CHEMISTRY

Paper 0620/11
Multiple Choice

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

Candidates performed well on this paper. Questions **1**, **2**, **3** and **25** proved to be the most straightforward, with a high proportion of candidates selecting the correct response.

Questions **5**, **11**, **14**, **17**, **19**, **20**, **22**, **27**, **30**, **35** and **40** were the most difficult for candidates.

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

Questions 5

Response **B**. Candidates clearly knew that hydrogen atoms have no neutrons but failed to spot that the question was asking about the nucleus, not the whole atom.

Questions 11

Response **C**. Candidates realised that the reaction was endothermic but not that carbonates neutralise acids.

Questions 14

Responses **A** and **B**. There was clearly some confusion concerning the colour changes of cobalt(II) chloride when water is removed and added.

Questions 17

Response **C**. Candidates knew that **B** and **D** were base properties but were not sure of the other reactions of bases.

Questions 19

Response **C**. Candidates were confused about changes in the reactivity of Group VII elements, thinking that they varied in the same way as the reactivity of Group I elements.

Questions 20

Response **D**. Candidates knew what should go in the gap (1) but selected the first answer which fulfilled this criterion, rather that reading the whole question.

Questions 22

Response **C**. Candidates did not realise that not all group 0 elements have eight electrons in their outer shells.

Questions 27

Candidates found this question difficult. All responses were popular, indicating a degree of guessing by candidates.

Questions 30

Candidates found this question difficult. All responses were popular, indicating a degree of guessing by candidates.

Questions 35

Response **C**. The main reason for this error was candidates misreading the word ‘ethane’.

Questions 40

Response **B**. Candidates knew about cracking but failed to identify the correct effect of aqueous bromine on hydrocarbon Q.

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Paper 0620/12
Multiple Choice

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

Candidates performed well on this paper. Questions **1**, **4**, **9**, **10**, **16**, **21**, **31**, **33** and **35** proved to be the most straightforward, with a high proportion of candidates selecting the correct response.

Questions **5**, **8**, **17**, **20**, **37**, **38** and **40** were the most difficult for candidates.

The following responses were incorrect responses to the questions listed:

Question 5

Response **B**. Candidates clearly knew that hydrogen atoms have no neutrons but failed to spot that the question was asking about the nucleus, not the whole atom.

Question 8

Response **C**. Candidates did not recall that hydrogen is produced when aqueous solutions of sodium chloride are electrolysed.

Question 17

Response **C**. Candidates knew that **B** and **D** were base properties but were not sure of the other reactions of bases.

Question 20

Response **A**. Candidates did not realise that 'Cs' is the symbol for caesium which is an alkali metal.

Question 37

Response **D**. Candidates assumed that hydrogen was correct because it contains no carbon. The question required consideration of the carbon chain length.

Question 38

Response **B**. Candidates only knew of one method of making ethanol.

Question 40

Response **A**. Candidates did not know that ethanoic acid (vinegar) has a strong smell.

CHEMISTRY

Paper 0620/13
Multiple Choice

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

Candidates performed well on this paper. Questions **3**, **4**, **6**, **9**, **15**, **18**, **20**, **21**, **23**, **24** and **39** proved to be the most straightforward, with a high proportion of candidates selecting the correct response.

Questions **1, 5**, **10**, **16**, **17**, **19**, **22**, **26**, **29** and **36** were the most difficult for candidates.

The following responses were incorrect responses to the questions listed:

Question 1

Response **D**. **D** was a popular wrong answer because in freezing the particles do move closer together.

Question 5

Response **B**. Candidates clearly knew that hydrogen atoms have no neutrons but failed to spot that the question was asking about the nucleus, not the whole atom.

Question 10

Response **D**. Candidates knew that **A** and **B** were false but many then incorrectly opted for response **D**.

Question 16

Response **A**. Candidates chose this answer on the basis of the first two columns of the table only.

Question 17

Response **C**. Candidates knew that **B** and **D** were base properties but were not sure of the other reactions of bases.

Question 19

Response **C**. Candidates did not know the properties of iodine and the mention of colour led them chose a transition element.

Question 22

Response **C**. Candidates would have benefitted from reading the whole question carefully.

Question 26

Response **C**. Candidates were confused between the production of mild steel, the reactions in the blast furnace and the production of stainless steel.

Question 29

Response **C**. Candidates confused carbon *mon*oxide's disadvantages with those of carbon *di*oxide.

Question 36

Response **C**. Candidates incorrectly assumed that, because polyethene is unsaturated it has an '–ane' suffix in its name.

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Paper 0620/21
Core Theory

Key Messages

- Many candidates need more practice in answering questions relating the structure and bonding of compounds to their uses.
- Greater specificity is required in answers in many cases. This is particularly true for questions involving the extraction of information from graphs and those involving kinetic particle theory.
- Some candidates need more practice in questions about organic chemistry, especially drawing structures of organic molecules.

General comments

Many candidates tackled this Core Theory Paper well, showing a good knowledge of Chemistry. Some of the questions were left unanswered by a minority of candidates, particularly **Question 4(b)(ii)**, **Question 5(c)** and **(d),** and **Question 6(b)**, **(c)** and **(e)**.

Some candidates need more practice in memorising simple chemical tests, e.g. the test for unsaturation with aqueous bromine, and in memorising definitions, e.g. the definition of a hydrocarbon.

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

Many candidates were able to extract relevant information from tables and balance symbol equations. Others need practice in calculating relative formula masses and identifying particular types of organic compound.

Comments on specific questions

Question 1

(a) In part **(i)**, many candidates identified barium chloride for the sulfate test. Part **(ii)** was generally well done with the commonest error being to suggest **F**. Part **(iii)** was almost invariably correct. Fewer candidates could identify H–C*l* as being acidic in part **(iv)**, the commonest errors being to suggest methane or barium chloride. Part **(v)** was less well done. There was no consistent incorrect answer. In part **(vi)**, most candidates realised that methane is the main component of natural gas. A common error was to suggest water.

(b) **(i)** Many candidates placed the arrow for heating in a suitable position. Common errors included heating the connection between the tubes; heating the top of the tube; and heating the aluminium chloride.

(ii) Many candidates suggested a suitable safety precaution. Those who did not gain credit generally wrote statements which were too vague. Very few mentioned the use of a fume cupboard.

(iii) Most candidates balanced the equation correctly.

Question 2

(a) Many candidates gave a suitable answer with most referring to the ease of dissolving or to ensure an even temperature distribution. Those candidates who did not gain credit often made comments referring to a chemical reaction.

(b) Most candidates gave at least one factor which should be kept the same. Common incorrect answers usually referred to the temperature of the room or the pressure.

(c) (i) Most candidates identified **Q** correctly. There was no consistently incorrect answer.

(ii) Nearly all candidates identified the endothermic changes. Those candidates who did not score the mark generally chose a mixture of endothermic and exothermic changes.

(d) (i) Most candidates recognised that ^{235}U is radioactive. The commonest incorrect answer was to choose ^{1}H.

(ii) Some candidates deduced the number of neutrons correctly. Others gave the proton number or the nucleon number.

(iii) Some candidates gave a suitable use of radioactive isotopes in medicine. Others did not read the words “in medicine” in the question and gave industrial uses.

(e) (i) A majority of the candidates recognised that kerosene is used as a fuel for jet aircraft. There were no consistent incorrect answers.

(ii) Most candidates balanced the equation correctly. Some candidates omitted this question.

Question 3

(a) Most candidates wrote “CO_2” as the correct product and balanced the equation correctly. Common errors included “C” and “O_2” as products.

(b) (i) Nearly all candidates completed the diagram correctly. The commonest error was to reverse the anode and cathode.

(ii) Some candidates correctly deduced that nickel is formed at the cathode. Other suggested that nickel is formed at the anode or at the graphite electrode.

(c) (i) Some candidates correctly recognised that nickel is formed at the cathode and chlorine at the anode. Other candidates suggested hydrogen or oxygen is formed at the anode or suggested chloride. A considerable number of candidates did not respond to this part of the question.

(ii) Many candidates realised that graphite conducts electricity. Fewer candidates realised that graphite does not react with the electrolyte and gave answers relating to other properties of graphite.

(d) (i) Few candidates could relate the structure and bonding of diamond to its properties. Common errors included the idea that the bonds were hard. Some candidates wrote about the structure of diamond as being “tetrahedral” or wrote that “there are lots of atoms”.

(ii) Few candidates could relate the structure and bonding of graphite to its use as a lubricant. A minority of candidates mentioned the layered structure. Those who mentioned sliding often just suggested that “the atoms slide” without further details. The commonest error was to suggest that the atoms themselves are slippery.

Question 4

(a)(i) Many candidates referred to the gradient of the graph or the relative time taken to complete the reaction. Other candidates just referred to the relative position of strontium and calcium in Group II of the Periodic Table.

(ii) Most candidates deduced the volume of gas produced correctly.

(iii) The majority of the candidates gave a suitable time for the completion of the reaction. The commonest error was to suggest 68–70 seconds.

(iv) Many candidates referred to the line for calcium not reaching the final volume. Other candidates gave rather vague answers which did not refer to the graph.

(v) Many candidates realised that smaller pieces of calcium have a larger surface area. Some candidates did not gain credit because they did not refer to the change in the rate of reaction.

(b) (i) Some candidates realised that a measuring implement with sufficient accuracy had to be used to deliver the strontium hydroxide solution. Other candidates incorrectly suggested using glassware with poor accuracy such as measuring cylinders or beakers.

(ii) Some candidates recognised the role of litmus as an indicator. Few candidates described the colour change of the litmus and some candidates gave an incorrect colour change. Many candidates did not respond to this part of the question.

(c) (i) There were many vague answers to this question. Many candidates did not refer to the pH values or volumes. Other candidates just concentrated on the drop in pH. Better-performing candidates mentioned a large drop in pH when 30 cm^3 of hydrochloric acid had been added and that the pH then decreased gradually. Very few candidates wrote about the slow decrease in pH at the beginning of the titration.

(ii) Many candidates gave the correct volume of acid. Others misread the graph and gave values between 30 cm^3 and 35 cm^3.

(iii) Many candidates named the salt correctly as strontium chloride. Common errors were to suggest strontium oxide or strontium hydroxide.

Question 5

(a) Few candidates scored full credit for this question. Many candidates scored some credit for comparing the movement of the particles in the solid and liquid. Many candidates incorrectly thought that the particles in the liquid were relatively far apart. A considerable number of candidates did not mention particles or molecules and just wrote about water and ice or the bulk properties of these.

(b) Most candidates gave a suitable use for water in the home and in industry. Some gave the same use for both.

(c) (i) The word equation was not always correctly written, with a few candidates not including the addition signs or the arrow. Common errors were water instead of hydrogen and lithium oxide instead of lithium hydroxide.

(ii) Few candidates gave suitable observations for the reaction of lithium with water. The commonest error was to suggest that lithium bursts into flames or explodes. Few candidates mentioned bubbles or floating on the surface. Many candidates did not give observations and wrote about lithium being less (or more) reactive than sodium or wrote vague statements such as “gives off a gas”.

(iii) Some candidates realised that potassium is more reactive than lithium. Other candidates thought that because they were in the same group of the Periodic Table, the two metals had a similar reactivity. A considerable minority suggested that lithium is more reactive than potassium.

(d) (i) A minority of the candidates drew the correct structure of ethanol. Common errors included: drawing the structure of methane or ethane; the inclusion of a double bond; and drawing the hydrogen of the OH group in the incorrect place, i.e. C–H–O.

(ii) Some candidates suggested, correctly, that heat or high temperature is required to make ethanol from ethene. Few candidates gave a second condition. The commonest errors were to suggest room temperature or the presence of carbon dioxide.

(e) Some candidates placed the metals in the correct order of reactivity. Calcium and cobalt were the metals most often placed incorrectly.

Question 6

(a) Many candidates were able to deduce the molecular formula of isoprene. The commonest error was to attempt to write a condensed structural formula.

(b) A minority of candidates recognised the test for unsaturated compounds using aqueous bromine. Few candidates gave the correct result with the main error being to suggest that the colour did not change. Other errors commonly seen were to suggest that the compound should be burnt (without any suggestion of the smokiness of the flame) or that ethanol should be added.

(c) (i) Some candidates related addition polymerisation to the presence of a double bond in the monomer. Other candidates gave answers which were insufficient or irrelevant such as just giving the name of a polymer or just writing "monomer".

(ii) The name of an addition polymer was rarely seen. Most candidates preferred to name a monomer such as ethene or propene.

(d) Some candidates were able to explain the lack of conductivity of isoprene in terms of its simple molecular structure. Others gave a suitable, but less accurate answer in terms of it not having a metallic structure. Common errors included "it is not reactive" and "it has got a double bond".

(e) Some candidates gave the correct products of incomplete combustion. Other candidates suggested carbon dioxide or hydrogen. A considerable minority gave incorrect products which included elements which were not in the reactants, e.g. nitrogen, oxides of nitrogen or nitrates.

(f) Many candidates identified the –ol suffix of the alcohols correctly. The commonest error was to suggest that the compound was a carboxylic acid.

Question 7

(a) Many candidates gave a good description of the numbers and charges of protons, neutrons and electrons in sodium. Some candidates concentrated on the electronic structure and did not appear to use the Periodic Table to help them. Common errors included: protons in shells; electrons in the nucleus; numbers of protons and electrons reversed; and no mention of the position of the subatomic particles. A considerable number of candidates did not respond to this part of the question.

(b) (i) A majority of the candidates balanced the equation correctly.

(ii) Some candidates gave a suitable definition of the term *hydrocarbon*. Other candidates omitted the essential word "only" or gave examples of hydrocarbons.

(iii) A minority of the candidates calculated the relative formula mass of sodium carbide correctly. Other candidates used atomic numbers or multiplied the values incorrectly.

CHEMISTRY

Paper 0620/22
Core Theory

Key Messages

- Many candidates need more practice in answering longer questions about the structure of atoms and about practical aspects of chemistry, such as crystallisation and deducing rates of reactions.
- Nearly all candidates need more practice in questions about flue gas desulfurisation and the origin of pollutants in the atmosphere.
- Some candidates would benefit by learning precise definitions for terms such as *element, mixture* and *homologous series*.

General comments

Some candidates tackled this Core Theory Paper well, showing a good knowledge of Chemistry. Some candidates did not respond to some of the questions, especially towards the end of the Question Paper.

Many candidates were able to extract information from tables and some were able to balance symbol equations. Others need more practice in writing the formulae for diatomic molecules and need to learn simple chemical reactions, such as the reactions of acids with metals. Many candidates need more practice in calculating relative molecular masses, especially when the formula involves brackets.

Comments on specific questions

Question 1

(a)(i) In part **(i)** a minority of candidates identified **E** as being a simple molecular compound. **D** (an element) was often given as an incorrect answer. Parts **(ii)** and **(iii)** were generally correct but many chose **D** rather than **E** as an atmospheric pollutant. In part **(v)**, the term diatomic was not well known, many choosing the triatomic molecule **E** or the monatomic **F** instead. In part **(vi)**, many chose the alloy **B** rather than ionic compound **C**.

(b) Only a minority of candidates gave a satisfactory definition of an element. A considerable number of candidates incorrectly suggested that elements have only one atom.

(c) Some candidates balanced the equation successfully. Others gave the formula of oxygen as "2O" or did not balance the oxygen molecules. A common error was to put "O_4"on the right-hand side of the equation.

Question 2

(a) Many candidates suggested at least one factor which should be kept constant. Incorrect answers included time and amount of fuel burnt (the latter was not credited because it was in the stem of the question).

(b) Many candidates recognised that the reaction was exothermic but few gave a reason for their answer. Explanations should have referred specifically to "heat", rather than energy in general.

(c) (i) Most candidates identified hexane. The commonest incorrect answer was "pentane", achieved by not taking the initial temperature into consideration.

(ii) Most candidates identified hexane as having the highest molecular mass. The commonest incorrect answer was "pentane".

(d) (i) Some candidates drew the correct structure of methane. Some drew dot-and-cross diagrams but added extra electrons. The commonest error was to draw the structure of ethane. A significant number of candidates did not respond to this question.

(ii) Many candidates identified the correct answer “natural gas”. The commonest incorrect answer was “gasoline”.

(e) (i) Many candidates focused correctly on the –ane ending.

(ii) A minority of candidates scored full credit for the definition of *homologous series*. Common errors included inverting the words “compounds” and “properties” and suggesting “elements” instead of “compounds”.

Question 3

(a) (i) Many candidates only gained partial credit because they did not refer to both the bubbles and the decrease in size. Others did not gain credit because they just repeated the statements from the observations of calcium with water. A significant number of candidates thought that barium was less reactive than calcium or magnesium.

(ii) A minority of candidates gave the correct answer “zinc”. The commonest error was to suggest magnesium or calcium.

(iii) Some candidates referred correctly to the reactivity series. Other candidates incorrectly stated that barium is lower than carbon in the reactivity series. Many answers were too vague.

(b) Many candidates indicated why barium oxide gets reduced by referring to the equation. Answers such as, “because barium is on the right-hand side” were insufficient.

(c) (i) Very few candidates gained credit in this question because although litmus or methyl orange was mentioned, the colour change of the indicator was not. A considerable number of candidates did not respond to this question.

(ii) Many candidates wrote the correct name of the salt formed. Others suggested names such as “barium hydrochloride” or “barium hydrochloric”. Hydrogen often written, rather than water, as the other product.

(d) (i) Many candidates recognised the burette. The commonest error was to suggest a pipette.

(ii) Some candidates did not consider the number of marks available for this question and just wrote “it decreases”. Other candidates gave good answers quoting pH values. A considerable number of candidates did not consider that the acid was being added to the alkali and suggested that the pH would increase.

(e) Many candidates drew the electrodes and external circuit correctly. Common errors included: not labelling the diagram; short circuiting the external circuit; and not including a power source.

Question 4

(a) (i) Some candidates recognised that the gas should be collected and measured in the measuring cylinder. Most candidates did not gain credit because they did not mention what should be measured or wrote vague statements such as “when the bubbles are faster, the rate is faster”. The main errors included: counting bubbles in the flask rather than in the measuring cylinder; giving vague statements about the water level changing; and writing about using a stopclock without stating what would be measured.

(ii) Most candidates recognised that the reaction rate increases. Other candidates did not gain credit because they referred to greater surface area but not to greater reaction rate. A considerable minority suggested that the surface area of the powder is smaller.

(b) (i) Many candidates identified two factors which should be kept the same. The best answers included the concentration of sulfuric acid and surface area, as well as the mass of iron.

(ii) Most candidates were able to extract the information from the table and gave good answers. A few candidates wrote statements which were too vague such as "the reaction increases" without relating this to changes in temperature.

(c) The better-performing candidates mentioned filtration and subsequent warming to the point of crystallisation. Most candidates were confused as to what they were filtering and many suggested that the iron(II) sulfate remained on the filter paper. Other candidates attempted to crystallise a mixture of iron and iron(II) sulfate. A significant number of candidates did not respond to this question.

Question 5

(a) Some candidates recognised that the particles were close together in both liquid and solid sulfur. Few candidates mentioned arrangement of particles. Many of those who did write about arrangement incorrectly stated that the particles in liquids were regularly arranged. Most candidates gained credit from an appreciation of the difference in motion of the particles. A significant number of candidates incorrectly suggested that the movement of the particles in liquids is completely free.

(b) (i) Few candidates described the formation of sulfur dioxide by burning fossil fuels containing sulfur. Even fewer candidates mentioned that sulfur dioxide is a gas. Common errors included: the idea that most sulfur dioxide originates from car engines; writing about acid rain when that was not required by the question; and suggesting that sulfur dioxide is formed by reacting sulfur with carbon dioxide.

(ii) Few candidates realised that sulfur dioxide is an acidic oxide. Common errors included: diatomic; metal; and carbon dioxide.

(iii) Hardly any candidates could describe the process of flue gas desulfurisation. Most candidates wrote vague statements about (solid) sulfur being removed through filtration or distillation. Only the better-performing candidates mentioned basic oxides or neutralisation.

(iv) Most candidates were able to balance the equation.

(c) Many candidates chose at least one suitable metallic property.

(d) (i) Most candidates gave answers related to strength and good electrical conductivity. Many candidates wrote about other properties as well. Some candidates did not distinguish between the aluminium and the steel and a few only wrote about one property.

(ii) Many candidates wrote about other properties related to copper as well as the fact that it is cheaper than silver.

Question 6

(a)(i)(ii) A minority of candidates gained full credit in parts **(i)** and **(ii)**. Many ringed the CH_2 group as well as the OH group or ringed extensive parts of the hydrocarbon chain in part **(i)**. Some candidates in part **(ii)** referred to the OH group or suggested that geraniol is saturated.

(b) (i) Most candidates identified the condenser correctly. The commonest incorrect answers were "tube" and "cylinder".

(ii) Few candidates could give a property of a mixture. A significant number of candidates referred to a single compound which is not bonded. Many candidates did not respond to this question.

(iii) Most candidates realised that the geraniol floats on top of the water.

(c) (i) Many candidates wrote the structure of ethanol with the correct number of atoms but with the bonding C–H–O. Other candidates wrote the structure of ethane and then included a C=O bond. A considerable number of methane molecules were also seen.

(ii) Some candidates realised that the combustion products were carbon dioxide and water. Other candidates suggested hydrogen as a product instead of water. A wide variety of incorrect answers were seen including “ethanol oxide”, “ethane” and compounds unrelated to carbon or hydrogen, e.g. sulfur or nitrogen compounds.

(d) Some candidates knew that 21% of the air is oxygen. The majority of incorrect answers were significantly different, e.g. 70% or 50%.

Question 7

(a) The better-performing candidates gave a good description of the numbers and charges of protons, neutrons and electrons in beryllium. Most candidates concentrated on the electronic structure and did not appear to use the Periodic Table to help them. Common errors included: protons in shells; electrons in the nucleus; numbers of protons and electrons reversed; and no mention of the position of the subatomic particles.

(b) Few candidates reduced the structure to the simplest ratio. Common errors were Be_3Cl_6 and Be_2Cl. Many miscounted the atoms and gave formulae such as $BeCl_4$ or Be_2Cl_6.

(c) (i) A majority of the candidates multiplied the molar mass of barium hydroxide by two because of the two in front of the formula. Some candidates gained credit for the correct atomic masses. Other candidates made errors such as giving hydrogen an incorrect atomic mass, or multiplying the atomic masses together.

(ii) Few candidates gave a correct adverse effect of methane on the environment. The commonest errors were to suggest effects related to acid rain or vague statements about it being poisonous or harming plants. A considerable number of candidates suggested that it affects the ozone layer.

CHEMISTRY

Paper 0620/23
Core Theory

Key Messages

- It is important that candidates read the questions carefully in order to understand what exactly is being asked.
- Many candidates need more practice in answering questions involving extended answers.
- Greater specificity is required in answers in many cases. This is particularly true for questions involving the extraction of information from graphs and those involving ion formation or kinetic particle theory.
- Some candidates need more practice in answering questions about organic chemistry especially drawing structures of organic molecules.

General comments

Many candidates tackled this Core Theory Paper well, showing a good knowledge of Chemistry.

Some candidates need more practice in reading and interpreting questions. The rubric was misinterpreted by a minority of candidates for some questions. For example, in **Question 4(a)(iii)** many candidates wrote about surface area even though there was no inorganic solid in the reaction mixture; and in **Question 5(b)** some candidates wrote about properties which were not mentioned in the table.

Many candidates need more practice in answering questions involving ionic structures and electrolysis. Some candidates need more practice in memorising simple chemical tests, e.g. the test for iron(II) ions, and in memorising definitions, e.g. the definition of a compound.

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

Some candidates were able to extract relevant information from tables and balance symbol equations. Other candidates need more practice in these areas.

Comments on specific questions

Question 1

(a) Most parts of this question were correctly answered, especially parts **(i)** and **(iii)**. In part **(ii)**, the commonest error was to suggest **D** and in part **(iv)**, **C** and **D** were the commonest errors, presumably because of their multiple bonds. The commonest errors in part **(v)** were to suggest that oxygen or chlorine decolourise aqueous bromine whilst in part **(vi)b** oxygen appeared as the commonest error for a product of respiration.

(b) A minority of candidates gave a suitable definition of the term compound. The idea of bonded atoms was often omitted. Many candidates did not gain credit because they implied that compounds are mixtures of different elements. A common error was to state that compounds contained atoms bonded together without mentioning that the atoms were *different*.

(c) Some candidates gave a suitable use for argon. A considerable number of candidates disadvantaged themselves by implying that the lamp filament was made of argon. The commonest incorrect answer was the suggestion that argon is used in balloons.

(d) Many candidates gained credit for the correct number of Mg atoms, although a few suggested two atoms. The commonest error was to write "2N" instead of "N_2" as the formula for nitrogen.

Question 2

(a) Many candidates calculated the energy released per gram. The commonest incorrect answer was "paper", given by candidates who did not take the mass burned into consideration.

(b) Most candidates recognised that the reaction was exothermic. "Endothermic" was by far the commonest incorrect answer.

(c) Many candidates counted the number of different types of atom correctly. The commonest error was to suggest three, perhaps through not noticing the single N atom. A considerable number of candidates gave answers of five or six.

(d) (i) Nearly all candidates could describe the purpose of the catalyst.

(ii) Many candidates did not consider that a substance containing C, H and O completely combusts to form carbon dioxide and water. Many candidates suggested sulfur dioxide or nitrogen dioxide as products, presumably thinking of pollutants in the waste. Calcium hydroxide was also not uncommonly seen. Water was often replaced by "hydrogen". A frequently-given product was "oxygen", despite the presence of oxygen as a reactant in the equation.

(e) Some candidates realised that sulfur dioxide is formed when sulfur-containing substances are burned. Other candidates disregarded the fact that burning in air results in the formation of an oxide and wrote about elemental sulfur being responsible for pollution. Some candidates realised that acid rain was formed. Other candidates gave vague statements about pollution or included carbon dioxide in the reaction.

(f) (i) Many candidates realised that methane is an alkane. The commonest error was to name another alkane with "ethane" being the commonest. Some candidates suggested "saturated".

(ii) Most candidates seemed to guess at the physical properties of ethanoic acid. The effect on litmus or other indicators was often mentioned (incorrectly). Many candidates chose other chemical reactions based on the fact that ethanoic acid is acidic. Better-performing candidates realised that ethanoic acid has a molecular structure and wrote about low melting points.

(iii) Few candidates were able to complete the structure of ethanoic acid successfully. Common errors included: lack of C=O double bond; pentavalent carbon atoms; H=O bonds; and alcohol-like structures.

Question 3

(a) Nearly all the candidates identified the Bunsen burner and flask correctly. The commonest error was to call the flask a "tube" or "cylinder".

(b) Many candidates named sodium sulfate correctly. The commonest errors were to name the salt either as sodium sulfide or as sodium sulfite.

(c) (i) The anode, cathode and electrolyte were labelled correctly by most candidates. The commonest error was to reverse the anode and cathode.

(ii) Although many candidates chose chlorine and hydrogen as the products at the electrodes, a significant number of them did not chose the correct electrode for each gas. The commonest error was to suggest that oxygen is one of the products.

(iii) Some candidates gave all three correct products for the reaction of hydrochloric acid with calcium carbonate. Other candidates suggested that hydrogen was produced or made up names such as "calcium acid", "hydrochloric carbonate" and "hydrocarbonate". A few candidates suggested that chlorine would be formed.

(d) (i) A majority of the candidates gave the correct value of the pH at the start of the experiment.

(ii) There were many vague answers to this question. Many candidates did not refer to the pH values or volumes. Other candidates just concentrated on the rise in pH. Better-performing candidates tended to mention a large rise in pH when 18 cm^3 of aqueous ammonia had been added and that the pH then increased gradually. Very few candidates wrote about the slow increase in pH at the beginning of the titration.

Question 4

(a) Some candidates recognised that the gas should be collected and measured in the measuring cylinder. Most candidates did not gain credit because they did not mention what should be measured or wrote vague statements such as “when the bubbles are faster, the rate is faster”. The main errors included: counting bubbles in the flask rather than the measuring cylinder; giving vague statements about the water level changing; and writing about using a stopclock without stating what exactly would be measured.

(b) (i) Many candidates described the shape of the graph correctly and most candidates mentioned the position of the maximum at about 60 hours. Those candidates who did not score a mark generally only mentioned an increase in rate without further qualification.

(ii) Most candidates deduced the reaction rate correctly. A few candidates thought that the *y*-axis was “cm^3 CO_2” rather than per unit time, i.e. cm^3 CO_2 per hour.

(iii) A considerable proportion of the candidates regarded the experiments as being a standard rate experiment involving inorganic solids and hence gave incorrect answers such as “increase the surface area” and “increase the concentration” (unqualified). Some candidates suggested that the flask should be heated, which was not accepted because this implies that the temperature is increased considerably. The commonest correct answers were “increase the concentration of glucose” and “increase the temperature”.

(c) Few candidates gave a suitable method of distinguishing between ethanoic acid and ethanol despite the hint in the stem of the question. A considerable number of candidates thought that ethanol was strongly acidic. Some candidates gave theoretical, rather than practical, answers such as referring to the alcohol having an –OH group and the carboxylic acid having a –COOH group.

Question 5

(a) Few candidates scored full credit for this question. Many candidates scored some credit for comparing the movement of the particles in the liquid and vapour. Many candidates thought that the particles in the liquid were relatively far apart. A considerable number of candidates did not mention particles or molecules and just wrote about liquid mercury and mercury vapour or the bulk properties of these. Many did not mention the arrangement of the particles.

(b) (i) Most candidates recognised that potassium is liquid at 100 °C. Few candidates related the temperature to the melting and boiling points of potassium. Common insufficient answers often referred just to the melting point or the boiling point but not both.

(ii) Most candidates recognised that copper and iron are transition elements because of their high melting points. Some candidates just referred to the boiling point, which was not given credit because aluminium also has a high boiling point.

(iii) This part was generally well answered. Some candidates did not read the instruction to use the information from the table and so gave alternative answers such as “malleable” which were not referred to in the table.

(c) (i) Nearly all candidates knew the conditions required for rusting. Some candidates omitted a second condition and other candidates incorrectly suggested “nitrogen”.

(ii) Some candidates realised that a layer is formed over the iron which prevents access of water and oxygen to the surface of the iron. Other candidates did not refer to a layer or covering, or suggested that there was a reaction between the paint and the air.

(d) (i) Most candidates completed the word equation correctly. The commonest error was to suggest iron hydroxide as a product. Water also sometimes incorrectly appeared as a product in place of hydrogen.

(ii) Some candidates gave a correct test and result. Other candidates gave a correct reagent but suggested a red-brown precipitate or left the result line blank. A wide variety of incorrect test reagents was seen, e.g. bromine, air, acid. A considerable number of candidates did not respond to this question.

(e) Many candidates gave a suitable use for stainless steel. The commonest correct answer was "cutlery". Incorrect answers usually referred to cars (unqualified) or bridges.

Question 6

(a) Some candidates correctly identified fractional distillation as the method. Other candidates suggested "cracking". The name of the physical property was often incorrect; "melting point" was a common incorrect answer.

(b)(i)(ii) In part **(i)**, many candidates identified "refinery gas" correctly. The commonest error was to suggest bitumen. In part **(ii)**, a common error was to suggest "fuel oil".

(c) (i) Nearly all candidates were able to identify the two unsaturated hydrocarbons. Incorrect answers were often a mixture of saturated and unsaturated hydrocarbons.

(ii) Many candidates literally broke the hydrocarbon into two pieces, "C_3" and "H_8". The other common error was to suggest "CH_2" and "C_2H_6".

(d) (i) A minority of candidates recognised that copper had been formed by reduction of the oxide. The commonest incorrect answers were "bitumen oxide", "copper bitumen" and "copper chloride".

(ii) Very few candidates referred to a reason why the water collects higher up the tube. Most just gave the simple answer that "it condenses", which is a process rather than a reason.

Question 7

(a) Some candidates gave a good description of the numbers and charges of protons, neutrons and electrons in chlorine. Some candidates concentrated on the electronic structure and did not appear to use the Periodic Table to help them. Common errors included: protons in shells; electrons in the nucleus; numbers of protons and electrons being reversed; and no mention of the position of the subatomic particles.

(b) The better-performing candidates gave a very simple answer in terms of one electron being transferred from the sodium atom to the chlorine atom. The commonest errors were in the precise use of language; answers such as "the sodium *ion* loses an electron" and the "chloride *ion* gains an electron" cannot be given credit.

(c) (i) Few candidates mentioned that iodine was brown in colour although they wrote about iodine in the answer. Vague answers such as "the reaction produces potassium chloride and iodine" were not sufficient to gain credit. A considerable number of candidates did not respond to this question.

(ii) Few candidates compared the reactivity of chlorine and iodine. Of those candidates who did, a considerable proportion suggested that iodine is more reactive than chlorine. The commonest errors involved a comparison with potassium or potassium iodide or just referred to oxidation. A considerable number of candidates did not respond to this question.

(d) Many candidates gave the correct molecular formula. Incorrect answers either involved errors in the counting of atoms or production of a condensed structural formula e.g. $CF_3CC\mathit{l}F_2$.

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Paper 0620/31
Extended Theory

Key messages

Answers should always address what has been asked in a question. For example, if a question asks about rate of reaction, then marks will not be gained by giving answers that deal solely with equilibria or some other aspect of chemistry.

Chemical equations should be balanced symbol equations unless the question specifically asks for a word equation. If a word equation is asked for then a symbol equation should **not** be given as the answer.

When the position of an equilibrium moves, it can move either to the right or to the left; it cannot move either up or down.

General comments

There was no evidence that candidates ran out of time with all scripts seen showing answers attempted throughout the paper. Some very high scoring scripts were seen and excellent answers were seen to all questions on the paper.

Question 2 proved demanding as it required recall of chemical properties and then application to state and explain a suitable separation technique.

Comments on specific questions

Question 1

(a) Parts **(i)** and **(ii)** proved to be more demanding than parts **(iii)** and **(iv)**, which were commonly correct. A common error in **(ii)** was to give Kr, presumably through candidates not reading the question carefully and just giving the name of another noble gas.

(b) In part **(i)** there were many fully correct answers, but it was common for candidates to miss the “2+” charge on the copper and so give an incorrect value for the number of electrons.

In part **(ii)** there were errors due to a confusion between “nucleons” and “neutrons” and also due to candidates forgetting that there would be an equal number of electrons and protons.

(c) Part **(i)** was very well answered, although some candidates gave only part of an answer, for example commenting on mass number but ignoring atomic number. It should be stressed that relative atomic mass is the mean mass allowing for isotopic abundance and so is not a suitable term to use when explaining what isotopes are.

Most candidates identified magnesium in part **(ii)**.

A wide variety of uses of radioactive isotopes were seen in part **(iii)** although a common error was to state that radioactive isotopes are used in chemotherapy; they are not, they are used in cancer treatment by *radio*therapy.

Question 2

(a) Many answers seen were based on spurious differences between copper and zinc, such as solubility or particle size. Some impractical methods, such as fractional distillation, or vague answers, such as “find a solvent which will dissolve only one of them” were seen. Only a minority of candidates recalled that, of the two elements, only the zinc would react with a dilute acid, and so adding excess dilute acid and then filtering would yield the copper.

(b) The two most common creditworthy answers seen were based either on fractional distillation (although many candidates did not mention liquefying the two gases first) or reacting something with the oxygen and leaving the nitrogen (although many candidates did not identify a substance that would produce a gaseous oxide and so enable separation).

(c) The reference in the question to R_f values enabled many candidates to select chromatography as a suitable method.

(d) This was the most poorly answered of the four parts in **Question 2**. Incorrect answers based on fractional distillation were as common as correct answers based on the amphoteric nature of zinc hydroxide. However, some candidates showed an excellent chemical knowledge and gave clear and fully correct answers.

Question 3

(a) Many candidates gave fully correct answers, some even went on to give (unnecessary) explanations of why the rate would be faster. However, some candidates were clearly unsure of how to answer this question and claimed that the use of a spray prevents the production of pollutants, despite the required product being sulfur dioxide.

(b) This question proved difficult for candidates. Candidates were expected to recall that air is 20–21% oxygen and apply this to the question. Some candidates gave implausible answers less than $1\,dm^3$.

(c) While a minority of answers just repeated what was in the question by stating that air is cheaper, many candidates realised that excess air would either move the equilibrium to the right and so use up most or more of the sulfur dioxide. Many candidates gave only half the required answer.

(d) In part **(i)** there were some excellent answers, although some candidates did not explicitly say what would happen to the position of equilibrium. It should be noted that a reaction does not have an endothermic (or exothermic) *side*; it is either the reverse or forward *reaction* that is exothermic (or endothermic).

Despite part **(ii)** asking about rate, many candidates gave answers based on equilibrium. The required answer had to be comparative, i.e. “slow*er*” rather than just “slow”. Full credit could not be awarded without some idea of particles or molecules as the explanation required was based on collision theory.

(e) In part **(i)**, some answers just said the equilibrium moves to the side with fewer moles without explicitly stating which side that was.

Part **(ii)** was well answered.

(f) The most common error was to omit the oxidation state of the vanadium or to state the catalyst used in the Haber process.

(g) There were some very confused answers which involved reducing sulfur trioxide back to sulfur dioxide or involved further reactions with oxygen and hydrogen. Some candidates gave full descriptions of the process starting from sulfur and air. However, there were some excellent answers that not only stated the two stages of the process (react with concentrated sulfuric and then with water) but also gave explanations (which were not required) as to why the sulfur trioxide could not be reacted directly with water.

Question 4

(a) In part **(a)(i)** there was some confusion as to the problems caused by the disposal of synthetic polymers in landfill sites. While many fully correct answers were seen, many answers were contradictory, for example claiming that the polymers do not break down (which is correct) but then stating that they will give off toxic compounds (contradicting the first point). Many answers were too vague to gain credit such as “pollution” or “environmental problem”.

In part **(a)(ii)** there were again some vague answers, such as "air pollution", which were not credited.

(b) The most common errors were either for candidates to name synthetic polymers (rather than give a use) or to state they were used to make plastics (which is not a use since plastic is a generic term which covers all synthetic polymers).

(c) While many completely correct answers were seen to part **(i)**, many structures omitted the C=C double bond that is essential in the monomer of an addition polymer. Some candidates gave the repeat unit of the polymer, which is not what had been asked for.

The functional group in part **(ii)** proved challenging for some candidates. The most common error was to say that it was an acid group. Those candidates who gained credit in part **(ii)** often also gained credit in part **(iii)**; other candidates seemed just to guess the names of two functional groups.

(d) While some excellent and well-structured answers were seen, many candidates seemed to start their answers with little idea of where they were going, and then ended up contradicting themselves. Candidates need to check they have answered all that is asked for in questions. It was not uncommon for candidates to miss the requirement to classify **A** and **B** or just to describe one of the two types of polymer.

Question 5

(a) Part **(i)** was almost always correct.

In part **(ii)**, answers were almost always completely correct or totally wrong. Only a small minority of candidates were able to work out the mole ratio of the elements but then not able to deduce a correct formula.

Part **(iii)**, proved very difficult for many candidates; they needed to make use of their previous answer and the data in the question. Many molecular formulae seen would clearly not have had an M_r of 86.

(b) In part **(i)**, the use of bromine water as a test for the presence of a C=C double bond was well known. However, candidates were often not aware that it is not a test for *any* double bond, such as C=O.

The production of hydrogen as an indication that the substance was acidic in part **(ii)** was less well known.

Part **(iii)** required use of the answers to parts **(b)(i)** and **(ii)** as well as the M_r given in part **(a)(iii)**. This was a demanding question. Candidates are reminded that any proposed structural formula should be plausible in terms of bonding and valency.

Question 6

(a) Some excellent answers to part **(a)(i)** were seen, although this area of the course was clearly not well known by some candidates. Poor answers referred to layers or even carbon atoms in the structure of silicon(IV) oxide.

Many candidates gave completely correct answers to part **(ii)**.

Part **(iii)** proved much more demanding. The most common error was to use an indicator of some sort; since silicon(IV) oxide has a macromolecular structure it is insoluble in water and so will not change the colour of an acid-alkali indicator.

(b) While a minority of candidates correctly stated that carbon dioxide has a simple molecular structure, many simply stated that carbon dioxide is a gas. Since the difference in boiling point is a physical property for which the candidates were expected to give an explanation, simply stating that that one is a gas does not answer the question.

Question 7

(a) Many candidates did not read the question in part **(i)** and just stated which step was reduction but offered no explanation. Some candidates stated that **step 1** was reduction but then stated that it showed the gain of electrons (which although a correct definition of reduction, was not shown in **step 1**).

In part **(ii)** there was also evidence of candidates not reading the question; some candidates gave no explanation and some gave the step and not the ion. There was careless use of terminology with claims that the silver ion (which is Ag^+ and not just Ag) oxidised brom*ine* or *Br*, rather than oxidising brom*ide*.

(b) Some excellent answers to this question were seen, giving clear descriptions of the colours that would be seen and a reason based on the photochemical reaction. However, many candidates failed to use the information in the question regarding the colour of the silver produced or focused on a reaction between the paper and the sunlight rather than of the silver bromide.

(c) Many correct answers were seen to part **(i)**, although some candidates mixed up the reagents and products.

Part **(ii)** was well answered. The most common error was to state that chloroplasts were the substance responsible for the colour in green plants.

The structure of the polysaccharide in part **(iii)** proved very demanding. Very few candidates gained full credit and many candidates failed to show the correct linkage between glucose units. Bridging hydrogen atoms was a very common error. Many of those who did correctly link together two glucose units failed to gain the second mark by drawing a disaccharide (terminal –OH groups) rather than a continuing polymer chain.

While there were some good answers to part **(iv)**, many candidates failed to link the process to a release of energy by reaction with oxygen or to the involvement of a biological system. The most common error was to confuse respiration with gaseous exchange.

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Paper 0620/32
Extended Theory

Key Messages

Candidates are advised not to give more than the specified number of answers, e.g. **one** use, **two** reasons. Every question should be read carefully; responses should directly address the question asked.

Knowledge of all parts of the syllabus is very important. It was evident by the number of omitted responses in **Question 4** that some candidates lacked knowledge of organic chemistry.

General Comments

It is important that candidates' written answers are clear enough to be marked. This particularly applies where names can be easily confused, e.g. alkane and alkene. Candidates should try to avoid using long sentences which may introduce contradictions. The use of short phrases or bullet points is acceptable.

If a word equation is asked for then a chemical symbol equation is not required. Likewise, a word equation will receive no credit if a chemical symbol equation is asked for. Capital letters should be used appropriately in element symbols.

Comments on Specific Questions

Question 1

(a) Most candidates scored full credit. Candidates are reminded that the symbol for fluorine is **not** F*l*.

(b) The formulae of the ions were generally known. Occasionally ga^{3+} was given.

(c) This was done well by candidates. Common incorrect answers were $Cr(SO_4)_3$ and $BaOH_2$.

Question 2

(a) (i) Relatively few candidates scored full credit for this question. The most common error was the omission of the word "complete" in responses in reference to complete combustion. Candidates who performed less well assumed that it was carbon combusting. Many candidates assumed carbon monoxide (and sometimes carbon dioxide) came from a multistage process, similar to the series of reactions which happen in the blast furnace.

(ii) Generally this question was well done. Sometimes statements were made about the effects of the gases without being specific about the gas referred to. Some candidates did not understand the term "adverse".

(iii) The idea of the high temperatures within a car engine allowing atmospheric nitrogen to react with oxygen in the air was well known. A significant number of candidates omitted the need for a high temperature. Candidates who performed less well often erroneously stated that nitrogen came from the fuel. Sometimes there was confusion with the reaction in the catalytic converter.

(iv) Most candidates knew that nitrogen monoxide (further) reacted with atmospheric oxygen.

(b) Not all candidates appeared familiar with the meaning of the term "adverse". Most candidates referred to the idea of acid rain and its problems; there was occasional confusion with global warming and ozone depletion.

(c) Most candidates identified the use of a catalytic converter. The correct equation was seen only rarely. Often the equations seen were self-contradictory.

Question 3

(a) This question highlighted the lack of understanding of the use of air instead of oxygen in industrial processes. Common incorrect word equations included sulfur as an additional product.

(b) Candidates who wrote the word equation generally scored full credit for this question.

(c) Most candidates realised that the electrolyte needed to be a solution containing zinc ions. The idea that the cathode was pure zinc was understood by most candidates.

The ionic half-equations proved difficult with many candidates failing to appreciate that charges must balance in ionic half-equations.

The final section about why the concentration of the electrolyte is constant was poorly attempted. Some candidates provided good responses explaining that zinc ions were provided by the impure anode and were discharged at the pure cathode, but relatively few candidates stated that these processes were concurrent or that they were happening at the same rate.

(d) (i) A significant number of candidates were unaware that copper is found in brass.

(ii) The advantages of alloying were well known by most candidates. Candidates should be aware that the term "rusting" applies to iron specifically; the generic term is "corrosion".

(e) (i) Many candidates failed to realise the significance of the absence of a barrier to air (oxygen) and water.

(ii) This question asked candidates to explain the observations in terms of the *formation of ions* and the *transfer of electrons*. Vague responses about sacrificial protection (by zinc) were often seen. Such responses gave no consideration to the behaviour of copper-coated steel.

Better-performing candidates related electron loss to the order of the three metals (copper, iron and zinc) in the reactivity series.

Question 4

(a) (i) The phrase "photochemical reaction" was correctly explained by nearly all candidates.

(ii) Many candidates drew a different conformer of the same structure.

(iii) The expected response was seen from many candidates.

(b) This calculation was poorly attempted by many candidates. Candidates are advised to structure their calculations clearly.

Candidates should be aware of the need to use precise and correct wording in their answers. Some candidates had changed "exothermic" to "endothermic" in their answers or vice versa. To avoid confusion, candidates must clearly strike through a word they do not want to be marked and rewrite the correct version alongside.

(c) (i) This proved a difficult question for many candidates. Many candidates were not able to extract the formulae of chloropropane or propanol from the information. Candidates who performed less well attempted to write word equations. If a word equation is required, the question will specifically ask for one.

(ii) Candidates must write with enough clarity to ensure the suffix of an alkene is clearly legible as –ene. Many pentavalent carbon atoms were seen in diagrams from candidates who performed less well.

(iii) Better-performing candidates knew that propanoic acid was the expected response. Candidates who performed less well assumed that a relevant manganese or potassium compound was produced.

(d) (i)(ii) Often Candidates who performed less well gave the two correct values in the wrong answer spaces. Some candidates gave the number of moles of each reactant here.

(iii) Better-performing candidates correctly calculated the number of moles of each reactant. This question was often left blank.

(iv) This question was not attempted by many candidates. The most common error was to produce a mass of ester (8.8 g) based upon the mass of propanol used, despite methanoic acid being the limiting reagent (shown in **4(d)(iii)**). A common error was to attempt to calculate a percentage yield for the ester.

Question 5

(a) Most candidates were able to score credit for realising that one function of coke in a blast furnace is as a reductant. Fewer candidates knew that that another function of coke was for the generation of the heat needed to run the process.

(b) The equation for the conversion of hematite to iron was well known. Candidates who performed less well often left the equation unbalanced. The species "Fe_2" was frequently seen as a product.

(c) The chemistry of the removal of silicon impurities using lime (from limestone) was well known and credit was frequently awarded. Credit for the process of separation from the molten iron was less frequently awarded.

(d) The removal of carbon was not as well known. Failure to state that it is oxygen (not air) which is pumped / blown / bubbled into the melt was the common omission. An equation was rarely seen in answers. The idea of gaseous carbon dioxide being able to escape was often not stated.

Question 6

(a) Many candidates answered in terms of valency without any mention of oxidation state and so were not awarded credit. The concept of an element's most common oxidation state seemed poorly understood. The description of the trend was very rarely correctly seen.

(b) Many candidates do not have a clear idea of the metallic bonding model. Candidates who performed less well showed a misunderstanding about what kind of particles formed the lattice and sometimes no particles were referred to at all. Many candidates did not address the question and instead gave a simple list of the properties of metals.

(c) The idea that an electron must be able to move so that metals can conduct electricity was poorly understood. Use of the specific term "mobile" is advised.

(d) Candidates who performed less gave poor responses to this question. The incorrect use of "chloride" instead of "chlorine" was very rarely seen.

(e) Candidates, in general, were not aware that physical properties such as melting point are dependent upon the structure and bonding of the substance.

(f) The difference in bond types was relatively well known. The most common error was for candidates to state (correctly) that "ionic bonds are strong" and then (incorrectly) state that "covalent bonds are weak". It is the intermolecular forces between the PCl_3 molecules that are weak and not the intramolecular bonds within them.

(g) Many good answers to this question were seen.

(h) The “finished” version of the dot-and-cross diagram was required showing eight outer shell electrons on the oxide ion and eight (or zero) outer shell electrons on the magnesium ion. Diagrams showing how these ions are formed from their constituent atoms often give rise to diagrams with too many electrons present.

Some candidates drew covalent as well as (correct) ionic diagrams. This is a contradiction and credit was not awarded.

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Paper 0620/33
(Extended Theory)

Key Messages

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

Chemical formulae should always be written without roman numerals, e.g. $FeSO_4$ is the correct formula of iron(II) sulfate as opposed to Fe(II)SO_4. It is essential that candidates know the rules for writing formulae and writing balanced chemical equations at this level.

Candidates should be aware that in ionic equations or ionic half-equations the total charge on both sides of the equation should be equal, as well as the number of atoms of each element.

Candidates should know the differences between physical and chemical properties and be able to give examples of each. This understanding was required in more than one section of the Question Paper.

General Comments

Candidates seemed well prepared for the Question Paper. There was no evidence of insufficient time to complete the Question Paper.

Comments on Specific Questions

Question 1

(a) This question was answered well by many candidates. Universal Indicator was sometimes incorrectly given as the reagent used to test for the presence of water. Some candidates were confused and suggested copper(II) chloride as the reagent to be used. The colour changes for cobalt(II) chloride and copper(II) sulfate were sometimes given the wrong way round.

(b) This question was answered well by many candidates. Universal Indicator was again sometimes given as an incorrect answer.

(c) This question was answered well by most candidates. Filtration and chlorination were very often seen as correct answers.

(d) This question was answered well by most candidates. A wide variety of correct answers were seen.

Question 2

All parts of this question were generally answered very well. The most common incorrect answer was butane in part **(c)**.

Question 3

(a) (i) Many candidates reported that ions were totally motionless, as opposed to vibrating about a fixed position.

(ii) A bond should normally be referred to a force of attraction. In this case the force of attraction between oppositely charged ions was required, but it was very rare to see both points mentioned and much more common to see reference to neither. It was far more common to see irrelevant references to transfer of electrons.

(iii) There was only very occasional reference to both positive and negative ions although reference to a regular arrangement of particles was more common. A sea of electrons was occasionally correctly referred to.

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(b) (i) This was answered quite well, although the electrons were often seen moving through the conducting wire in the wrong direction, or through the electrolyte.

(ii) (iii) Ionic equations and ionic half-equations continue to be a source of error. Electrons are often written on the wrong side of the equation. Symbols for atoms, rather than molecules, are often seen. Positive ions are often given discharging at the positive electrode and negative ions given discharging at the negative electrode.

(iv) Brom*ide* ions were often incorrectly referred to as brom*ine* ions or even as bromine. Candidates usually made correct reference to oxidation as loss of electrons.

(c) The majority of candidates identified the colourless gas as hydrogen, although the other two marking points were scored less regularly. Lithium hydroxide or hydroxide ions were often mentioned, although the link with alkalinity was often absent. Attempts at ionic half-equations again emphasised the problems referred to in parts **(b)(ii)** and **(b)(iii)**.

Question 4

(a) (i) This was often answered well. A common error was to refer to physical properties (excluded by the question). There was also some confusion shown between empirical, molecular, structural and general formulae.

(ii) Those candidates who made correct references to the general formulae of alkanes and alkenes scored full credit. Some candidates attempted to refer to bonding in part **(ii)**, rather than in part **(iii)**.

(iii) Both alkanes and alkenes contain single bonds, but alkanes *only* contain single bonds. The word *only* was often missing, thus limiting the credit available to candidates. The answers to parts **(a)(ii)** and **(a)(iii)** were often reversed.

(b) (i) Candidates should be aware that cracking occurs under conditions of high temperature and in the presence of a catalyst. Those who were more specific often referred to incorrect catalysts (such as nickel or sulfuric acid) or incorrect temperatures. References to steam and pressure were given full credit if stated appropriately, instead of using a catalyst.

(ii) (iii) Many correct answers to parts **(b)(ii)** and **(b)(iii)** were seen. It is important that candidates balance equations accurately.

(iv) This question was answered well by many candidates.

(c) (i) (ii) These questions were answered reasonably well. There were no apparent common errors.

(iii) This question was discounted.

Question 5

(a) (i) Candidates are advised to learn the definition of an acid as a “proton donor”.

(ii) Candidates should be aware that strong acids “completely dissociate into ions” whereas weak acids “partially dissociate into ions”. Such knowledge is essential at this level. The concentration of H^+ was often referred to in candidates’ responses.

(b)(i) (ii) There was a wide variety of incorrect responses given including barium sulfite and barium sulfate in the wrong places; references to sulfides; and also references to bromine sulfite and bromine sulfate.

(b) (iii) Many equations had species other than bromine molecules on the left-hand side. The errors concerning ionic half-equations referred to in **3(b)(ii)(iii)** were frequently repeated here.

(iv) The correct answer was seen infrequently. There was a wide variety of other answers given.

(c) All parts of this question were usually answered well.

(d) (i) Water was often seen as a product. The formulation "acid plus alkali / base gives a salt plus water" only applies if the alkali / base is an oxide or hydroxide, rather than ammonia. The formula of ammonium sulfate was usually given incorrectly.

(ii) The incorrect formula, $NaSO_4$, was just as common, if not more so, as the correct formula, Na_2SO_4.

(iii) This was answered much better than the other two parts of **(d)** with many candidates scoring full credit. Fe(II) was sometimes incorrectly seen on the left-hand side; Fe(II)SO_4 was sometimes incorrectly seen on the right-hand side.

Question 6

(a) (b) These questions were both answered very well and candidates scored very highly.

(c) This question was answered reasonably well. There were no common errors.

(d) This was answered very well and candidates scored very highly.

(e) This was attempted in a variety of ways by candidates and many candidates scored highly. Some candidates referred to magnesium instead of manganese. Candidates needed to refer to how they could decide which metal was the more reactive from the results of their experiments.

(f) Many candidates scored highly in this question. Candidates sometimes gave physical properties in both sections.

Question 7

(a) The three parts to this calculation were answered reasonably well. There were occasional rounding errors. If in doubt, it is advised that candidates give more significant figures rather than too few. The second part of the calculation was answered more successfully.

(b)(i)(ii) A common incorrect answer was that the indicator could be removed by distillation or fractional distillation. The methods of separation required was adding charcoal and filtering.

To answer part **(ii)** successfully candidates needed to refer to the volumes of both solutions that were required to make solutions of the salts.

(c) Many successful methods were described to give a positive result for the acid and a negative one for the salt. The most successful methods used an indicator or magnesium metal.

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Paper 0620/04
Coursework

General comments

This was the final session for this paper for 0620 candidates and only one Centre submitted work on this occasion. There were no problems encountered in the moderation of the work submitted.

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Paper 0620/51
Practical

Key Messages

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

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

General comments

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

Supervisors' results were submitted with all of the candidates' scripts. These results were used when marking to compare with the candidates' responses, particularly in **Question 2**. Centres reported no problems with the preparation of materials or the running of this practical examination.

Comments on specific questions

Question 1

(d) The four experiments were usually successfully carried out and the times recorded in the table of results in ascending order of magnitude. The majority of candidates recorded times that were comparable to the Supervisors'. A minority of candidates did not record the times in seconds. A significant number of candidates recorded the values to 2 d.p. which was unnecessary.

(e) The best responses gave the required detail and valid observations. Candidates should be reminded that "gas given off" is not an observation. Many candidates referred to hydrogen being formed or a "splint popping" without reference to a *lighted* splint. Others candidates referred incorrectly to a glowing splint. Many candidates did not record the temperature of the acid and those who did often failed to record the temperature rise after the magnesium was added.

(f) Most candidates plotted the points for all four experiments on the grid correctly but some plotted the concentration of the acid for Experiment 1 at 0.1 mol/dm^3 instead of at 1.0 mol/dm^3. Some candidates did not show clearly the position of their points on the grid. Lines of best fit varied according to the results obtained.

Pleasingly, the majority of candidates drew smooth line or straight line graphs. Several candidates drew a straight line of best fit when the points plotted clearly better fitted a smooth curve. A number of candidates included obviously anomalous points in their line of best fit; other candidates incorrectly joined all the points with straight lines.

(g) (i) Most candidates worked out the concentration of the sulfuric acid and showed clearly how they had used their graph to do so. Some errors in reading the scale of the *x*-axis were evident and a number of responses gave no indication how the answer was obtained.

(ii) Many good extrapolations were drawn. A minority of candidates misread the scale on the *y*-axis.

(h) The idea of using the same amount of magnesium in the experiments to enable a comparison of results / fair test was well understood by the majority of candidates.

(i) (i) The type of reaction was correctly identified as exothermic by the majority of candidates.

(ii) Hydrogen was correctly identified by most candidates.

(iii) A minority of candidates thought that using less magnesium would have no effect on the temperature change.

(j) Better-performing candidates were able to communicate the idea that using a gas syringe to measure the volume of gas evolved at a certain time interval was a different method to measure the rate of the reaction. Other good answers included using a thermometer to measure the temperature change of the reaction over time.

Many answers used the same method as in the four experiments already carried out, despite being asked for a *different* method. Using the same method but with powdered magnesium instead of magnesium ribbon scored no credit. Responses referring to the measurement of pH changes using Universal Indicator would not have worked and so were not credited.

Question 2

Solution **X** was aqueous iron(II) chloride (ferrous chloride).

Solution **Y** was aqueous silver nitrate.

Some very good answers were seen to this qualitative analysis question with all of the expected observations clearly detailed. The results obtained by some candidates to certain tests bore no resemblance to the expected observations, despite other candidates from the same Centre scoring high marks.

(a) Most candidates were able to describe the appearance of solution **X** as yellow or green; Supervisors' results were referred to if candidates' results reported other observed colours. A significant number of answers referred to the presence of a precipitate or solid which showed a lack of understanding.

(b) This question was generally well answered with a white precipitate identified. Many candidates noted the formation of a cloudy solution, but failed to describe the colour appropriately.

(c) Better-performing candidates noted the initial changes in the mixture and those after five minutes.

(d) The formation of a green precipitate was the expected observation.

(e) A minority of candidates recorded the decolourisation of the aqueous potassium manganate(VII); many candidates only scored credit for the formation of the brown precipitate. A large number of vague answers referred to the formation of a black / green precipitate or a brown solution.

(f) This question was generally well answered with a white precipitate identified.

(g) Some responses showed that candidates did not follow the instructions given and therefore observations were missed. Despite the final instruction, the gas given off was often not tested. Some candidates just wrote "ammonia is produced" without stating the test carried out and so were awarded no credit. Some candidates failed to note the presence of bubbles or effervescence. Only the more observant candidates noted the formation of a brown precipitate.

(h) This question was generally well answered with the yellow precipitate identified. Many candidates noted the formation of a green, white or creamy-coloured precipitate.

(i) This question was generally well answered with many identifying candidates identifying solution **X** as iron(II) chloride. Many candidates showed a lack of understanding and stated the presence of iron(III) ions, because they had not recognised the oxidation of iron(II) ions in test **(e).**

(j) Only the better-performing candidates scored full credit for identifying solution **Y** as silver nitrate or lead nitrate. Many candidates referred to the presence of ammonium iodide or ammonium nitrate, not recognising or understanding the formation of ammonia from the nitrate test in **(g)**.

CHEMISTRY

Paper 0620/52
Practical

Key Messages

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

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

General comments

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

Supervisors’ results were submitted with all of the candidates’ scripts. These results were used when marking to compare with the candidates’ responses, particularly in **Question 2**. Centres reported no problems with the preparation of materials or the running of this practical examination.

Comments on specific questions

Question 1

(d) The four experiments were usually successfully carried out and the times recorded in the table of results in ascending order of magnitude. The majority of candidates recorded times that were comparable to the Supervisors’. A minority of candidates did not record the times in seconds. A significant number of candidates recorded the values to 2 d.p. which was unnecessary.

(e) The best responses gave the required detail and valid observations. Candidates should be reminded that “gas given off” is not an observation. Many candidates referred to hydrogen being formed or a “splint popping” without reference to a *lighted* splint. Others candidates referred incorrectly to a glowing splint. Many candidates did not record the temperature of the acid and those who did often failed to record the temperature rise after the magnesium was added.

(f) Most candidates plotted the points for all four experiments on the grid correctly but some plotted the concentration of the acid for Experiment 1 at 0.1 mol/dm^3 instead of at 1.0 mol/dm^3. Some candidates did not show clearly the position of their points on the grid. Lines of best fit varied according to the results obtained.

Pleasingly, the majority of candidates drew smooth line or straight line graphs. Several candidates drew a straight line of best fit when the points plotted clearly better fitted a smooth curve. A number of candidates included obviously anomalous points in their line of best fit; other candidates incorrectly joined all the points with straight lines.

(g) (i) Most candidates worked out the concentration of the sulfuric acid and showed clearly how they had used their graph to do so. Some errors in reading the scale of the *x*-axis were evident and a number of responses gave no indication how the answer was obtained.

(ii) Many good extrapolations were drawn. A minority of candidates misread the scale on the *y*-axis.

(h) The idea of using the same amount of magnesium in the experiments to enable a comparison of results / fair test was well understood by the majority of candidates.

(i) (i) The type of reaction was correctly identified as exothermic by the majority of candidates.

(ii) Hydrogen was correctly identified by most candidates.

(iii) A minority of candidates thought that using less magnesium would have no effect on the temperature change.

(j) Better-performing candidates were able to communicate the idea that using a gas syringe to measure the volume of gas evolved at a certain time interval was a different method to measure the rate of the reaction. Other good answers included using a thermometer to measure the temperature change of the reaction over time.

Many answers used the same method as in the four experiments already carried out, despite being asked for a *different* method. Using the same method but with powdered magnesium instead of magnesium ribbon scored no credit. Responses referring to the measurement of pH changes using Universal Indicator would not have worked and so were not credited.

Question 2

Solution **X** was aqueous iron(II) chloride (ferrous chloride).

Solution **Y** was aqueous silver nitrate.

Some very good answers were seen to this qualitative analysis question with all of the expected observations clearly detailed. The results obtained by some candidates to certain tests bore no resemblance to the expected observations, despite other candidates from the same Centre scoring high marks.

(a) Most candidates were able to describe the appearance of solution **X** as yellow or green; Supervisors' results were referred to if candidates' results reported other observed colours. A significant number of answers referred to the presence of a precipitate or solid which showed a lack of understanding.

(b) This question was generally well answered with a white precipitate identified. Many candidates noted the formation of a cloudy solution, but failed to describe the colour appropriately.

(c) Better-performing candidates noted the initial changes in the mixture and those after five minutes.

(d) The formation of a green precipitate was the expected observation.

(e) A minority of candidates recorded the decolourisation of the aqueous potassium manganate(VII); many candidates only scored credit for the formation of the brown precipitate. A large number of vague answers referred to the formation of a black / green precipitate or a brown solution.

(f) This question was generally well answered with a white precipitate identified.

(g) Some responses showed that candidates did not follow the instructions given and therefore observations were missed. Despite the final instruction, the gas given off was often not tested. Some candidates just wrote "ammonia is produced" without stating the test carried out and so were awarded no credit. Some candidates failed to note the presence of bubbles or effervescence. Only the more observant candidates noted the formation of a brown precipitate.

(h) This question was generally well answered with the yellow precipitate identified. Many candidates noted the formation of a green, white or creamy-coloured precipitate.

(i) This question was generally well answered with many identifying candidates identifying solution **X** as iron(II) chloride. Many candidates showed a lack of understanding and stated the presence of iron(III) ions, because they had not recognised the oxidation of iron(II) ions in test **(e).**

(j) Only the better-performing candidates scored full credit for identifying solution **Y** as silver nitrate or lead nitrate. Many candidates referred to the presence of ammonium iodide or ammonium nitrate, not recognising or understanding the formation of ammonia from the nitrate test in **(g)**.

CHEMISTRY

Paper 0620/53
Practical

Key Messages

Burette reading should be recorded to 1 d.p. Candidates should be reminded that it is not possible for the initial reading on the burette to be greater than the final reading.

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

Candidates should be aware that the mark allocation reflects the number of points required for the answer.

General comments

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

Supervisors' results were used in the marking of **Question 1**. It was pleasing to see that all Centres had submitted Supervisors' results. Centres generally recorded volumes of aqueous potassium manganate(VII) for Experiments 1 and 2 in **Question 1** in the expected range. Centres reported no problems with preparing for or carrying out this practical examination.

A number of candidates failed to follow all of the instructions for certain parts of **Question 2**.

Comments on specific questions

Question 1

(a)(b) The tables of results were completed by all of the candidates. The majority of candidates scored full credit. A minority of candidates recorded initial burette readings greater than the final burette readings. Some candidates recorded volumes to the nearest whole number only. Burette readings should be recorded to 1 d.p.

(c) (i) Candidates generally understood that the burette was washed with distilled water to clean it and remove traces of solution **M**.

(ii) Only the better-performing candidates realised that the burette was then rinsed with solution **N** to remove traces of water. A common misconception was to describe its purpose as being for the removal of solution **M** which had already been removed in **(c)(i)**.

(d) (i) Incorrect colour changes, such as colourless to red or purple, were frequently given. Credit was given for colourless to pink. Some candidates confused the initial and final colours.

(ii) The majority of candidates knew that an indicator was not needed as a colour change was clearly shown in the experiments. This was expressed in a variety of ways, such as "potassium manganate is self-indicating".

(e) (i) This question was generally well answered. Some candidates answered "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, i.e. that (almost) double the volume of potassium manganate(VII) solution was used in Experiment 1. Stating that more or less solution was used was insufficient.

(iii) Better-performing candidates realised that solution **N** was more concentrated than solution **M** as a smaller volume of solution **N** was used to react completely with the aqueous iron(II) sulfate. The best answers stated that solution **N** was twice as concentrated as solution **M**. Incorrect answers referred to solution **M** being more concentrated as a greater volume of solution **M** was used; this showed a lack of knowledge and understanding.

(f) Full credit was given for candidates halving their value from Experiment 2.

(g) Many candidates were able to describe an advantage of using a measuring cylinder. Answers that referred to the accuracy of a measuring cylinder as an advantage were prevalent and were not credited.

In the part about a disadvantage, common incorrect responses referred to liquid remaining in the cylinder or parallax problems.

Question 2

Solid **P** was tartaric acid.

Solid **Q** was anhydrous copper(II) sulfate.

The full range of marks was awarded for this question. The majority of candidates scored high marks on this question. For a minority of candidates, their observations bore no resemblance to those expected.

(a)(g) One mark was awarded for correctly describing the colour of both solids. Most candidates were able to describe the appearance of solid **P** as white crystals and solid **Q** as white, grey or light blue. References to blue and green were common.

(b) Detailed observations were frequently missing. Many candidates gained credit for a description of the change of state to a liquid when the solid was heated. The mark for the recognition of condensation forming was often not gained because candidates gave only vague descriptions of vapours.

(c) The pH of the solution was generally correct. Some candidates recorded colour changes involving litmus paper or Universal Indicator paper instead of a number.

(d) The initial and final temperatures were generally correctly recorded indicating a decrease in temperature when solid **P** was added to water.

(e) This question was generally well answered with the formation of a blue solution identified. Some candidates referred to the formation of a black precipitate showing a lack of understanding that excess copper(II) oxide was present.

(f) Vague references to “hydrogen formed” scored no credit. Many candidates scored only partial credit because they did not describe the effervescence of the mixture and wrote only “gas formed”. A significant number of candidates tested the gas with a glowing splint and reported the presence of oxygen.

(h) The initial and final temperatures were generally correctly recorded. Candidates generally indicated the expected increase in temperature when solid **Q** was added to water.

(i) This question was generally well answered with the formation of a blue precipitate identified.

(j) There were many good answers to this question describing the formation of a blue precipitate dissolving in excess aqueous ammonia to form a deep blue solution. Some contradictory responses described the precipitate dissolving to form a precipitate.

(k) Most candidates realised that the pH recorded in test **(c)** indicated that solid **P** was acidic. Few candidates realised that the solid was hydrated or that water was present from test **(b).**

(l) The vast majority of candidates scored credit because they correctly identified that solid **Q** contained copper(II) ions.

CHEMISTRY

Paper 0620/61
Alternative to Practical

Key messages

Questions requiring candidates to plan an investigation should be answered with details of the apparatus to be used. The practical procedures should be clearly specified and candidates should provide a conclusion. Candidates are advised to write preliminary notes before starting to write the plan.

Candidates should use a sharp pencil for plotting points and for drawing lines of best fit on their graphs. The line of best fit might be a curve or a straight line. 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.

General comments

The majority of candidates attempted all of the questions. Some candidates showed a lack of experience with and knowledge of practical procedures.

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

Comments on specific questions

Question 1

(a) Many candidates scored the mark for identifying the teat pipette.

The evaporating dish was correctly identified by about half of the candidates. Vague answers such as dish, basin or bowl were insufficient.

(b) (i) Some candidates expressed the idea that the material used to hang the limestone from the stand should have a high melting point. A significant number of candidates incorrectly suggested materials that would burn or melt such as string, rubber bands and nylon.

(ii) Candidates that had experienced the use of a Bunsen burner were able to state that the air hole should be open. A large number of responses showed a lack of knowledge and understanding of a Bunsen burner.

(c) (i) This question was generally well answered.

(ii) Many candidates realised that solution **A** was limewater and scored credit for the effect of passing carbon dioxide through limewater.

Question 2

(a) A significant number of candidates incorrectly drew lines of best fit which included the anomalous point. Some candidates failed to use a ruler.

(b) Reasons for the anomalous point were often vague.

(c) This question was generally well answered. Most candidates were able to extrapolate the graph and record the energy value for n = 6. Some candidates misread the scale on the *y*-axis.

(d) This question was often poorly attempted. Some answers failed to give the energy values; other answers gave incorrect values and only scored partial credit.

Question 3

(a) The vast majority of candidates gave electrolysis as the process involved.

(b) The majority of candidates correctly identified the expected observations. Comments which did not refer to observations were ignored.

(c) Candidates who performed well correctly specified platinum as a suitable metal for the inert metal electrodes. References to unsuitable metals, such as iron and copper, were prevalent and scored no credit. Graphite and carbon were common incorrect answers.

(d) The test for oxygen was well known.

(e) The majority of candidates realised that hydrogen formed at the negative electrode.

(f) Only the better-performing candidates realised that chlorine gas would be formed, which is a toxic gas. A frequently occurring wrong answer referred to the hazards of concentrated hydrochloric acid. A lack of practical experience was shown by some candidates who discussed flammability and the dangers of repeating the experiment.

Question 4

(d) The table of results was usually completed correctly and many candidates scored full credit.

(e) The majority of candidates correctly plotted the results and drew a smooth line graph. Some candidates plotted the point for the concentration 1.0 mol/dm^3 at 0.1 mol/dm^3.

(f) (i) This question was well answered although some candidates did not show clearly on the graph how the answer was worked out.

(ii) Most candidates scored credit for extrapolating the curve to the *y*-axis to show the time expected using sulfuric acid of concentration of 1.2 mol/dm^3.

(g) The idea of a fair test or comparability of results was well understood by candidates.

(h) This question was well answered. Candidates had no difficulty using the thermometer diagrams to record the two temperatures.

(i) (i) This question was well answered.

(ii) Hydrogen was correctly identified by the vast majority of candidates.

(iii) Better-performing candidates realised that *half* the value of magnesium used would result in half the temperature change.

(j) Many responses indicated that candidates had not read the question carefully because many candidates did not suggest a different method. Good answers described using a gas syringe or thermometer to measure the volumes of gas evolved or the temperature changes over time respectively.

Question 5

Answers to this qualitative analysis question varied considerably between Centres. It was evident that some candidates had no knowledge of the tests required to complete the observations in the table for parts **(a)** to **(e)**.

(a) A wide range of guesses were evident with many incorrect colours suggested. A worrying number of candidates described the appearance of solution **X** as a precipitate.

(b) Most candidates recognised that a white precipitate would be formed. Common incorrect answers included coloured precipitates and effervescence.

(c) The majority of candidates recognised that a green precipitate would be formed.

(d) Fewer candidates recognised that a green precipitate would be formed with excess aqueous ammonia.

(e) Only the better-performing candidates realised that a red-brown precipitate would form as iron(II) ions would have been oxidised to iron(III) ions.

(i) Some candidates recognised that solution **Y** was a nitrate. Fewer candidates deduced that silver ions or lead ions were present. Many responses gave conclusions which showed a lack of knowledge and understanding of the chemistry in test **(g)** which was a test for a nitrate. The formation of ammonia lead many candidates to believe that ammonium ions were present and that solution **Y** was ammonium iodide.

Question 6

The quality of responses to this question was extremely broad. Most candidates scored some credit for taking a measured weight of the toothpaste and adding water to it.

Some incorrect responses discussed filtering the toothpaste which would not work. Others candidates suggested heating the toothpaste, incorrectly thinking that the water and the sodium fluoride would evaporate. Likewise, methods involving the formation of sodium fluoride crystals showed a lack of knowledge and understanding of practical work involving insoluble substances.

Well-planned answers from better-performing candidates gave the essential experimental details with a clear practical method and means of separating the calcium carbonate from the toothpaste and purifying the sample. The best responses also indicated how to carry out the calculations to find the percentage of calcium carbonate in the toothpaste from their experimental results.

CHEMISTRY

Paper 0620/62
Alternative to Practical

Key messages

Questions requiring candidates to plan an investigation should be answered with details of the apparatus to be used. The practical procedures should be clearly specified and candidates should provide a conclusion. Candidates are advised to write preliminary notes before starting to write the plan.

Candidates should use a sharp pencil for plotting points and for drawing lines of best fit on their graphs. The line of best fit might be a curve or a straight line. 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.

Candidates are advised to read the questions thoroughly.

General comments

The majority of candidates attempted all of the questions. Most candidates were able to complete the tables of results from readings on diagrams and plot points successfully on a grid.

Candidates found **Questions 1**, **2(d)(e)**, **3(g)** and **6** to be the most demanding.

Some candidates had difficulty understanding the instructions given in questions. This was particularly noticeable in **Question 1(e)(iii)**.

Comments on specific questions

Question 1

(a) Most candidates scored both marks for identifying the pipette and burette.

(b) Many good answers were seen, for example referring to methyl orange or litmus. The use of Universal Indicator showed a lack of practical experience with titrations.

(c) This question was generally well answered with candidates achieving full credit.

(d) (i) The type of chemical reaction was usually correctly identified. Incorrect answers included redox, displacement and endothermic.

(ii) Common incorrect responses were “the formation of a precipitate” or “no more fizzing”.

(e) (i) The anomalous result in experiment 2 was correctly identified.

(ii) About half of the candidates correctly identified that there was a measuring or recording error.

(iii) A significant number of candidates did not follow the instruction and averaged all four results. Some candidates omitted the unit.

(f) Only the better-performing candidates understood that the hydrochloric acid was more concentrated as a smaller volume of it was needed to react completely with the 25.0 cm^3 of aqueous sodium hydroxide. Most candidates misunderstood the question and identified one of the four experiments as being the most concentrated.

Question 2

(a) This question was generally well answered.

(b) The majority of candidates answered correctly. Inappropriate methods, such as using a spatula or brush, showed a lack of understanding of practical techniques. Common answers were pen / pencil / ink and a locating agent; this showed that more careful reading of the question was needed.

(c) This question was well answered.

(d) Only the better-performing candidates understood that compound **Q** was insoluble in the solvent and therefore remained on the baseline. Many incorrect responses focussed on the density of **Q**; discussed the composition of **Q**; or just stated that **Q** had a low R_f value.

(e) This question was generally well answered. A number of candidates were unable to follow the guidance given. It appeared that some candidates did not have a ruler or electronic calculator.

Question 3

(a) Completing the table of temperature readings was done extremely well by candidates.

(b) The points on the graph were usually correctly plotted although a few candidates got the *y*-axis scale wrong and some candidates missed points out. Some lines of best fit were not smooth curves and some candidates drew straight lines through all the points. A number of candidates, despite identifying the inaccurate point in **(c)**, included it on their line of best fit.

(c) The vast majority of candidates spotted the inaccurate point and explained that it was not on the smooth curve.

(d) This question was generally well answered. Errors included misreading the value from the *y*-axis; reading the starting value from the *x*-axis; or drawing an incorrect tie line. Some candidates missed the unit out or gave it incorrectly.

(e) (i) Most candidates specified that the rate of reaction would increase as the temperature increased. A significant minority of candidates confused rate with reaction time.

(ii) Many correct answers to this question were seen. It was necessary to refer to rate of reaction, rather than reaction time, in the answer.

(f) (i) Most candidates scored credit for this question.

(ii) Many correct sketch curves were seen. Some candidates did not attempt this question.

(g) Better-performing candidates were able to communicate the idea that the purpose of the cotton wool was to prevent the escape or splashing of acid and to allow the carbon dioxide gas to escape. Common misconceptions were that the cotton wool prevented gas escaping and stopped air entering the flask.

Question 4

Common errors in this question were to test for oxygen using a lighted splint instead of a glowing splint. The test for ammonia was often confused with the test for ammonium ions. Some candidates relied on smell as a test for ammonia which is not advised. Some good creative chemistry scored credit, e.g. using potassium manganate(VII) to test for ethene and bubbling ammonia through a solution of copper(II) ions to test for ammonia.

Question 5

Answers to this qualitative analysis question varied considerably between Centres. It was evident that some candidates had no knowledge of the tests required to complete the observations in the table for parts **(d)** and **(e)**.

(c) Credit was awarded for understanding that copper ions were present. Full credit was awarded for copper chloride though many other copper compounds were mentioned by candidates.

(d) Many candidates thought that a precipitate or solid would be observed, despite the fact that this was solution **L**. Only a minority of candidates described the solution correctly as colourless. Yellow and white were common incorrect responses.

(e) (i) Many candidates incorrectly stated that the precipitate was soluble or that effervescence was seen.

(ii) Many incorrect references to the formation of a white precipitate were seen. A large number of incomplete answers were also seen.

(iii) Common incorrect responses were white precipitate or no precipitate.

Question 6

The quality of responses to this question was extremely broad. Those candidates who did not score any credit failed to describe an experiment that would work. Most candidates who scored credit included reference to fair testing and a conclusion based on the results obtained. Some candidates discussed measuring rate without explaining the measurements to be taken. Candidates who were less explicit about the measurements they needed to make tended to suggest observations based on their knowledge of the reactivity series.

Some candidates did not read the question which informed them that all they were provided within terms of chemicals were metals and dilute acids. Several candidates who used the displacement method failed to describe the production of salt solutions.

Well-planned answers from better-performing candidates gave essential experimental details with a clear practical method and a meaningful conclusion.

CHEMISTRY

Paper 0620/63
Alternative to Practical

Key Messages

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

Observations are those which can be seen, heard or smelled. For example, "fizzing" is an observation but "a gas was given off" is not. Smells, such as the bleach or swimming pool smell of chlorine, are acceptable as observations.

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

Not all titrations are acid-base titrations. Candidates should refer to the actual solutions used in such titrations, rather than referring to them as acids and bases. Indicators are not required in titrations which involve a colour change at the end-point.

General comments

The vast majority of candidates successfully attempted all of the questions.

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

Question 6 was a planning task which candidates generally found quite straightforward. The quality of answers for this question was high, with many candidates gaining full credit.

Comments on specific questions

Question 1

(a) This question was well answered. Some candidates incorrectly named the second piece of apparatus as a crucible.

(b) (i) Some descriptions were very confused and at times contradictory. Most candidates recognised the need to crush the zinc carbonate and then add it to the acid and stir. Fewer candidates understood how to recognise the end of the reaction.

(ii) Filter or filtration was a very common answer.

(iii) Many candidates simply described the processes shown in the diagram without adding any further information. The better answers described the science behind the process, such as evaporation and crystallisation point. Very few candidates mentioned cooling the solution. Some candidates appreciated that evaporation was required, but described a process that involved the removal of all the water.

Question 2

(a) The vast majority of candidates mentioned electroplating. The most common incorrect answers were electrolysis and galvanising.

(b) Most candidates appreciated that the steel was chromium-plated to prevent rust or for appearance.

(c) A large proportion of candidates correctly named the cathode or negative electrode, although some responses were self-contradictory, such as “the negative electrode – anode”.

(d) This question was well answered by better-performing candidates. Candidates who performed less well simply named solutions they had encountered in other electrolysis situations, such as sodium chloride or copper sulfate.

(e) Many vague responses in terms of impurities or other reactions were seen for this question. Many candidates did not really appreciate the effect that grease might have on the electroplating process.

(f) This question produced a wide variety of responses. Although a lot of candidates appreciated that the electrolyte should cover the spoon and chromium electrode, many gave responses that would make no difference to the actual process. The most common incorrect answers mentioned the use of a bulb or ammeter in the circuit or that a battery should be used rather than a power supply.

Question 3

(a) This question was well answered, with the vast majority of candidates gaining full credit.

(b) This question was well answered

(c) The plotting of the four points was very good with the vast majority of candidates gaining credit. Many candidates drew straight lines that intersected at the point for experiment 2 without extrapolation, or drew a curve that peaked at the point for experiment 2; they therefore failed to gain full credit.

(d) (i) Most candidates could correctly read the greatest temperature rise that could occur, although a small number chose a point on the extrapolated line beyond the peak.

(ii) The scale on the graph caused some confusion with some candidates not appreciating that the values for **C** decreased while those for **D** increased on moving along the *x*-axis. Units were often not included or given as °C.

(e) This question was well answered.

Question 4

(a) Responses showed a good understanding of this reaction, although a wide range of incorrect answers were seen, including an incorrect colour of precipitate or bubbling.

(b) Although a high proportion of candidates could read the scale correctly, some read it in the wrong direction, for example quoting 11.2 instead of 10.8. The use of 1 d.p. was well adhered to except for 0.0, where 0 was often used.

(c) This was answered better than **4(b)**.

(d) (i) Most candidates gained credit for this question.

(ii) Although many candidates realised that distilled water had to be removed to avoid diluting solution **N**, some candidates thought that this was another way of removing residual solution **M** from the previous experiment.

(e) Many answers appreciated that potassium manganate(VII) acted as the indicator, giving a colour change at the end-point. However, other candidates incorrectly stated that an indicator was not used because it would be obscured by the intense purple colour, or that it was not needed because the experiment had already been carried out once.

(f) (i) This question was well answered, although a small minority of candidates did not read the question and said that Experiment 1 had used more.

(ii) Although many candidates could see that more solution was used in Experiment 2, they did not often describe it in a sufficiently quantitative way.

(iii) Many candidates understood the link between concentration and volume and gained full credit. Some candidates did not make it clear that it was the concentration of the potassium manganate(VII) which differed and even suggested that the concentration of solution **L** changed.

(g) Many candidates recognised that reducing the volume of solution **L** by half would result in half the volume of potassium manganate(VII) being used.

(h) Many candidates gained full credit here.

Question 5

(f) Very few incorrect answers were seen to this question.

(g) Most candidates scored one mark, but fewer gained full credit for this question. Candidates sometimes included additional comments that were contradictory or incorrect.

(h) This question was not well answered. Blue was a common incorrect answer.

(i) The responses to this question were variable. The change to blue was the most common correct comment. Some candidates failed to understand that the question required the direction of the temperature change.

(j) This question was generally well answered. The response of “blue precipitate” was by far the most common answer.

(k) The responses to this question were generally weaker. Some candidates did not gain full credit because they contradicted earlier comments.

Question 6

The question was generally well answered. Many candidates gained full credit. The responses showed that candidates had a clear idea of how to control variables, such as the mass of magnesium.

Some candidates were confused when describing the variation or control required for the sulfuric acid. Some candidates thought that having varying volumes of acid was equivalent to changing the concentration; some candidates started with the same volume of acid, but diluted it for different concentrations without keeping the same total volume.

Most candidates opted for timing the reaction until the magnesium disappeared. A smaller proportion of candidates opted for measuring the volume of gas over a set period of time. A small minority of candidates did not appreciate that the question related to the *rate* of reaction and suggested measuring the temperature rise or mass loss at the end of the experiment.