CHEMISTRY

Paper 0620/11
Multiple Choice

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

Candidates performed well on this paper. There were 2825 candidates with a mean score of 28.5. The standard deviation was 6.1.

Questions 1, 3, 10, 11, 14, 21, 25, 33, 35, 39 and **40** proved to be very straightforward with a large majority of candidates choosing the correct response.

Questions 2, 4, 13 and **23** proved to be relatively difficult.

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

Question 2 Responses A and B. Candidates chose a step in the preparation but chose the wrong one. The process was known but not fully understood.

Question 4 Response B. Some confusion clearly arose here through a misunderstanding of the question, which asks which students can be correct not which were correct.

Question 7 Response C. For some reason candidates thought that both forms of carbon conduct electricity.

Question 13 All responses. It was clear that many candidates guessed the answer to thi relatively few got it correct and other responses were evenly divided between the other answers.

Question 16 Response C. Candidates knew that the reaction was a neutralisation but co endothermic with exothermic.

Question 18 Response C. Candidates confused ‘reducing agent’ with the substance being reduced.

Question 20 Responses B and C. Candidates knew that at least one test must work and guessed wrongly.

Question 23 Response D. This response was more popular than the correct answer (C). Candidates clearly knew that all methods could be used to produce salts but did not take note of the fact that copper does not react with dilute acids.

Question 24 Response B. Candidates only considered the colour without taking account of the physical state.

Question 28 Response A. Candidates clearly chose calcium oxide because of its association with lime water and did not read the question.

Question 29 Response A. Candidates chose the metal with most ‘yeses’ as the most reactive.

Question 30 Response C. Candidates clearly forgot about the alkali metals.

CHEMISTRY

Paper 0620/12

Multiple Choice

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

Candidates performed well on this paper. There were 2108 candidates with a mean score of 29.6. The standard deviation was 6.9.

Questions 2, 4, 10, 11, 12, 21, 24, 32, 34, 37 and **40** proved to be very straightforward with a large majority of candidates choosing the correct response.

Questions 3, 7, 14 and **22** proved to be relatively difficult.

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

Question 3 Responses A and B. Candidates chose a step in the preparation but chose the wrong one. The process was known but not fully understood.

Question 5 Response C. For some reason candidates thought that both forms of carbon conduct electricity.

Question 7 Response B. Some confusion clearly arose here through a misunderstanding of the question, which asks which students can be correct not which were correct.

Question 14 All responses. It was clear that many candidates guessed the answer to thi s relatively few got it correct and other responses were evenly divided between the other options.

Question 19 Response C. Candidates confused ‘reducing agent’ with the substance being reduced.

Question 20 Responses B and C. Candidates knew that at least one test must work and guessed wrongly.

Question 22 Response D. Candidates clearly knew that all methods could be used to produce salts but did not take note of the fact that copper does not react with dilute acids.

Question 25 Response B. Candidates only considered the colour without taking account of the physical state.

Question 28 Response A. Candidates chose the metal with most ‘yeses’ as the most reactive.

CHEMISTRY

Paper 0620/02

Core Theory

General comments

The Paper was tackled well by many candidates and good answers were seen to most of the questions. The range of marks obtained by the candidates was fairly wide and most were entered at the appropriate level. It was encouraging to note that the number of very low scoring candidates was lower than usual although the standard of the Paper was unchanged. In general, the rubric was well interpreted. The major exception was in **Question 2(c)(iii)**, where many candidates ticked two boxes rather than the one required. Many candidates attempted all parts of each question and there were fewer questions left unanswered than in previous sessions. The standard of English was generally good. Although many candidates had a good knowledge of how to balance simple equations compared with previous sessions, fewer than usual were able to remember the properties of transition metals or explain the essential conditions for rusting. A considerable proportion of candidates had difficulty in explaining how steel is made from iron by reducing the carbon content. As in previous sessions many candidates had a poor knowledge of chemical tests for specific ions or molecules. For example, very few could describe tests for unsaturation or for chloride ions. It was encouraging to note that fewer candidates than usual wrote symbol equations where word equations were asked for or vice versa. The names of pieces of apparatus, such as measuring cylinder and flask, were better known than in many recent sessions. It was also pleasing to note that many candidates were able to perform the simple calculations in **Questions 1(d)** and **3(b)(ii)** and to draw the structure of ethanol in **Question 3(a)**.

Comments on specific questions

Question 1

The first parts of this question were generally well-answered but many candidates had difficulties in explaining the source of sulfur dioxide in part **(e)(ii)** and the pH changes in part **(e)(iii)**.

(a) This question was generally well-answered and most gained the mark. The commonest error was to suggest that oxygen and nitrogen were in the same Group – a muddling of Groups with Periods.

(b) Most candidates realised that krypton had the highest proton number from the list provided. The commonest error was to suggest bromine.

(c) Most candidates knew that oxygen and nitrogen are the commonest gases in the atmosphere. The commonest error was to suggest that carbon was a common atmospheric gas, perhaps due to the recent emphasis in the news on carbon trading and carbon emissions.

(d) The calculation was generally well answered. Incorrect answers included 80, obtained through using atomic masses and 155. Correct answer 175.

(e) (i) Most candidates failed to understand the word ‘type’ in the stem of the question and were content just to name compound C as potassium oxide. Only a few candidates mentioned that potassium oxide is a basic oxide.

(ii) Although many candidates mentioned acid rain, few gained the mark for the source of acid rain through writing rather vague statements. Just mentioning car exhausts or fuels was not enough because many fuels do not contain significant amounts of sulfur. Answers such as ‘in industries’ or ‘from factories’ are far too vague to score.

(iii) Candidates who scored all three marks usually mentioned a decrease in pH sta alkaline value. Although many mentioned neutralisation, few linked the change in acidi considerable number of candidates thought that the pH increased as the acid was added.

(iv) Although many candidates gained the mark for mentioning a pH meter or Universal indicato surprisingly large number suggested that litmus or an indicator such a phenolphthalein could be used to measure the pH.

(v) Most candidates recognised potassium nitrate as being the salt formed in the reaction. The main errors were to suggest potassium trioxygen nitrogen and potassium nitrite or nitride. A few candidates disadvantaged themselves by writing water as well as potassium nitrate so that the Examiners were being asked to choose the answer.

Question 2

The first part of this question was generally answered well with many candidates scoring all four marks in part **(a)**. Parts **(b)** and **(c)(ii)** and **(iii)** were less well done than expected. Most candidates scored at least two of the four marks available but a wide range of quality of diagrams was seen.

(a) Many candidates scored all four marks. The commonest errors were made in the definitions of ion and molecule.

(b) This was the least well answered part of **Question 2**. Most candidates failed to gain the mark because they thought that sodium chloride was a mixture. The commonest incorrect combination was air and sodium chloride. Steel was not often recognised as being a mixture of atoms.

(c) (i) Many candidates gained their marks by drawing fairly simple diagrams of a helium atom. A significant number failed to label their diagrams despite being requested to do so in the question. The nucleus was rarely labelled. Common errors included (i) giving helium two shells of four electrons (ii) just writing n and p in the middle of the atoms (iii) drawing particles in the middle of the atom without labelling them and (iv) suggesting that the outer limits of the nucleus included an inner shell of electrons. A few candidates suggested that the protons were in shells outside the nucleus.

(ii) About half the candidates were able to suggest a suitable use for helium. The commonest correct answer was 'for balloons' but many disadvantaged themselves by writing 'hot air balloons'.

(iii) A considerable number of candidates failed to gain the mark here because they ticked two boxes. The commonest combination of boxes ticked was the last two – the error being to suggest that helium has an incomplete outer shell of electrons. Many also thought that helium was in Period two of the Periodic Table, presumably because it has two electrons in its outer shell. If candidates were to refer to the position of helium in the Periodic Table by reference to the Table at the back of the examination paper, these mistakes might not have occurred.

Question 3

This question was fairly well answered, although most candidates had difficulty in remembering the properties of transition metals in part **(c)** and describing observations in part **(d)**. It was encouraging to note that a large number of candidates could balance the equation in part **(b)(iii)**.

(a) This was generally well answered compared with similar questions in previous sessions. The commonest errors were (i) the put a double bond between the carbon atoms (ii) to draw a structure similar to ethanoic acid with a double bond from a carbon to an oxygen and (iii) to add a hydrogen between the OH group. A significant number of candidates drew the structure of ethane rather than ethanol.

(b) (i) Most candidates gained the mark for recognising an exothermic reaction. The com r was to suggest endothermic.

(ii) Many candidates were able to do the calculation based on simple proportion. Of those who to get the correct answer (16.2 g), a considerable percentage made basic errors in keying figures into their calculators.

(iii) At least half the candidates were able to balance the equation. The commonest error was to suggest that two moles of water were formed from one mole of ethanol.

(c) Fewer candidates than in previous sessions seemed to know the properties of the transition metals. Many just wrote about the Group 1 metals or about general metallic properties. The commonest errors were to suggest that transition metals themselves were coloured or that they had low melting points.

(d) (i) Correct answers to this question required candidates to state observations rather than inferences. Few candidates gave observations such as ‘bubbles given off’ or ‘the copper carbonate solid disappears’. Most were content to focus on the equation and gave statements such as ‘carbon dioxide is given off’ or ‘water is formed’. These could not score marks. Some candidates realised that there was a change of state during the reaction but failed to gain the mark for this because they just paraphrased the state symbol information in the equation. i.e. ‘the copper on the left is solid and the hydrochloric acid is liquid but the copper on the right is aqueous’. This answer also highlights another error due to sloppy writing i.e. writing copper instead of the relevant copper compound.

(ii) Most candidates gained a mark for simply stating that (aq) means aqueous. Although many candidates went on to write conflicting statements, these were largely ignored. Many candidates seem to think that aqueous is the same as liquid or that it is simply a solution rather than a solution in water.

(e) This was generally well answered, many candidates obtaining all three marks. The commonest errors were to (i) invert monomers and addition and (ii) to write more than one word in each of the spaces available.

Question 4

Although most parts of this question were well done, few candidates could describe a test for chloride ions or determine the number of electrons in the outer shell of a caesium atom. The latter example came about through the candidates simply not reading the stem of the question carefully enough. The general metallic properties of caesium were better known than the properties of transition elements in **Question 3(c)**.

(a) This was fairly well answered. The commonest errors were (i) to suggest that caesium has a high boiling point and (ii) to refer to chemical properties, rather than physical properties.

(b) It was surprising to the Examiners how few candidates were able to deduce the correct number of electrons in the outer shell of caesium. This either arose because the candidates had not read the question properly or that they did not refer to the Periodic Table. Incorrect answers included 5 (obtained by reference to the (incorrect) Period number), 55 (obtained from the proton number) and 2 (obtained by thinking that caesium was in Group II of the Periodic Table).

(c) (i) Most candidates were able to give an adequate definition for an isotope. Only a few suggested that the proton number was different. A few candidates wrote about ‘atomic mass number’ differing. This could not be given credit because it conflates atomic number and mass number.

(ii) Many candidates were able to calculate the correct number of neutrons (78) in caesium-133. The commonest error was to give the proton number.

(d) This was generally well answered, most candidates gaining both the marks available. Few made errors in calculating a suitable value for the boiling point of caesium, the commonest being to give values above 700^{o}C. Nearly all candidates gave a suitable statement about the reactivity of caesium in comparison with the other alkali metals.

(e) This was generally well answered. The commonest errors were (i) to write multiples r 9CsCl and (ii) to give a charge on one ion only e.g. $CsCl^-$.

(f) Nearly all candidates were able to state the pH of a neutral solution. The commonest errors to suggest 0 or 13.

(g) Very few candidates knew a test for chloride ions. Most candidates thought that litmus was a suitable test. Another common error was to suggest that sodium hydroxide was a suitable test reagent.

Question 5

Most candidates gained at least half marks for this question. Part **(d)** was especially well done. Fewer candidates than in previous sessions seemed to be able to identify the test for an unsaturated compound.

(a) Most candidates were able to identify the double bonds in the structure of limonene. The commonest errors were (i) to ring the single bonds and (ii) to ring other groups e.g. CH_3 as well as the double bond.

(b) This was generally not well answered. Many candidates failed to count up the individual atoms and gave answers such as CH_3. Rather than writing the molecular formula, most candidates wrote structural formula such as CH_3CHCH_2 etc. In any case, these were often wrong.

(c) Few candidates knew the test for an unsaturated compound. Although many candidates knew that bromine was decolourised, fewer mentioned the colour of the bromine. A large number of candidates muddled the colour change and wrote that the bromine changed from colourless to brown.

(d) (i) Most candidates were able to identify the apparatus and many gained all three marks. The least well known piece of apparatus was the condenser.

(ii) Although most candidates gained at least one mark for the arrangement and movement of the particles in a gas, few gained both marks. Common errors were (i) writing too vague statements about the proximity of the particles e.g. 'the particles are quite close' (rather than far apart) (ii) the suggestion that the particles slide over each other.

(e) (i) Most candidates were able to explain the term 'incomplete combustion' in simple terms although many failed to gain the mark by writing vague statements about incomplete reactions.

(ii) Although many candidates knew that carbon monoxide was poisonous, many gave rather vague and / or incorrect answers relating to (i) having a bad effect on the lungs (ii) causing cancer (iii) causing unspecified effects on the blood.

(f) (i) About two-thirds of the candidates correctly identified a carboxylic acid.

(ii) Most candidates correctly identified ethanol. Of those that did not, most suggested a carboxylic acid.

(iii) Nearly all candidates correctly identified the hydrocarbon

Question 6

Many candidates found this question difficult, especially parts **(b)**, **(c)** and **(f)**. Most candidates, however, were able to balance the equation in part **(g)** and to suggest a correct use of aluminium in part **(h)**.

(a) Although many candidates selected decomposition as the correct answer, the distractors were selected in about equal proportions.

(b) Few candidates could explain that ions are responsible for electrolytic conduction in a melt. Most either mentioned (uncharged) particles, electrons or molecules or wrote vaguely that 'the aluminium oxide has to be molten for electrolysis to occur'.

(c) Many candidates realised why cryolite has to be used in the electrolysis of aluminiu[illegible] a considerable number of vague answers were seen.

(d) This was generally well answered, most candidates correctly selecting B.

(e) A wide range of answers were seen including incorrect products such as hydrogen and chlorine. Compounds such as aluminium oxide and water were often put down as products. Few candidates gained both marks and many suggested that aluminium was formed at the anode and oxygen at the cathode. A not inconsiderable number of candidates wrote down two products for each electrode.

(f) Few candidates gained both marks for understanding why the anodes have to be renewed periodically. Many vague answers were given and reference to oxygen reacting with the anodes was rarely seen. Where candidates did gain a mark, it was usually for a simplistic idea of the anodes ‘wearing away’.

(g) Most candidates were able to balance the equation by adding 3 electrons to the left. The commonest error was to suggest a balance of two electrons. A considerable number of candidates wrote aluminium ions in place of a number.

(h) Most candidates could suggest a suitable use for aluminium, aircraft bodies being the most popular. A few candidates failed to gain the mark through not writing specific enough answers. For example ‘aluminium foil’ rather than ‘cooking foil’ or ‘for utensils’ rather than ‘for cooking utensils such as knives’

Question 7

This question was poorly done. Few candidates had a secure knowledge of rusting and hardly any seemed to know about the production of steel from impure iron. Parts **(c)**, **(d)** and **(e)** were on the whole well done.

(a) Many candidates failed to gain marks through not writing enough about the conditions needed for rusting. A minority made the mistake of just writing down yes or no without giving any reasons. Candidates should realise that there are generally no marks for choosing one of the two predictions and that the reason is required as well. Many candidates failed to gain the first mark because they did not mention both water and air. In order to gain the second mark, it was not sufficient to write that ‘the nail is dry’: some indication of the lack of water was needed. Many candidates failed to gain this mark by merely suggesting that the drying agent prevented the rust. The third mark was seldom obtained. Most candidates were content to repeat the information in the diagram, for example ‘the zinc covers the iron’.

(b) This was probably the most poorly answered question on the Paper. Few candidates seemed to know the details of steel production. Very few mentioned blowing oxygen through or onto the impure iron. Those who did, usually obtained more than one mark. A few candidates managed to gain a mark by mentioning the formation of slag, although this was often more in the context of the blast furnace than the basic oxygen furnace. The commonest errors were (i) to suggest that carbon was added to react with the impurities (ii) that other metals were added to purify the iron (mistakenly mixing up alloys with mild steel production) and (iii) to refer to the addition of limestone to react with the iron.

(c) Most candidates could give a correct use for stainless steel, the commonest correct answer referring to cutlery. Some candidates failed to gain a mark by suggesting that stainless steel is used for car bodies. Some gave too vague answers, such as ‘for pots in the kitchen’.

(d) Although it was rarely well expressed, most candidates could explain reduction in terms of removal of oxygen from the iron oxide. Those who failed to gain the mark, did so because they wrote comments which were either too vague (for example: ‘the water is formed from the hydrogen and oxygen’) or just paraphrased the equation.

(e) Most candidates were able to change the symbol equation into a word equation. Common errors included (i) failure to put an arrow between the reactants and products (ii) writing hydrochloride instead of hydrochloric acid (or hydrogen chloride) and (iii) writing hydrogen instead of water on the right hand side of the equation.

CHEMISTRY

Paper 0620/31

Extended Theory

General Comments

Examiners have commented on an imprecise use of chemical terminology. This skill is an essential requisite for both the understanding of Chemistry and for attaining creditable grades in examinations. Many candidates use the words ions/electrons interchangeably This difficulty was noted in **Question 3(b)**, **Question 3(c)(i)**, **4(b)(ii)** and **(iii)**.

It is imperative that if candidates cross out an answer it should be made clear as to what is deleted and what is to be marked. This is very often not the case. Similarly if the answer has been repeated elsewhere on the paper then the original attempt should be clearly deleted and reference made to the location of the second attempt.

Candidates are not acting on the instructions in the question with a consequent loss of marks:

give three properties – only give three
give another use – do not give the one mentioned in the question
name a gaseous element – do not give a compound
what would you see – this should be taken literally, marks are awarded for observations

Comments on Specific Questions

Question 1

(a) (i) Generally this part was well answered, a named noble gas was the usual correct response. Some candidates appeared not to have read the question and suggested carbon dioxide or one of the atmospheric pollutant gases. However, the most frequent error was to think that air contained hydrogen.

(ii) The two compounds in unpolluted air are carbon dioxide and water. Many were only able to suggest one of these compounds or named a compound which is a pollutant, typically carbon monoxide.

(b) Most candidates were able to describe the formation of carbon monoxide but not that of the oxides of nitrogen – stating that petrol contained nitrogen or that nitrogen burnt in oxygen. The required idea that nitrogen and oxygen react at high temperatures was not widely known. This reaction was frequently thought to occur in the exhaust rather than in the engine where the temperature is very much higher. Accounts of the working of catalytic converters which explained that carbon monoxide was oxidised to carbon dioxide and the oxides of nitrogen were reduced to nitrogen were far too rare. Many candidates contented themselves with general answers of the type – “they are changed into less harmful gases”.

Question 2

(a) Most candidates completed the pH section of the table accurately but many were unable appropriate examples e.g. they named a mineral acid rather than an acidic oxide. Most cand gave either carbon monoxide or, more commonly, water as a neutral oxide.

(b) (i) The term amphoteric was reasonably well explained but a proportion of potentially acceptable responses were negated. It is an oxide/compound/substance which has both basic and acidic properties is perfectly acceptable but it is an element which has both basic and acidic properties is not.

(ii) Naming two reagents to show that an oxide was amphoteric proved to be quite difficult, a common difficulty was to state “acid and alkali” without naming specific reagents.

Question 3

(a) (i) The need for heat to convert zinc blende, in the presence of air or oxygen, into zinc oxide was usually omitted.

(ii) The equation for reduction of zinc oxide by carbon was usually correct, sometimes carbon monoxide was substituted for the carbon, this could not be accepted.

(b) This question was found to be difficult by many candidates. Their attempts indicated a complete lack of initial planning and any consideration of what were the salient ideas. The explanations of why the exposed steel does not rust were often long-winded and repetitive with the movement of ions, protection by layers of zinc ions, zinc ions being more reactive than iron ions and the role of various zinc compounds being the common errors. Three marks were awarded for the explanations of the following type:

- zinc is more reactive than iron
- zinc loses electrons which move on to the steel/iron
- iron cannot lose electrons or it cannot be oxidised

(c) (i) The explanations of why the anode and cathode change size were generally weak. The required ideas were:

at the zinc electrode - zinc atoms change into zinc ions (go into solution).
at the copper electrode – copper ions from the solution change into copper atoms (deposited on the electrode).

(ii) The particles were correctly identified by the majority of the candidates - ions in the electrolyte and electrons in the external circuit.

Question 4

(a) The separation of oxygen and ozone was often incorrectly linked to the electric spark mentioned in the question although many candidates recognised that fractional distillation would be a suitable technique as the components have different boiling points. Usually when asked to specify a technique to separate a mixture of gases, the majority of candidates suggest diffusion but on this paper only a small minority gave this technique. Either was awarded the mark. Many answers gave chemical processes, a particular favourite was that carbon would burn in oxygen. These candidates did not realise that ozone would behave in the same way.

(b) (i) “What you would see” questions require observations, not explanations or names of substance. It is not possible to see ions, atoms or molecules. The comment that there was a change of colour can never score marks unless the colour change is specified. Using the equation given for the reaction for oxidation of an iodide by ozone, many candidates focused on *bubbles of gas* evolved rather than the obvious colour change. Why many candidates thought that there would be a precipitate of potassium metal is a puzzle, there is no indication in the ionic equation of this and candidates ought to know that this is impossible with a very reactive metal. Those candidates who realised there would be a colour change regularly said it would be purple to colourless or orange to green rather than colourless to brown.

(ii) Most were able to relate the oxidation of iodide ions to electron loss.

(iii) Candidates found the explanation of ozone being an oxidant difficult and often gave this in oxidation numbers or that it was reduced or that it experienced electron loss. Relatively few the correct explanation in terms of electron transfer – it accepted electrons.

(c) (i) There were many good diagrams of the arrangement of the valency electrons in a molecule of dimethyl sulfide although some candidates gave a thiol-type structure and others omitted the non-bonding pairs on the sulfur atom.

(ii) Many combustion products were given, rarely were all three correct.

Question 5

(a) (i) Candidates should learn to differentiate between a physical property which is a characteristic of the bulk material and details of its structure. "It has a tetrahedral structure" is not a physical property and the presence of strong bonds in the structure does not necessarily mean that the material is strong. If a question requires three responses then candidates should be strongly advised to give three properties and no more.

(ii) A frequent error was to state that "each carbon atom was bonded to four carbon atoms". There were a variety of errors in the second line, co-ordination numbers other than four, for example 1, 2, 3, 6 and 12 but admittedly 4 was the most popular.

(b) Many ignored the comment that germanium oxide is macromolecular and assumed that it had a simple molecular structure similar to that of carbon dioxide. The standard of the diagrams of macromolecular structures was usually poor, with Ge bonded to Ge, O to O or oxygen molecules instead of atoms and too many bonds around an oxygen atom. Few recognised that the structure was tetrahedral, this could have been shown on the diagram or indicated by a comment.

(c) (i) Candidates found it difficult to use their knowledge of alkanes to draw the structure of the hydride, many included double bonds or H atoms in the middle of the structure. Frequently the symbol for germanium was wrong – ge or G or Gr. Candidates have access to the Periodic Table and should refer to it if they are uncertain about a symbol.

(ii) The combustion products were frequently quoted as carbon dioxide and water. The majority of answers included carbon dioxide despite the fact that the hydride does not contain carbon.

Question 6

(a) (i) Most of the candidates gave the correct answer – sulfur or a metal sulfide is burnt in air or oxygen.

(ii) The uses of sulfur dioxide were well known, particularly in the manufacture of paper. It should be pointed out that it is used to bleach wood pulp, not paper.

(iii) Most could recall that the catalyst is vanadium oxide or vanadium(V) oxide. The common error was an incorrect oxidation state.

(iv) The reaction rate would be too slow is the essence of the explanation. There were some excellent answers of the type – the rate would be too slow for the process to be economic.

(v) Most of the entry was aware that the dissolution of sulfur trioxide in water would produce an acidic mist which is very slow to settle.

(b) (i) Many of the answers for showing the reaction is reversible were about the use of the backward/forward arrow sign. Possibly, the candidates misinterpreted the question. There was a marked tendency to over-complicate the answer, a simple comment would suffice – add water to the yellow powder, it would go green or green crystals would form.

(ii) All the comments made in **Question 4(b)** are equally applicable to this question. Candidates must describe observations rather than the underlying Chemistry. The colour change given here was often confused with that for potassium iodide in the earlier question or with that for the reduction of dichromate(VI). It was frequently, but incorrectly, stated that bubbles of a gas would marks were awarded for stating that the purple solution would become colourless.

(iii) The conversion of sulfurous to sulfuric acid was usually correctly attributed to a reaction wi oxygen in the air. The common errors were reaction with atmospheric water vapour and inspection of the formulae the comment "adding an atom of oxygen".

(c) The calculation seemed to be more successful than in recent examination sessions with many candidates scoring 5 or 6 marks. In contrast, quite a number started with 1 mole of $FeSO_4$ and only scored one mark for the mass of one mole of Fe_2O_3. The correct solution to this calculation is given below.

number of moles of $FeSO_4$ used = 9.12/152 = 0.06
number of moles of Fe_2O_3 formed = 0.03
mass of one mole of Fe_2O_3 = 160 g
mass of iron(III) oxide formed = 0.03 x 160 = 4.8 g
number of moles of SO_3 formed = 0.03
volume of sulfur trioxide formed = 0.03 x 24 = 0.72 dm^3

Question 7

(a) (i) In the reaction conditions for cracking, the quoted temperature was usually too low and if a catalyst was named it was often incorrect, for example, nickel or platinum.

(ii) The equation for the cracking of decane was generally accurate.

(iii) It was well known that water was the reagent required to convert but-1-ene to butan-1-ol.

(b) (i) About half of the entry were able to balance the equation for the combustion of butan-1-ol. Some forgot the hydrogen atom in the OH group when balancing the water molecules and others forgot the oxygen atom on the OH group when balancing the oxygen molecules.

(ii) Few candidates could write the word equation for the preparation of butyl methanoate. Many confused the acid and alcohol, butanoic acid and methanol rather than butanol and methanoic acid. Most omitted water as a product.

(c) (i) The structures given for propanol and propanoic acid were very weak and rarely correct. The number of carbon atoms drawn, particularly in the acid structure were hardly ever three. Many candidates did not know the functional group of carboxylic acids.

(ii) Candidates realised that petroleum is a limited resource and the development of biofuels will conserve this valuable commodity and provide an alternative source of energy as the supply of petroleum decreases. Another reason to develop biofuels is that they have a smaller effect on the level of atmospheric carbon dioxide than petroleum-based fuels. General comments of the type "they are more eco friendly" did not warrant the award of the mark.

(iii) The most common suggestions of how to show that the two "forms" of butanol are the same compound relied on chemical tests. Usually, to make an ester and get the same smell or to react them with bromine/bromine water or to show that they have the same combustion products. Some candidates tried to duck the issue with the suggestion – show that they have the same molecular formula. No details of how this could be achieved were offered and there is the additional complication of isomers which would have the same molecular formula but are different compounds. The obvious method would be to show that they have the same boiling point but any other appropriate physical property would be awarded the mark.

CHEMISTRY

Paper 0620/32

Extended Theory

General Comments

Examiners have commented on an imprecise use of chemical terminology. This skill is an essential requisite for both the understanding of Chemistry and for attaining creditable grades in examinations. Many candidates use the words ions/electrons interchangeably This difficulty was noted in **Question 3(b)**, **Question 3(c)(i)**, **4(b)(ii)** and **(iii)**.

It is imperative that if candidates cross out an answer it should be made clear as to what is deleted and what is to be marked. This is very often not the case. Similarly if the answer has been repeated elsewhere on the paper then the original attempt should be clearly deleted and reference made to the location of the second attempt.

Candidates are not acting on the instructions in the question with a consequent loss of marks:

give three properties – only give three
give another use – do not give the one mentioned in the question
name a gaseous element – do not give a compound
what would you see – this should be taken literally, marks are awarded for observations

Comments on Specific Questions

Question 1

(a) (i) Generally this part was well answered, a named noble gas was the usual correct response. Some candidates appeared not to have read the question and suggested carbon dioxide or one of the atmospheric pollutant gases. However, the most frequent error was to think that air contained hydrogen.

(ii) The two compounds in unpolluted air are carbon dioxide and water. Many were only able to suggest one of these compounds or name a compound which is a pollutant, typically carbon monoxide.

(b) (i) Despite what was written in the question, a surprisingly large cohort stated sulfur dioxide or the oxides of nitrogen.

(ii) The full answer is that when fossil fuels, which contain sulfur are burnt, sulfur dioxide is formed. Most explanations did not mention fossil fuels.

(iii) The formation of the oxides of nitrogen was explained by stating that petrol contained nitrogen or that nitrogen burnt in oxygen. The correct idea that nitrogen and oxygen react at high temperatures was not widely known**.** This reaction was frequently thought to occur in the exhaust rather than in the engine where the temperature is very much higher.

(c) Most of the candidates knew that fractional distillation was involved but failed to add that liquid air was used.

Question 2

(a) Most candidates completed the pH section of the table accurately but many were unabl... appropriate examples e.g. they named a mineral acid rather than an acidic oxide. Most cand... gave either carbon monoxide or, more commonly, water as a neutral oxide.

(b) (i) The term amphoteric was reasonably well explained but a proportion of potentially acceptable responses were negated. It is an oxide/compound/substance which has both basic and acidic properties is perfectly acceptable but it is an element which has both basic and acidic properties is not.

(ii) This part was consistently well answered.

Question 3

(a) (i) The need for heat to convert zinc blende, in the presence of air or oxygen, into zinc oxide was usually omitted.

(ii) The equation for the reduction of zinc oxide by carbon was usually correct, sometimes carbon monoxide was substituted for the carbon, this could not be accepted.

(b) This question was found to be difficult by many candidates. Their attempts indicated a complete lack of initial planning and any consideration of what were the salient ideas. The explanations of why the exposed steel does not rust were often long-winded and repetitive with the movement of ions, protection by layers of zinc ions, zinc ions being more reactive than iron ions and the role of various zinc compounds being the common errors. Three marks were awarded for the explanations of the following type:

- zinc is more reactive than iron
- zinc loses electrons which move on to the steel/iron
- iron cannot lose electrons or it cannot be oxidised

(c) (i) The explanations of why the anode and cathode change size were generally weak. The required ideas were:

at the zinc electrode - zinc atoms change into zinc ions (go into solution).
at the copper electrode – copper ions from the solution change into copper atoms (deposited on the electrode).

(ii) The particles were correctly identified by the majority of the candidates - ions in the electrolyte and electrons in the external circuit.

Question 4

(a) The separation of oxygen and ozone was often incorrectly linked to the electric spark mentioned in the question although many candidates recognised that fractional distillation would be a suitable technique as the components have different boiling points. Usually when asked to specify a technique to separate a mixture of gases, the majority of candidates suggest diffusion but on this paper only a small minority gave this technique. Either was awarded the mark. Many answers gave chemical processes, a particular favourite was that carbon would burn in oxygen. These candidates did not realise that ozone would behave in the same way.

(b) (i) "What you would see" questions require observations, not explanations or names of substance. It is not possible to see ions, atoms or molecules. The comment that there was a change of colour can never score marks unless the colour change is specified. Using the equation given for the reaction for oxidation of an iodide by ozone, many candidates focused on *bubbles of gas* evolved rather than the obvious colour change. Why many candidates thought that there would be a precipitate of potassium metal is a puzzle, there is no indication in the ionic equation of this and candidates ought to know that this is impossible with a very reactive metal. Those candidates who realised there would be a colour change regularly said it would be purple to colourless or orange to green rather than colourless to brown.

(ii) Most were able to relate the oxidation of iodide ions to electron loss.

(iii) Candidates found the explanation of ozone being an oxidant difficult and often gave this oxidation numbers or that it was reduced or that it experienced electron loss. Relatively f the correct explanation in terms of electron transfer – it accepted electrons.

(c) (i) There were many good diagrams of the arrangement of the valency electrons in a molecule of dimethyl sulfide although some candidates gave a thiol-type structure and others omitted the non-bonding pairs on the sulfur atom.

(ii) Many combustion products were given, rarely were all three correct.

Question 5

(a) (i) Candidates should learn to differentiate between a physical property which is a characteristic of the bulk material and details of its structure. “It has a tetrahedral structure” is not a physical property and the presence of strong bonds in the structure does not necessarily mean that the material is strong. If a question requires three responses then candidates should be strongly advised to give three properties and no more.

(ii) Many of the diagrams were poorly drawn and it was not possible to award the mark for tetrahedral structures. Some realised that the co-ordination number in both diagrams was four but a significant minority believed it was four in diagram 1 but a different value in diagram 2.

(b) Many ignored the comment that germanium oxide is macromolecular and assumed that it had a simple molecular structure similar to that of carbon dioxide. The standard of the diagrams of macromolecular structures was usually poor, with Ge bonded to Ge, O to O or oxygen molecules instead of atoms and too many bonds around an oxygen atom.

(c) (i) Candidates found it difficult to use their knowledge of alkanes to draw the structure of the hydride, many included double bonds or H atoms in the middle of the structure. Frequently the symbol for germanium was wrong – ge or G or Gr. Candidates have access to the Periodic Table and should refer to it if they are uncertain about a symbol.

(ii) The combustion products were frequently quoted as carbon dioxide and water. The majority of answers included carbon dioxide despite the fact that the hydride does not contain carbon.

Question 6

(a) (i) There were some imprecise sources of sulfur given, such as underground and sulfur ores but in general most candidates were able to gain marks for this part of the question.

(ii) The uses of sulfur dioxide were well known, particularly in the manufacture of paper. It should be pointed out that it is used to bleach wood pulp, not paper.

(iii) Most could recall that the catalyst is vanadium oxide or vanadium(V) oxide. The common error was an incorrect oxidation state.

(iv) The reaction rate would be too slow is the essence of the explanation. There were some excellent answers of the type – the rate would be too slow for the process to be economic.

(v) Most of the entry was aware that the dissolution of sulfur trioxide in water would produce an acidic mist which is very slow to settle.

(b) (i) Many of the answers for showing the reaction is reversible were about the use of the backward/forward arrow sign. Possibly, the candidates misinterpreted the question. There was a marked tendency to over-complicate the answer, a simple comment would suffice – add water to the yellow powder, it would go green or green crystals would form.

(ii) All the comments made in **Question 4(b)** are equally applicable to this question. Candidates must describe observations rather than the underlying Chemistry. The colour change given here was often confused with that for potassium iodide in the earlier question or with that for the reduction of dichromate(VI). It was frequently, but incorrectly, stated that bubbles of a gas would be seen. The marks were awarded for stating that the purple solution would become colourless.

(iii) The conversion of sulfurous to sulfuric acid was usually correctly attributed to a reacti oxygen in the air. The common errors were reaction with atmospheric water vapou inspection of the formulae the comment "adding an atom of oxygen".

(c) The calculation seemed to be more successful than in recent examination sessions with many candidates scoring 5 or 6 marks. In contrast, quite a number started with 1 mole of $FeSO_4$ and only scored one mark for the mass of one mole of Fe_2O_3. The correct solution to this calculation is given below.

number of moles of $FeSO_4$ used = 12.16/152 = 0.08
number of moles of Fe_2O_3 formed = 0.04
mass of one mole of Fe_2O_3 = 160 g
mass of iron(III) oxide formed = 0.04 x 160 = 6.4 g
number of moles of gases formed = 0.08
volume of gas formed = 0.08 x 24 = 1.92 dm^3

Question 7

(a) (i) In the reaction conditions for cracking, the temperature was usually too low and if a catalyst was named it was often incorrect, for example, nickel or platinum.

(ii) The equation for the cracking of nonane was generally accurate.

(iii) It was well known that water was the reagent required to convert but-1-ene to butan-1-ol.

(b) (i) About half of the entry were able to balance the equation for the combustion of butan-1-ol. Some forgot the hydrogen atom in the OH group when balancing the water molecules and others forgot the oxygen atom on the OH group when balancing the oxygen molecules.

(ii) Few candidates could write the word equation for the preparation of butyl propanoate. Many confused the acid and alcohol, butanoic acid and propanol rather than butanol and propanoic acid. Most omitted water as a product.

(c) (i) The structures given for propanol and propanoic acid were very weak and rarely correct. The number of carbon atoms drawn, particularly in the acid structure were hardly ever three. Many candidates did not know the functional group of carboxylic acids

(ii) Candidates realised that petroleum is a limited resource and the development of biofuels will conserve this valuable commodity and provide an alternative source of energy as the supply of petroleum decreases. Another reason to develop biofuels is that they have a smaller effect on the level of atmospheric carbon dioxide than petroleum-based fuels. General comments of the type "they are more eco friendly" did not warrant the award of the mark.

(iii) The most common suggestions of how to show that the two "forms" of butanol are the same compound relied on chemical tests. Usually to make an ester and get the same smell or to react them with bromine/bromine water or to show that they have the same combustion products. Some candidates tried to duck the issue with the suggestion – show that they have the same molecular formula. No details of how this could be achieved were offered and there is the additional complication of isomers which would have the same molecular formula but are different compounds. The obvious method would be to show that they have the same boiling point but any other appropriate physical property would be awarded the mark.

CHEMISTRY

Paper 0620/04

Coursework

General comments

As is usual in the November session, only a few Centres submitted work for moderation. In nearly all cases the tasks set and the standards applied were satisfactory. Where there were problems they were due to the issues listed below.

- Tasks for C1 which were too straightforward did not give candidates the opportunity to show that they could follow complex instructions.
- Tasks for C2 were often limited either to quantitative or to qualitative observations. There should be a mixture of tasks so that candidates have the chance to demonstrate both sets of skills.
- Tasks for C3 often gave too much guidance to candidates as to how they should process their results or which led them to a conclusion with too many leading questions.
- Tasks for C4 were sometimes too trivial and did not give candidates the opportunity to discuss the controlling of variables to ensure a 'fair test'.

There were also occasions where tasks set were needlessly complex. In these cases candidates usually performed well but there is always the risk that weaker candidates can be disadvantaged by such tasks.

Centres are reminded that the procedure for selecting samples of work for moderation changes from June 2010.

Please consult the 2010 Syllabus for guidance.

Details of and work sheets for the exercises used will still need to be submitted along with the relevant mark schemes.

CHEMISTRY

Paper 0620/05

Practical Test

General comments

The majority of candidates successfully attempted both questions and there was no evidence that candidates were short of time. There are still a minority of Centres which failed to submit a copy of the Supervisor's results with the candidates' scripts. The Examiners use Supervisors' results when marking the scripts to check comparability.

Centres reported few problems in obtaining the necessary chemicals or with candidates carrying out the two questions in the time allowed. However, in **Question 1**, a few Centres reported greater temperature changes than anticipated and these changes resulted in modification of the scale for the bar chart in some cases. Candidates were not penalised for this modification.

The observations in **Question 2** were well reported by the majority of candidates.

Comments on specific questions

Question 1

The vast majority of candidates successfully noted an observation when the magnesium ribbon was added to dilute sulfuric acid. A small number tested the gas with a glowing splint and recorded that it relit.

The four experiments were carried out by the majority of candidates.

The table of results was, generally, fully and successfully completed. A minority of candidates who did not obtain the highest temperature changes in decreasing order of magnitude from Experiment 1 to Experiment 4 lost marks. Also, some candidates had results which were not remotely comparable to the Supervisor's results.

The changes in temperature in part **(a)** were correctly calculated by candidates.

(b) The bar chart of the results was generally well completed. Candidates with temperature changes that were higher than expected often adjusted the y-axis, while others made suitable reference to the problem. Some candidates did not label the bars.

(c) (i) Most candidates correctly answered this question. Credit was given for the reaction being described as exothermic or redox or displacement. A significant number of candidates gave endothermic or neutralisation.

(d) Generally well answered. Poor answers referred to the reactivity of the acid instead of its concentration.

(e) (i) A good discriminating question. Some candidates did not read the question carefully and failed to note that the effects on the temperature changes were required. The more able candidates realised that the changes would be higher. References to rate were common and were ignored.

(ii) Most candidates incorrectly thought that using double the volume of acid would double or increase the temperature change, not realising that the acid was in excess to start with. The idea of a lower temperature change because of the increased volume of acid was only realised by a small minority of candidates.

(f) Sources of experimental error remain a problem area despite comments made ... examinations in the Principal Examiner's Reports. Vague answers referring to reading ... restating experimental error were common. Those who scored credit mentioned the ... variation in the length/mass of the magnesium ribbon used, heat losses and lack of insulatio... the use of a measuring cylinder instead of a burette/pipette.

Question 2

(a) The majority of candidates scored the mark for describing the solutions as colourless. Some gave 'clear' or 'transparent' and were penalised.

(b) The pH values were generally given within an acceptable range. A small number of candidates mixed up the solutions and recorded the wrong values.

(c) The majority of candidates scored most of the marks. The common error in **(c)(i)** was to state 'blue precipitate insoluble in excess to give a deep blue solution' when obviously the precipitate was soluble in excess. In **(c)(ii)** no change/reaction was the expected observation. A surprising number of candidates recorded the formation of a white or yellow precipitate.

(d) Generally well answered. However, in **(d)(ii)** a significant number of candidates correctly recorded the white precipitate but then indicated that it was insoluble in excess.

(e) Usually correctly answered.

(f) and **(g)** Many candidates showed confusion and identified various metal cations such as Cu^{2+}, Fe^{2+}, Zn^{2+} and Al^{3+} as being present, not realising that some of these metal ions were actually added to solutions **K** and **L**. The more able candidates identified solution **K** as ammonia and solution **L** as sodium hydroxide and correct descriptions e.g. weak alkali or strong alkali respectively, scored full credit.

(h) The identification of solution **M** as an acid chloride or hydrochloric acid scored both marks. A significant number of candidates thought **M** was sulfuric or nitric acid while others specified the presence of chlorine (ions).

CHEMISTRY

Paper 0620/06

Alternative to Practical

General comments

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

Candidates found **Questions 3**, **4(e)**, **4(f)**, and **6(a)** to be the most demanding. Some Centres had not covered all sections of the syllabus. Compared to previous years, most candidates had a more successful attempt at the last question.

The majority of candidates were able to complete a table of results from readings on diagrams and plot points successfully on a grid as in **Questions 4** and **6**.

Comments on specific questions

Question 1

(a) The naming of the pieces of apparatus was generally well answered. Some candidates were unable to name the syringe - many referred to measuring tubes/cylinders and rulers. The flask was sometimes labelled as a beaker.

(b) Generally well answered, though some candidates got side-tracked and referred to the catalytic nature of the manganese(IV) oxide.

(c) The test for oxygen was well known although many candidates used a lighted splint instead of a glowing splint and were penalised for answers such as ‘it relights a lit splint’.

Question 2

(a) Most candidates recognised an advantage of silver plating a spoon though a number of answers mentioned increasing the value of the spoon. Many candidates realised that a thin layer would wear off in part **(ii)** but references to ‘chipping off or scratched off’ and the potential problem of poisoning the user scored no credit.

The need for a clean spoon was less well answered with many candidates worrying about electroplating the grease or impurities, or the grease getting into and contaminating the food.

(b) Most candidates gave the correct answer.

(c) A good discriminating question with only the more able candidates stating silver. Many used graphite, platinum, copper or zinc.

Question 3

There were many blank spaces left throughout this question, which was a good discriminator.

(a) Generally badly answered. Near misses, using aluminium and a dilute acid instead of sod hydroxide resulting in the formation of ammonia, scored partial credit.

Some answers referred to the brown ring test and scored full credit for correct details.

(b) The most common tests given for pure water were anhydrous copper sulfate or cobalt chloride. Candidates do not appreciate that these tests only detect the presence of water and that the determination of boiling point was required to identify pure water.

(c) This part was usually well answered though bromide was sometimes used instead of bromine.

Question 4

(a) The table of results was usually completed correctly and candidates were able to calculate the temperature changes.

(b) Most candidates drew bar charts correctly with the occasional inappropriate scale. A few plotted the final and original temperatures whilst others attempted to draw an inappropriate line graph.

(c) Generally well answered. Neutralisation and endothermic were common incorrect answers.

(d) (i) and (ii) Most candidates scored full credit. A minority referred to the reactivity of the sulfuric acid instead of its concentration.

(e) (i) Candidates found this difficult and it was a good discriminator. Many candidates thought that the temperature change would be the same or lower. Vague answers discussed the rate of the reaction and did not answer the question.

(ii) Most candidates assumed that the temperature change would double or be greater if twice as much acid was used, not realising that the acid was already in excess. Erroneous references to faster reaction and more collisions were prevalent.

(f) Many candidates suggested a valid source of error, such as heat losses, use of a measuring cylinder instead of a burette or varying lengths/masses of magnesium. The most common incorrect responses referred to different starting temperatures, human or instrumental errors, and parallax problems and lack of repeat experiments.

Question 5

(b) A complete range of pH values was seen and many were less than 7 for the solution of sodium hydroxide.

(d) Generally well answered though a number of blank spaces were seen. A white precipitate, insoluble in excess, was a common incorrect response in **(ii)**.

(f) Not attempted by the weaker candidates. Many candidates scored 1 mark for alkali or base but too many referred to the presence of ammonium instead of ammonia.

(g) Only the better candidates scored credit. Common incorrect answers included reference to copper or chlorine instead of chloride ions. Full credit was given for identifying hydrochloric acid.

Question 6

(a) The most common errors were inappropriate scales, starting at the origin and badly drawn curves.

(b) Indications on the grid were often omitted.

(c) Many candidates missed the point and wrote about the calcium carbonate reacting or dissolving away.

(d) Many candidates stated that the purpose of the cotton wool was to stop the gas escap

(e) Generally well answered. Common errors included 5 mins and 4 seconds.

(f) Curves were often missed out or drawn randomly. Only the more able candidates sketched curve above the original line and then indicated that it would flatten out at the same level.

Question 7

(a) Most candidates realised that a mortar and a pestle were required, but few could spell the names. Vague references to crushers, grinding bowls etc. were penalised. Few candidates mentioned the use of sand and/or an organic solvent, with water and heat being commonly employed.

(b) The majority of candidate scored some credit for this question. Chromatography is well known by candidates. Some candidates dipped the paper in water, others in the leaf extract and therefore lost a mark. In a lot of cases the ‘dot’ was drawn below the surface of the solvent. Many had a range of dots on the origin, and the separated dots were rarely vertically above the original dot. Ninhydrin and locating agents were sometimes included but were not penalised.