CHEMISTRY

Paper 0620/01

Multiple Choice

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

General comments

The candidates for this paper achieved a mean mark of 31.4 with a standard deviation of 6.4. While satisfactory, the relatively high mean had the effect that marks were skewed towards the top end. The paper is intended to discriminate between candidates aiming for a Grade G to C but current practice is for all candidates to offer the paper. The more able candidates found some of the questions rather easy - hence the relatively high mean. However, as the statistics of the individual questions show, it would not be readily possible to increase the overall difficulty of the paper without making it too hard and less discriminating for the intended target group of candidates.

This being so, the comments below on the individual questions tend to focus on the performance of the Grade G to C candidates.

Comments on specific questions

Question 3

This proved to be relatively hard even for the more able candidates although it discriminated well. The proportions of candidates attracted by responses **A** and **C** were low.

Question 4

This also proved to be quite hard but with good discrimination. The popularity of response **C** seems a little surprising because it is 'the wrong way round': it is the water that freezes at 0 °C with the salt solution freezing at a lower temperature.

Questions 5, **6** and **7** were found easy by all candidates, indicating that candidates well understand the relevant topics.

Question 10

This was quite easy for the more able but response **D** proved attractive for the less able. This suggests that such candidates do not readily understand oxidation number terminology.

Question 11

This calls for a similar comment, i.e. easy for the more able but much more difficult for the less able. Two thirds of the latter chose **C**, indicating that they do not realise that hydrogen has diatomic molecules.

Question 15

This was quite hard overall but had a very high discrimination, indicating that only the most able coped with it. The popularity of response **C** amongst the less able suggests that they do not readily distinguish between exothermicity and the use of external heating of a reaction.

Question 25

This was another question that less able candidates found rather demanding. About a quarter of such candidates chose either **A** or **B** i.e. about half overall, suggesting either simple lack of knowledge or difficulty with the concept of activity series.

Question 26

This did not deceive the more able but response **A** attracted 40% of the less able. They apparently overlooked the fact that if **X** is a catalyst, then it is not used up in the reaction.

Question 27

This seems to be an easy question for these 'whole-subject-Chemistry' candidates.

Question 31

Response **B** was somewhat popular with the less able. Did such candidates confuse "nuclear" with "nucleic acid"?

Question 32

As many as a third of the less able candidates chose **D**. There does not seem to be a ready explanation for this!

Question 34

Some 40% of the less able chose **D**. This seems to be the only example where lack of care in reading the question might be the explanation, namely that if 'acid rain' is mentioned, sulphur dioxide has to be the answer!

Question 36

Response **C** was the most popular wrong choice amongst the less able.

Paper 0620/02

Paper 2 (Core)

General comments

In general most candidates tackled the paper well and there were many good answers showing a thorough grasp of the subject matter. Many candidates scored over three-quarters of the marks available. In general, the rubric was generally well interpreted and few candidates misinterpreted the instructions. Atomic and molecular structure, as in previous years, was generally well known even with low scoring candidates. There were a few instances in this particular paper where candidates disadvantaged themselves by giving multiple answers and it is encouraging to note that most candidates confined themselves to a single answer when requested. As commented on in previous reports, some candidates had difficulty in explaining the meaning of some chemical terms e.g. 'fuel'. It was encouraging to note that the majority of candidates were able to write correct formulae in the appropriate places and showed a good ability at balancing equations.

Candidates still appear to have difficulty in answering questions based on environmental problems associated with Chemistry, correctly e.g. **Question 4**. In the minds of many candidates, global warming and acid rain often seem to be indiscriminate answers for any environmental problem and unrelated to any particular pollutants. The quality of the answers to questions on organic Chemistry appears to be improving and more candidates seem to be able to write the full displayed/graphical formula of organic compounds. A significant minority of candidates, however, are still not drawing the bonds within the functional group.

Questions of a more generalised nature, requiring a greater freedom of response, such as **Questions 3 (b)(ii)** and **6 (a)** still pose a problem for some candidates. Many tended to respond rather vaguely. It should be noted that the number of marks usually equates to the number of specific points required in the mark scheme. Most candidates attempted every part of each question and the standard of English was generally good, most candidates answering in whole sentences where required.

Comments on specific questions

Question 1

This was generally a high scoring question, with most candidates scoring at least three-quarters of the marks available. The electronic structure of the chlorine molecule posed most problems. It appears that most candidates are able to reproduce the electron arrangement for single atoms but the concept of pairing up the electrons in a molecule caused problems for a minority.

(a) Most candidates obtained full marks on this part and the test for oxygen was well known, although a few gave the test for hydrogen. Some candidates suggested that the moist litmus paper in the chlorine test turned red and did not mention bleaching. The limewater test for carbon dioxide was well known although a small minority of candidates just referred to 'water' rather than lime water.

(b)(i) Practically all candidates recognised nitrogen as being the commonest gas in the air.

(ii) This was generally answered correctly. C was the commonest incorrect response – a few candidates, obviously believing that carbon dioxide was present in the air at a concentration of 1%.

(iii) Carbon dioxide was almost invariably correctly given as the product of respiration, the most common error being to replace this with oxygen.

(c)(i) The electronic structure of a chlorine atom was very well known, the most common error in this part being to put too many inner shells.

(ii) This was the least well answered part of this question, some candidates just repeating their answers to part **(i)** by drawing a chlorine atom or putting double the number of electrons in the outer shell of a single atom. A few candidates did not show the bonding pair joining the atoms with sufficient care. They must be put on the overlap or the join of the circles.

(d)(i) This was generally answered well, but a few candidates put an answer 'low' for this part and 'high' for part **(ii)**. It should be noted that comparisons are not accepted. An answer such as 'higher than hydrogen' could refer to only a few degrees higher.

(ii) The same comments as for part **(i)** are relevant here. In addition, some candidates gave the incorrect answer as high for both parts.

(iii) This was the least well answered of part **(d)**, with the incorrect responses 'poor conductor' or 'not a very good conductor' being not infrequently seen.

Question 2

The first sections of this question were well answered but the last parts were not and it proved a good discriminator in terms of part **(f)**. When describing the particulate nature of matter, candidates should be encouraged to distinguish between the different phases, solid, liquid and gas, rather than writing vague statements such as 'the particles get further apart' without reference to the state.

(a)(i) Copper or zinc were almost invariably seen here. Only a minority of candidates incorrectly put aluminium as an answer.

(ii) About 80% of candidates obtained the mark here, the most common mistake was to think that aluminium was a non-metal.

(iii) The correct answer (76%) was almost universally seen, but a small minority of candidates calculated this incorrectly as 78%, even after having done the correct working.

(b) This question elicited a variety of incorrect responses and proved to be a good discriminator. Incorrect responses included vague statements such as 'combines the good properties of both elements' and the incorrect 'higher melting point'. The Examiners are looking for a particular property for the answer and candidates should be encouraged not to give boiling point or melting point answers.

(c) Response C was generally correctly given. The most common mistake was to ring B. Candidates should be encouraged to consider the stem of the question in all cases – it was clear that incorrect responses were caused by lack of attention to the ratio of 9:1 copper: zinc.

(d)(i) The oxygen molecule was generally shown, but about 10% of the candidates failed to realise that oxygen should be written diatomically in a symbol equation.

(ii) The word equation was generally completed correctly, the most common error being to replace water by hydrogen or put three elements/compounds instead of two. e.g. copper + chlorine + water. The way the lines have been written out on the question paper has been in existence for many years and candidates should realise that the two lines under each other on the left represent the name of a compound. This has been commented on in previous Examiner's Reports.

(iii) This part proved to be a good discriminator. About two-thirds of the candidates realised that acids react with bases but a large minority made vague statements about basicity or that metal oxides were basic rather than referring to the reaction as instructed by the question. There was a not uncommon misconception amongst some candidates that acid-base reactions were also redox reactions.

(e) 'Cracking' was often seen as an incorrect answer in place of distillation.

(f)(i) This part as a whole, served to differentiate many candidates and also tested their ability to answer questions with precision. Particle theory is an area about which many candidates write poorly - see also **Question 6 (a)**. Most candidates were able to explain that the particles move faster when the state changes from solid to liquid to gas but some gave very generalised answers referring to the gross state rather than particles themselves e.g. 'it evaporates by heat and becomes a gas'.

(ii) This was only answered correctly in full by about half the candidates. Many did not refer to the state and made vague statements about particles spreading out. There is clearly a distinction between the distance between particles in a solid (touching), in a liquid (slightly further apart or still touching) and in a gas (far apart). Any two of these would obtain the mark.

(iii) This was the least well answered of the particle theory questions. Many candidates do not seem to know the difference between arrangement and proximity and gave similar answers to this part to those that they gave in part **(ii)**. 'Close together' or 'moving fast' were common incorrect answers, neither of which refer to how the particles are arranged. As in part **(ii)**, many candidates referred incorrectly to the generalities of state and described the properties of solids, liquids and gases.

Question 3

(a) Most candidates scored at least 2 of the 3 marks available, the most common errors being to put 39 neutrons by summing the electrons and protons or to, surprisingly, mix up the number of neutrons and electrons i.e. 19 neutrons, 20 electrons.

(b)(i) Most candidates realised that hydrogen gas was given off in the reaction but a significant minority suggested, incorrectly, that either carbon dioxide or oxygen were evolved.

(ii) This part was generally not answered very well. Many candidates failed to refer to the practical procedures asked for and gave answers referring only to reaction rate and not to the reading of the gas volume. Many candidates failed to refer to the measurement of time as the reaction proceeds. Even fewer candidates obtained the mark for comparing the rates of reaction. It should be stressed that questions of a practical nature such as this one, require practical answers.

(iii) Most candidates realised that the rate of reaction of alkali metals increased down the group.

(c)(i) The reaction of an acid with an alkali was poorly known, common errors being to class this reaction as a displacement or redox reaction.

(ii) Although a large proportion of the candidates gave the correct answer (base), a significant minority incorrectly ringed the 'acid' option. The incorrect response 'salt' was less frequently seen.

(iii) The properties of ammonia were not always well known. Although most candidates realised that ammonia was an alkaline gas, fewer realised that it formed ammonium salts. Strangely, the most common incorrect response was to tick the first box when the fourth had been ticked. This must indicate that many candidates commonly muddle up the colour change of litmus in acid and alkaline conditions, a fact which has been noted in previous Examiner's Reports.

Question 4

This question proved to be a good discriminator, with the environmental aspects being poorly answered by many candidates. This has been commented on in the last two Examiner's Reports.

(a) Few candidates appreciated what a fuel was. Many candidates gave vague answers relating to 'making engines work' or 'heating things'. A good number of candidates commented on the energy aspects of fuels but failed to put it in the context of burning them to release the energy. A typical response such as 'heating to release energy' failed to score the mark due to inexactitude.

(b)(i) A minority of candidates realised that glucose is involved in fermentation. Candidates should be reminded that the use of formulae in word equations is not given credit.

(ii) As in previous years, the definition of enzymes as 'biological catalysts' was known by about half the candidates. Common misconceptions include the idea that enzymes are actually living things rather than discrete molecules. Many candidates failed to gain the mark by just referring to enzymes 'breaking down large molecules into small ones', a statement which fails to address the catalytic aspect. Although not on the syllabus, it would be useful for candidates to be aware that enzymes are also involved in synthesis as well as breakdown.

(c) Although many candidates gave the correct answer 'distillation', a significant minority, just mentioned heating or evaporation without any suggestion of condensation.

(d) This was poorly answered by the majority of candidates, few of them obtaining both marks. The most common error was to suggest that alcohol did not cause any pollution, which is clearly incorrect, since carbon dioxide is still given off. Similarly, answers involving lack of nitrogen dioxide or carbon monoxide emissions can hardly be sustained because nitrogen is still present in the air mixture and incomplete combustion can still occur in the car engine. Arguments based on cost are not necessary effective, since the cost of distillation is often above that of refining and depends on a number of other factors as well.

(e) A wide variety of fuels were suggested and a number of reasonable suggestions were accepted. However answers such as 'coal' or 'wood', which were not uncommonly seen, indicated that the candidates did not always read the question properly.

(f) As in many previous examinations, the candidates' knowledge of the causes of global warming, acid rain and the destruction of the ozone layer seem to be muddled and confused. Very often, the answers given were vague e.g. 'destroys our environment' or 'kills plants'. Candidates should be encouraged to write specific effects for pollutants. The effect of lead compounds was often not known and many candidates stated, incorrectly, that they were responsible for global warming or acid rain. Those candidates who referred to biological damage usually gave the correct answer and referred to the adverse effect on the nervous system or development of young children.

Question 5

It is encouraging to note that many more candidates are obtaining the marks on the questions involving organic chemistry compared with a few years ago. This question was generally well answered, with many candidates scoring more than two-thirds of the marks available.

(a) Practically all candidates calculated the mass of ethanol correctly. (1g)

(b)(i) The displayed/geometrical formula of ethanol was often well known, the commonest mistake being to omit the bond from the functional group.

(ii) The name or formula of the functional group was well known. It should be noted that candidates are more likely to obtain the mark in such questions (posed without reference to formulae or name) if they put the formula of the functional group rather than the name, as the name could give rise to ambiguity with the homologous series.

(c) This part acted as a good discriminator. Only about a third of the candidates were able to identify correctly the carboxylic acid group and all manner of incorrect answers were given, ranging from circling the carbon ring to including the adjoining carbon to the carboxylic acid group. A significant minority of candidates seem to think, incorrectly, that the functional group always includes the adjoining carbon atom. This has been seen by Examiners in previous papers but not previously commented on.

(d) About two thirds of the candidates obtained both marks, the commonest error being to leave out the sodium. This was not the only species left out, however – many candidates omitted sulphur or oxygen or only wrote down three species. A minority of candidates telescoped the elements and wrote e.g. 'sulphate' or other compound ions.

(e)(i) Most candidates responded with the correct answer or 'addition' but a significant minority chose 'oxidation'. Few gave the other responses.

(ii) The bromine water test for unsaturation/double bonds was well known. It is encouraging to note that most candidates put the colour change from brown (or other suitable colour) to colourless and that fewer incorrect responses such as 'goes clear' are being seen by Examiners.

(iii) Most candidates understood the significance of the bromine water test.

(iv) Approximately two-thirds of the candidates obtained both marks. Most candidates realised that ethene was a covalent compound but fewer realised that it was molecular. The most common incorrect responses were giant-molecular, ionic covalent or atomic-covalent.

(v) Most candidates obtained both marks here, the most common error being to substitute 'elements' in place of the correct answer 'compounds'.

Question 6

This question was generally well answered apart from part **(a)**, where candidates often failed to describe the movement of particles in detail and often gave a too biologically orientated answer.

(a) Many candidates tried to explain diffusion by referring to osmosis. In fact many candidates actually mentioned the word osmosis. Candidates should be advised not to use terms such as particles moving from high to low concentration, since this only describes the bulk flow of the particles before and after the process. Both types of particles, the ions and the water molecules are moving. The idea of only the ions moving is incorrect. The notion of moving from high to low concentrations also suggests that all the ions move from one place to the other, rather than moving randomly to spread themselves throughout the solution. Most candidates used the word diffusion but fewer gained the mark for describing the dissolving of the potassium permanganate.

(b) This was not always attempted very well. Many candidates did not use the word for the process of evaporation or crystallisation but attempted a description of the process. Many candidates assumed that the potassium permanganate was still solid and suggested, incorrectly, that it should be filtered off.

(c) Most candidates were able to calculate the formula mass of potassium permanganate correctly the most common error being to use the atomic numbers. Answer = 158 (units not required).

(d) Practically all candidates balanced the equation correctly by placing a 2 before the potassium permanganate.

(e) The properties of the transition elements were not known by many of the candidates. Many candidates merely made a list of the general properties of all metals e.g. good conductors, malleable etc. Some candidates lost marks through not referring to the compounds when writing about colour. The answer 'transition metals/they are coloured' is clearly incorrect. A common misconception was that transition metals are unreactive.

(f)(i) It was pleasing to note that many good diagrams were drawn and at least two-thrirds of the candidates achieved full marks. Many candidates drew condensers and thermometers, although theses were not really necessary to gain the marks. Candidates should be reminded that, the apparatus they draw should not show lines across places in the apparatus which vapours need to travel through (although they were given credit if the lines represented joints). The most common error was to make the apparatus completely closed, which would clearly be a hazard. Some ingenious devices for collecting vapours were seen and given credit when appropriate.

(ii) Many candidates gained the mark for an explanation of reversible. Candidates should be advised that words in the stem of the question should not be used as an answer. Since the word reversible appears in the stem, 'a reaction which can be reversed' was not given credit. The Examiners required some idea of reactants being reformed from products or vice-versa or some idea of the reaction going both ways.

(iii) About half the candidates obtained both marks for the colour change. A minority of candidates thought that the copper sulphate went black or put the opposite colour change i.e. white to blue. Candidates should notice that for two marks, the colour before and after heating is required. The oft-seen response 'goes white' could only be credited a single mark.

Paper 0620/03
Paper 3 (Extended)

General comments

The standard of responses in **Questions 1**, **2** and **3** was significantly higher than for **Questions 4** and **5**. Candidates have not prepared all the topics in the syllabus with the same degree of thoroughness, specifically parts of **Questions 2** and **3** seemed to be well known by the majority of the candidates yet, in contrast, very few appeared to be aware of the role of the proton in acid/base chemistry or the most direct and simplest method of performing calculations involving volumes of gases.

A comment made every year is that candidates must answer the question asked on the examination paper and not a similar one of their choice. There is evidence that candidates are not always reading the question with understanding but they are responding to the stimulus of the topic and then they formulate their answer in general terms rather than address the issues required by the question. Some questions would be better answered if there had been some preliminary planning and initial thought about exactly what is needed to answer this question. This advice is particularly relevant to **Question 1 (d)**, **Question 2 (c)(iii)** and, above all, **Question 5 (a)**.

Comments on specific questions

Question 1

(a)(i) Most candidates were able to name a metal more reactive than aluminium. A minority suggested a less reactive metal, such as iron, or the non metal boron.

(ii) Generally the word equation did not pose any significant problems to the majority of the candidates. A few wrote an equation for the reaction between aluminium chloride and sodium hydroxide rather than with sodium metal.

(iii) Those who chose a monovalent metal, such as sodium, enjoyed far more success in completing the symbol equation than the candidates who suggested magnesium. This equation was more difficult to balance. They resorted to $MgCl_3$ in the hope of simplifying the balancing.

(b)(i) The correct version of this equation is:

$Al^{3+} + 3e = Al$

A multiple of this equation was a frequent and acceptable response.

$4Al^{3+} + 12e = 4Al$

The most common mistakes were as follows:

$Al = Al^{3+} + 3e$

$Al^{3+} - 3e = Al$

$Al^{3+} = Al + 3e$

$Al^{3+} + 3e = 3Al$

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

(ii) The spelling of "bauxite" was very varied but this was not critical as long as the Examiners thought that the correct name was intended. "Haematite" was a common mistake.

(iii) The first word inserted had to mean that the electrolyte was in the liquid phase – molten, fused, liquid or homogeneous. Despite the temperature being given as 900°C, water was thought to be a component of the electrolyte. The second component of the mixture is cryolite, no other answer was accepted. Many candidates felt that the oxygen came from the cryolite.

(iv) The explanation had to include the suggestion that oxygen was formed at the anode and that this reacted with carbon to give carbon dioxide.

(c) Most of the candidates could give appropriate uses of aluminium and could relate the named use to a property of the metal. The most frequent mistake in **(i)** was to give making planes or cars as the use. The ability to resist corrosion may be of some advantage but the prime reason for using aluminium in these industries is low density. Some candidates misinterpreted the question and gave uses of metals other than aluminium.

(d)(i) The reasons had to relate to the reaction between aluminium metal and hydrochloric acid. There are only two – the presence of the oxide layer and that initially the temperature might be low. The responses required for **(ii)** followed:

- temperature increase as reaction is exothermic
- removal of oxide layer and the increased exposure of the metal to the acid.

There were many pleasing answers that followed the above pattern but others tended to answer in general terms and to give all the factors that influenced rate of reaction and not to direct the comments to this specific situation. Catalysts, increase in surface area as the pieces of aluminium became smaller, pressure and activation energy, even enzymes were all included in general discourses on rates.

Question 2

(a)(i) Most were able to name a suitable raw material, the choice included limestone, marble, chalk and calcium oxide. Lime was not accepted as it could be slaked lime which is calcium hydroxide. Not infrequently the constituent elements were given – Ca, O and H.

(ii) The formula of the sulphate ion proved to be particularly difficult, SO_4^- , SO_3^- and S^{2-}. Others repeated the formula Cu^{2+} instead of giving Ca^{2+} or they assigned the calcium ion a single charge, Ca^+.

(iii) Probably due to the reinforcing influence of practical exercises, there were many pleasing descriptions of this reaction – the formation of a light blue precipitate which dissolved in excess of aqueous ammonia to give a deep blue solution. Unfortunately some of these descriptions were contradictory - the precipitate was insoluble in excess and formed a deep blue solution.

(b) There were many excellent descriptions of photosynthesis, probably due to the influence of Biology. The most frequent mistake was to miss out oxygen as one of the products.

(c)(i) Acceptable explanations were that yeast acted as a catalyst or provided enzymes. An alternative idea was that the yeast respired anaerobically and that ethanol was a waste product. The standard of answers was high.

(ii) Provided anaerobic respiration had not been mentioned in **(i)** then it was credited in this part. The other route to the marks was the oxidation of the ethanol to ethanoic acid or vinegar. The complete oxidation of ethanoic acid to carbon dioxide and water would not be a significant reaction when aqueous ethanol is exposed to oxygen at ambient temperatures.

(iii) There were three valid points, two of which would be awarded the marks.

- below 35°C the yeast would become inactive or the rate would decrease
- above 35°C the yeast or the enzymes would be denatured
- at a temperature of 35°C, the enzymes would be at their most efficient etc

Many very pleasing answers were based on the above points but some candidates simply repeated the question – the optimum temperature for the yeast is 35°C.

(d) The acid was butanoic and the alcohol was propanol. The most common errors were to reverse the names – propanoic acid and butanol or to guess and write ethanoic acid and ethanol.

Question 3

(a)(i) The standard of answers was high, many candidates gained full marks by completing the table on fats, protein and carbohydrates correctly.

(ii) Most could identify the polymers containing the same linkage as the natural products as nylon (polyamides) and terylene (polyesters). An unfortunate mistake was to omit the prefix “poly”.

(iii) A suitable test would involve either bromine, iodine or potassium manganate(VII). The following points were expected for the test using bromine:

- bromine (water)
- stays brown etc
- goes colourless or is decolorised

One of the last points was essential, the solution goes clear or the brown colour disappears were not accepted. The brown colour disappears does not inevitably imply that the liquid goes colourless; it could be replaced by another colour. The original colour of the bromine water was not always mentioned.

Incorrect reagents suggested for this test included potassium dichromate and sodium hydroxide. Some strange tests were described that involved the formation of emulsions.

(b)(i) The required response was catalytic converter, exhaust or engine were not sufficiently precise to be accepted.

(ii) The majority knew that carbon monoxide was formed by the incomplete combustion of the fuel. A prevalent misconception is the chemistry parallels that of the blast furnace – carbon dioxide is formed and reacts with carbon to form the monoxide.

(iii) The crucial idea is that the only product is water which is not a pollutant. To state that hydrogen is a clean fuel or that hydrogen is not a pollutant will not suffice. Carbon dioxide cannot be produced by the combustion of hydrogen so to state that this is formed and it is harmless is utterly wrong.

(c) Hydrogen can be manufactured from water using electrolysis, alkanes or coke. A significant proportion of the entry described laboratory reactions which produce hydrogen, particularly those involving the more reactive metals, sodium, potassium, calcium etc. These were not accepted. A popular misconception was that hydrogen could be made by the fractional distillation of water. This belief indicates that the writer has no appreciation of the differences between mixtures and compounds.

Question 4

(a)(i) Almost invariably correct.

(ii) Iodine *and* astatine were required and both featured on the majority of scripts. A few omitted astatine and others gave a list of the halogens in the hope that the correct ones would be selected by the Examiner.

(b)(i) The correct equation is :

$Cl_2 + 2Br^- = 2Cl^- + Br_2$

There were many incorrect versions of this equation and the following illustrate the usual errors.

$Cl_2 + Br^- = Cl^- + Br_2$

$Cl_2 + 2Br^- = 2Cl + Br_2$

$Cl_2 + 2Br^- = 2Cl^- + 2Br$

$Cl_2 + Br_2 = 2Cl^- + 2Br^-$

$Cl_2 + 2Br^- = Cl^{2-} + Br_2$

$Cl_2 + 2Br^- = Cl_2^- + Br_2$

(ii) The question required that the explanations had to involve electron transfer – the bromide ion was oxidised because it lost electron(s) and chlorine was the oxidising agent because it gained electrons or it accepted electrons from the bromide ion. Candidates failed to heed this advice and gave correct, but unacceptable, statements such as – chlorine is the oxidising agent because it is reduced or chlorine is more reactive than bromine.

(iii) The usual responses were ethene, an iodide or a named metal, all of which are correct. The most common incorrect suggestions were iodine, chlorine potassium manganate(VII) and potassium dichromate.

(c) Most of the diagrams were carefully drawn and accurate, the ability to construct these diagrams has improved considerably over the years. However there were some incorrect versions - PBr, PBr_3 and $P^{3+}3Br^{-}$. The other error was to omit the lone pair on the phosphorus atom.

(d)(i) The equation was usually balanced correctly.

(ii) There were some excellent answers, often models of preciseness and brevity – measure the pH using a pH meter or universal indicator, the weaker acid has the higher pH. Using the same volume and concentration of each acid add similar sized pieces of calcium carbonate, the stronger acid will give off carbon dioxide faster.

The most frequent reasons for not awarding the marks were:

- describing the difference between a strong and a weak acid in terms of dissociation but not giving any test.
- litmus can be used to measure pH.
- give details of an appropriate test but not mentioning the result.
- stating that the stronger acid would produce more of the product rather than produce it faster.
- the titre of the strong acid would be bigger than that of the weaker acid when they are both titrated against the same volume of the same aqueous base. They were confusing acid strength and concentration.
- the intensity of the colour, rather than the colour itself, of pH paper or indicator measures acidity.

(e)(i) Very rarely were protons or hydrogen ions named as the particle lost by hydrogen bromide; electron and bromide ion were far more common.

(ii) Usually some reference to redox rather than to acid/base chemistry – a frequent comment was that water is a reducing agent.

Question 5

(a) Candidates treat questions on the Kinetic Theory as an invitation to write about the theory in general terms, some even discussed solids. The difficulties in answering this type of question are compounded by an inability to formulate the appropriate concepts with clarity and succinctness. Statements of the type – in a liquid the particles are loosely packed and in a gas they are less loosely packed are virtually valueless. Similarly it is not true to state that in a gas the particles can move about whereas in a liquid they cannot. The role of intermolecular forces in the different phases was often neglected yet they are pivotal in determining the freedom of the molecules.

Happily, there were explanations of a pleasing standard:

In a liquid, the particles are close together, the intermolecular forces will not allow them to move apart. They can move in the volume of the liquid to take up the shape of the container. In a gas, the forces are much weaker and the particles can move apart in all directions to fill the container.

(b)(i) Volume and time were the only options, "amount", although common was not accepted.

(ii) Carbon dioxide scored highly as the gas that would diffuse the faster but the explanation often involved "lighter" or "smaller" or "lower mass" rather than density, relative molecular mass or speed of molecules.

(c) Only a few candidates seemed to be aware that for gases the mole ratio and the volume ratio are the same. There was a marked tendency to over complicate this question by using molar volume or attempting to change volumes into moles. Candidates confused cm^3 and dm^3.

(i) $110 cm^3$ being 2:11 therefore 20:110

(ii) $80\ cm^3$ from 2:8 therefore 20:80

(iii) $120\ cm^3$ must be 150 –110 + 80

(d) moles of butyne = 1/6

moles of water = 1/2

mass of water = 9 g

This mole/mass calculation was found to be easier than **(c)** which was based on reacting volumes. Typical errors were to give the answers 2, 6 and 108g or 6, 18 and 324 g. Instead of multiplying the moles of water by 18, the mass of one mole of water, candidates used 54, molar mass of butyne.

Paper 0620/04

Coursework

General comments

There was a significant increase in the number of Centres submitting coursework this summer compared with the same time last year. The hard work which colleagues are putting into their practical courses and the professional way in which assessments are carried out is greatly appreciated.

The general quality of both candidates' practical experiences and the interpretation and application of the syllabus criteria by colleagues were very good this year. It is noteworthy that in the majority of cases, the Moderators were able to support Teachers' judgements of marks awarded, and that in the minority, where a mark adjustment was deemed necessary, increases balanced decreases.

Marking schemes are the most important sources of evidence used by Moderators in making judgements about the procedures used in a Centre. The main and recurring causes for concern are listed below:

- misplaced skills, for example C2 skills assessed under C3 which then reduces the validity of the C3 mark awarded;
- mark schemes which produce levels of attainment on the six point scale by converting accumulated marks into levels without due regard being paid to the demands of each marking point; for example six marks awarded for success in six level two skills should not translate into level six; it remains evidence for level two and no more;
- the assessment of C1 and C4 on the same task is not considered appropriate since some of the skill descriptors are mutually exclusive;
- the award of levels 5/6 on tasks which are really too simple to allow candidates to demonstrate this degree of attainment;
- mark schemes which are simply copies of the generic criteria as published in the syllabus are of little help in the moderation process; best practice is seen from Centres who translate the syllabus criteria into the context of each task.

There was some evidence this year that in a minority of Centres, there was concern that the full mark range was difficult to cover because of the generally high calibre of candidates. There is no requirement to cover the full range. If all candidates are able then there may well be an absence of low marks. Colleagues should not worry about this and, more importantly, not mark candidates' work over-severely.

The annotation of the work in the sample is extremely helpful to Moderators. This continues to be a little variable and those colleagues who have taken the time to complete this thoroughly are thanked.

Comments on specific skills

C1

Although this does not produce written evidence from candidates, it is essential that staff produce information about how levels were awarded. A useful policy is to weight the marking of individual activities to reflect the demand of the activity. In this way a high total raw score should be obtained only by good performance on the high demand activities. The use of checklists is a common and perfectly acceptable method of managing the gathering of data to make judgements about C1. An extremely wide range of contexts is used for the assessment of C1.

C2

This Skill assesses the ability of candidates to make observations and/or measurements and to record these in a clear manner. The better schemes for C2 concentrate on tasks in which there are a great many observations or measurements to be made, some of which are subtle or require patience and skill. As for C1, marks for C2 could be weighted to reflect the demand placed on candidates. Common contexts are qualitative and quantitative analysis and simple test tube organic reactions.

C3

Physical Chemistry tasks which generate numerical data provide a useful context for the assessment of C3. This allows marking points based on data handling and evaluation of their reliability to form the backbone of the scheme. However, some Centres have developed very successful observational tasks, which require candidates to observe demonstrations and then draw conclusions from what they have seen. For higher levels, increasingly perceptive evaluation of the reliability of conclusions is required. Common contexts are kinetics, thermochemistry and electrolysis

C4

This is the most demanding skill for both candidates and Teachers, and its assessment has steadily improved in recent years. In every case, candidates are carrying out their experimental plans and this allows them the chance to evaluate the outcome. At least one of the planning exercises should allow candidates to investigate a cause and effect relationship, and common contexts are kinetics, thermochemistry and electrolysis.

Paper 0620/05
Practical Test

General comments

The majority of candidates successfully attempted both questions. The importance of Supervisors supplying results cannot be over emphasised. These results are taken into consideration when marking the scripts. A minority of Centres did not include Supervisor's results. A significant number of Centres did not include the results for **Question 2**. Some excellent scripts were seen. However some very poor scripts indicated a lack of preparation for this practical exam.

Comments on specific questions

Question 1

The observation for Experiment 2 was not completed by some candidates. Brown precipitate was a common correct answer. The table of results was generally well completed. However, some candidates confused the Final and Initial readings. A number of candidates gave the initial reading as $50cm^3$ instead of $0.0cm^3$. Readings are expected to be to 1 decimal place.

In **(a)** the majority of candidates correctly described the colour of solution **A**. However, in **(b)** instructions were often not followed and pink and orange were common incorrect answers.

In part **(c)(iii)** reference to concentration was required, the unit of volume was often absent in **(c)(iv)**. Part **(d)** discriminated well. Good candidates referred to iron(III) and linked with either the brown precipitate or oxidation. Changes to the apparatus in **(e)** often referred to more accurate apparatus or 'thinner burettes'. Reference to replacing the measuring cylinder, used to measure the iron(II) ions, by a burette or pipette was the most common correct answer.

Question 2

Solid **S** was copper(II) oxide and solid **T** was manganese(IV) oxide.

The observation discriminated well between good and weak candidates. In **(b)** reference to gas scored no credit – observations such as fizz, bubble or effervescence are required. In **(c)** the damp blue litmus test bleached for most candidates – Supervisors' results were taken into account. In **(d)** contradictory statements such as 'the precipitate dissolved to give a deep blue precipitate' or 'the precipitate was insoluble and gave a deep blue solution' were common.

In **(f)** the gas was often incorrectly identified as ammonia or chloride. Iron(II) was a common incorrect answer for **(g)**.

Paper 0620/06

Alternative to Practical

General comments

The vast majority of candidates attempted all of the questions. The paper discriminated well and a range of marks was seen. However, poor scripts were rare this year. Centres are carrying out relevant practical work to support candidates doing this written alternative to practical paper.

Comments on specific questions

Question 1

Discriminated well. Many candidates described **C** as a cylinder. Tests for carbon dioxide often involved splints.

Question 2

Generally well answered. Only the better candidates realised that the colour of the drink would interfere in **(a)(ii)**.

Question 3

In **(a)(ii)** 'To collect the gas' was a common answer. In **(b)** the cotton was often pulled when it should have been used to lower the tube into the acid. Knowledge of 'excess' in **(c)** was variable. In **(d)** smooth line graphs were rare even though this point has frequently been made in previous reports. In part **(g)** the sketch graph should have levelled out at $40cm^3$.

Question 4

Common incorrect answers to **(a)** included the dissolving of the calcium. In **(b)** collisions between molecules was frequent and reference to gas rare.

Question 5

A significant number of candidates gave the wrong values for the burette readings. In **(a)(iii)** reference to concentration and not strength was required. Part **(b)** was generally well done. Part **(c)** was poorly answered with answers lacking detail.

Question 6

The observations in **(d)** were generally known. Conclusions in **(g)** were often incorrect. Correct responses referred to catalyst, transition metal oxide and the better candidates gave manganese(IV) oxide.

Question 7

This question discriminated well. In **(a)** many answers gave a chloride test which would not have distinguished the pair. Other candidates used an indicator but referred to the alkalinity of the aqueous sodium chloride which is neutral.

Part **(b)** was generally well done. Part **(c)** answers varied from Centre to Centre. A common answer was to measure the pH.

Question 8

This question discriminated well. Poor answers involved using the sandpaper or nickel sulphate as an electrode. Molten nickel sulphate and electrodes the wrong way round were common. A lot of candidates scored maximum marks from a clear diagram.