CHEMISTRY

Paper 0620/01
Multiple Choice

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

General comments

The entry of nearly 11 000 candidates achieved a mean mark of 29.3 with a (relatively high) standard deviation of 7.0. The reliability coefficient of 0.88 was also high. These statistics indicate that the paper successfully discriminated between candidates across the ability range. Apart from **Questions 9**, **11**, **19** and **35**, the higher-scoring candidates found little difficulty with the paper. This being so, this report concentrates on the responses of the candidates with lower scores.

Comments on individual questions

Question 5

A quarter of the lower-scoring candidates chose B rather than the key, D. The question refers to an 'ion' and not an 'atom'. This points to the need for careful reading!

Question 6

Responses B (the key) and C were almost equally popular with the lower-scoring candidates. This is somewhat puzzling in that if the 'C-choosers' did not realise that only one of chlorine's 7 outermost electrons is involved in bonding, more candidates with similar misunderstanding might have been attracted to response A.

Question 6

Almost 40% of the lower-scoring candidates chose response A. This is the 'traditional' error of taking the formula of the ammonia molecule as NH_4.

Question 9

Both the lower-scoring candidates and the higher-scoring candidates found this question hard, the popularity of response A being 60% and 22%, respectively. More thought was required. Molecule 1 is monatomic and cannot, therefore, be either hydrogen or oxygen. Molecule 2 is singly bonded hydrogen and molecule 3 is doubly bonded oxygen. It is not sufficient to think that molecules 1 and 2 are in the right proportion for water.

Question 11

Only 11% of the lower-scoring candidates chose the key C. About 40% across the ability range were overly tempted by response D. This choice overlooks the fact that sodium is too reactive to be deposited at an electrode in an aqueous solution.

Question 12

Nearly a third of the lower-scoring candidates chose response C. Presumably, they did not realise that the increase in temperature during the experiment corresponded to an exothermic reaction.

Question 13

The popularity of response D amongst the lower-scoring candidates points to some confusion between oxidation and reduction.

Question 16

Over half of the lower-scoring candidates chose response C. The text and the diagram shows barium hydroxide to be soluble in water. The text also refers to an excess of this alkali being added - so that the key is D. This could be due to insufficient care with reading the question.

Question 19

The lower-scoring candidates appear to have guessed between all four responses. Thinking that copper reacts with dilute acid is a traditional error that seems very difficult to eradicate.

Question 20

The fact that the lower-scoring candidates also appear to have guessed in this question is somewhat disappointing. The aqueous halide ions are, of course, colourless and displacement only occurs when the more reactive halogen is added to the aqueous halide ion.

Question 23

Over half of the lower-scoring candidates chose response C. It is a little surprising that such candidates did not recognise that since hydrogen is the lightest element, it is lighter than helium and that its' balloon would thus also float up.

Question 27

This was the only question to prove to be too easy, with poor discrimination.

Question 29

As for **Question 16** and **23**, over half of the lower-scoring candidates chose response C (instead of the key, D). The use of plating to prevent the access of air (oxygen) or water to the iron is a standard method of preventing rusting.

Question 35

Responses A and B were almost equally popular with the lower-scoring candidates (about 25% each). These candidates evidently did not recognise the -OH numbered 1 as being the alcohol group and thus not reactive towards sodium hydroxide.

CHEMISTRY

Paper 0620/02

Paper 2 Core

General comments

Many of the candidates tackled the paper well and good answers were seen in some parts of the paper e.g. **Question 1**. However, in every question, many candidates found at least two parts difficult. Some quite straightforward questions e.g. identifying which oxides are metal oxides and the uses of some elements, proved difficult for candidates. In general, the rubric was well interpreted and most candidates attempted all parts of each question. The standard of English was generally good. Although most candidates had a good knowledge of formulae many were found to have a poor knowledge of general organic and inorganic reactions. For example, many could not identify a fermentation reaction or define reduction.

Many candidates had difficulty with **Question 3 (a)**, where they were required to draw a suitable apparatus for investigating a reaction which produces a gas. Inadequate knowledge of suitable chemical apparatus has also been commented on in previous Principal Examiner Reports.

There were some instances where candidates disadvantaged themselves by giving multiple answers, especially in **Question 6** (parts **(e)** and **(f)**) but it is encouraging to note that most candidates confined themselves to a single answer in questions requiring a box to be ticked or a specific answer to be ringed.

It was encouraging to note that many candidates showed a good ability at balancing simple equations when the formulae were given. A considerable number of candidates appeared to have difficulty in explaining electrolytic processes (**Question 6**). This follows the general pattern from this paper in previous years. Tests for ions were not well known, the tests for chloride and Cl ions proving a stumbling block for candidates from particular Centres. This has also been commented on in previous Principal Examiner Reports. Candidates often disadvantaged themselves by sloppy and non-specific writing. As in previous examinations, few candidates explained environmental effects in a convincing way e.g. in **Question 4 (b)(ii)**, many candidates referred merely to 'burning', factories' or 'from cars' without reference to fossil fuels or exhaust gases. Organic chemistry proved to be a stumbling block for many candidates but it was encouraging to note, that most candidates' answers to calculations e.g. **Question 2 (e)(ii)** were generally good.

Comments on specific questions

Question 1

Most candidates tackled this question well and many obtained at least two-thirds of the marks available. The uses of argon, helium and oxygen were, in general, not well known. It was encouraging to note that most candidates could draw electronic structures of atoms well.

(a) (i) The commonest error here was to choose Cl as an element with five electrons in the outer shell rather than nitrogen. Many candidates appeared not to use their full Periodic Table at the back of the answer booklet to answer this. Neon or helium were also seen quite often as incorrect.

(ii) This was generally well answered. The commonest error here was to choose neon or helium as having diatomic molecules. Many candidates seem unclear about the structure of these gases (see also part **(v)** below). The incorrect answer, sulphur, was rarely seen, even though it is in the same group as oxygen. The commonest correct answers seen were Cl and oxygen.

(iii) This was invariably correct

(iv) This was invariably correct, with helium and krypton being most commonly chosen.

(v) This was the least well done in this section. Argon and krypton were often given as answers. This indicates that many candidates do not appreciate (1) what a giant structure is and (2) that noble gases exist as isolated atoms.

(vi) This was generally correct, with C, N and O being most commonly seen.

(vii) About 20% of the candidates chose oxygen as being the most common gas in the air rather than nitrogen. Few responded with other incorrect responses.

(b) (i) A use of argon was not well known. Many gave vague answers such as ‘for light’. A not uncommon error was to suggest that it is used for the lamp filament. This could not be given credit. It also suggests that many candidates do not know the state of argon or the meaning of the word filament.

(ii) Most candidates implied that helium was used in balloons but some failed to obtain the mark because they wrote ‘used in a hot air balloon’. This may reflect a failure to understand that helium is not one of the main gases in the air. A few candidates made vague references to ‘flying’ which could not be credited.

(iii) Some candidates wrote vague answers here. An answer such as ‘in hospitals’ is too vague to give credit. Many merely wrote ‘for respiration’ or ‘for breathing’. These were marked in context, but it must be stressed that these might also be considered as rather vague answers if this were not a Core Paper.

(c) (i) The electronic structure of argon was well known, the most common error being to place two electrons in the outer shell.

(ii) The idea of a full outer shell in noble gases was not appreciated by many candidates. The commonest incorrect answer was ‘because it is a noble gas’. This does not give a reason. Some candidates failed to gain the mark because they failed to explain the outer shell e.g. ‘there are full electrons’ will not gain a mark although ‘all the shells are full’ will. Another common error was to suggest that ‘there are no electrons in the outer shell’. This does not imply that the shell below is full.

Question 2

Most candidates scored at least two-thirds of the marks available on this question. However, few knew the test for chloride ions.

(a) Most candidates realised that the formula for sodium chloride is $NaCl$. The most common errors were to put $NaCl_2$ or to think that the formula for sodium is S. candidates should be encouraged to use the Periodic Table supplied to check formulae.

(b) Most candidates realised that evaporation (of the solvent) was required. The commonest error was to suggest that the solution should be filtered. This probably arises through not reading the question properly or understanding the word ‘solution’.

(c) Most candidates ticked the correct box, the most common error being to suggest that an aqueous solution of sodium chloride contains oxide ions (4^{th} box).

(d) The test for chloride ions was not well known. Many candidates tested with litmus or other indicators. Candidates at this level should also be discouraged from including oxidation numbers unless they are absolutely sure of their ground. A few candidates wrote ‘test with silver (II) chloride – this was not given the mark.

(e) (i) Although many candidates identified calcium sulphate, many apparently cannot identify the formula for a sulphate ion and put incorrect answers such as ‘limestone’, ‘calcium sulphur oxide’ or ‘calcium sulphur’.

(ii) Most candidates obtained the correct formula mass (136). The commonest error was to use atomic numbers instead of atomic masses. It might be noted that many candidates put g after the answer. This is obviously incorrect, although it was not penalised here since only one mark was available.

(iii) This was generally well done. The commonest error was to omit the 2 in front of the H_2O.

(iv) Most candidates realised that the reaction involved hydration. A minority of candidates suggested, incorrectly, that the reaction involved fermentation or combustion.

(v) This question was reasonably well done, about one-third of the candidates gaining both marks and most gaining one mark. The commonest error was to put SO_4 or HSO_4 on the left instead of H_2SO_4.

(vi) Over half the candidates realised that the reaction gave out heat continuously and so kept the mine warm. A minority of candidates merely repeated the stem of the question and gave the answer 'because it is exothermic' or stated that 'it gave out energy'. The latter answer is not accurate enough, since energy comes in many forms.

(f) Only about half the candidates obtained the correct answer here, indicating that they either did not know the percentage of oxygen in the air or did not understand how to go about answering the question. The commonest incorrect answers were to suggest that the level of oxygen was either 'the same' or, the surprisingly more commonly seen, '¼ of that of the outside air'.

Question 3

This was probably the second most difficult question on the Paper from the candidates' point of view, with very few achieving full marks for part **(a)** and only slightly more giving convincing answers to part **(b)(iii)** and **(c)**.

(a) Candidates often find it difficult to answer questions involving apparatus diagrams. A minority of candidates left this blank. Candidates should be encouraged to draw and label apparatus for relevant experiments, especially those involving measuring rate of reaction by analysis of gas volume. Some candidates suggested using measurement of mass as a method, but this would not given good results since the hydrogen peroxide is in aqueous solution and hence the change in mass would be too small to measure. Some candidates used appropriate apparatus but did not indicate that it was graduated. In this respect, many drew pictures of gas jars rather than measuring cylinders. It was clear that these were gas jars, because in many instances they were labelled as such. Many drew beakers instead of flasks (and labelled them 'flask'), although this was not penalised as long as the beaker was closed at the top. A common error was to suggest that the apparatus should be heated.

(b) (i) The definition of a catalyst was more poorly done this session compared with previous sessions. Many just gave the name of a catalyst presumably through misreading the question as 'what is the catalyst?'

(ii) Although many candidates identified X as the catalyst producing oxygen the fastest, there were few convincing explanations as to why. Many candidates did not make a comparison. An answer such as 'it produces 55 cm^3 of gas in 30 seconds', tells us nothing of a comparative nature. Many just repeated the stem of the question by saying that 'it produces the gas at the highest speed'. In order to obtain the marks, some idea of comparative time (to produce a given volume of gas) needed to be given.

(iii) Few candidates focused on the fact that the amount of hydrogen peroxide use was the same in all three experiments and many candidates were content to put that the hydrogen peroxide had finished reacting or been all used up or that the same amount of catalyst had been used.

(iv) The properties of transition metals were not well known. Many candidates still think that all transition metals are magnetic and that the metals themselves are coloured. To gain the mark for colour, the word '(transition metal) compound' is important. A considerable number of candidates failed to read the question properly and gave properties of metals in general e.g. electrical and thermal conductivity.

(c) Most candidates obtained the mark for the idea that the particles move faster, but the more difficult second mark for increasing collision frequency was rarely seen. Many candidates merely repeated the stem of the question and wrote that the 'reaction went faster' in trying to gain the second mark.

(d) (i) The definition of a catalyst was also more poorly done this session compared with previous sessions. Ideas of enzymes being living things still persist. Many candidates also fail to realise that the word ‘natural’ relates to all things in nature including rocks etc. – the word does not equate to ‘biological’. Similarly the word ‘organic’ has a wider meaning than the word ‘protein’.

(ii) Response B was the commonest incorrect response to this question. Many candidates seem to have just looked for the formula for ethanol on the right hand side of the equation rather than looking at the nature of the reactant and co-product.

Question 4

This question proved to be a good discriminator, with few candidates obtaining full marks in parts **(a)** and **(b)**. Many candidates also found part **(d)** demanding. As has been mentioned before in Principal Examiner Reports for Core Chemistry, processes such as reduction are often poorly understood by candidates.

(a) Many candidates failed to identify two basic oxides. It was common for a candidate to lump together an acidic oxide (usually sulphur dioxide) with a basic oxide. The reason for their choice was rarely given, the most common response merely being to state the implication in the stem of the question that they formed alkalis when dissolved in water. This merely redefines the word basic.

(b) (i) Although sulphur dioxide was often a correct response, many candidates suggested that sodium oxide contributes to acid rain. This response was most often given by those candidates who put this oxide as an incorrect response to part **(a)** of the question. This may suggest that such candidates equate ‘highly reactive oxides’ with acid rain.

(ii) As has been noted in previous Principal Examiner Reports, environmental aspects of Chemistry are poorly understood by many candidates. There were many vague answers. Many candidates referred merely to ‘burning’, factories’ or ‘from cars’ without reference to fossil fuels or exhaust gases. Many referred to fertilisers or nitrogen dioxide coming from the air when it reacts with oxygen (without the intervention of lightning).

(c) (i) Most candidates scored the mark for calcium oxide

(ii) Few candidates realised that heat was required to decompose calcium carbonate to calcium oxide. Most wrote about catalysts or specific catalysts or the need for oxygen. Some confused heating with combustion.

(d) (i) Although many candidates had an inkling that differences in reactivity were involved, most gave very vague answers or merely referred to ‘strength of sodium compared with carbon’ (not even stronger reductant).

(ii) Although many candidates scored at least one mark for the equation, a significant minority put oxygen or carbon monoxide on the right.

(iii) A suitable definition of reduction was not well known. The commonest correct answer given referred to loss of oxygen from a compound. However, many candidates did not think clearly enough and put ‘loss of oxygen from an element’. Far too many candidates referred to a decrease in size or mass of a compound, suggesting that they were using the word reduction in an everyday sense rather than in a chemical sense.

Question 5

As noted in previous years, organic chemistry continues to be a stumbling block for many candidates. Few candidates obtained more than half marks on this question and the test for unsaturation was not well known.

(a) Although many candidates gave the correct answer (methane), a large proportion put ‘ethane’.

(b) Most candidates recognised that A and B belonged to the same homologous series, although it was not uncommon to see the combination C (alcohol) and E (carboxylic acid). Candidates should be advised to learn to distinguish between these two groups of compounds.

(c) (i) Many candidates chose the correct answer (C) but a considerable number focused on the O – H group of the carboxylic acid, rather than considering the - CO_2H group as a whole.

(ii) Few candidates drew the displayed formula of ethanol correctly. Many failed to put in an O – H group at all or forgot the bond between the oxygen and hydrogen.

(iii) Very few candidates knew how ethanol was made industrially from ethene. Most candidates referred to fermentation, the use of enzymes, addition of oxygen or, most commonly, the use of water (rather than steam). The use of a catalyst was seldom mentioned.

(d) (i) Most candidates could identify an unsaturated hydrocarbon.

(ii) The test for an unsaturated hydrocarbon was not well known, even though they were keyed into the word ‘unsaturated’ in part **(i)** of the question, where most identified an unsaturated hydrocarbon correctly. Many candidates referred to the use of litmus. Many of the candidates who recognised the bromine water test failed to gain the second mark because they thought that the bromine water did not change colour.

(e) (i) Few candidates identified compound E as ethanoic acid. ‘Butanoic acid’ and ‘methanoic acid’ were the most common errors followed closely by ‘ethanol’.

(ii) About a quarter of the candidates found difficulty in identifying a suitable test for acidity. A common error was to state that an ‘indicator paper’ should be used without reference to the type of indicator paper. Candidates should also be advised not to mix up colour and pH e.g. stating that the colour (of Universal Indicator Paper) should be between 1 and 6.

Question 6

As in previous years, candidates find the concept of electrolysis difficult. Few candidates obtained more than two-thirds of the marks on this question. The main stumbling blocks were part **(b)** and part **(f)(ii)**. Many candidates failed to gain marks for parts **(e)** and **(f)(i)** because they made quite extensive lists of reasons/properties, some of which were not correct. It must be stressed, that if candidates give several reasons where only one is required, the presence of an incorrect answer will negate the presence of a correct answer. If additional answers are considered neutral, however, no penalty is given. Many candidates did not appear to use the information in the table.

(a) Few candidates realised that aluminium oxide was used in the electrolysis. Some candidates put the answer ‘bauxite’ which was not marked correct since this is an ore i.e. an impure rock containing aluminium oxide. Many candidates put ‘A*l*’, thus showing that they did not understand the word ‘compound’.

(b) This was poorly done. Many candidates wrote incorrectly about electrons or particles moving rather than ions moving.

(c) (i) Although many candidates realised that carbon/graphite electrodes were used for the electrolysis of aluminium oxide, a range of other metals were suggested, the most common incorrect answers being ‘platinum’ or ‘copper’.

(ii) Most candidates recognised that the A*l* ions move towards the cathode during electrolysis, but the explanation in terms of charges was not always convincing, few actually stating that the A*l* ions are positively charged. Many candidates realised, however, that the ions and cathode were oppositely charged.

(d) Most candidates scored at least two of the three marks available. Various combinations of incorrect answers were seen here, the commonest being ‘increased, bauxite, chemical’

(e) (i) Many candidates suggested that A*l* was stronger than copper, despite the data in the table. Candidates who wrote less dense and cheaper or stronger were penalised because the information shown in the table shows that the last two answers are incorrect.

(ii) Most candidates obtained the mark here. Of those who did not, many failed to use the data in the table and wrote about steel rusting.

(iii) Many candidates failed to use the information from the table correctly and suggested that steel was more conductive than A*l*.

(iv) Most candidates obtained the mark for 'ceramic'. The most common incorrect answer was 'graphite'

(f) (i) Most candidates understood that A*l* is used in aircraft bodies because it is lightweight, but some negated this mark by suggesting that A*l* was cheap, when the table shows that it clearly is not.

(ii) The test for A*l* ions was not well known, many candidates leaving this blank. A few candidates did not take sufficient care when writing their answers. Several wrote that 'a soluble precipitate is formed' when they meant 'a precipitate which dissolves in excess (sodium hydroxide)'. Candidates are also recommended to stick to suggesting one reagent. If they write 'add sodium hydroxide and ammonia', they cannot get the third mark because it would be unclear whether the precipitate would dissolve or not) unless they make the distinction between ammonia and sodium hydroxide clear).

CHEMISTRY

Paper 0620/03
Reports

General Comments

This session, unlike previous ones, there were very few candidates who were awarded very low marks. That is not to say that they would not have benefited from being entered for Paper 2, the reasons for which have been catalogued in previous reports.

Candidates persist in offering more than the required number of responses. As stated in the past, there is no advantage in doing this.

In numerical problems, answers should be given to an appropriate number of significant figures. Candidates should be advised not to round up or down too early in the question.

Centres are advised to encourage candidates to use basic examination techniques, such as ensuring they read the question carefully and to make the judgement – 'does my response answer the question?' This would have improved the level of attainment of many candidates.

Individual Questions

Question 1

(a) Usually answered correctly. The most common error was to select the first statement – the metals are highly coloured e.g. yellow, green, blue. Unlike previous years virtually the whole entry followed the instructions and ticked only three boxes.

(b)(i) Most gave the correct response, period 4. A minority gave period 3 but they had not counted the first period which includes only hydrogen and helium. Another misconception is that the Transition Elements are a period rather than part of one.

(ii) 26 protons and 30 neutrons was the required response, which was given by a large majority of the candidates. The usual mistake was to believe that there were 56 neutrons.

(c)(i) Sometimes this was answered without reference to the substances given in the question, for example chalk instead of limestone.

(ii) Coke and carbon monoxide were frequent incorrect answers.

(iii) The word or phrase had to be selected from the list, therefore iron oxide was not accepted. The choice had to be iron ore.

(d) The function of coke in forming carbon monoxide or as a reductant was well known but far more elusive was its role in burning and supplying the requisite energy. Many thought that coke removed impurities.

(e) Generally very well answered. Candidates ought to be advised to avoid obscure answers, for example robots, and restrict their choice to the common uses.

Question 2

(a) Usually the correct order was given.

(b) This proved to be more difficult. Magnesium was thought to be metal Z or metal X rather than metal W. Copper as metal Y proved to be much easier.

(c)(i) Excellent answers from the majority, only marred by glowing splints instead of lit or burning ones.

(ii) A list of acceptable responses is given below.

- universal indicator goes blue or shows that it is alkaline
- pH>7
- litmus paper goes blue
- with an ammonium ion ammonia gas is formed
- some metallic ions form a precipitate
- acids with an observable result

Candidates ought to be reminded that "how can you show" requires a practical test and an observation. The common error was to believe that a test for water was required and consequently it was suggested that anhydrous copper sulphate should be added or the boiling point of the liquid shown to be 100°C.

(iii) Usually correct, just a few Group 2's and an occasional Group 7

(iv) Apart from attempts to replace X with a more reactive metal or even by fluorine, the main error was to omit "molten".

Question 3

(a) Many scored full marks, however some included their own numbers and others reversed the pH's of the two bases.

(b) Observations were not always given, for example – a weak acid is a poorer conductor is a correct comment but is not an observation. Weak acids still conduct, so bubbles would be observed but produced at a slower rate and the bulb would be less bright. Quite a common misconception was that rate would be slower at one electrode but faster at the other.

(c) "Hydrogen ions" was not accepted since "proton" was required for the mark. Far more gave the correct formula for the particle, H^+. Typical errors were H, H_2 and H_3O^+.

(d)(i) It was only necessary to give one oxide in each category, such as magnesium or calcium oxide. In common with other parts of this question, the type of oxide was either known or guessed and marks were typically either 4/4 or 1/4. Some ignored the comment "not with alkali" and included aluminium oxide in this category.

(ii) The inclusion of an extra, but incorrect response, meant that a correct choice could not be awarded the mark.

(iii) Many could not recall that aluminium oxide is the only amphoteric oxide in the list.

(iv) Both carbon dioxide and carbon monoxide were often chosen as being the neutral oxides. This answer, which includes one correct and one incorrect response, was not awarded the mark.

Question 4

(a) When offered the choice, most candidates would be better advised to rely on description rather than attempting to draw a tetrahedral structure but if determined to draw the structure then they should limit it to five atoms of germanium and indicate continuation on the four outer atoms. Common errors were:

- carbon not germanium
- carbon and germanium
- germanium and oxygen
- drawing graphitic-type structures
- giving a complex diagram that included 1:3 and/or 1:5 co-ordination

(b)(i) The following were the marking points:

- free or mobile electrons
- layers
- provided layers were mentioned – that they can slip or the forces between the layers are weak .

Frequent mistakes were ions instead of electrons and to refer to the bonds between layers as intermolecular forces.

(ii) The property specified had to be one of those given in the question, either soft or good conductor of electricity. Frequently it was not and the mark could not be awarded. If one of the properties was chosen then the answer response was almost invariably correct.

(c)(i) The formula of silicon(IV) oxide caused all sorts of problems – Si_2O_4, SO_2 and SiO

(ii) The concept of structure is not widely appreciated and was confused with bonding or with physical state.
The required responses were:

CO_2	simple molecule or simple covalent molecule
SiO_2	macromolecular or giant covalent molecule or giant molecular

(d) Quite a number of GeH_4 and Ge_2H_4 were encountered. A significant number gave the symbol for germanium as G not Ge so the formula was incorrectly given as G_2H_6.

Question 5

(a)(i) Both "burn" and "oxygen or air" were needed, frequently one of these was omitted. 'React sulphur with oxygen' did not gain the mark.

(ii) and (iii) These two parts were well known.

(b)(i) Most candidates made the correct choice that the yield would decrease.

(ii) That the reaction is exothermic was usually recognised but was often followed by an unacceptable reason – the reaction is bond forming or it is the combustion of sulphur dioxide or heat is given out. A variety of correct explanations were offered. The back reaction is favoured by increasing temperature so it is endothermic etc., or the forward reaction is favoured by low temperatures so it is exothermic.

(iii) It was not sufficient to state that an increase in temperature would increase the rate but decrease the yield and vice versa. There had to be the idea that 450°C was a compromise, a high yield and an economic rate. Common difficulties were to discuss rate or yield but not both or to omit the idea of a compromise.

(iv) This question generated the whole range of marks(0, 1, 2) for descriptions based on incorrect Chemistry [0], for just stating react sulphur trioxide with water and not mentioning concentrated sulphuric acid and the formation of oleum [1]to the full description which included react/dissolve in concentrated sulphuric acid and then add (the correct amount of) water [2].

Question 6

(a)(i) A chemical bond is between two atoms, it can be described in words, a carbon - hydrogen bond, or using symbols, C—H. Many gave molecules, such as CH_4 or gave hybrids $C—H_2$, neither were accepted.

(ii) The model answer is more energy is released in bond forming than is used in bond breaking. Candidates confused the direction of the energy transfer – energy is used in bond forming or tried to account for the difference in energy by stating that more bonds were formed than broken. In general, the explanations were confused and lacked any real insight into the underlying concepts.

(b)(i) The symbol for uranium was given by most of the candidates but the nucleon number was usually stated to be 238 instead of 235.

(ii) Usually correct, the two common errors were to generate electricity, which is the use mentioned in the question, and carbon dating. This is not a use of ^{14}C, the radioactive isotope is already present in the material and measurements are made on this naturally occurring material.

(c)(i) Many stated that zinc was the reductant but very few knew that the oxidant was hydrogen ions from the acid. Despite being told that the oxidant was an ion, the most popular suggestion was iron.

(ii) The following suggestions were awarded the mark.

- replace zinc with a more reactive metal
- replace iron with a less reactive metal
- use metals further apart in the reactivity series
- use more concentrated acid

The following suggestions were not accepted.

- use a stronger acid
- use bigger electrodes
- use a magnesium electrode –did not specify where
- include a bigger battery
- increase the current

(iii) The common wrong answer was electroplating, this is electrolysis. The diagram is of a cell and it illustrates the mechanism by which iron or steel is protected from rusting by either galvanising or sacrificial protection.

(c)(i) The colour change was well known, a minority gave the change for potassium dichromate(VI).

(ii) Very few correct answers seen. Potassium ions were included in many of the attempts
$KI = K^+ + I^-$
Other incorrect versions of this equation were:
$2I^- + 2e = I_2$ (very common)
$I^- +- e = I$
$I_2 = 2I^- + 2e$

Question 7

(a)(i) Very well answered by the majority of candidates. The question required a different equation to that in the introduction.

(ii) Generally well answered, the common mistakes were:

- trivalent and pentavalent carbon atoms
- alkanes not alkenes
- to give the same isomer twice
- to give other products of cracking

(b)(i) A number guessed and wrote "heat and pressure" or quoted catalysts used in other processes, for example a nickel catalyst.

(ii) Most gave an acceptable answer, such as photochemical or substitution or chlorination or halogenation.

(iii) There was a tendency to write down chlorobutane and hydrogen chloride. However, these are not organic products. Many candidates included bromoalkanes or even more prevalent gave alkenes.

(c)(i) Either of the two propanols were acceptable and a correct structure of one of them, usually propan-1-ol, featured on most scripts.

(ii) Not as well answered as part (i). There were many 1:3 dibromopropanes and 1:1 dibromopropanes as well as 1-bromopropane.

(d) The solution to this calculation is as follows.
moles of CH_3-CH=CH_2 reacted = 1.4/42 = 0.033

maximum moles of CH_3-CHI-CH_3 that could be formed = 0.033

maximum mass of 2-iodopropane that could be formed = 0.033×170 = 5.61 g

percentage yield = 4/5.61 ×100 = 71.3%

The exact percentage calculated depends on how many 3's are retained in the first line.
For example 0.0333333×170 =5.67 g and a percentage of 70.6%
All correct versions were awarded the marks.

Difficulties experienced:

- Candidates correctly calculated the moles of propane as 0.03333 but then quoted 0.03, but they retained the full value on the calculator so that subsequent answers did not follow on from the previous one. This difficulty could be avoided if all answers were given to three significant figures.
- Moles of 2-iodopropane were frequently thought to be 4/170 = .024. This was rounded down to 0.02 giving the maximum mass as 3.40 g which is less than the actual yield of 4.0 g. They tried to rectify the situation by calculating 3.4/4×100 =85%.
- Candidates should be advised that yields over 100% are impossible and the calculation needs to be checked.

CHEMISTRY

Paper 0620/04

Coursework

General comments

Many of the Centres entering candidates for this alternative have been doing so for many years and have well tried and tested sets of assessment exercises. They have mark schemes, which are applied consistently over the years. There are usually few problems with these centres.

Centres new to centre based assessment of practical work are obviously more likely to be out of line when it comes to assessing at the correct levels and it has been necessary to moderate the marks of a few Centres, both up and down, this year. It is important to stick as closely as possible to the criteria in the mark schemes. In this way candidates are not unnecessarily penalised.

Unusually this year, there were a significant number of Centres that made errors in transferring marks from the Centre's mark sheets to the board's MS1. Great care should be taken here, as it is the MS1, which is used to record the candidates' mark for their final award.

There were very few Centres this year where anything was omitted from the sample. Thank you to all those Centres that go to a great deal of trouble to provide the Moderators with all the required information in an accessible and helpful manner.

Comments on individual skills follow below.

C1

Centres are reminded that activities designed to make 6 marks accessible should have some complexity. They should be multiple stage processes and at some point candidates should have to make a decision as to which course to take. Their ability to make this decision correctly should be one of the marking points. This point must be gained to enable 6 marks to be awarded.

No written work is needed as evidence for the award of this skill but a detailed mark scheme is required and a tick-list to show how marks are awarded to different candidates is very helpful.

C2

There are usually few problems with this skill. Tables should not be provided for results as this makes it impossible for candidates to gain full marks. The assessment scheme makes it clear that this skill involves both quantitative and qualitative observations. A Centre's exercises should include examples of both skills. Some Centres concentrate on measurement and some on visual observations of change, but both should be included.

C3

There were instances, this year, of over generous marking in this skill. Graphs should have best fit lines to gain the highest marks. Simple calculations are, on their own, seldom sufficient to score high marks.

C4

It is essential that candidates carry out the investigations that they have planned. To gain the highest marks they need to comment on errors that occurred, and what could be done to avoid them. They need to suggest improvements. Without carrying out the experiment they can do neither of these.

It is also necessary that an investigation should involve a number of variables. Without this, marks cannot be awarded for controlling those not being investigated.

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Paper 0620/05

Practical Test

General comments

The majority of candidates successfully completed both questions. A small minority of Centres reported difficulties with **Question 1**, which involves testing manipulative skills. As such, complaints regarding problems setting up the apparatus were not valid. Some Centres ignored the requirement in the confidential instructions 1(f), regarding the rate of oxygen production. Some results indicated that the hydrogen peroxide was well over 5 volumes in concentration while others had gas volumes of less than 10 cm^3 for all concentrations used. Centres that followed the instructions adjusted the concentration of the hydrogen peroxide as necessary and indicated as such on the Supervisor's report. As in previous years the Supervisors' reports were used to compare results for both questions with their candidates. A few Centres did not enclose a Supervisor's report.

Comments on specific questions

Section A

Question 1

The vast majority of candidates carried out the 4 experiments successfully and completed the table of results. A minority of candidates had a greater volume after 10 seconds than after 20 seconds. Some readings indicate that some candidates did not refill the collection cylinder with water after each experiment.

(a) Most candidates plotted their results on the grid correctly. A common error was to miss out (0,0) on the grid. A minority of candidates did not label each line as requested. Smooth curves or straight lines as appropriate were often badly drawn.

(b) Generally well-answered. Reference to effervescence/bubbles/fizzing scored credit but gas given off is not an observation and did not score credit.

(c) Reference to more concentrated hydrogen peroxide was common but only the more able candidates were able to refer to more collisions. References to increased energy and faster collisions received no credit.

(d) It was common for candidates to identify errors which were basically their own incompetence rather than limitations of the procedure or apparatus. Meaningful references to gas leakage, problems with the procedure and inaccurate use of measuring cylinders scored credit. Similarly meaningful improvements to the procedure or apparatus scored credit in **(ii)**. Common incorrect references to 'use a more accurate measuring cylinder' were penalised.

(e) A good differentiating question. Many candidates concentrated on the fact that catalysts speed up reactions rather than 'do not get used up'. The introduction to **Question 1** stated that 'A catalyst remains unchanged at the end of the reaction'. Good answers referred to filtering the manganese oxide off at the end of the reaction, and then comparing the mass of the catalyst before and after the Experiment or repeating the Experiment and comparing results.

Experiment 5

Some interesting test results- a squeaky pop with a lighted splint was common. Some candidates managed to relight a lighted splint! Others managed to relight a plain wooden splint.

Question 2

(a) Generally well-answered.

(b) A significant number of candidates thought that the cobalt chloride paper was litmus and so decided that an acid was made- 'paper turned red' scored no credit. Others were penalised for assuming that chlorine was evolved and bleaching the paper. Some Centres provided candidates with damp cobalt chloride paper. Observations referring to condensation/droplets of liquid at the top of the tube, or residue changing colour to yellow, received credit.

(c) Often well-answered. A minority of candidates got coloured precipitates although the Supervisor got a white one in parts **(i)** and **(ii)**. Some candidates missed the dissolving of the precipitates in excess reagent. In **(iv)** some candidates recorded a variety of observations when no reaction/change was expected.

(d) A large number of candidates failed to describe the bubbles/fizzing and a minority reported a negative limewater test.

(e) A good differentiating question. Only the better candidates referred to the presence of water. The gas given off was often thought to be acidic or chlorine as mentioned in **(b)**.

(f) A good discriminating question – only the better candidates cited the absence of halide ions because of the negative test in **(c)(iv)**.

(g) Some candidates confused compounds B and C. A minority were unable to draw correct conclusions despite correct observations earlier and the practical notes on page 8.

CHEMISTRY

Paper 0620/06
Alternative to Practical

General comments

The majority of candidates attempted all of the questions. Candidates generally showed a good knowledge of practical chemistry. The paper showed good differentiation according to the ability of the candidates. Poor syllabus coverage by a minority of Centres was evident with candidates unable to answer specific questions.

Comments on specific Questions

Question 1

(a) The boxes were often correctly completed. Common errors included gas jars instead of tubes, carbon for electrodes and water instead of acid.

(b) Generally well-answered.

(c) A common error was testing for chloride ions rather than Cl gas.

Question 2

(a) Vague answers referring to separation were prevalent. The idea of dissolving was required.

(b) A lack of understanding and detail was evident. Some indication of removal of solid/insoluble material scored credit.

(c) A lot of candidates mentioned removal of water without giving a method involving the use of heat. Distillation was a common incorrect response.

(d) Many diagrams showed the wrong number of spots. Diagrams were drawn that explained how to carry out the process of chromatography rather than the results expected.

Question 3

Most candidates correctly completed the table of results.

(a) A good discriminating question which weaker candidates were unable to understand.

(b) Generally well-answered.

(c) Most candidates referred to heat loss but a minority mentioned that the glass could shatter, crack or break easily. This type of answer scored no credit.

(d) Points were usually plotted correctly. However, many candidates failed to draw two straight intersecting lines correctly. Many drew two lines meeting at 30 cm^3, a three section line or a curved hump.

(e) A good discriminating question, answered correctly by the more able candidates. Answers were often incorrect despite having drawn correct graphs in **(d)** showing two straight lines meeting at 24 cm^3 and a maximum temperature at 50.5^{o}C.

(f) A surprising number of candidates assumed that the reaction was reversible.

Question 4

The tables of results were generally correctly completed.

(a) Points were usually correctly plotted. However, smooth curves were less common. Many graphs were dot-to-dot lines. Most graphs were labelled correctly.

(b) A significant number of candidates thought that at higher concentrations the particles moved faster or that catalysts gave the particles energy. Appreciation of the idea of an increased number of collisions was appreciated by the more able candidates.

(c) Sources of error and consequent possible improvements were often lacking detail and vague in nature. Inaccurate use of equipment was not specific to score credit. A lack of precision with the amount of catalyst was often negated by discussion of the volume of the catalyst instead of the mass.

(d) Many answers were based on the idea that catalysts make reactions faster. The better answers focused on information given at the beginning of the question i.e. 'the catalyst remains unchanged at the end of the reaction'. Recovery of the catalyst by filtration and repeating the experiment to show similar results or comparing the mass of the oxide before and after scored two marks.

Question 5

(b) Some answers did not include the colour of the precipitate, or failed to indicate it was a precipitate.

(d) Some confusion between cobalt chloride paper and litmus paper caused some candidates to identify the gas as acidic.

(e) Many candidates missed the negative halide test.

(f) A surprising number of candidates failed to identify the gas as carbon dioxide and the presence of carbonate ions. Some Centres had not covered this area of the syllabus.

Question 6

This question discriminated well. The best answers described a detailed titration method. Candidates that came up with a reaction of sodium hydroxide that could be done quantitatively often scored good marks e.g. a gravimetric method involving metallic hydroxide precipitation. However, many candidates could not identify a suitable reaction. A significant number just tested the oven cleaners with Universal Indicator or a pH meter to determine the pH. These methods would not work to show which cleaner contains the highest concentration of sodium hydroxide. Some candidates tried chromatography and a few even claimed that sodium hydroxide was an acid and so should be reacted with an alkali such as sodium hydroxide! Methods that compared how fast the cleaners removed grease from dirty oven panels scored no credit.