hydroxide ions remain in the solution, therefore the solution becomes a solution of sodium hydroxide. There is no reaction between sodium ions and hydroxide ions and therefore it is inappropriate to write an equation for such a 'reaction'. Occasionally half equations were seen with electrons and/or species on the wrong side. H was occasionally used instead of H_2 as was Cl instead of Cl_2.

(ii) The majority of candidates obtained full credit for this question.

Question 6

(a) This was answered very well by large numbers of candidates, although candidates occasionally referred to different numbers of electrons in the outer shell of rubidium and strontium atoms without saying how many electrons were concerned in each case. Some candidates mentioned the fact that the elements were in different groups in the periodic table without mention of electrons.

(b) (i) Many candidates used strontium carbonate as a starting material to make strontium carbonate.

'Precipitation' means forming an insoluble substance (the precipitate) by mixing two solutions.

The reagents that were suggested should always have been in aqueous solution. Because nitrates and sodium salts are always soluble in water it was appropriate to start with sodium carbonate solution (or rubidium carbonate solution as suggested in the question) and strontium nitrate solution.

(ii) This was answered correctly by large numbers of candidates. Sr or (non-existent) SrCO were sometimes seen instead of SrO, as was CO_3 (also non-existent) as the other product instead of CO_2.

(c) The syllabus requires candidates to describe the action of heat on nitrates of the listed metals. This means identifying (by name, formula and appearance) the products of thermal decomposition of nitrates as well as being able to write equations for such decompositions.

(i) Rubidium nitrate and rubidium nitride (amongst others) were seen more often than rubidium nitrite.

(ii) There were several correct answers seen to this question, although strontium and strontium nitrite were often given instead of strontium oxide.

Question 7

(a) (i) The O-H bond should be shown if all atoms and bonds are requested. The rest of the molecule was drawn well by the majority of candidates

(ii) A small but significant number of candidates read this question as though it referred to a homologous series of carboxylic acids rather than a homologous series in general.

'Characteristics' refers to properties that members of a homologous series have in common or show gradual changes in, as opposed to names and particularly name endings(e.g. –ane, -ene) which were mentioned occasionally.

The same or similar physical properties were occasionally mentioned instead of physical properties that vary in a predictable manner.

(iii) Many candidates obtained full credit for this question. Partial dissociation and the formation of protons/H^+ was expected, rather than reference to pH, concentration, reactivity and corrosiveness, all of which are irrelevant to the meaning of 'the term weak acid(s)'.

(b) (i) The first part of the name of an ester comes from the alcohol used to produce it and the second part comes from the carboxylic acid used to produce it. Therefore methanol produces methyl esters and propanoic acid produces propanoates, so this particular ester is called methyl propanoate.

(ii) There were several correct answers to this question, although ethyl methanoate was seen quite often.

(c) (i) Fractions can be used to balance equations, and in this case 5 ½ O_2 (as well as $3H_2O$) was required. 5 or 6 were often seen instead of 5 ½. Alternatively 11 O_2 and $6H_2O$ could have been used in which case the other values should have been changed to 6 and 8.

(ii) Candidates should be aware that ethanoic acid can be made by oxidation of ethanol, therefore propanoic acid can similarly be made by the oxidation of propanol/propan-1-ol.Alkanes were often given as the answer.

Question 8

(a) Many candidates obtained full credit on this question, although some had the blue and pink colours the wrong way round.

(b) This question produced a wide range of answers. The best answers gave reference to adding an excess of cobalt(II) carbonate, filtration, evaporation to crystallisation point followed by isolation of the pure crystals.

(c) This question produced a wide range of answers. There were several candidates who obtained full credit. The use of an appropriate number of decimal places was successfully carried out by the majority of candidates although rounding was sometimes inappropriate.

CHEMISTRY

Paper 0620/04
Coursework

General comments

The November entry for this component was, as usual, small.

Only one sample of work was received and the tasks and the standards applied were completely satisfactory.

Centres are reminded that when marks are submitted for the Coursework component of this syllabus it is a requirement that the work be submitted for moderation.

CHEMISTRY

Paper 0620/51
Practical Test

Key messages

Burette reading should be recorded to one decimal place and it is not possible for the initial reading on the burette to be greater than the final reading.

In qualitative analysis exercises, candidates must follow the instructions given and record all observations. Candidates should be aware that the mark allocation reflects the number of valid points to be made for parts of questions.

General comments

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

A few Centres had contacted CIE prior to the examination indicating that they were unable to obtain the salt, chromium(III) potassium sulfate, required for **Question 2**. Alternative similar salts were suggested and if used were indicated on the Supervisor's report so that candidates were not disadvantaged.

A number of Centres recorded unexpected volumes of acid in experiments 1 and 2 in **Question 1**. Centres should ensure that the Confidential Instructions, which clearly specify the concentrations of the solutions for **Question 1**, are followed. Supervisors' results were used in the marking of both questions. All Centres had submitted the required Supervisors' results.

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. A minority of candidates recorded initial burette readings greater than the final burette readings. Some candidates recorded volumes to the nearest whole number only and could not be credited. Burette readings should be recorded to one decimal place. There was sometimes a wide variation in the results produced by different candidates from the same Centre. A significant number of candidates had burette readings over 10 cm^3 in experiment 2.

(c) (i) Incorrect colour changes such as orange or colourless to red were frequent. Credit was given for yellow to pink/orange. Some candidates confused the initial and final colours.

(ii) The majority knew that the purpose of the methyl orange was to act as an indicator or show when neutralisation had occurred. Vague answers such as 'to see the colour change' or 'check the pH of the mixture' scored no credit.

(iii) Well answered. Most candidates recognised that a neutralisation reaction had occurred. Credit was allowed for exothermic. Incorrect responses included displacement and redox.

(d) (i) Generally well answered though some candidates indicated experiment 2 even though their results showed that experiment 1 used the greater volume of acid.

(ii) Some quantitative indication was required in the comparison. Merely saying that more or less was used was insufficient.

(iii) Good candidates realised that solution B was more concentrated than solution A as less volume of B was used to neutralise the alkali. Incorrect answers referred to A being more concentrated as more volume of A was used which showed a lack of knowledge and understanding. Some confused answers discussed the difference in the rate at which the two acids reacted i.e. A took longer to react or B reacted faster.

(e) Partial credit was given for recognising that half the volume of hydrochloric acid would be required to react with 10 cm^3 of solution **C**. Full credit was given for candidates halving their value from experiment 2 and giving the correct unit.

(f) Having used a measuring cylinder in the experiments, many were able to describe an advantage of using a measuring cylinder as easy/quick and convenient to use. Answers that referred to the accuracy of it as an advantage were prevalent and scored no credit.

Disadvantages commonly seen involved vague references to liquid remaining in the cylinder or parallax problems which were ignored.

(g) The question asked for a method, other than a titration using a different reactant, that could be used to compare the concentration of the two acids. Good answers

- named a chemical reactant such as magnesium or calcium carbonate
- realised that an equal volume of both acids would be needed
- described the reaction
- compared the results according to the different concentration of the acid

Vague answers such as 'use a metal' or 'use a reactant' were not credited, nor was the use of unsafe reactants such as sodium. A large number of candidates suggested adding a different indicator, e.g. Universal Indicator, phenolphthalein or litmus, to the acids. Indicators are not reactants and also they would not distinguish the two acids. Some answers attempted an electrical method with a bulb in a circuit which also would not work.

Question 2

Liquid **D** was chrome alum. The full range of marks was awarded for this question. Some observations bore no resemblance to those expected.

Test on the solid

(a) (i) Most candidates were able to describe the appearance of solid **D** as purple or black crystals. References to powders were common.

(ii) Most gained partial credit for a description of the colour change when the solid was heated. Credit for the recognition of condensation or drops of liquid forming was often lost because vague descriptions of vapours were given.

Tests on the aqueous solution

(b) (i) and **(ii)** The incorrect use of terms was prevalent. Expected observations were green/grey precipitate formed in both reactions. The precipitate dissolved/was soluble in **(i)** and was insoluble in **(ii).** The use of the terms soluble, insoluble, dissolves and solution was often confused. Reference to the formation of white precipitates showed a lack of care in observing the reactions.

(c) Marks were awarded for using a glowing splint to test the gas, and the result obtained, effervescence and colour changes. Vague references to 'oxygen formed' scored no credit. Many candidates did not describe the effervescence of the mixture and wrote 'gas formed'.

(d) 'No reaction' was the expected response as this test for a chloride should have been negative. A significant number of candidates recorded the formation of a white precipitate, colour changes or effervescence.

(e) Generally well answered with the recognition of the formation of a yellow precipitate. Some candidates used terms such as milky, cloudy or solid which were not credited.

(f) Some candidates realised that the formation of condensation in test **(a)(ii)** indicated that solid D was hydrated or that water was present. Recognition that a coloured compound indicated that transition metal cations were also present.

(g) Only the more able candidates scored full credit here. The majority identified that solid D was iron(II) sulfate. The absence of halide ions was rarely described and indeed many answers indicated that solid D was a chloride.

CHEMISTRY

Paper 0620/52
Practical Test

Key messages

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(f) Some candidates realised that the formation of condensation in test **(a)(ii)** indicated that solid D was hydrated or that water was present. Recognition that a coloured compound indicated that transition metal cations were also present.

(g) Only the more able candidates scored full credit here. The majority identified that solid D was iron(II) sulfate. The absence of halide ions was rarely described and indeed many answers indicated that solid D was a chloride.

CHEMISTRY

Paper 0620/53
Practical Test

General comments

The majority of candidates successfully completed both questions and there was no evidence that candidates were short of time. Supervisors reported very few problems with the requirements of this practical examination. The Examiners used the Supervisors' results for **Question 1** to check comparability.

There was a range of different observations recorded in **Question 2** involving candidates from the same Centre.

Key Messages

Candidates should be encouraged to carry out the tests as instructed and reminded not to guess the results expected.

Candidates should be instructed to record details of all observations in **Question 2** including effervescence.

Comments on specific questions

Question 1

(d) All of the candidates carried out the four experiments. The table of results was generally, fully and successfully, completed. Credit was awarded for recording the initial temperature of the water, the final temperature of the solutions, and then for completing the temperature difference boxes. Good answers showed any decreases in temperature with a minus sign.

A minority of candidates had results, which were not comparable to the Supervisor's results.

(e) Vague answers referred to clear or blue solutions being formed. Many candidates scored partial credit but only the more able recorded both effervescence and the formation of a blue precipitate.

(f) The scale on the y axis caused some candidates problems and inappropriate scales were not credited. Marks were lost for plotting a point graph instead of a bar chart. A minority of candidates did not label the bars or labelled them incorrectly because they abutted each other.

(g) (i) Despite the expected temperatures being recorded in the table, the experiment that involved the smallest temperature change was sometimes incorrectly identified.

(ii) Some candidates were confused and identified the solids which produced an exothermic change instead of an endothermic change which showed a lack of understanding. Good answers mentioned both solids, J and K, but some only gave one. The idea that the temperature decreased in an endothermic change was generally well described.

(h) Vague answers referring to increasing or decreasing temperature changes were common. Credit was given in **(i)** and **(ii)** for giving half the values of the temperature changes from the table in **(d)**. In **(iii)** only a minority of candidates realised that using half of the original amount of solid would lead to half the original temperature change.

(i) This was generally well answered. Some candidates did not explain that the reaction mixture would return to the initial temperature or room temperature because the reaction/dissolving of the solid had finished. Some candidates did not answer the question which asked 'predict the temperature…' and gave vague statements such as 'heat would be lost to the surroundings and it would cool down'.

(j) Fewer candidates scored any credit. Many candidates just repeated their answers to **(e)**. Good answers mentioned the presence of copper ions or the reaction of an acid with a carbonate and the production of carbon dioxide.

Question 2

This question was generally well answered by candidates who gave details of all observations and recorded them accurately.

Solution M was aqueous hydrochloric acid.

Solution N was aqueous sodium hydroxide.

(a) and **(e)** Only a minority of candidates recognised the appearance of the solution as clear or transparent which scored no credit. Both solutions were colourless.

A pH number was required for each solution. References to the effect of these solutions on litmus paper were not credited.

(b) This was generally well answered. A number of candidates recorded no reaction or change and did not record the bubbles/effervescence when the reactants were mixed.

Credit was given for observing that a lighted splint was extinguished. References to glowing splints and limewater were prevalent and were not credited.

(c) A minority of candidates showed a lack of detail in recording the observations. Good answers included a description of the evolution of a gas but descriptions of effervescence were often missing.

Guesses were evident with regard to testing the gas evolved. The gas given off was hydrogen and many candidates successfully tested the gas with a lighted splint popping.

(d) White precipitate was the expected observation for two marks. Vague references to cloudy, milky and solid formed were ignored. Some candidates observed that the white precipitate was soluble which was could not be credited.

(f) This test was unusual as it was the reverse of the familiar test to show the presence of zinc ions. A colourless solution followed by the formation of a white precipitate with excess of solution N was the expected result.

(g) The majority of candidates recorded the observation that the red litmus turned blue. A number of candidates also correctly described the pungent smelling gas evolved.

(h) The gases were often correctly identified as hydrogen and ammonia.

(i) Marks were awarded for the recognition of the presence of chloride ions and an acid. Hydrochloric acid obtained full credit.

(j) Marks were awarded for concluding that the tests on solution N indicated the presence of a strong alkali such as sodium or potassium hydroxide. Many incorrect answers mentioned zinc or ammonia which showed a lack of understanding. These candidates did not realise that these were reagents used in the tests on solution N. References to the presence of bases or a basic solution were not credited.

CHEMISTRY

Paper 0620/61
Alternative to Practical

Key message

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

General comments

The majority of candidates attempted all of the questions though a significant minority left many questions unattempted. The full range of marks was seen, however some candidates were clearly not well prepared for this examination.

Candidates found **Questions 1, 2(b), 3, 4(h)** and **6** to be the most demanding.

Comments on specific questions

Question 1

(a) Most candidates obtained credit for identifying the glass rod/stirrer. There were many references to sticks and thermometers which were ignored.

The container of the lead oxide was correctly identified as a watch glass or evaporating dish/basin. Vague answers such as dish, basin or bowl were not credited. Petri dish was a common incorrect answer.

(b) Many candidates got the idea of the acid being heated to increase the rate of the reaction. A significant number of candidates thought that it was heated to start the reaction which was not credited.

(c) Generally well answered.

(d) (i) Credit was given for noting that the lead oxide would be visible or no longer react. Many answers wrongly referred to ‘no more bubbles/effervescence’ or that all the lead oxide would be dissolved.

(ii) Filtration was a common correct answer. Wild guesses such as distillation or crystallisation were seen.

(iii) Excess or residue were the terms allowed to describe the unreacted lead oxide. References to Insoluble or solute were not credited.

(d) This question was often poorly attempted. Reference to evaporation, formation of crystals and possible decomposition of the solid formed were valid points. Many confused responses referred to the formation of lead and the evaporation of the nitrate. Some candidates discussed the effect of the heat on the glass apparatus.

Question 2

(a) Credit was given for a smooth curve. A significant number of candidates included the anomalous point in their graph. Others missed out the first two points or left the question unanswered.

(b) Good answers showed an understanding that in Experiment 2 the reaction produced twice as much gas and was quicker than in Experiment 1. Consequently the use of more catalyst and double the volume of hydrogen peroxide or double the concentration of the hydrogen peroxide scored full credit. Answers which described changing the temperature of the reactant mixture showed that candidates had not read the question.

(c) Generally well answered with catalyst and increase the rate being common correct answers.

(d) Full credit was given for a sketch with a less steep slope than Experiment 1 but levelling out at the same point. Many missed the second marking point.

Question 3

(a)(i) The vast majority gave chromatography as the method used.

(ii) Many vague answers referred to gases, air or oxygen entering or leaving the beaker. Others worried about the effect of contaminants. Only more able candidates could focus on the preventing the loss of solvent.

(b) Responses showed that good candidates could specify that the paper should be removed when the solvent reached the top of the paper or solvent front. References to ‘when the colours separate’ or ‘after the solvent has dissolved/absorbed into the paper’ were prevalent and not credited.

(c) (i) Only the more able realised that there were four different coloured compounds in the fruit drink. Answers ranged from 1 to 7.

(ii) There were frequently confused answers. Creditworthy answers described that one artificial dye was at the same height as one of the coloured compounds in the fruit drink.

Question 4

The full range of responses was seen in the completion of the tables of results. Very few candidates gave burette readings to one decimal place as expected.

(a) Marks were awarded for a correct initial value of 0.0 or 24.4 and all readings to one decimal place.

(b) This table was completed better and many candidates obtained full credit as failure to specify the readings to one decimal place was treated as error carried forward. Marks were awarded for a final reading of 6.1 and a correctly calculated difference.

(c) (i) The majority of candidates correctly identified the reaction as a neutralisation or exothermic. A minority gave endothermic, redox or displacement.

(ii) Indicator was a common correct answer or to show the neutralisation point. References such as ‘to show the change in colour’ were not credited.

(d) Most candidates obtained credit for realising that the burette was rinsed to remove acid A or clean contaminants from the previous experiment.

(e) Part **(i)** was generally correct. In **(ii)** a correct comparison from the readings in the tables in **(a)** and **(b)** obtained credit. Just saying more or less acid was used in the experiments was insufficient.

(iii) More able candidates understood that acid B would be more concentrated as a lower volume of it was used. Confused answers suggested that using a larger volume of acid in the reaction indicated that the acid was more concentrated.

(f) Some candidates deduced that using 10 cm^3 of C would require half the volume of acid B. Full credit was given for half the value from the table in **(b)** and the correct unit.

(g) Generally well answered. Many thought an advantage of a measuring cylinder was that it is accurate when this is in fact a disadvantage. Disadvantages referring to parallax errors and traces of solutions being left in the cylinder were not credited.

(h) Answers involving methods that would not work obtained no credit. Some of these used indicators to compare the concentrations of the two acids while others electrolysed the solutions. Evaporation and distillation of the acids were other incorrect methods. Vague references to adding a metal, a base or a reactant were also not credited.

(i) Good answers described adding a named reactant e.g. magnesium or a carbonate to equal volumes of both acids, observing the reaction and a comparison to show which would be the most concentrated.

Question 5

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

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

(d) Some recognised that a white precipitate would be formed. Coloured precipitates were common, as well as effervescence and a plethora of colour changes.

(e) Some recognised that the solid D was a transition metal compound or that water was formed. Lots of answers gave conclusions which could not have been drawn from test **(a)** as asked for in the question.

(f) Meaningful conclusions were pleasingly common. Credit was awarded for understanding that solid D was hydrated and that iron(II) ions were present. References to copper and sulfate were not credited.

Question 6

(a) (i) Many blank spaces were left and the diagram was often not attempted. Credit was awarded for a measuring cylinder in a trough of water or a gas syringe. Some labels were missing.

(ii) The test for carbon dioxide using limewater was well known though some candidates did not give the expected result to the test. Tests involving a lighted splint popping or being extinguished were not credited

(b) The quality of answers spanned the entire spectrum. Most candidates obtained partial credit for mentioning a measured volume of the fizzy water and weighing the residue.

Confused answers discussed collecting and measuring the gas formed when the water was heated. Methods involving the formation of crystals showed a lack of knowledge and understanding.

Well planned answers from more able candidates gave essential experimental detail with a clear practical method and a means of removing all of the water and measuring the amount of residue in the water.

Credit was given for:

- Using a measured volume of water
- Evaporating the water to dryness in a suitable container
- Weighing the residue using a balance
- Idea of calculating the result from the weighings

Many candidates did not attempt this question.

CHEMISTRY

Paper 0620/62
Alternative to Practical

Key messages

Candidates should ensure that the instructions in the questions are read carefully and then followed. There were too many instances which clearly showed that candidates had skimmed the question and missed important detail.

Questions requiring candidates to plan an investigation should be answered with details of apparatus to be used, reactants/substances involved and quantitative information clearly specified. Candidates who made notes of their approach or underlined key words in the question before finalising their answer generally scored high marks.

General comments

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

A lack of ability or care in following question instructions was also apparent in **4b** where several curves were drawn instead of the requested intersecting straight lines.

Candidates found **Question 1, 3** and **6a** to be the most demanding. **Question 6b** was answered better than in previous sessions.

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) Credit was given for U tube. U often appeared with various other pieces of apparatus such as test-tube or flask. The gas jar was only identified by a minority of candidates. Answers such as measuring cylinder or collecting vessel were not credited.

(b) Most candidates obtained credit for understanding that ammonia is lighter than air and dissolves/reacts in water. Some candidates made observations such as ‘ammonia is more dense/heavier than air’ or ‘ammonia is less dense than water’.

(c) Most scored partial credit for the idea that the white smoke was produced by a reaction. Better answers named the product as ammonium chloride and understood that a neutralisation had occurred as ammonia is alkaline and hydrogen chloride is acidic.

(d) Often correct with a test using litmus paper being well known. Some candidates omitted red and could not be credited. A few got the test the wrong way round and thought that blue litmus would turn red. A number used the same test as in **(c)** despite being asked for a different test and obtained no credit.

Question 2

The test for chlorine was often correct using the bleaching effect on litmus.

Correct tests for sulfuric acid included the use of named indicators, barium nitrate/chloride or addition of carbonates or magnesium. The addition of sodium hydroxide and phenolphthalein were not credited as no result would have been visible.

The use of bromine(water) to test for alkenes was well known and the use of a lighted splint to ignite the hexene was allowed.

Some confused answers for limewater involved the addition of carbonates but the majority stated that carbon dioxide would turn the limewater cloudy/milky.

Question 3

(a) Most candidates scored credit for the use of a spatula – spoons were not credited. A surprising number of candidates used apparatus used to transfer liquids such as burette, pipette and measuring cylinder which showed a lack of understanding.

(b) (i) Sulfuric acid was identified by the vast majority of candidates.

(ii) The reason for the acid not being heated was poorly understood. The danger of explosion, loss of reagents and presence of toxic gases were common incorrect responses. A number of references to the reactivity of magnesium were ignored as magnesium was not a reagent in the process. Only a minority of candidates understood that acids react rapidly at room temperature with carbonates and heat is not needed.

(c) A significant number stated that the magnesium carbonate was in excess because they knew it ought to be while some gave magnesium sulfate or water. The majority realised that sulfuric acid was in excess but most were unable to explain why it should not have been.

(d) (i) Well answered. The formation of crystals scored credit but some suggested evaporation to dryness which was not credited.

(ii) Common responses referring to the formation of powder or the melting or breaking up of the crystals scored no credit. The idea that the crystals would lose water/dehydrate and become anhydrous was recognised by better candidates.

Question 4

(a) The table of results was completed correctly by the vast majority of candidates. Any errors in recording the temperatures were seen in the 0, 50 and 60 volumes.

(b) The points were usually correctly plotted. Many candidates could not be credited for drawing a curve instead of following the instruction given. Straight lines were sometimes wobbly and not drawn with a ruler.

(c) (i) Well answered with the indication on the grid usually clear.

(ii) A range of marks was seen. Candidates scoring full credit clearly indicated the point at which the lines intersected, read the axis scale correctly and gave a correct unit. Some misread the value as 30.4 instead of 34 and some gave 58 as they drew the tie line horizontally instead of vertically.

(d) Confused candidates thought that the hydrochloric acid had the highest concentration as a greater volume of it was used or that the sodium hydroxide was dilute. A number of candidates gave a temperature as their response which showed a lack of understanding of the term reactant.

(e) The type of reaction was usually correctly given as exothermic. Titration and redox were common wrong answers.

(f) There were some candidates who thought the temperature of the mixture would keep getting hot resulting in some improbably high temperatures or that now the reaction was over it must cool down to 0^{o}C. A lot did not realise that the start temperature of 26^{o}C from the table would have been room temperature and stated a range of temperatures from 20^{o}C to 30^{o}C. Some did not explain that the reaction was finished/complete.

(g) The majority of candidates realised that repeating the experiment was a good idea. The second credit was scored more often for averaging rather than comparing the results. References to changes to the apparatus or experimental method were not credited.

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.

(a) Some very odd colours were given. Colourless and green were common errors. A fair number claimed that the solution would be a solid or a precipitate.

(b) The majority of responses were correct but a few contradicted the mark for the precipitate by saying it would dissolve in excess.

(c) Generally well answered with the same answer 'red-brown precipitate' as in **(b)**.

(d) This test for a chloride producing a white precipitate was well known.

(i) Meaningful conclusions about solution **B** were seen though some guesses were abundant. Most candidates were able to identify aluminium sulfate. Zinc sulfate and aluminium chloride were common incorrect answers.

Question 6

(a) Only the more able scored full credit. There were many long descriptions of how to filter the oven cleaner when just 'filter' would suffice. Good answers referred to the washing and subsequent drying of the bentonite residue. Too often those who tried to do something after filtration wrongly focused on the filtrate instead of the residue and tried to crystallise the bentonite from the filtrate. This showed a lack of understanding. Many candidates failed to read the question properly and overcomplicated the process with fractional distillation or chromatography.

(b) The quality of answers spanned the entire spectrum though this planning question was generally better answered than some in previous sessions. Many candidates scored partial credit for using equal volumes of both oven cleaners. A significant number of candidates did not attempt the question and left the space blank.

The best answers were well planned and attempted a titration. Marks were awarded for

- equal volumes of C and D
- a named acid in a burette or pipette
- use of an indicator
- noting the volume of acid added when the colour changed
- repeating the experiment with the other cleaner
- comparing results/conclusion

Some added the oven cleaner to the acid which was perfectly fine.

Methods involving the addition to the oven cleaners of various metal ions, indicators and wrong reactants such as magnesium would not work and were penalised. Some answers were in a random sequence where half way through they realised that something had been missed out earlier on. Candidates need to plan answers first.

CHEMISTRY

Paper 0620/63
Alternative to Practical

General comments

The vast majority of candidates successfully attempted all of the questions. The full range of marks was seen. The paper discriminated successfully between candidates of different abilities but was accessible to all.

The majority of candidates were able to complete tables of results from readings on diagrams and plot points successfully on a grid

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. When requested to draw two straight intersecting lines, then not only should a ruler be used, but there should only be two lines. When candidates have to decide on their own scales, they should be easy to use, going up in 5 or 10 units for example, and should cover at least half of the grid provided.

Candidates need to be familiar with command words. In **Question 4(h)** the instruction was to "Suggest the temperature change that would occur if …". This required an actual temperature change, but many candidates just gave answers such as higher or lower. When candidates are asked to "compare" values, they should look for simple quantitative relationships, such as twice as much or half as much.

Burette readings should always be given to one decimal place, e.g. 0.0 cm^3.

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, are correct observations.

Comments on specific questions

Question 1

(a) There were many good labelled diagrams showing the collection of carbon dioxide. There was a wide range of correct and incorrect answers, with most candidates obtaining credit through the use of a test-tube, measuring cylinder or gas jar. There was a good mix of downward delivery and collection over water, although many candidates used upward delivery or delivery into sealed vessels. Perhaps the most reliable answer to questions such as this one is to use a measuring syringe, as it can not only be used for all gases, but can also measure the volume if required.

(b) The tap funnel was not well known. Alternative answers such as separating funnel or dropping funnel were accepted.

(c) Answers to this question were often too vague when all that was required was that the reaction is fast enough at room temperature. There were many acceptable ways of saying this.

(d) The test for carbon dioxide was well known.

Question 2

(a) Most responses obtained full credit here. The most common error was not to give all burette readings to one decimal place.

(b) The points were well plotted and there were many excellent smooth curves. A few candidates incorrectly diverted their curve to go through the anomalous point, whilst others forgot to plot the point at the origin.

(c) Although many realised that the mass went down because carbon dioxide was being given off, many others thought that it was because the marble chips were dissolving or simply evaporation.

(d) The vast majority identified the anomalous result and suggested its true value.

(e) Sketch graphs were well drawn by most candidates.

Question 3

(a) Carbon (or graphite) was the most common answer for the non-metal used for the electrodes.

(b) There were several correct answers here, the most common being that the bulb was lit and that bubbles were seen. Some candidates did attempt the colour change of copper chromate solution even though they could not be expected to know that it would go yellow, although several did deduce this. A fairly common error was giving the brown deposit, mentioned in the question.

(c) Many candidates knew that copper was the brown deposit and that it was formed at the cathode. The negative electrode was accepted as an alternative to the cathode.

(d) Electrolysis was very well known.

Question 4

(c) The table of results was often completed correctly. A few did not differentiate between temperature increases and decreases.

(e) This was also well answered, with the majority correctly plotting bars, upwards for positive temperature changes and downwards for negative ones. Most used a scale going up by 5 or 10 units per square. A small minority ignored the zero line or plotted a line graph.

(f) Again, most realised that rinsing was to remove the remains of the solutions used in the previous experiment.

(g) Most candidates could identify and explain the endothermic reactions. Some were confused that the absorption of heat (from the surroundings) meant that the temperature (of the surroundings) would go down.

(h) Many misread this question, although it clearly stated “suggest the temperature change …” Few gave a temperature change. Most commented that it would be less or half as much, but this was not what the question asked.

(i) Most realised that the temperature would be back to room temperature after an hour as all the solid had already dissolved (or reacted).

(j) There were many correct answers, but a lot of candidates did not refer back to the observations in Experiment 5.

(k) There were many correct suggestions that the experiments should be repeated and the results compared or an average calculated.

Question 5

(e) Most realised that sodium hydroxide solution was colourless, fewer realised that its pH would be between 11 and 14.

(f) Nearly everyone gave the sodium hydroxide test for zinc ions. Far fewer realised that it was reversed in this example. The mark scheme did mean that candidates who got it the wrong way round were still able to obtain fair credit for their answers.

(g) Most knew that the red litmus would go blue, fewer gave the pungent odour of ammonia.

(h) Nearly everyone identified hydrogen. Ammonia was the most common, and correct, answer in the second part, but a large minority did go for chlorine.

(i) This was challenging, although a full range of marks was seen.

Question 6

Whilst nearly everyone could make an attempt at this question, fewer obtained full credit.

In the first part, the colour had to be extracted from red cabbage and blueberries. Credit was available for crushing both samples of the plant material separately with water (or another suitable solvent). Further credit was for filtering (or equivalent) and fewer candidates said this. Nearly half of the candidates went on to separate the component colours using chromatography. This was not necessary, so it was not credited.

In the second part, the effectiveness as indicators had to be tested. Nearly everyone said that they should be added to an acidic and an alkaline solution. The more challenging final credit was for a colour change or for different colours in acid and alkali. This proved harder, as many candidates simply recorded or observed the colours.