CHEMISTRY

Paper 0620/01

Multiple Choice

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

General comments

The number of candidates was over 11 000. They achieved a mean mark of 27.5 with a standard deviation of 7.0. Together with the reliability coefficient, these parameters indicate that the paper was successful in discriminating across the ability range.

No question proved to be unduly easy and comments are made below on those few questions that were found to be relatively hard.

Comments on individual questions

Question 2

Amongst the lower-scoring candidates, response C was more than twice as popular as the key, D. This appears to be a 'reading ' issue'. They recognised that a thermometer is needed because a specific temperature is stated but they did not realise that 'a known mass' would require the use of a balance.

Question 6

Response C was the most popular amongst the lower-scoring candidates. This might also be a 'reading' issue in that insufficient notice was taken of the words "outer shell".

Question 15

For the lower-scoring candidates, response D was as popular as the key, B, although no obvious reason suggests itself.

Question 18

The overall facility was only 50%, primarily because a third of the lower-scoring candidates chose response B. However, this Q should have been a simple matter of recall.

Question 31

This was the hardest question on the paper. Overall, only a third of the candidates answered correctly and only 14% of the lower-scoring candidates did so, this being, for them, the least popular response! The point of the question is that steel has a lower percentage of carbon compared with the iron used to make it.

Question 37

Nearly half of the lower-scoring candidates chose response B, rather than the key, C. As for **Question 18**, this should have been a simple matter of recall.

CHEMISTRY

Paper 0620/02

Core Theory

General comments

Many candidates tackled this paper well and many good answers were seen, especially at the beginning of the paper. Each question, however, provided candidates with a number of pitfalls and there were few questions where candidates scored full marks. Fewer candidates left blank spaces compared with previous sessions and nearly all the candidates tackled each part of every question. A notable exception to this involved the question on a qualitative test for copper(II) ions. A significant number of candidates exhibited a less than thorough grasp of the subject matter. Some quite straightforward questions, e.g. the test for hydrogen, the products of combustion of hydrocarbons and the fractions derived from petroleum distillation, proved difficult for candidates. In general, the rubric was well interpreted but a few candidates still failed to distinguish the difference between a word equation and a symbol equation. It was encouraging to note that only a few candidates gave multiple answers to the question requiring a box to be ticked but many lost marks through giving conflicting statements in one mark questions. A significant number of candidates failed to respond to **Question 4(b)(ii)** where an additional curve should have been drawn on the axes supplied. Another mistake in reading the rubric was in **Question 1(b)(i)**, where a minority of candidates responded by inserting percentages rather than quoting a source of lead in the environment. The standard of English was generally good. Although most candidates had a good knowledge of basic chemical structures and atomic structure, many were found to have a poor knowledge of basic Inorganic Chemistry. It was encouraging to note that many candidates showed a good ability at balancing equations especially when the formulae were given. Despite the simplified way the question was asked, a considerable number of candidates appeared to have difficulty in explaining electrical conduction in ionic solutions (**Question 7(g)**. This follows the general pattern from Paper 2 in previous years. Tests for gases and ions were not particularly well known, the test for copper ions proving a stumbling block for candidates from particular Centres. Candidates often disadvantaged themselves by sloppy and non-specific writing. For example, there was often confusion about the environmental effects of acid rain or sulphur dioxide, many candidates thinking that the main effect was to cause ozone depletion or global warming. An area that should be singled out to be of particular concern was the inability of many candidates to be able to plot a graph and construct sensible axes. This is particularly important because these skills are also required for paper 6 and as specified by the mathematical requirements in the syllabus. As commented on in previous Principal Examiner Reports, few candidates were able to explain terms such as 'cracking' in a convincing way.

Comments on specific questions

Question 1

This question was well answered, the majority of candidates gaining at least seven of the marks available. Parts **(b)** and **(c)** provided candidates with most problems. Questions about environmental issues are often confused in candidates' minds.

(a) (i) Most candidates correctly identified ethane, the commonest error being to suggest methane.

(ii) This was generally well answered, the most common error being to choose F (lead).

(iii) Most candidates identified ammonia as a gas turning red litmus blue.

(iv) This was almost universally correct.

(v) Most candidates identified methane as a constituent of natural gas, although a considerable minority incorrectly chose sulphur as the answer.

(vi) B and C were generally chosen as organic compounds although a few suggested that ammonia was organic. In this and in part **(vi)** a few candidates disadvantaged themselves by only writing down one letter.

(vii) This was the least well answered of this set of questions, with combinations of A and D, C and D and B and D being frequently seen. This suggests that candidates tend to confuse elements with molecules. This has been commented on in previous Principal Examiner Reports.

(b) (i) Less than half the candidates gave a correct answer. The most common errors were to write vague answers such as ‘from factories’ or ‘burning fossil fuels’ and to give a percentage rather than a source. A few candidates gave the names of lead compounds but only a few gave the incorrect answer ‘from pencils’.

(ii) The effect of lead on health was not well known. Common errors included the suggestion that lead causes lung cancer or causes respiratory <u>disease</u>. A large number of candidates suggested that lead affected the blood pigments, muddling it up with the effect of carbon monoxide. Candidates should also be reminded that the word ‘affect’ is rather vague and can be used in a positive as well as a negative way. Candidates should be encouraged not to use this word.

(c) This part of the question was the least well done with many candidates muddling up acid rain, global warming and ozone depletion. There were many vague statements such as ‘harms the environment’ or ‘harmful’. Without further qualification, such answers cannot be awarded a mark. Many candidates seemed to think that carbon monoxide was involved and many thought that sulphur itself, rather than sulphur dioxide, was responsible for acid rain. Many candidates were content just to write ‘acid rain’ without suggesting its effect on animals or buildings. The word corrosion was also used interchangeably to mean (chemical) erosion.

Question 2

Most candidates scored fairly well on this question but it was disappointing to note the large number who failed to name the commonest gases in the air, recognise the tests for carbon dioxide and water or were unable to work out the Period which argon belongs to.

(a) Many candidates seemed to think that carbon dioxide is a gas which makes up most of the air, perhaps as a result of the present emphasis on global warming. It was disappointing to see that many candidates still think that there is a considerable proportion of hydrogen in the air!

(b) (i) About two thirds of the candidates recognised the test for carbon dioxide, the commonest errors being to suggest that limewater tested for hydrogen or chlorine.

(ii) This part was poorly done. Common incorrect answers included sodium hydroxide (the most frequently seen answer), oxygen and limewater.

(iii) It was encouraging to note that a high proportion of the candidates were able to balance the equation. The commonest error was to suggest that oxygen is monatomic.

(c) (i) This part was poorly done with a high proportion of candidates suggesting that argon belongs to Period 0. The muddling up of Groups and Periods was also reflected by candidates who wrote down ‘Group 0’ as an answer, presumably through not reading the question carefully enough. Only a few candidates suggested the incorrect answer ‘Period 2’.

(ii) About two thirds of the candidates gave one of the accepted answers, although a considerable minority suggested, incorrectly, that argon was a halogen.

(iii) It was encouraging to note that most candidates could write the correct electronic structure for argon. Common errors included giving argon the configuration 2,8, giving argon four outer electrons and giving too many electron shells.

(iv) Although a good proportion of candidates gained the mark for suggesting that argon is inert, many wrote vague or incorrect statements such as ‘cools the filament’, forms a bright light when burnt’ or ‘improves the bulb’. A common error was to suggest that argon conducts electricity.

(v) The number of neutrons in argon (22) was calculated correctly by just over half the candidates. A considerable number of candidates surprisingly left this blank.

(d) The calculation of the relative molecular mass of xenon difluoride was surprisingly badly done. Common errors included 171 (obtained by using 133 for the atomic mass of Xe), 300 (obtained by multiplying Xe by 2) and 72 (obtained by using atomic numbers). (Answer = 169)

(e) (i) Writing the formula ($XeOF_4$) provided some challenges for many candidates. Many seemed to think that the double bond meant double the amount of oxygen and gave the incorrect answer XeO_2F_4. A common mistake was to give the molecule two fluorine atoms rather than four.

(ii) Many candidates went down the road of 'double and single' bonds rather than concentrating on the two basic bond<u>ing</u> types they know. The incorrect answer 'ionic' was about half as common as the correct answer 'covalent'.

Question 3

This question proved to be one of the most demanding on the paper. Many candidates could not remember the products of burning a hydrocarbon and very few obtained full marks for stating correct fractions and uses obtained from the distillation of petroleum. Most candidates' knowledge of the cracking process was very rudimentary and less than half the candidates were able to draw the structure of ethene showing all bonds.

(a)(i) Most candidates gained the mark for balancing the equation, the commonest error being to put a two to four ratio of hydrogen to water.

(ii) Very few candidates focused on the fact that water is an abundant and renewable resource even though the stem of the question gave the necessary information. Many wrote about hydrogen burning to release energy or water being formed without mentioning the importance of the source. Many suggested that hydrogen was present in the air. This has already been commented on in relation to **Question 2(a)**.

(iii) This was almost universally correct.

(b) The number of candidates suggesting that hydrogen or carbon monoxide is formed when octane is completely burnt in air was considerable. Many candidates seem to thinks that the hydrocarbon merely breaks down to give hydrogen rather than considering the process of combustion fully.

(c) Few candidates could name two fractions obtained from petroleum and even then the uses were often not specific enough. The list of incorrect fractions included specific hydrocarbons such as butane as well as unlikely compounds such as ethanol (fairly commonly seen) and plant oils. Many candidates gave vague answers such as 'oil' (often compounded by the fact that plant oils were implied in the usage). The other common mistake was to suggest petrol as a fraction despite the fact that the stem of the question asks for **other** fractions. Many candidates were unfortunate in suggesting 'gasoline' as their chosen fraction, not realising that this is the alternative and more commonly used name for the petrol fraction. Many candidates had even less knowledge of the uses of specific fractions. The Examiners were fairly generous in their marking of the uses but many candidates failed to gain the 'use' mark because they did not mention fuel for specific modes of transport.

(d) (i) Many candidates failed to realise that cracking is specific to hydrocarbons or similar organic molecules and is not merely thermal decomposition. Some candidates even mentioned breakdown of inorganic compounds such as carbonates. A considerable minority suggested incorrectly that cracking involves distillation or separation of fractions.

(ii) The conditions needed for cracking were not well known. Some suggested that the hydrocarbons were burnt. Most candidates obtained the simple mark for 'heating' (although high temperature would have been a better description). Some candidates lost the first mark through just mentioning temperature. Candidates should be advised that the word temperature alone could be low or high and does give enough information. The same applies to the word pressure. Fewer candidates realised that a catalyst was involved.

(iii) The structure of ethane seemed less well known than in previous years. Common errors included the lack of a double bond in a C_2H_4 structure and a C_2H_6 structure but with a double bond.

Question 4

This question also proved to be one of the most demanding on the paper with few candidates gaining full marks in ***Section (b)***. Many candidates appeared to have difficulty with graph plotting and fewer understood how to draw the line to show the effect of the catalyst. Most candidates, however were able to name the salt $ZnCl_2$ and understand the function of a catalyst.

(a) (i) Most candidates were able to describe the function of a catalyst but many insisted that catalysts were enzymes. Many candidates also wrote rather vaguely about catalysts 'altering' or 'changing' the rate of reaction. On this occasion this was accepted although the preferred statement would be 'a catalyst increases the rate of reaction'.

(ii) Many candidates disadvantaged themselves by giving names of specific metals rather than the generic 'transition metals'. When specific names were given, they were often not transition metals, magnesium being a popular incorrect answer.

(b) (i) Although most candidates scored a mark for correct use of the axes, most dropped one or more marks for the plotting. Common errors included the lack of a point at zero-zero and incorrect plotting of the time at 50 and 60 minutes – this was often put at the 120 cm^3 level. A small proportion of candidates arranged the scale in units of 27, thinking that the graph continued in a straight line all the way. Consequently they plotted the 100 and 110 points incorrectly. The mark for the line was generally acceptable although there are still too many candidates joining the points up by straight lines where there should be a curve.

(ii) Many candidates seemed unsure of how to draw the line for the catalysed reaction. Many just labelled the line already present or drew horizontal or vertical lines to where the reaction finished and labelled this C. A few candidates appeared not to respond at all to this question. Many of those candidates who realised that the initial rate was faster, failed to gain the second mark because they put the final volume of gas well above the volume in the uncatalysed reaction.

(iii) Few candidates were able to explain that it was the zinc that was used up rather than the hydrochloric acid. Many merely stated that the reaction finished or incorrectly stated that 'the catalyst is used up'. Some failed to get the mark through suggesting merely that the zinc had dissolved. This was not credited since it merely implies that the zinc is still there not that it has reacted.

(c) (i) Most candidates realised that the rate was faster but a few mentioned quicker time rather than rate. The latter was not accepted.

(ii) In comparison with part **(i)** fewer candidates gained this mark. Many wrote 'decreased rate' perhaps because they did not refer back to the stem of the question in order to compare the concentrations.

(d) (i) Most candidates wrote the correct answer 'zinc chloride' although a few suggested incorrectly 'zinc hydrochloride'. A few candidates disadvantaged themselves by writing both products not just the salt.

(ii) As has been commented on above, the test for hydrogen is not always well known. Too many candidates still muddle it with the test for oxygen. It is not sufficient to put 'water formed' for the second mark since this is not an observation (not every colourless liquid is water).

Question 5

Many candidates scored about half marks on this question. The test for copper proved a stumbling block for many.

(a) Most candidates scored the mark for 'electron' although a few put 'electrolysed' or 'electrolysis'. A small proportion suggested that e- means a chloride ion or a silver ion presumably because these occurred in the stem of the question, although the former mistake has been seen in previous papers in a different context.

(b) Most candidates scored at least one of the marks here. The Examiners sensed, however, that the candidates were often thinking solely of transition metals because of the high proportion of answers which included high boiling and melting points and catalytic activity.

(c) About half the candidates recognised the correct meaning of the Roman numerals. The most popular incorrect choice seemed to be B.

(d) The test for aqueous copper(II) ions was not well known. Although many candidates realised that ammonia or sodium hydroxide were required for the test, some failed to gain the first mark because they suggested that an acid was also added. A large number suggested that the solution should be electrolysed. The colour of the precipitate was often stated to be white or yellow rather than (very) light blue. Not all candidates gaining the first two marks went on to mention the third point.

(e) Although many candidates realised that copper was used for electrical wiring, a considerable minority wrote vaguely that it was used 'for wires', 'in electrolysis' or 'as an alloy'. An answer relating to a <u>specific</u> use was expected.

Question 6

This was one of the least well answered questions on the Paper. Parts **(a)**, **(b)** and **(c)** proved to be particularly challenging for many candidates.

(a) Just over half the candidates were able to write the correct products of the reaction. Common errors included (i) bromide rather than bromine (ii) potassium chlorine (iii) chlorine bromide + potassium.

(b) A significant proportion of candidates failed to recognise that chlorine was less reactive than iodine and focused on the relative reactivities of potassium and iodine or chlorine and bromine!

(c) (i) About two-thirds of the candidates stated correctly that chlorine was a gas although a considerable minority suggested that it was a liquid. The colour of solid iodine was not well known. Many candidates were obviously thinking of iodine 'solution' when they wrote 'brown'. However 'yellow' appeared to be the most popular incorrect colour chosen by far. Candidates should be advised of the pattern in colour change in the halogens (darker down the Group).

(ii) Practically all candidates were able to suggest a correct density for bromine but the negative values for the boiling point of fluorine proved a stumbling block for many. Many did not use the two differences in the table provided to make any approximations.

(d) (i) These two parts were surprising badly done compared with responses to this sort of question in previous years. Answers of 19 were common through using the atomic mass rather than atomic number.

(ii) 'One' was a common incorrect answer here. Presumably candidates were thinking of the number of electrons needed to complete the outer shell rather than the number in the outer shell.

(e) Most candidates recognised a suitable use of chlorine. Candidates should be encouraged, however, not to suggest that chlorine is used in 'cleaning'. This is too vague a term because it suggests physical cleaning as well and does not necessarily imply chemical disinfection.

Question 7

Many candidates obtained over half the marks for this question. ***Sections (a)***, ***(f)*** and ***(g)*** were usually well answered whilst **Questions (b)**, **(d)** and **(e)(iii)** proved to be good discriminators for relatively higher grade candidates.

(a) Most candidates focused on the fact that the aluminium lies below the electrolyte. The most common incorrect answer was to suggest that the aluminium was dissolved or that it was molten.

(b) This proved to be a good discriminator. Common incorrect answers included (i) solid (ii) inert (iii) hydrocarbons.

(c) Most candidates obtained the mark here.

(d) Only about a third of the candidates explained the electrolytic reduction being related to the high reactivity of aluminium. Many suggested that it was to do with the high melting point (rather than the very high temperature required for carbon reduction of a reactive metal). A considerable proportion of candidates tried to make a link with rates of reaction.

(e) (i) Over half the candidates realised that the oxygen came from the electrolyte, although a worryingly large number suggested that it came from the air.

(ii) Practically all candidates could write the formula for carbon dioxide.

(iii) Only a few candidates were able to explain that the carbon was removed because the gas bubbles off as carbon dioxide. In order to obtain the mark here, the candidates had to demonstrate that they realised that the carbon dioxide escaped rather than a compound was formed. Many candidates merely repeated the stem of the question saying that carbon dioxide was formed. Incorrect answers often referred to dissolving or movement of ions to the opposite electrode.

(f) It was encouraging to note the number of candidates who successfully completed the calculation correctly. A common mistake was 1886.79 (obtained by $(400 \times 1000)/212$). Correct answer 530 (kg)

(g) This was well answered by the majority of candidates. Many candidates, however, are still unsure about the nature of electrical conduction in ionic solids as shown by the number of times molecules or atoms was written (instead of ions) in the second space.

CHEMISTRY

Paper 0620/03

Extended Theory

General comments

There is evidence that some candidates lost marks through not reading the question thoroughly and not considering exactly what is required to be awarded the mark(s). E.g. Differences in properties of two elements demand that both are mentioned or that there is a clear indication of comparison. In addition, when a question asks for "another", it indicates that the answer (the chemical or process) has to be different to that given in the question.

A pleasing development is that most candidates are now indicating when they have used the blank pages and want this work to be marked.

Centres should note that incorrect symbols, for example CL or na, are penalised.

Candidates should be advised of the virtue of considered and precise responses. Examiners have commented that acceptable answers have been invalidated, usually by contradiction, when candidates have elected to elaborate them.

Comments on specific questions

Question 1

(a) Both parts **(i)** and **(ii)** were well answered.

(b) (i) Generally there was a good standard of answers. A frequent problem was giving alternative names for the same product – petrol and gasoline. Naphtha was not accepted, it is a feedstock for secondary distillation or for a chemical process.

(ii) The predictable error was to give fuels, often repeating them from part **(i)**. Acceptable responses included the following – waxes, grease, lubricants, polishes, bitumen (tar, asphalt) or naphtha.

(iii) The answer had to relate to a mixture of liquids that is separated on an industrial scale by fractional distillation – liquid air, ethanol and water, mixture of alkenes formed by cracking and the noble gases. The most common mistakes were to give crude oil (probably thinking it is different to petroleum), ethanol on its own and sea water.

Question 2

The first row of the table which referred to ionic compounds was usually completed correctly. The requirement that the macromolecular compound must contain atoms of two different elements was not recognised by many candidates. Typical incorrect suggestions were diamond, graphite, nylon and polyesters. These were more common than the correct ones – silicon(IV) oxide (the alternative names - silicon oxide, silicon dioxide, silica and sand were all accepted) and silicon carbide. Polymers which contained only two elements, e.g. poly(ethene) were awarded the mark. The majority of candidates knew that liquid metals were good electrical conductors but identifying the particles present as positive ions and (delocalised) electrons was far more problematical.

Wrong answers included:

- positive and negative ions
- protons, neutrons and electrons
- positive electrons
- atoms
- particles
- molecules

Question 3

Very few candidates scored zero but relatively few were awarded full marks, typical marks were in the range 5 to 8. Selecting the correct method provided quite a challenge to most of the candidates, however many of these could name the correct reagents and write the equations. Candidates should be advised to follow the instructions in the question and specify method as A, B or C and not give their own description of the method.

Not all of the candidates seemed to be familiar with the term “reagent”. In the preparation of zinc sulphate, the reagent line was left blank but the word equation correctly included sulphuric acid.

The most difficult part was **(iii)**, many could not name the reagent. Iodine rather than a soluble iodide was a frequent error, but this was often followed by the correct ionic equation which included the iodide ion. Others did not balance the equation and were awarded only partial credit.
$Pb^{2+} + 2I^- = PbI_2$ was required for full marks.

Other errors were to give half equations or molecular equations or to think that it was lead(II) nitrate that was being prepared and stated that the reagent was nitric acid.

Question 4

(a) (i & ii) These parts were usually correct, with only a few giving BrO instead of BaO and B_2O_5 rather than B_2O_3.

(b) (i) There was confusion between S^{2-} and SO_3^{2-} or SO_4^{2-}.

(ii) The majority correctly gave Ga^{3+}.

(c) This was the best answered question on the whole paper. It would improve the style of the answer, but not the marks, if the non-bonding pair on the nitrogen atom was represented as a pair and not as two separate electrons.

(d) (i & ii) Most of the candidates were not aware of the difference between a physical and a chemical property. Correct properties were often given but not in the right part - so no marks were awarded. Another common failing was not to draw the required comparison; the mark was allocated for comparison and not for a correct statement about one element. “Vanadium is a hard metal”, a factually correct statement but no marks. “Vanadium is the harder metal” or “vanadium is hard and potassium is soft” does gain the mark. The appearance of an element is regarded as a physical property but that of a compound derived from the element is considered to be a chemical property of the element.

As a general point – high melting point and boiling point are taken as one physical property not two.

Candidates should confine their responses to that which they have been taught or can confidently predict:

- potassium more reactive
- potassium reacts with cold water, vanadium does not.
- potassium has only one oxidation state, vanadium more than one
- potassium has only one valency, vanadium more than one
- potassium forms only one ion, K^+ , vanadium forms more than one
- vanadium coloured compounds, potassium white or colourless
- vanadium and its compounds are catalysts, not potassium

"Transition metals form (coloured) complex ions, potassium does not" was noted on a number of scripts and it gained the mark.

(e)(i) Generally this part was well answered.

(ii) Once again physical and chemical properties were confused. Many answers lacked the requisite detail – "they react with metals" instead of "they react with metals to form ionic compounds". The following gives a selection of acceptable comments.

- both have valency of one
- both can react with other elements to form halides
- both are oxidants
- any correct Chemistry, e.g. they both form acidic hydrides
- both have diatomic molecules
- both accept one electron or form ion X^-
- both have seven valency electrons
- both react with non-metals to form covalent compounds
- both react with metals to form ionic compounds
- both form acidic oxides

Common mistakes were:

- compare rather than give similarities
- give reactions of the halide ions for example with Ag^+
- to think that they had one outer electron instead of seven
- toxicity - which is hardly unique to the halogens
- as previously stated the appearance of the element is not accepted as a chemical property.

Question 5

(a)(i) This was usually correct.

(ii) A few repeated "magnesium" , otherwise an appropriate choice was made from K, Na, Ca, Li, Sr Ba, that is metals which are more reactive than magnesium. Aluminium was suggested but this was not accepted. Candidates should be aware of the apparent low reactivity of aluminium due to its adherent oxide layer.

(iii) Far too many lost a mark by assuming that water had been added and only mentioned filtering. Candidates incorrectly suggested electrolysis or crystallisation as techniques which would separate the metal from the mixture.

(b) (i) Most had this part correct, thanks probably to **OILRIG**. The definition should be confined to oxidation as electron loss and comments of the type "by an atom" should not be added. This would imply that electron loss by a molecule is not oxidation. The addition is only correct if the list is complete – by an atom, ion or molecule. Either give "electron loss" or the full definition.

(ii) Most knew that the gas formed at the cathode was hydrogen.

(iii) Some ions were given - particularly hydroxide and chloride. Hydrogen was given in this part as well as in **(ii)**. Most candidates identified chlorine as one of the gases but oxygen proved a lot more elusive. Carbon dioxide and water vapour were wrongly suggested as gases formed at the anode.

(iv) There were very few correct answers based on electron transfer or redox, examples of which are:
It cannot lose electrons because…..
It receives electrons from the battery.
The rig is the cathode.
Reduction occurs at the cathode.
Oxidation, that is rusting, occurs at the anode not the cathode.
Electrons are "pushed" to rig.
Preventing it from being oxidised that is losing electrons.

The idea that oxygen is necessary for rusting and it forms on the titanium anode, not the rig, was awarded one mark.

Common mistakes were as follows.

- the rig is covered with oil
- the rig is not in contact with the water
- the rig is painted
- all the water was split up into oxygen and hydrogen
- the rig is galvanised or covered with titanium
- titanium is a more reactive metal, it would oxidise first

(v) Cathodic and anodic protection both protect steel from rusting by supplying electrons and making the steel object a cathodic area so preventing electron loss. The only difference is the source of the electrons, for anodic protection a more reactive metal is the source and for cathodic protection they are supplied by electrolysis from an inert electrode. This question proved to be highly discriminating. The marking points are:

SET 1
sacrificial protection is a cell
does not need electricity
cathodic protection is electrolysis
cathodic protection needs electricity

SET 2
sacrificial protection needs a more reactive metal (in contact with steel)
this metal corrodes instead of steel
cathodic protection needs an inert electrode accept unreactive
or less reactive metal as an electrode

ONE comment from each set was required.

Candidates were frequently distracted by oxide layers and one metal plated on another. The most popular correct answer was – anodic protection needs a more reactive metal and cathodic protection needs an electrical supply.

Question 6

(a) Very few candidates gained four marks - particularly difficult was "sodium aluminate". In contrast most recognised that filtration would remove the undissolved iron(III) oxide.

Common errors were:

- iron oxide not iron(III) oxide
- bauxite rather than alumina
- the oxides the wrong way around (that is iron(III) oxide in the first line instead of alumina)
- electrolysis to remove undissolved iron(III) oxide

(b) There was a higher standard of answers here than in **(a)**. Typical mistakes were to give too low a temperature, sodium hydroxide instead of cryolite and not specifying a <u>carbon</u> cathode.

(c)(i) The majority of candidates had this part correct.
The usual mistakes made by those who gave an incorrect equation were:

$Al^{3+} + 3e = 3Al$
$Al^{3+} + 3e = Al_3$
$Al^{3+}(aq) + 3e = Al$
$Al^{3+} - 3e = Al$

(ii) This question was well answered by almost all the candidates. A few stated that the carbon cathode, instead of anode, reacted or that the carbon anode reacted with aluminium oxide.

(d)(i) A number of explanations were acceptable – low density and resistance to corrosion. "Strong" did not gain the mark unless associated with aluminium alloys or in strength/weight ratio.

(ii) The award of two marks should have alerted the candidates that two of the following reasons were needed.
- not attacked or corroded or unreactive
- protected by an oxide layer
- easily shaped or malleable or ductile

Only iron and ferrous alloys can rust, aluminium cannot rust. This is incorrect Chemistry and can invalidate any associated material.

Some candidates mistakenly believe that "corrosive" means "easily corroded".

(iii) Very few could recall why aluminium cables have a steel core. The reason is for strength or so it does not break or does not sag or can have pylons further apart. Steel is not a better conductor. "Aluminium protects steel from rusting" did not gain credit - it would have that effect but that comment does not address the question (why do cables have a steel core?).

Question 7

(a) Generally this question produced a pleasing standard of answers. Compared with previous years very few candidates omitted the hydrogen atoms. Typical errors were:

- ethanol and butanoic acid
- propanol instead of butanol
- O-H-C in the structure of butanol, especially if it is drawn on the left hand side of the molecule
- the carboxylic group written as an aldehyde group
- naming the carboxylic acid as methanoic acid but giving the structural formula of ethanoic acid
- writing the carboxylic group as –COOH

Despite the above criticisms there were many correct answers which were awarded full marks.

(b) (i) Commendably accurate structural formulae were common. However, some candidates appeared not to have read the question and produced a variety of polymers – polyamides or addition polymers.

When drawing the structural formulae of polymers, continuation must be shown at both ends of the structure.

(ii) A sizeable minority of candidates believe that all esters have the same properties and the same uses – making soap, in perfumes and as food additives.

Others commented "plastic" or "making plastics" and the suggestion "making nylon" was quite common.

(c) (i) Usually the correct value, 8, was given, although for no obvious reason 7 was quite popular.

(ii) To be awarded both marks - the double bond changed into a single, one bromine atom on each carbon and both carbon atoms showing four single bonds.

Typical errors were:

- trivalent carbon
- retain double bond
- polymer formed
- both bromine atoms on the same carbon

(iii) Usually this part was correct – corn oil. Soya oil was the favourite wrong answer closely followed by "butter"- probably an example of candidates not reading the question.

(d) The solution to this calculation is as follows.

100 g of fat react with 86.2 g of iodine;
884 g of fat react with 762 g of iodine;
one mole of fat reacts with 762/254 moles of iodine molecules;
one mole of fat reacts with 3 moles of iodine molecules;
number of double bonds in one molecule of fat is 3.

There was mixed response to this question, most candidates gained the first mark for calculating that 884 g of fat react with 762 g of iodine. Some went on to complete the calculation correctly but others used 127 not 254 as the Mr of iodine and arrived at - one mole of fat reacts with 6 moles of iodine molecule so number of double bonds in one molecule of fat is 6.

There was some confusion between moles and molecules producing an answer of 1.8×10^{24}. Other than the above there was no real pattern to the mistakes, which tended to be random.

There was no widespread realisation that you cannot have a fraction of a double bond. The third mark was given for the number of moles of iodine molecules expressed as the nearest integer.

one mole of fat reacts with 3.7 moles of iodine molecules(incorrect) number of double bonds in one molecule of fat should be given as 4 not 3.7, the third mark could be allocated by consequential or ecf marking.

CHEMISTRY

Paper 0620/04

Coursework

General comments

First of all many thanks to those Centres who regularly submit coursework which is well organised and is annotated to show where and why marks were given. This makes the task of moderation more straightforward and ensures that candidates are credited with the marks that they deserve.

There were a few Centres, mostly new ones, where there were a few issues regarding the interpretation of the assessment criteria. The Principal Examiner would ask those Centres in particular to take note of the comments below and of the comments on their feedback forms.

Very few Centres needed to have their marks changed. It is never pleasant for Moderators to scale marks down as it is seldom the fault of the candidates. More often it is the design of the assessment exercises which does not allow the candidates to show what they are capable of. Comments on each skill follow.

Skill C1

Some Centres are still not sending ‘tick lists’ to show how marks have been awarded for this skill. Sometimes, the Moderators think that this skill has been assessed too severely, but without evidence it is difficult to do anything about it. Remember that to gain 6 marks a candidate must have made a choice at some point in the exercise and that this choice should be a marking point.

Also remember that skill C1 cannot be assessed on a skill C4 exercise. You cannot be assessed for following instructions which you wrote yourself.

Skill C2

Two or three Centres have been confusing this skill with skill C3 and assessing the drawing of graphs in this area. Skill C2 has to do with observing and recording both quantitative and qualitative results. No format should be given if full marks are to be gained.

Skill C3

As stated above, this includes the drawing of graphs and the processing of numerical data as well as coming to conclusions. Graphs, to gain full marks, should be large, have correctly labelled axes with units and should have an appropriate smooth line or curve. If graphs are drawn using IT packages such as Excel, they should be of an equal quality to hand drawn ones in size and should have the same best fit lines or curves.

Conclusions should be correct to receive full credit.

Skill C4

Most exercises used by Centres are fine but some Centres continue to use investigations where there is little opportunity to show the control of variables. This inevitably limits the maximum mark which can be obtained.

Centres are also reminded that candidates must carry out the investigation, having planned it. Full marks cannot be obtained unless the procedure is evaluated and appropriate modifications are suggested.

Finally, Mark schemes should be related to the assessment exercise which they refer to. They should not simply be the criteria copied out from the syllabus.

CHEMISTRY

Paper 0620/05

Practical

General comments

The majority of candidates successfully completed both questions. Only a few Centres failed to include a copy of the Supervisor's results. These results are used to compare candidates' results with those obtained by the Supervisor, e.g. **Question 2(a)**. The level of difficulty of the paper was thought by the Examiners to be similar to previous years. The paper showed good discrimination between candidates of different ability.

Comments on specific questions

Question 1

The table of results was generally completed. Some students only noted readings to the nearest 1 cm^3 instead of one decimal place. A minority of candidates did not know how to fill in this standard table and confused initial and final readings. Their results often did not fit with figures they used in other parts of the question.

(a) Mostly correct but some very strange colours quoted here.

(b) Some candidates misread the instructions and so in **(a)** gave the colour before adding iodide to iodate, and then in **(b)** gave the colour change when the iodide and iodate were mixed.

(c) Mostly correct but again some colours were given that had nothing to do with this experiment. The role of the starch was poorly understood. 'Catalyst' was a common answer, as was 'to test for iodine'.

(d) In part **(ii)** some candidates just rewrote the volumes in the table rather than commenting on them. In (iii) a common error was to have the difference in concentration the wrong way round or just mention different concentration. Reference to reactivity was penalised.

(e) Lots of approximations lost the value mark. A fair number of candidates worked out a value for the wrong experiment. The unit was often omitted.

(f) Many ignored the question and changed the apparatus.

Question 2

Some candidates were unable to draw the correct conclusion for **Question 2** despite obtaining the correct observations and having access to the notes on page 8.

(a) Many different colours were given. The Supervisor's results were used to mark this part of the question.

(b) The pH was often left out and some gave incorrect acidic pH values. Values of 12-14 were penalised.

Incorrect colours were prevalent in the last part while some just said 'it changed colour'.

(c) One mark was awarded for reference to fizzing/bubbles etc. Many candidates did not note this observation and stated 'that a gas was given off'.

(d) Some candidates did not follow the instructions and added potassium iodide to the solid in the filter paper. Consequently wrong observations were recorded.

(e) Blue was a common answer instead of green. In part **(iii)** the pH was often not mentioned even though correct colour change of the indicator paper was noted.

(f) A large number incorrectly identified iodide, in spite of the fact that they had added iodide in (d)!

(g) Nitrate was a common incorrect ion due to the ammonia being given off - confusion of ammonia and ammonium ion was common. Some students mixed up D and E and therefore got **(f)** and **(g)** the wrong way round.

CHEMISTRY

Paper 0620/06
Alternative to Practical

General comments

The majority of candidates attempted all of the questions. The level of difficulty of the paper was thought to be similar to those set in recent years. The paper successfully differentiated between candidates of different ability. The responses to some questions was centre dependent. For some Centres, it was clear that certain areas of the syllabus had not been taught in depth and consequently candidates were unable to respond successfully.

Comments on specific questions

Question 1

This first question is designed to give candidates a confident start to the paper and was generally well answered.

(a) Most scored full marks. Some candidates ignored the letters and gave the apparatus from left to right including D.C was sometimes given as a stand or Bunsen burner instead of a tripod.

(b) Well answered. The most common error was to cool the liquid instead of the vapour.

(c) A common error was to try some chemical test instead of measuring the boiling point.

Question 2

(a) Many candidates missed the labels. A large number of candidates labelled the wrong places (mainly on the wires).

(b) Often centre dependent. Most candidates got the bulb lighting up. A common error was to say ‘gas made’ instead of giving an observation such as bubbles, effervescence etc.

(c) Hydrogen was a common incorrect answer. Confusion between chloride and chlorine was penalised, as was the use of silver nitrate solution to test for chlorine gas.

Question 3

This question was well answered by most candidates. Some missed the point in (a) and referred to the position of the amino acids being known without discussing the use of pencil instead of ink, etc. In part **(d)** the idea of ninhydrin as a locating agent was not realised by a minority.

Question 4

The vast majority of candidates were able to correctly complete the table of results.

(a) Incorrect answers included catalysts and the use of starch to test for iodine rather than act as an indicator.

(b) Weaker candidates were unable to comprehend parts **(i)** and **(ii).** In part **(iii)** some wrote about the concentration of sodium thiosulphate while a fair number got the wrong relationship and said that B was more concentrated.

(c) Common mistakes were to halve the value for Experiment 1 or to just say the volume needed becomes half of what it was before without giving an answer. Most got the units mark.

(d) Badly answered. The majority did not read the question and suggested changes involving the apparatus.

Question 5

(c) Most missed the observation of fizzing but got the next two marks. Candidates from some Centres were unable to correctly answer this question.

(d) White precipitate was seen as often as the correct answer 'yellow precipitate'.

(f) Centre dependent. Many guesses and gases were evident.

(g) Not correct as often as **(f) -** random guesses such as carbon dioxide and iron oxide were prevalent.

(h) Very few candidates scored full marks. Some candidates confused ammonia and ammonium ions. Others assumed that the ammonia indicated the presence of nitrate ions.

Question 6

(a) Usually correctly completed. Some candidates confused the readings e.g. 37 being recorded as 30.7.

(b) Generally well done. Points were plotted correctly. Errors included incorrect scales and curves that were not smooth.

(c) Most selected X but a few were unable to give a correct explanation and referred to more oxygen evolved without mentioning the time element.

(d) Not well answered. 'All hydrogen peroxide reacted' scored no credit. Most common incorrect answer was 37 cm^3, misreading the question as what and not why.

(e) Some candidates missed this out. Others were careless and lost the mark for levelling out at the same volume. Some candidates did not follow the instruction to sketch the line on the grid and sketched it on the blank page without the necessary detail.

Question 7

(a) Well-answered by many candidates. A minority failed to use a thermometer. Some candidates heated the reactants and others thought that gas was given off. Some answers talked at length about cement but did not attempt the question. Answers that did not specify the mixing of water and cement were penalised. Confusion between endothermic and exothermic reactions was seen.

(b) Generally correctly answered