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CHEMISTRY

Paper 0620/01
Multiple Choice

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20	**A**	40	**A**

General comments

Candidates achieved a mean mark of 26.9 with a standard deviation of 6.7. These and other statistics show that the paper performed satisfactorily in discriminating between candidates of differing competence in the subject. Although primarily intended to discriminate between grades C to G, candidates achieving higher grades also offer this paper. Only a few of the questions challenged these latter candidates (see below). This being so, this report concentrates on aspects of the answers offered by candidates achieving the lower grades.

Comments on specific questions

Question 3

This question proved to be on the hard side (but with good discrimination). Almost as many of the lower grade candidates chose **A** as chose **B**, the key. Presumably, they failed to recognise that sodium chloride is a neutral salt so that its solution also has pH 7.

Question 5

The statistics for the lower grade candidates were very similar to those for **Question 3** but with the comparison being with the relative popularity of key **C** and response **D**. Oxygen is a Group VI element that forms ionic oxides with metals!

Question 8

A slightly hard question with excellent discrimination because response **A** attracted two thirds of the lower-scoring candidates. Such candidates evidently correctly identified the numbers of bonds in the two molecules concerned but overlooked the fact that there are two electrons per covalent bond.

Question 9

Candidates found this to be one of the hardest questions in the paper. Of the lower-scoring candidates, two fifths chose **B** and a quarter chose **C**. For the former, quite apart from the fact that they did not appreciate that nitric acid is monobasic and lead is divalent, they were too ready to draw the wrong conclusion from the name lead(IV) oxide. On the other hand, did the **C**-choosers become confused about which compound was lead(II) and which was lead(IV)?

Question 14

A moderately hard question, stemming from the fact that about a quarter of the lower-scoring candidates chose **A**. This may have been a misreading of the question, namely that when combined with carbon, methane is a possible product which is indeed a fuel.

Question 15

The first of the questions that slightly taxed the higher-scoring candidates. The basis of the question is that bond-breaking requires energy and bond-formation releases energy. The case where weak bonds are broken and strong bonds are formed is then the most exothermic. There is some hint in the statistics that, having eliminated **D**, the lower-scoring candidates may have guessed between **A**, **B** and **C**.

Question 17

Responses **A** and **B** were equally popular amongst the lower-scoring candidates. The **A**-choosers correctly recognised that the powdered zinc would react more rapidly but erroneously thought that it would also produce more hydrogen.

Question 18

Perhaps the lower-scoring candidates merely guessed.

Question 19

Another taxing question for the higher-scorers. They - and their lower-scoring colleagues - found response **C** too attractive. Both aluminium hydroxide and zinc hydroxide dissolve in excess of aqueous sodium hydroxide so the key has to be aqueous ammonia in which zinc hydroxide will dissolve but not aluminium hydroxide.

Question 20

This question did not work well - low facility and low discrimination. Response **C** was rather popular across the ability range. However, calcium hydroxide is partially soluble in water, e.g. in testing for carbon dioxide.

Question 25

Response **B** was somewhat popular across the ability range. Presumably, candidates preferred the highest density rather than the highest melting point.

Question 29

A moderately hard question due to the fact that nearly half of the lower-scoring candidates went for **A**. Did such candidates really think that air is 50% oxygen?

Question 30

Two fifths of the lower-scoring candidates each went for either **B** or **C**. The **B**-choosers may be confused about which pH values are acidic and which alkaline.

Question 31

Half of the lower-scoring candidates chose **B** but there seems to be no obvious reason for this.

Question 32

Found quite difficult across the ability range, with about 30% of all candidates choosing **D**. This is 'the wrong way round': it is the more reactive metal that is sacrificially corroded.

Question 35

This proved to be easy with low discrimination.

Question 40

Response **B** was disappointingly popular both with the lower-scoring and the higher-scoring candidates. The addition reaction of ethene and steam is explicit in the syllabus but hydrogen is not a product.

Paper 0620/02

Paper 2 (Core)

General comments

Most candidates who sat this paper were appropriately entered and there was a good range of marks but fewer very low marks (below 10 out of 80) than in previous years. Most candidates attempted every part of each question, the questions most commonly not eliciting a response being **Question 3 (a)** and **Question 6 (d)(iv)**.

The standard of English was generally good, most candidates answering in whole sentences where required. Many candidates tackled the paper well and there were many good answers showing an appropriate grasp of the subject matter. The rubric was generally well interpreted and hardly any candidates misinterpreted the instructions or did not read them carefully enough. However, a small number of key words were not understood e.g. 'chemical test' in **Question 2 (c)(ii)**. A further example of not reading instructions correctly arose in **Question 5 (d)**: 'Which elements are in the same group'? must indicate that more than one element is required. However some candidates, only wrote down the name of one halogen and hence deprived themselves of a mark. Similarly, many candidates only wrote one name down in **Question 1 (a)**, when three was clearly specified. A not insignificant number of candidates only ticked one box in **Question 5 (f)**, whereas the question asks them to tick two. It should be stressed that if there are two marks available (as in this case), one incorrect answer does not negate the correct answer.

Electronic structure was generally well known but many candidates had difficulty in identifying an element from diagrammatic representations. It is encouraging to note that, compared with previous years, fewer candidates disadvantaged themselves by giving multiple answers when only one was required. It was encouraging to note that the majority of candidates were able to write chemical names in the appropriate places in equations and to name compounds correctly. A small number of candidates, however, failed to grasp the difference between a word equation and a symbol equation, and put chemical formulae in word equations. This can not be marked correct because it does not indicate whether the candidate knows the correct name of the species or not. Most candidates could balance simple symbol equations. Many candidates appeared to have difficulty in answering questions where a greater proportion of free response was required e.g. **Question 3 (a)**. Questions related to experimental techniques have often been a stumbling block to candidates. Candidates should be reminded that the syllabus contains a variety of statements about experimental techniques which should also be learnt for the theory examinations. Candidates continue to find explanations of chemical terms difficult to describe e.g. the definition of a compound (**Question 1 (e)(i)** was often poorly written as were the explanations of hydrocarbon and alkane (**Question 4 (d)**). It was encouraging to note that the candidates' knowledge of the uses of various chemicals was good.

Comments on specific questions

Question 1

In general, this was a fairly high scoring question although few candidates scored full marks. Most candidates scored at least 10 marks. Parts **(a)** and **(e)(i)** caused the most problems.

(a) This part presented some difficulties to many candidates. Inclusion of A (an alloy) was a frequent error and many candidates did not read the question properly and only opted to write down the name of one letter (element). When this happened, B was commonly chosen. The reason was rarely acceptable, common errors being: 'they are molecules'; 'they are all the same' (not specifying what is the same) and 'they are just one element'. The latter is unacceptable as no explanation has been given and merely repeats the 'element' in the stem of the question.

(b) This was commonly correct, B being the commonest incorrect answer, presumably because of confusion between the terms atom and molecule in the minds of the candidates.

(c)(i) This was usually correct, with D being the most frequent error. The reason for this is unclear, although some candidates may think, mistakenly, that diatomic means two types of atoms.

(ii) A wide range of acceptable answers was seen. The most common incorrect answer was carbon dioxide, which follows on from mistaking D for a diatomic molecule in part **(c)(i)**. Hydrogen and chlorine were the most common examples encountered.

(d)(i) This was invariably correct. It is encouraging to see that candidates have learnt this structure.

(ii) Pencils, lubricants and electrodes were the most common correct answers given, pencil leads being the best known. A minority of candidates just wrote 'in electrolysis' which was far too vague an answer.

(e)(i) Chemical definitions such as 'what is meant by a compound' still give difficulties for many candidates. 'Two atoms combined' was a common incorrect answer (no reference to different types of atom). The chemical language has to be accurate to score the mark. Many candidates failed to obtain the mark by starting their (otherwise correct) statement by 'a compound is a mixture …'.

(ii) This was reasonably well answered, methane being the choice most often seen. Water and ammonia were not infrequently put but hydrogen chloride was rarely put down as an answer.

(f)(i) At least 80% of the candidates drew the correct structure of hydrogen chloride. Failure to show the hydrogen was the most common error of those who failed to gain a mark. This was not marked correct since it would indicate an ionic structure (Cl^- ion). Although not requested, about 10% of the candidates drew the full electronic structure but they were not penalised for this. Some candidates drew the structure as being HCl_2. No marks were given for this since it leads to the incorrect number of outer shell and bonding electrons.

(ii) This was invariably correct even when the answer to **(f)(i)** was incorrect.

(iii) This was surprisingly poorly done, only about half the candidates writing a correct colour change. Missing the colour of the litmus at the start was frequent. Many candidates maintained that the litmus went blue in acid or went orange or green. It is clear that some candidates confuse litmus paper with Universal/full range indicator paper. There was also some confusion over the concentration of the acid, some thinking that the litmus would go blue if the acid was less concentrated and pink when more concentrated. A not inconsiderable number of candidates also maintained that the litmus would be bleached, presumably through confusion with chlorine.

(iv) A wide range of answers was seen but pH2, the correct one, was the commonest. However, the number of candidates opting for an answer which indicated an alkaline pH was surprisingly high.

(v) The correct answer (2) was almost always noted. A small number of candidates still insist on putting symbols in place of the numbers e.g. HCl. HCl. This was not adjudged correct.

(vi) This was invariably correct. Occasionally both magnesium chloride and hydrogen was written down. Since hydrogen is not a salt, no marks can be given. The word 'the' should clue candidates in to what is required.

Question 2

In general, this was a fairly high scoring question although few candidates scored full marks. Most candidates scored about half the marks available. Descriptions were poor e.g. in part **(a)** and **(c)(ii)**. About two thirds of the candidates did not seem to know what is meant by a chemical test **(c)(ii)**. Comment has been passed about this in previous Examiner Reports.

(a) This part was poorly answered. The majority of candidates only repeated the question by stating that the filter removed the stones and sand. This suggests that many candidates believed that it was the stones and sand that were the impurities.

Removal of insoluble materials or solids was hardly ever seen. More candidates realised that the purer water was filtered through. Some thought, incorrectly, that large objects were removed by the filter e.g. bits of iron, scaps etc. These are screened off and would nor get through the thin pipes shown in the diagram. The answer 'big particles are removed' was not accepted because the size of particles is not clear and the idea of insolubility is still not accessed.

(b)(i) The use of chlorine to kill bacteria was well known. Most candidates obtained the mark.

(ii) Neutralisation was well known.

(iii) It was rare to find the correct answer (calcium hydroxide). Limestone and limewater were common incorrect answers.

(iv) This was poorly answered. The most common correct answer related to neutralising acid soils or wastes. Many candidates thought that slaked lime was used in the blast furnace (presumably through confusion with limestone). Some confused it with the fruit and thus gave the answer for drinking. Cement was a common incorrect answer – cement manufacture does not use slaked lime though it is present in lime plaster, limewash etc. A small number of candidates believed that slaked lime is present in toothpaste, perhaps again through confusion with calcium carbonate filler.

(c)(i) The boiling point of water was well known but a small proportion of candidates omitted the C for Celsius. A few strange figures such as 95 and 10 were seen.

(ii) About two thirds of the candidates ignored the word 'chemical' in the question and opted for the boiling point being 100°C. 'Use pH paper' was another common example which was not accepted. Many candidates did not recognise that the reagent used has to be exactly correct e.g. anhydrous/white copper sulphate. Just turns blue is only worth one of the two marks. Some candidates failed to write the name of a compound and just referred to cobalt paper, which is insufficiently accurate to merit a mark.

(iii) This was generally correct with 'washing' and 'cleaning' as being the most popular responses.

(d) This was usually correct with C being the most common incorrect response. Response A was hardly ever seen.

(e) Few candidates gave the correct response of ethanol although ethanol + hydrogen was often seen. Carbon dioxide and water were not infrequent incorrect answers, presumably through candidates muddling this with a combustion reaction.

(f) Many candidates realised that hydrogen was released but potassium oxide often served as an incorrect answer in place of the correct potassium hydroxide. The incorrect answer potassium chloride was occasionally seen and oxygen instead of hydrogen. Candidates should also be encouraged not to put symbols in place of words in a word equation. Word equations test whether the candidate knows the name of a compound or element not whether he or she knows the formula.

Question 3

This question was generally poorly done, parts **(a)**, **(c)** and **(d)(i)** giving the candidates particular problems.

(a) Many candidates did not realise what was required or that rate involves both volume and time. About 5% of the candidates failed to write anything at all. Questions related to experimental techniques have often been a stumbling block to candidates. Candidates should be reminded that the syllabus contains a variety of statements about experimental techniques which should also be learnt for the theory examinations. Seeing how long it takes to turn limewater milky was often seen. This could not be accepted as an answer as it is so subjective. Obscuring a cross on a piece of paper was a frequent incorrect alternative. For those having a flask and gas syringe or measuring cylinder, mention of time was often missing. Many candidates also failed to distinguish between the words calculate and measure. A common incorrect answer runs along the lines 'calculate the volume of carbon dioxide' without saying how this is to be done.

(b)(i) Most candidates gained the mark for increased rate of reaction, but candidates should be careful with their English: 'increased reaction' and 'more reaction' are rather vague as answers.

(ii) Of the three rate questions, this one was least well answered. Many candidates thought that the rate increased or gave unrelated incorrect answers such as the not uncommon 'water neutralises the acid'.

(iii) Most candidates gained the mark for increased rate of reaction.

(c) Responses to this part were poor. Few candidates knew the test for calcium ions. This mirrors poor knowledge of such tests commented on in previous Examiner Reports. Electrolysis and vague statements about limewater were common. Very few candidates mentioned what happened when excess sodium hydroxide (or ammonium hydroxide) was added. The addition of acid and then sodium hydroxide was sometimes given.

(d)(i) About half the candidates obtained this mark. Common errors were to suggest that calcium reacts with carbon, that calcium was hard to extract and that calcium does not contain oxygen. Some candidates got close to the point by stating that calcium is stronger than carbon but this could not be accepted because strength is a specific property not related to reactivity.

(ii) There were many excellent diagrams with the shells carefully separated and the electrons neatly paired. A few candidates drew too many electron shells for the core and some only drew the valence shell. Candidates should be encouraged to look at the number of marks for the question and try to draw (or write) the detail appropriate for the marks available. A small number of candidates included s and p orbitals in their diagrams. These answers, if correct, were of course given credit, but it should be noted that a knowledge of sublevels is neither necessary not desirable at IGCSE Level. This is clearly stated in the syllabus.

Question 4

Most candidates performed reasonably well on this question. On average, six marks out of the ten available, being obtained. Uses of the organic compounds were very well known.

(a) Most candidates gave correct uses for the stated organic compounds. The most common errors were to suggest that ethanol was used for polymers and that ethene is a liquid solvent.

(b) All four suggestions were chosen by the candidates with the correct answer (ethanol) being seen most often. Methane and bitumen were the most common incorrect responses.

(c)(i) Of the four parts of **(c)**, this was least well done. B was often chosen as an example of fermentation. It seems that many candidates do not revise 'ethanol' – see also comments on **Question 2 (e)** above.

(ii) Most candidates recognised polymerisation.

(iii) Most candidates recognised combustion, even when they had chosen this incorrectly as an example of fermentation in part **(i)**.

(iv) This was not particularly well done. Many candidates chose A or C as an answer.

(d)(i) Many candidates failed to gain the mark here through vague answers. Exactitude is required here: an answer such as 'it contains carbon and hydrogen' is not sufficient because, for example, ethanol also contains carbon and hydrogen. The word 'only' in the answer is vital here.

(ii) About a third of the candidates correctly quoted the general formula. A few candidates failed, however, to include "+2" in their general formula suggested. There is a problem which is linguistic rather than scientific that should be drawn to the candidates' attention. It was not uncommon for candidates to state that 'an alkane has a single bond'. They should be encouraged to state that an alkane has only single bonds (in the plural).

Question 5

This was the highest scoring question on the paper with many candidates obtaining more than nine of the 12 marks available. Parts **(c)** and **(g)** produced the greatest number of errors.

(a) About 10% of the candidates did not respond to the instruction 'increasing' (order) and gave answers in decreasing order. Some candidates muddled up the order of iodine and chlorine.

(b) This was less well done than part **(a)**. Some candidates merely repeated the order they had written correctly in part **(a)**. Candidates should be encouraged to look at the key in the Periodic Table if they are unsure which number to use.

(c) Although **(a)** and **(b)** were often correct, the reason for the difference in the order of atomic number and relative atomic mass was not understood by many candidates. The first box was often ticked, indicating that candidates mistake neutrons for protons.

(d) Although nearly all the candidates could identify a halogen, a considerable number of candidates wrote down only one or two of the halogens and hence forfeited the mark. The question, 'which elements are in the same group?' must indicate that more than one element is required.

(e)(i) Some candidates inexplicably gave argon as an answer for part **(i)** and potassium as an answer for part **(ii)**. Part **(i)** was less well done than part **(ii)**, iodine and chlorine often being given as answers. Such answers can only be explained by the idea that candidates are thinking of charges or number of electrons to complete the valency shell rather than number of electrons in the valency shell.

(ii) This part was more often correct than not, with chlorine and iodine again being the incorrectly given by a number of candidates.

(f) Most candidates scored one of the two marks, usually for the 4th suggestion. Some candidates only ticked one box.

(g)(i) This was generally well answered, although a few candidates put 'low' or gave figures such as 100°C or 35°C. Some candidates responded with the answer 'higher'. This was not adjudged acceptable because, if they are (incorrectly) comparing it with chlorine, it is not clear how much higher the value is. For example it might only be a few degrees higher.

(ii) Many candidates wrote the correct, 'good' or 'high' conductivity. A minority of candidates obviously thought that potassium chloride was a mixture of potassium and chlorine and wrote that 'potassium' or 'chlorine' have low conductivities. This sort of answer could also arise through a confusion of the atoms (of chlorine) with the ions.

(h) The majority clearly stated the transfer of a single electron, often going on to describe charges and completed shells. Only a few candidates wrote about more than one electron being transferred or electron sharing. A small number wrote about loss or gain of the incorrect type of particle e.g. gaining or losing atoms or protons.

Question 6

In general, this was a fairly high scoring question although few candidates scored full marks. The most difficult parts from the point of view of the candidates seemed to be **(a)** and **(d)(i)**.

(a) About 60% of the candidates correctly described carbon monoxide as the name of the gas produced in the reaction. Carbon dioxide or just carbon oxide were the most common errors. The most surprising mistake was the not uncommonly seen, 'hydrogen'.

(b) Many candidates disadvantaged themselves by not referring to the iron oxide or by making blanket statements about reduction being gain of electrons. Of those who mentioned electron change, about half suggested incorrectly that electrons were lost from the iron. Another common vagary was to suggest that iron oxide gained electrons. A statement such as this does not make it clear which part of the iron oxide, the iron or the oxide is gaining electrons.

(c) Most candidates obtained the correct answer. The most common error was to attempt to balance the number of carbon atoms with a 2 rather than a 3.

(d)(i) There were very few correct answers to this part. The most common incorrect responses involved making slag, making the iron molten or making the reaction faster. Where oxidation was mentioned, many candidates thought incorrectly that it was the iron that was being oxidised rather than the impurities.

(ii) The correct answer 'exothermic' was almost invariably supplied by most candidates.

(iii) Most candidates realised that the slag floated on top of the molten steel, but some referred to the thickness of the layer or the colour of the shading (grey rather than white).

(iv) Although the correct answer of 'calcium oxide' was chosen by many candidates, there was no pattern to the incorrect responses, the other 3 being chosen equally.

(v) Most candidates chose strength or resistance to corrosion. A few candidates used the word 'corrosive' in place of corrosion. Candidates should realise the distinction. This has been commented on in previous Examiners Reports.

(e) About 60% of candidates scored at least two of the three marks available for the distinctive properties of transition elements. However, a considerable number wrote about general metallic properties rather than focusing on distinctive properties as requested. Compared with previous years, fewer candidates opted for linguistically (and scientifically) incorrect answers such as transition elements are highly coloured.

(f) Only about half the candidates obtained this mark. Incorrect answers included 'combination metals', 'metal compounds', 'transition metals' and ores.

Paper 0620/03

Paper 3 (Extended)

General comments

The perennial comment about the entry is even more pertinent to the paper this year than in previous years. There still exists a cohort for whom this paper presents an unrealistic challenge, their level of attainment is so low, less than 10 marks, it is not unreasonable to suppose that they derived little benefit from studying and sitting Paper 3. They would have been better served by studying for Paper 2, the idea that this denies them access to the higher grades is purely of hypothetical interest.

The following advice could be offered to candidates preparing for future papers. None of it is new, all these points have been mentioned in previous reports.

- Always show your working in calculations, do not just give the answer. It is possible to be awarded marks even though a mistake has been made-provided the Examiner can follow the method.
- Warn candidates about illegible handwriting and excessively untidy work. If it cannot be read, it cannot be marked.
- Delete unwanted work clearly, then repeat the corrected answer in a suitable space. If this is on a different page, include a reference to it by the deleted work.
- Do not offer more answers than is required by the question. If the question asks for two uses, think and give two. Do not immediately offer two then think and add a third.
- In a similar vein be careful about qualifying an answer, on many occasions the additional comment has invalidated the original and correct first answer.
- There is considerable evidence that some candidate's preparation for this examination has been woefully inadequate. The facts must be learnt and the skills practised and mastered.

Comments on specific questions

Question 1

(a)(i) The essential idea was that batteries are portable. Mobile was not accepted. Many stated that they are small, light but did not add – easy to carry.

(ii) The other chemical is oxygen or air. A whole range of petroleum-based fuels was offered – petrol, diesel and, particularly popular, kerosene.

(b)(i) They both have four outer valency electrons and need to share four more to complete energy level. These were the necessary marking points. The second mark proved more elusive than the first. Candidates wrote that they have a valency of four or they can form four bonds, neither of which was awarded the mark

(ii) The following predictions were accepted.

- hard
- brittle
- high melting boiling point
- poor conductor of electricity or semi-conductor

The following were not.

- insoluble in water
- tough
- any comment about appearance
- high density
- not malleable

(iii) The elements that were accepted were germanium and, rather generously, carbon. Diamond was mentioned in the question and graphite has entirely different properties. Other suggestions that did not merit the mark were B, P, Fe, Sn and Pb.

(c)(i) Almost 100% correct.

(ii) The simplest explanation is that oxygen was lost. A decrease in oxidation number also gained the mark but not that silicon(IV) oxide accepted electrons unless this was accompanied by a valid explanation- which is difficult, it is not an appropriate explanation for a covalent macromolecule.

(iii) The required points, either as a diagram or as statements, were:

- 4 oxygen atoms around 1 silicon atom
- 2 silicon atoms around 1 oxygen
- tetrahedral

Most found the diagram difficult to draw and future candidates should be advised to practise it. The award of all three marks was rare, usually the 2 silicon atoms around one oxygen was omitted. Many assigned a carbon dioxide type structure to silicon(IV) oxide, others included carbon instead of silicon.

Question 2

(a)(i) The countries that were deemed to have sulphur beds were USA or Texas, Poland, Mexico, Japan, Ethiopia, Australia and Italy. In the ground, in sulphur beds, by the Frasch Process did not gain the mark.

Other sources of sulphur are petroleum, natural gas, metal sulphides and volcanoes. Coal does contain sulphur but it is just removed rather than recovered.

(ii) An extensive number of uses were encountered and were awarded the mark. This part question was well answered. A selection of uses are preserving food, bleaching silk and wool, sterilising, fumigation, disinfecting, making paper, bleaching wood pulp, making wine or jam, making dyes.

Sulphur dioxide is not used to make wood pulp, it is used to bleach it as part of the manufacture of paper.

(iii) Sulphur is burnt in air to make sulphur dioxide. Molten sulphur is sprayed into the furnace. Many omitted the "burn" and wrote sulphur reacts with oxygen.

(iv) Most knew that the catalyst is vanadium(V) oxide. The correct oxidation state was not necessary.

(v) An increase in temperature increases the rate but reduces the yield of sulphur trioxide because the position of equilibrium moves to the left. Many good answers. Most candidates then defined a catalyst without the necessary idea that it only increases the rate, it does not affect the position of equilibrium.

A popular misconception was that a catalyst preferentially increases the rate of the forward reaction.

(vi) The word equation is: sulphur trioxide + sulphuric acid = oleum

A correct symbol equation was accepted. The most common error was to include water rather than sulphuric acid.

(vii) The majority wrote the equation as: $H_2S_2O_7 + H_2O = H_2SO_4$

It was not balanced.

(b)(i) Virtually every one knew that potassium was the third element. A few offered magnesium but this is not one of the NPK trio.

(ii) There was not the same consensus on ammonium sulphate as the nitrogen-containing fertiliser. Incorrect answers were nitrogen sulphate, ammonium nitrate, NPK and the incorrect formula for ammonium sulphate NH_4SO_4.

(iii) $Ca_3(PO_4)_2$ and $Ca(H_2PO_4)_2$ were usually correct.

(iv) The only acceptable responses were-it accepts a proton for two marks or it accepts hydrogen ions for one mark. Most simply wrote that it (the base) neutralised the acid and formed a salt.

Question 3

(a) It was essential that the idea of dissolved in water or as a solution in water was given. "Soluble" did not suffice, this means that it can be dissolved not that it is. Most wrote "aqueous" without any additional comment. Liquid and gas were universally known, a well answered part question.

(b) The diagram had to show 6 electrons in the bond between two nitrogen atoms and 2 electrons on each nitrogen atom. Candidates often gave one atom of nitrogen or compounds of nitrogen such as ammonia. A common error was to omit the two non-bonding pairs.

(c)(i) The reaction rate decreases or the reaction stops. A very common error was to describe how the volume changed rather than the rate - it increased at first then levelled off.

(ii) To be gain both marks the explanation had to include the concept of concentration decreasing or of fewer effective collisions. Other correct explanations were given only one mark, for example – the organic compound was used up. There was a tendency to discuss how the rate varied, not why it varied.

(iii) The sketched graph had to show a greater initial slope and the same final volume of nitrogen. It was the second marking point that proved the more difficult, the majority of candidates wrongly thought that the final volume would be greater.

(iv) Almost unanimous agreement that powdered copper was more effective as a catalyst because it had a greater surface area than a piece of copper.

A small minority stated that the reaction goes faster but not why.

Question 4

(a)(i) The usual choice of a soluble zinc salt was the chloride or the sulphate and then the corresponding sodium salt was the missing product.

If hydroxide or oxide was given then no marks were awarded as the reaction requires a soluble salt.

(ii) Typical errors were:

- not balanced
- valency of lead thought to be four hence $PbCl_4$
- Na_2NO_3 instead of $NaNO_3$

(iii) The correct equation is:

$Ag^+ + Cl^- = AgCl$

Very few good answers, incorrect charges, Ag^{2+}, plenty of incorrect spectator ions, ion pairs rather than separate ions and molecular equations.

(b)(i) $Fe^{3+} + 3OH^- = Fe(OH)_3$

To complete this equation proved to be a challenge. The most frequent errors are shown below.

$Fe^{3+} + OH^- = Fe(OH)_3$
$Fe^{3+} + 3OH^- = FeOH_3$
$Fe^{3+} + 3OH^- = Fe(OH)^-_3$
$Fe^{3+} + 2OH^- = Fe(OH)_2$

(ii) Most candidates gained one mark for drawing the graph for iron(II) chloride with the same shape as for iron(III) chloride but only the most able realised that the maximum should be at $8cm^3$ for the iron(II) salt. The height of the precipitate was not a crucial factor.

(iii) The graph for an aluminium salt reaches a maximum then height of precipitate decreases and the graph slopes down to x axis or comes to zero. The reason is that aluminium hydroxide dissolves in excess or that it is amphoteric. Almost the entire entry thought the height of the precipitate was the significant difference and that the reason lay in reactivities. This proved to be very difficult question.

Question 5

(a) There had to be three different uses, each of the uses depending on one of the three structural characteristics. The mistakes were to give a property and not a use, for example - malleable instead of copper pipes. Another shortcoming was to quote the same use twice, the most common example was to suggest wires.

(b)(i) The equation was:

$Cu^{2+} + 2e = Cu$

Good standards of answers, a few gave the equation for the discharge of the hydrogen ion.

(ii) The gas is oxygen. The reason why the solution changes from blue to colourless is that aqueous copper(II) sulphate changes to sulphuric acid or that copper ions are removed from solution. There were some very good answers that included comments of the type as follows:

- copper ions are reduced to copper at the cathode
- blue copper ions are discharged at the cathode
- copper ions are replaced by hydrogen ions
- oxygen from the hydroxide ions

The commonest mistakes were to believe that the gas was hydrogen or carbon dioxide or even sulphur dioxide and that anhydrous copper sulphate was formed as electrolysis used up all the water.

(c)(i) The word equation is: copper atoms - electrons = copper ions

A correct symbol equation was accepted and many gained the mark by this route. The obvious mistakes were to give the equation for the discharge of a copper ion or to have added, rather than subtracted, the electrons to copper atoms.

(ii) There were some very pleasing answers that included valid comments of the type:

- concentration of copper ions does not change
- amount or number of copper ions does not change
- copper is transferred from anode to cathode
- copper ions removed at cathode are replaced from anode
- the electrolyte is just the medium for the transfer of copper

(iii) A well answered question - refining copper or electroplating with copper were the expected uses. The major difficulty was that candidates did not appreciate the significance of the phrase "this electrolysis", the use had to relate to copper. Purifying metals, extraction of aluminium and extraction of metals were not accepted.

Question 6

(a)(i) This question was well answered by the complete range of candidates, even those candidates who found other parts of this paper difficult were able to draw the correct structure.

(ii) Another well answered question, most giving one of the correct answers - glucose or maltose. The latter was allowed and it became obvious that some candidates knew that the enzyme hydrolysis of starch gave maltose not glucose therefore it was not unreasonable for them to believe that maltose could be the monomer.

A simple sugar-did not gain the mark.

(iii) Macromolecules seems to be a popular topic, there were very many pleasing answers of the type – polyacrylamide is formed by addition polymerisation, the polymer being the only product and starch is formed by condensation polymerisation, the products being the polymer and water.

(b)(i) The test is - heat with sodium hydroxide and then test for ammonia with damp red litmus paper. By far the most frequent error was to add sodium hydroxide and aluminium, the test for the nitrate ion.

(ii) Measure the pH and then comment that it is more than 1 and less than 7 or give a correct colour. These were the routes by which most candidates gained two marks. An alternative way was to discuss the rate of reaction with magnesium or calcium carbonate. The fallacy still remains that it would require less sodium hydroxide to neutralise a weak acid than the same volume and concentration of a stronger acid.

(c)(i) Ethyl acrylate is the correct name but ethyl propanoate was frequently given instead. Either ester or alkene was acceptable as the type of compound.

(ii) It was essential to state brown/orange/yellow to colourless. Clear was not credited with the mark neither was red as the colour of bromine. Generally well answered.

The mistakes in writing the formula of the product were:

- both bromine atoms on the same carbon atom
- to give the bromination product of the ester and not of the acid
- to write the formula of dibromoethane

Question 7

(a) Very poorly answered, on many scripts the comment was - the mass of the substance divided by its relative molecular mass. The standard definition is:

A mole of a substance is the amount of that substance that contains the same number of particles (atoms, ions or molecules) as there are atoms of ^{12}C in 12.000g of ^{12}C. Other definitions are acceptable.

A mole contains Avogadro's Number of particles

The formula mass in grams

A mole contains 6 x 10^{23} particles

A mole contains 6 x 10^{23} atoms, ions or molecules

A particular problem was that the definitions given were confined to atoms and not the full range of elementary entities or particles.

(b)(i) moles of Mg = 3/24 = 0.125

moles of CH_3COOH = 12/60 = 0.200

magnesium is in excess

OR 3.0g of magnesium react with 15g of acid

only 12.0 g of acid present

magnesium is in excess

Errors:

moles of CH_3COOH = 12/120 = 0.100

therefore acid in excess

0.2 > 0.125

therefore acid in excess

(ii) moles of H_2 = 0.1

Error

To bring forward the wrong number of moles from **(i)** or to ignore **(i)** and state 1.0 moles.

(iii) volume of hydrogen = 0.1 x 24
= 2.4 dm^3

(c)(i) moles of NaOH = 25/1000 x 0.4 = 0.01

Error

Not to change the volume into dm^3

(ii) moles of acid = 0.01/2 = 0.005

(iii) concentration of acid = 0.005 x 1000/20
= 0.25 mol/dm^3

For these calculations the entry is polarised, one half seems to be completely unfamiliar with this type of question and there is no purpose or pattern to their attempts. They tend to include whole numbers in the vain hope of being awarded error carried forward marks. The other half have practised this type of question and even when they make a mistake the Examiner can see the correct method and probably award partial credit.

Paper 0620/04

Coursework

General comments

It is pleasing to report that very few Centres required adjustment to their marks this year. In addition the large majority of Centres sent in well organised samples of work with all the necessary information included. The few Centres which required slight adjustments to their marks, did so usually because of the tasks set and the instruction sheets used, rather than because of the standard of work submitted by their candidates. It is sometimes the case that a Moderator suspects that candidates would be capable of producing work of the required standard but sees no evidence of that fact.

It is important that Centres choose appropriate tasks and that work sheets used do not give too much help to the candidates. Particular care should be taken when using work sheets from published resources as they often do give so much help to candidates that the higher marks are not available.

More generally can the Moderator make an appeal that mark schemes should be written so that they apply both to the particular investigation and the marking criteria in the syllabus. Too often mark schemes are simply a rewrite of the syllabus with no reference to the particular investigation or a mark scheme is specific to the investigation but bears little resemblance to the syllabus criteria.

Some problems which can make an assessment more difficult are listed in the next section.

Comments on specific questions

Skill C 1

Using an investigation where there is no opportunity for the candidate to make a decision as to which of two or more actions to take as a result of an observation or measurement. This aspect of the skill must be demonstrated and included in the marking scheme if 6 marks are to be awarded.

Attempting to assess **Skill C1** in an exercise assessing **Skill C4**. Candidates cannot both follow the teachers instructions and write their own.

No written evidence from candidates is required for **Skill C1** but it is helpful if a tick list, showing how the marks were awarded to each candidate, is included.

Skill C2

Using a work sheet which provides a table or spaces for a candidate to record their results and observations. One aspect of this skill is recording the observations appropriately. If they are given the format their marks are severely curtailed however good their observations are.

Care should also be taken not to make the tasks too trivial, taking one or two reading from a digital balance does not constitute a sufficiently difficult task, nor does observing a single colour change.

Skill C3

Here again the main problem is usually too much help in the work sheet. If grid lines with labelled axes are given for a graph or even if they are told what to plot on which axis, higher marks are not available. Equally, doing a calculation in response to a series of prompts where the calculation is broken down into a number of easy steps cannot gain full marks.

Skill C4

It is particularly important to choose an investigation where there are a number of variables to control, otherwise candidates cannot be given credit for controlling them. For example, planning and executing a titration exercise is unlikely to gain many marks.

It is also necessary for candidates to carry out the planned investigation and for them to evaluate and suggest improvements. Without this step full marks cannot be achieved.

Paper 0620/05
Practical Test

General comments

The vast majority of candidates successfully attempted both questions. A minority of Centres did not include Supervisor's results for the questions. Candidates' work is marked using these results as conditions vary from Centre to Centre.

Comments on specific questions

Question 1

The tables for *Experiments 1* and *2* were often correctly completed. The fact that some candidates added **A** and **B** to the acid at different rates was taken into account. Essentially *Experiment 1* involved the temperature rising and in *Experiment 2* decreasing.

(a) The graph was generally well plotted but a significant number of candidates misread the scales. Smooth line graphs were rare – most were joined up 'medical charts'. Most graphs were correctly labelled.

(b)(i) A significant number of candidates could not work out the scale for 2 minutes 15 seconds.

(ii) A good discriminator. Some candidates got the answers the wrong way round.

(c) Observations were often correct but some referred to temperature change despite the instruction.

(d) A good discriminator. The more able candidates were able to refer to carbonate/hydrogen carbonate and the effervescence with dilute acid. Vague answers such as base, metal oxide were prevalent.

(e) A significant number of candidates were unable to understand that as the reaction had finished the temperatures would return to the starting/room temperature. Many had very high and small values for the final temperature.

Question 2

(a) Reference to colour was required.

(c) Generally well answered. A minority of candidates still refer to cloudy instead of white precipitate in **(i)**. A number of candidates incorrectly recorded the bleaching of indicator paper in **(iii)**. A large number of candidates failed to give the pH value in **(iv)**.

(d) Common incorrect answers were ammonium and zinc/aluminium.

(e) Chlorine was a common incorrect answer.

(f) A good discriminator. More able candidates deduced that the filtrate was calcium hydroxide solution and that carbon dioxide had turned it milky etc.

(g) Nitrate was commonly identified but carbonate was often given. This was because some candidates think limewater is calcium carbonate.

Paper 0620/06

Alternative to Practical

General comments

All parts of the paper were accessible. The vast majority of candidates attempted all of the questions. Some very high marks were seen, and few very low marks.

Comments on specific questions

Question 1

(a) Most candidates called **C** a 'dropper'. A small minority gave the answers in the wrong order.

(b) Most candidates got the surface area mark, many did not explain why this was needed.

(c)(d) Generally well answered but varied from Centre to Centre.

Question 2

(a) Most candidates got this mark, but some candidates referred to all four tubes.

(b) Some candidates simply repeated the answer to **(a)** and did not give an explanation. Those who got **(a)** wrong were unlikely to pick the marks up here. A worrying number of candidates think that rust is caused only by oxygen or water.

Question 3

(a) Many did not give the obvious 'bulb lights up' answer. Some even said 'the bulb does not light up'. Those who went for observations in the tube often went for 'lead made at the cathode' – and so did not get the mark.

(b)(i) Most candidates got this right, although some bizarre electrode materials, including a range of insulators were seen.

(ii) It was not uncommon for candidates to miss this question out.

(c) Most candidates got this right, although 'bromine oxide' was seen a few times.

(d) While most candidates realised something toxic was being used/made, others ignored the diagram and opted for 'harmful'. Some candidates think fume cupboards keep the air away from the reaction!

Question 4

A small minority of candidates missed out the readings. Most got full marks here. Those who made a slip should have spotted a problem when they plotted the graph – but they did not!

(a) Graphs were generally good. Nearly all were labelled. Most candidates had no problem with the scale (but see **(b)(i)**). Lines were fair, but some Centres had a lot of 'join the dots with a ruler' graphs.

(b)(i) Some problems were evident in reading the scales (despite not having a problem with plotting the points).

(ii) Mostly correct, but some had these the wrong way round.

(c) One of the most infrequently gained marks on the paper. Most ignored the reference to 'effervescence' and 'compound' on page 5, and so could not get the marks.

(d) Most got this right.

Question 5

(a)(i) No real problems, but some contradictions 'white ppt dissolves. . . . . .insoluble in excess'.

(ii) Some random guesses here, rather than Centre specific.

(b) A worrying number gave the name of a substance that is not gas.

(c) A large number of candidates think limewater IS calcium carbonate.

(d) Nitrate was seen more often than hydroxide. Carbonate was a frequent wrong answer. Some candidates seemed to ignore what they said in **(c)** and so got this wrong.

Question 6

(a) As in **Question 3 (b)(ii)**, some candidates missed this part of the question.

(b) Colour change was rarely fully correct, blue was often seen, as were the two correct answers the wrong way round

(c) Most knew the ice was to cool something, but few knew what. Gas, liquid, and copper oxide were common answers.

Question 7

In all parts of this question, some candidates could not cope with the idea that one of the substances would not do anything, and so made up strange results. This question was a good discriminator.

(a) Some interesting tests were seen. A few had the anhydrous copper sulphate colours the wrong way round or mixed up with anhydrous cobalt chloride. Bromine water was often wrongly used.

(b) Often the sulphate ion test was given – these candidates sometimes stated that both substances would give a 'white ppt' – they seem to have missed the point of the question.

(c) A common misconception seems to be that nitric acid is a weak acid – or even that it is an alkali!

Question 8

Some candidates seemed determined to use all of the apparatus, and so heated things with spills, filtered distilled water at the start or in one case put it all in the beaker and heated it up!

Most common mark missed was to check the gas produced was oxygen. Some ignored the question and insisted the gas made was hydrogen!