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CHEMISTRY

Paper 0620/01
Multiple Choice

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

General comments

The paper achieved a mean mark of 29.2 with a standard deviation of 6.4. These statistics indicate that the paper was satisfactory in discriminating between candidates of differing competence in the subject.

As has been the case for several years, the paper is offered by candidates aiming for Grades A to C as well as those of more modest expectations. There were three questions which the higher scoring candidates found relatively demanding (**Questions 21**, **27** and **31** see below). This being so, the **Comments on specific questions** concentrate on aspects of the performance of the lower scoring candidates.

Comments on specific questions

Questions 1 and 2

These were found easy by all candidates but it is policy to have one or two easy ‘starter’ questions.

Question 3

By contrast, the lower scoring candidates found this question quite hard – nearly a third chose **A.** This seems to imply that more careful reading of the question might have been helpful. It is correct that sodium chloride is soluble in water but, in this experiment, the salt is in a glass tube and, thus, not in contact with the water. Its solubility is irrelevant in this context.

Question 5

This is another question where more careful reading or thinking might have benefited the lower scoring candidates, nearly half of whom chose **D**. It appears that such candidates merely saw the two numbers of 4 and 2 – but the 4 is the total number of nucleons not just the neutrons.

Question 6

Another careful reading/thinking example? Two thirds of the lower scoring candidates chose **C**. Even the use of heavy type to draw attention to neon ATOM versus sodium ION does not seem to have struck home with these candidates.

Question 8

This question was found easy by all candidates and, accordingly, did not discriminate well.

Question 9

This was also relatively easy for these 'whole subject' candidates, probably because both of the stoichiometric values on the left hand side of the question were given so that balancing the numbers of the atoms involved was straightforward.

Question 10

This was harder than might have been anticipated, primarily because over 40% of the lower scoring candidates chose **A**, a higher percentage than the key, **B**. The question refers to three atoms as against elements.

Question 11

This was found decidedly hard. There was evidence that the lower scoring candidates merely guessed. The key, **A**, was the one case that heating would cause an increase of mass as a consequence of oxidation.

Question 15

This was found slightly hard but with excellent discrimination. There seems to be no obvious reason for this quite direct question based on recall.

Question 19

The lower scoring candidates were fairly equally divided between responses **B**, **C** and **D**. This seems to imply poor recall.

Question 21

This was found to be very hard although the discrimination was satisfactory. About half of all candidates chose **B**, instead of the key **C**. The left-hand diagram relates to the release of ammonia from its salts by the action of alkali *but* the damp red litmus paper "stays" red. It is the reduction of the nitrate ion that results in the release of ammonia. Careful reading of the question required.

Questions 22, 24 and 30

Candidates found these quite easy.

Question 27

This was moderately hard. Response **A** was the most popular incorrect choice. Impure iron contains an excess of carbon from the coke used in the blast furnace and this excess has to be removed.

Question 31

This was found relatively hard by all candidates. A third of the higher scoring candidates went for **A** but amongst the lower scoring candidates, response **C** was over twice as popular as the key, **D**. Hydrogen is not regarded as a constituent of 'clean air'.

Question 39

The lower scoring candidates were equally divided between **C** (the key) and **D**. Poly(ethene) is a separate – not a direct – product of the process of cracking.

Question 40

This was slightly hard but with very good discrimination. The statistics suggest that perhaps two fifths of the lower scoring candidates knew the answer but that the others guessed.

Paper 0620/02
Paper 2 (Core)

General comments

Some of the candidates tackled the paper well and good answers were seen in some parts of the paper e.g. **Question 3**, but many candidates exhibited a less than thorough grasp of the subject matter. Some quite straightforward questions e.g. the test for hydrogen and the products of combustion of hydrocarbons, proved difficult for candidates. In general, the rubric was well interpreted and most candidates attempted all parts of each question. However, as commented on in previous years, many candidates fail to distinguish the difference between a word equation and a symbol equation. The standard of English was generally good. Although most candidates had a good knowledge of methods of purification many were found to have a poor knowledge of general organic and inorganic reactions. Many candidates had difficulty with the interpretation of the graph in **Question 2** and the usual problem with interpolating and extrapolating data (**Question 1**) was manifest. There were fewer 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. The exception to this was in **Question 6 (a)**, where some candidates ticked two boxes – a case of not reading the rubric correctly. It was encouraging to note that the majority of the candidates showed a good ability at balancing equations when the formulae were given. A considerable number of candidates appeared to have difficulty in explaining electrolytic processes (**Question 6**). This follows the general pattern from this paper in previous years. Tests for gases and ions were less well known than in previous years, the test for nitrate ions proving a stumbling block for candidates. Candidates often disadvantaged themselves by sloppy and non-specific writing e.g. it is not good enough to suggest that nitrogen dioxide merely 'affects breathing' (**Question 4 (d)(ii)**). As in previous examinations, few candidates explained environmental effects in a convincing way. It was encouraging to note, however, that the candidates' answers to calculations (**Question 6**) showed an improvement compared with previous years.

Comments on specific questions

Question 1

Although most candidates obtained at least half the marks available for this question, many candidates had difficulty in working out the patterns in parts **(b)** and **(c)** or were unsure of the properties of metals and the test for hydrogen.

(a) This was generally well answered but a common error was to state that the density increased according to the group (rather than the period or *down* a group). A common error of English was to write 'the higher the density the higher the group'. Answers such as 'it changes down the group' were occasionally seen. This cannot be given credit.

(b) Many candidates gave values that were not only outside the accepted range (670-714^{o}C) but bore no relationship to the pattern e.g. answers below 650^{o}C were not uncommon. Candidates were expected to produce an answer that reflected a decrease in the difference between successive boiling points.

(c) Some candidates disadvantaged themselves by failing to put the decimal point in front of their answer e.g. 270 is incorrect. As in part **(b)** answers which failed to show any relationship to the pattern were frequently given e.g. values below 0.250.

(d) Some candidates tried to link their answers to the density of the elements and failed to realise that this was a distinct question, unrelated to part **(c)**. Many were content to repeat the word rapid or used a synonym of this such as 'quick'. Candidates who followed a comparative route e.g. 'slower than sodium' were most successful in gaining the mark.

(e) The general properties of metals were not known. Some candidates gave properties of transition metals e.g. high melting and boiling points and high density. Many gave vague chemical properties such as reaction with oxygen.

(f)(i) Most candidates realised that the product was sodium hydroxide. A not uncommon mistake was to write sodium oxide.

(ii) The test for hydrogen was not as well known as in previous years. At least 30% of the candidates thought that a glowing splint should be used, muddling the test with that for oxygen. This was not a simple error of English because many compounded this by saying that the splint relights. A small proportion of candidates had no idea and gave a variety of tests for ions.

(g)(i) The name of the proton as the positively charged particle was generally well known, the most common error being 'electron'.

(ii) The correct response, isotopes, was generally given. The most common mistake was, predictably, to write 'isomer'.

(iii) About 50% of the candidates gained the correct answer (3), with the most common incorrect response being '2'. This probably arises through the fact that the symbol for neutron is 'n' but some candidates, assume that this stands for nucleon.

(iv) The commonest correct answer was 'to treat cancer'. Many candidates, however, either wrote about *x*-rays or about non-medical uses such as detecting cracks in pipes. Vague answers such as 'for cancer' or 'helps with cancer' should be discouraged.

Question 2

This question highlighted some of the difficulties that some candidates have with Organic Chemistry. A variety of answers in parts **(a)** and **(b)** indicated that guesswork was often involved. Part **(d)** proved to be a good discriminator and few candidates gained this mark for the displayed/graphical formula. It was disappointing to note that many candidates could not extract information from the graph.

(a) Although at about half the candidates wrote the correct answer (A, D), the other half seemed to guess the answer, A and B being the most common incorrect response, rather than A and C or A and E.

(b) This was answered better than part **(a)**, but there was a wide variety of incorrect responses, although it appeared that some candidates thought, incorrectly, that the C=C group was a carboxylic acid group.

(c) A variety of answers were seen, the most common errors being C_5H_9, C_4H_8, this presumably arising through incorrect counting of the atoms. The concept of molecular formula was lost on some candidates, who wrote the general formula instead.

(d) This was poorly done. The commonest 'near misses' were to put two bromines on one carbon atom, to leave the double bond in place and to write the formula for 1-bromoethane. Many candidates, however, did not even appreciate the 'combining power' of carbon or hydrogen. Hydrogen atoms with two bonds and in the middle of a carbon chain were frequently seen.

(e)(i) Many candidates failed to read the graph correctly and either failed to select successive days or else misread the question and chose days 6-7, where a decrease in ethene concentration was occurring.

(ii) Respiration was chosen by the majority of candidates. Of the incorrect responses, combustion was the most commonly chosen.

(iii) About a third of the candidates failed to interpret the information from the graphs correctly and suggested that there was an increase in ethene production as the concentration of carbon dioxide increased. A significant number of candidates did not refer to the graph at all and wrote about acids being produced by the fruits or gave the name of a process such as neutralisation.

(iv) At least three quarters of the candidates obtained the mark for 'diffusion'. The most common incorrect answer was aeration.

(v) This question proved to be a good discriminator. Incorrect ideas about ethene reacting with nitrogen or nitrogen neutralising the ethene, suggested that many candidates do not realise that nitrogen is relatively inert under normal conditions of temperature and pressure. Some candidates merely repeated the stem of the question by stating that 'nitrogen slows down the reaction'.

(vi) Although most candidates realised that enzymes are catalysts, surprisingly few gained the mark for their biological or protein nature. A common mistake was to regard enzymes as being living organisms, especially fungi, bacteria or yeast. This is not acceptable for a mark.

(f)(i) Most candidates realised that the diagrams showed chromatography. The most common error was to put diffusion. This may arise from the fact that the spots of colour are seen to spread out after a time.

(ii) Nearly all candidates put the correct answer, S.

(iii) Nearly all candidates put the correct answer, R and T, although a few only put down one letter.

Question 3

Most candidates obtained at least half marks from this question. The quality of the diagrams was slightly improved compared with similar questions from previous years. However, it is clear that candidates still have difficulty in understanding and explaining practical processes. It was encouraging to note that most candidates could label apparatus correctly.

(a) About half the candidates chose a measuring cylinder for measuring out 25 cm^3 of acid. This was followed in popularity by a burette. A significant number of candidates chose, incorrectly, either a test tube or beaker for measuring. About 10% of the candidates chose a pipette without stating the type. A mark cannot be given for this: it is too vague an answer.

(b) Few candidates realised that the sulphuric acid would be completely reacted by adding excess nickel carbonate. Most failed to grasp the significance of the word excess and either stated that the nickel carbonate would be used up or gave answers which were completely irrelevant such as 'to speed up the reaction'.

(c) Many candidates gained the mark here through mentioning carbon dioxide or gas in their answers. However, it was clear from the amount of irrelevant information that the candidates wrote that many gained this mark by luck rather than by careful thinking.

(d) Most candidates scored at least 2 of the 3 marks available for the filtration apparatus. It was encouraging to note that nearly all the pieces of apparatus were correctly labelled and that the instructions in the question were followed. A minority of candidates failed to go back to the stem of the question and drew flasks instead of beakers. Candidates should also be advised to make sure that the filter paper is drawn a little way from the funnel so that the Examiners can see it clearly. A few candidates were penalised for not showing the filter paper as a cone, but placing it flat across the top of the filter funnel.

(e) The correct answer, filtrate, was well known.

(f) Many candidates failed to gain the first mark by suggesting that the whole solution was evaporated or that the nickel sulphate was evaporated. This is a vague answer: it is the solvent/water which is evaporated. Just 'heating' alone was not accepted as an answer because this may result in dehydration of the crystals if continued. Only a few candidates obtained the second mark. The stem of the question states clearly that the crystals are to be dry. Many candidates suggested heating them to dry them. This, taken in conjunction with the poor answers to part **(g)**, suggests that many candidates do not understand the relationship between hydrated and anhydrous salts.

(g)(i) This, taken in conjunction with the poor answers to part **(f)**, suggests that many candidates do not understand the relationship between hydrated and anhydrous salts. Hydrogen was a common answer and the formula for nickel sulphate was also seen repeated on the right hand side of the equation. Even when water was correctly given as an answer, the 7 was often omitted.

(ii) Most candidates realised that the reaction was reversible but there were quite a few vague answers such as 'the reaction goes two ways'. Such answers do not accurately describe the reaction going backwards as well as forwards.

(iii) Many candidates seem to think that cooling the anhydrous salt will cause it to become green again. The answer, add water and heat again, was often seen. Many candidates also seemed to think that adding more sulphate in the form of sulphuric acid would do the trick. Candidates should be encouraged to revise this section.

Question 4

This question proved difficult for many candidates, especially the sections about aspects of environmental chemistry in parts **(c)** and **(d)**. Few candidates scored more than half the marks available for this question.

(a) Many candidates did not realise that the nitrogen in the air used to combust the petrol in the engine was unreactive. The information about the % of gas X was put into the table to help the candidates but few realised the significance of this. Many thought that this would be nitrogen dioxide. As the comments on **Question 2** show, many candidates do not realise that nitrogen is the 'unreactive' component of the air. Fuel, methane, carbon dioxide and water vapour were also commonly seen as incorrect answers.

(b)(i) Surprisingly few candidates knew the equation for the combustion of a hydrocarbon. Many failed to recognise that oxygen is needed for combustion and a common incorrect product was 'hydrogen' Some candidates disadvantaged themselves by writing the formula for oxygen, O_2, on the left hand side of the equation. It should be stressed that marks will not be given by mixing up words and symbol in the same equation.

(ii) Nearly all candidates recognised that hydrocarbons contain both hydrogen and carbon.

(iii) Some candidates gave specific names e.g. ethane rather than the name of the homologous series. Quite a few wrote alkene instead of alkane.

(c) Compared with previous years, fewer candidates seemed to grasp the idea of incomplete combustion. Candidates should also be advised not to write phrases such as 'because there is no oxygen'. If there were no oxygen, carbon monoxide would not be formed. A significant minority of candidates thought that carbon dioxide was formed but that it then reacts with carbon to form carbon monoxide. Perhaps these candidates are thinking about what happens in a blast furnace rather than in a car engine.

(d)(i) This was sometimes omitted. Common errors included writing $4NO_2$ in the right hand side of the equation or inserting other formulae such as H_2.

(ii) Few candidates wrote a suitable effect of nitrogen dioxide on the body. Most were content to write vague statements such as 'it affects the lungs' or 'affects breathing'. Candidates should be discouraged from using the word 'affects'. Examiners wish to know what the effect is. Many candidates described nitrogen dioxide as causing brain damage (muddling with lead) or preventing oxygen from combining with red blood cells (muddling with carbon monoxide) .

(e)(i) Many candidates had an inkling that the answer was something to do with fuels, but the essential word 'fossil' or reference to coal was often omitted. Vague answers such as 'from industries' or 'from factories' could not be accepted. There were several references to global warming, showing that candidates often get environmental affects muddled.

(ii) Most candidates gained the mark for a suitable definition of oxidation.

(iii) About half the candidates calculated the relative molecular mass of sulphuric acid correctly (98). Those who failed to gain the mark either failed to include the hydrogen (the incorrect answer 96 was often seen) or used atomic numbers.

(iv) Only about a third of the candidates completed the equation correctly. Few seemed to know the pattern, acid + metal → salt + hydrogen. Water was often seen as a product. Iron sulphide was seen fairly often as an incorrect answer as was iron oxide and sulphur. Some candidates disadvantaged themselves by writing formulae in the spaces. It should be stressed that marks will not be given by mixing up words and symbol in the same equation.

(v) Many candidates wrote answers along the correct lines but quite a few insisted that the calcium carbonate rusted or corroded. Some even went as far as stating that 'the metal corroded', seeming to think that calcium is separate from carbonate.

Question 5

Many candidates found this question demanding and only a small percentage were able to remember the test for nitrate ions.

(a)(i) Although many candidates obtained the mark here, a significant minority failed in their attempt because of vague writing or stating what happens to the soil rather than what happens to the plants. Answers such as helps plants to grow, do not quite access the idea of increased growth or yields.

(ii) Zinc, magnesium and sodium were the common incorrect responses to this question. However, the commonest incorrect response was 'nitrogen'. Please encourage candidates to read the question – the stem clearly states that a metal ion is required.

(iii) Nearly all candidates gave the correct response 'phosphate'.

(b) The test for nitrates was not well known. Most candidates who realised that aluminium had to be added, obtained all four marks. A few disadvantaged themselves by adding acid in place of sodium hydroxide. A few candidates seem to think that acid is always added at first in any test even when adding alkali. A number of candidates gave good answers for the 'brown ring test'.

(c)(i) Few candidates recognised that acid + alkali is a neutralisation reaction. Common incorrect answers (in order of decreasing incidence) included oxidation, precipitation and addition.

(ii) Although many candidates attempted to balance this equation, only about a third of them obtained the correct answer. NH_4 was a common error. This presumably arose through just looking at the formula of ammonium ion in ammonium nitrate and taking no account of the hydrogen in the nitric acid.

(d) This was usually answered correctly. The commonest incorrect statement to be ticked was the first (ammonia is insoluble in water).

Question 6

The later parts of this question were fairly well answered but many candidates have difficulties with the concepts involved in electrolysis. This has been commented upon in previous Principal Examiner Reports. It was encouraging to note that the calculations in part **(e)** were generally well done and that nearly all candidates could balance the simple equation in part **(d)**.

(a) Most candidates were able to select the correct properties of sodium chloride, although a significant number ticked two boxes instead of one. The rubric clearly states in bold type that one box is to be ticked. Although the candidates may be harking back to **Question 5 (d)**, such mistakes can only arise though not reading the rubric with sufficient care.

(b)(i) Few candidates were able to describe the process of electrolysis. It is not sufficient to state that ions are separated; this could apply to electrophoresis. The idea of the decomposition or breaking down was rarely seen. Many candidates were content to describe electrolysis as the passing of an electric current through a solution or ions moving in a solution. A significant number referred to specific cases; 'electrolysis is the way aluminium is extracted from its ore' was a common incorrect answer.

(ii) This was generally well answered although quite a few candidates obviously had no ideas and left this part blank. Cation was occasionally seen instead of cathode.

(iii) There were a variety of answers many of which referred to metals too reactive to be used as electrodes. Copper was a not uncommon response perhaps because candidates are thinking of the purification of copper by electrolysis rather than the electrolysis of a particular compound using inert electrodes.

(c)(i) Many candidates thought, incorrectly, that hydrogen or oxygen atoms were charged subatomic particles. Only about a quarter of the candidates wrote the correct answer, electron.

(ii) The test for chloride ions was no better known than the test for the nitrate ion. The addition of sodium hydroxide was a common error which probably arises from the fact that several other tests for ions involve this. A considerable number of candidates misread chloride and gave a test for chlorine, that is; 'bleaches litmus paper'.

(d) It was encouraging to note that nearly all candidates were able to balance this simple equation.

(e)(i) The calculation was successfully completed by many candidates. A not uncommon error was to write (2550) tonnes in the answer instead of kg (Correct answer = 2550 kg).

(ii) Over half the candidates showed by calculation that the percentage of impurities was 3.6%. The most common incorrect answers chosen were either 36% or 96(4)%. The latter arose from the fact that the candidates had calculated the percentage purity – another case of carelessness in reading the rubric.

(f)(i) Practically all candidates gained at least one of the marks available, the most common error being to interchange the words saturated and unsaturated. Over half the candidates gained two marks. In this case, 'monomeric' often appeared as the answer in the first gap.

(ii) This was usually well answered. Candidates often failed to gain the mark because they gave vague answers e.g. 'for burning' or answers which indicated that they did not appreciate the properties of hydrogen e.g. for 'light bulbs', 'for breathing apparatus in hospitals/diving'. The commonest acceptable answer was 'for balloons' despite of the fact that the syllabus statement refers to the use of hydrogen as a fuel.

Paper 0620/03
Paper 3 (Extended)

General comments

Most of the relevant comments are included in the section on specific questions. They are included in context of the question and include old favourites such as do not include a multiplicity of answers in the forlorn hope that the Examiner will select the correct option.

There is one aspect of this paper in which it differs from previous November papers. It is the first November paper under the new scheme of assessment which requires twenty of the marks to be targeted at the lower grades and to contain only Core material. The questions carrying these marks were concentrated, although not exclusively, at the beginning of the paper. It has been a constant theme in these reports that candidates should be entered for the paper that provides the most appropriate test of their skills and knowledge. The attainment of some candidates based on these less demanding questions clearly indicated the potential benefits that could be derived by entering them for Paper 2. This paper is based on the Core Curriculum and as the questions are not targeted at Grades A and B, they are less demanding. The inappropriateness of Paper 3 for this cohort of candidates was further underlined by the dramatic fall-off in their performance when they attempted the questions targeted at the higher grades.

Comments on specific questions

Question 1

(a) Usually answered correctly with responses selected from – carbon dioxide, water vapour, noble gases or a named noble gas. The most frequent error was to suggest hydrogen.

(b) The essential ideas were that sulphur dioxide was formed by burning fossil fuels that contain sulphur and that this gas is one of the causes of acid rain. Most of the candidates gained two marks. The mark for "containing sulphur" was rarely awarded. The most common error was to state that sulphur compounds were burnt without any reference to fossil fuels.

The majority knew that the source of lead compounds was motor vehicles using leaded petrol. A few mentioned lead in paint, this was accepted. A trend was to list a number of harmful effects in the hope that the Examiner would select the correct one – cancer, respiratory problems, skin diseases and damage to the brain particularly in small children.

(c)(i)(ii) Most of the candidates scored here, naming combustion as the another process that controls the percentages of oxygen and carbon dioxide in air. They were able to complete the equation and knew that respiration is an exothermic reaction.

(d)(i) A popular and well answered question. The major difficulty was giving an incomplete description of the test – not stating that the splint was glowing or that it relights in oxygen.

(ii) It was necessary to give the two measurements as volume and time. "Amount" was not accepted neither were the units of these measurements.

(iii) The rate of photosynthesis slows down was the pivotal idea which should have been followed by a comment of the type:

- because the reaction is photochemical
- the rate depends on the intensity of the light
- the light is less bright or less light falling on plant
- light provides energy for photosynthesis.

A frequent misconception was that light is the catalyst for this reaction. Another was to think that the light had been switched off so photosynthesis stopped.

Question 2

The standard of the responses to this question was excellent. Virtually the whole entry scored 4/6 or better. The only common errors were – heat the solution until it is white instead of saturated and to form white, rather than blue, crystals.

Question 3

This question proved to be highly discriminating, particularly because of a lack of knowledge and of understanding of the underpinning concepts and partly through an inability to formulate the responses with sufficient clarity and precision to be awarded the mark.

(a)(i) Very few could explain the concept of a reversible reaction at equilibrium. The required ideas were either no change in concentration of reagents or the rates equal. The most common incorrect answers were:

- the reaction goes both ways, (no mention of the rates)
- equal amounts of reactants and products
- the forward reaction occurs at the same time as the back reaction
- the forward reaction is the same as the back reaction
- the reaction is in balance.

(ii) There had to be a comment about the thermicity of either the forward or back reaction – the back reaction is endothermic or the forward reaction is exothermic. This was to be followed by the effect of temperature on one of these reactions:

- an increase in temperature favours the endothermic reaction which is the back reaction
- the forward reaction, which is exothermic, is favoured by lower temperatures.

Probably the most frequent error was to state that the reaction is exothermic. It is crucial for reversible reactions to specify which reaction is being referred to by adding either "forward" or "back".

(iii) One advantage of high pressure is an increased reaction rate because the molecules collide more frequently or the concentration of molecules is increased.

A popular error was that higher pressure increased the kinetic energy of the molecules.

The other advantage of using high pressure is an increased yield. The reason is that high pressure favours the side with fewer moles of gas or the smaller volume, which is the right hand side.

It did not matter in which order these two advantages were given but the advantage and the associated reason had to be in the same box.

Candidates found the idea of a higher rate easier than that of an increased yield.

A significant proportion discussed the possibility of methanol condensing or of preventing it from condensing.

(b)(i) Most candidates knew that the products were CO_2 and H_2O but not all of them could balance the equation: $2CH_3OH + 3O_2 = 2CO_2 + 4H_2O$.

The difficulty was they did not take into account the oxygen atoms in the methanol and gave the following equation: $2CH_3OH + 4O_2 = 2CO_2 + 4H_2O$.

(ii) Methyl ethanoate and water were the products. This question was generally well answered, just a few ethyl methanoates.

(iii) Methanoic acid from almost the entire entry. A small minority gave the general term – carboxylic acid, instead of naming the individual acid.

Question 4

(a)(i) The bulk of the candidates gave a correct equation with a more reactive metal. The usual mistakes were to quote a less reactive metal, particularly iron or copper, write the symbol incorrectly, for example AL or assign the wrong charge: $Al = Al^{2+} + 2e$.

(ii) A very pleasing standard of answers with definitions referring to electron transfer, specifically electron loss, and not to the gain of oxygen. Quite a number of candidates gave both definitions, they scored the mark for the one based on electron loss.

(iii) Positive ions are likely to be oxidising agents because they can accept electrons from or take electrons away from another species. Candidates might like to try this approach.

The following is a redox reaction: $Mg + CuSO_4 = MgSO_4 + Cu$.

Written ionically: $Mg + Cu^{2+} = Mg^{2+} + Cu$.

The two half equations are: $Mg = Mg^{2+} + 2e$ and $Cu^{2+} + 2e = Cu$.

Magnesium atoms have lost electrons so they have been oxidised (OILRIG).

Copper ions have accepted these electrons or taken them from the magnesium atoms. Copper ions are the oxidising agent, they caused the magnesium atoms to be oxidised.

There is a similar argument about reduction and reducing agents.

The majority of the candidates believed that the positive ions would lose more electrons or that they would attract electrons. This is undoubtedly true but electrostatic attraction does not equate to gaining electrons.

(iv) If candidates appreciated the above argument about redox, they would realise that the only ion in the list that can oxidise mercury metal is the silver(I) ion and not the ion of a more reactive metal, e.g. Zn^{2+}.

(b)(i) Most of the candidates had the idea that the voltage would increase because there was a bigger difference in reactivity. The reason was not required for the mark.

(ii) Unfortunately although most of the candidates knew that the zinc electrode would go into solution as positive ions they did not give a reason – it loses electrons more easily or it is more reactive.

(iii) From zinc to lead did not suffice, they were asked to predict the direction of the electron flow in cells of this type. Many tried to make it into a practical question – to the electrode at which hydrogen is evolved, from the electrode that becomes thinner or even suggested using a voltmeter. There was a considerable discussion of anode and cathode but this is the crux of the question how do you predict which is the positive and which is the negative electrode. The simplest and best answer is the electrons flow from the more reactive to the less reactive metal.

Question 5

(a) Group II metals will lose 2e and Group VI elements will gain 2e. The usual reason for not awarding the marks was that many candidates did not specify which gained 2e and which lost 2e or implied that they could both lose and gain electrons. Typical comments were:

- they could lose or gain two electrons
- they lost and gained two electrons
- one gained two electrons and the other lost two electrons.

(b) Most candidates gained all three marks, very pleasing levels of skill and knowledge. A few thought that it was an ionic compound despite being told in the question that it was covalent and others gave the formula as SCl.

(c) Many candidates in part **(i)** repeated the information in the table – solid strontium chloride is a poor conductor and liquid strontium chloride is a good conductor of electricity but did not explain why. A similar situation pertained in part **(ii)** that is repetition of the information in the table without explanation. To be awarded the marks, the response had to include the following.

(i) Ions cannot move in a solid or they are free to move in a liquid.

(ii) No ions in sulphur chloride or it is a covalent compound or it only has molecules or only liquid strontium chloride has free ions.

A widespread mistake was to think that electrolytic conduction was due to the presence of free electrons.

Question 6

(a)(i) The standard of the responses to this question was very variable ranging from the correct structure of 1, 1 dichloroethene to ethene, 1, 2 – dichloroethene, chlorinated alkanes and polymers. The method of arriving at the structure of a monomer from the structure of the polymer is to include a double bond along the chain and remove the bonds that indicate continuation.

(ii) Oxygen diffuses faster because it has a lower M_r or a lower density or its molecules move faster. To state that oxygen is lighter does not warrant both marks although the comment – "oxygen molecules are lighter" would. Many candidates talked about oxygen molecules being smaller, others persisted in the mistaken belief that diffusion can be explained using the idea of a sieve. Neither of these approaches were awarded any marks.

Candidates from some Centres used the concept of the average kinetic energy of the gas molecules and its dependence on temperature. This level of sophistication is not required by the syllabus but obviously if it is applied correctly then both marks were awarded.

(b)(i) Most gained partial credit for the ester linkage but the majority were not able to draw the polymer chain. This difficulty was compounded by those who attempted to expand the group C_6H_4. The following was required: $–OOC–C_6H_4–COOCH_2CH_2O–$.

(ii) Fats or lipids were the correct answers given on most scripts.

Carbohydrates or proteins were the usual errors.

(iii) It does not decompose easily when heated – is an adequate explanation of the term thermal stability. It is not true to say that the substance does not change when heated, it could melt. The word "stable" cannot be used to explain stability.

(c)(i) The marking points were:

- does not decompose or is non-biodegradable
- shortage of landfill sites or of space
- visual pollution
- poisonous/toxic/harmful gases when burnt
- dangerous to animals.

Generally this question was well answered. The usual error was to state that plastics gave off harmful gases but omitted to add "when burnt". Another mistake was to quote a harmful gas, carbon monoxide, which can be produced when any carbon-containing substance is burnt. Candidates should be advised to use general terms, such as toxic and poisonous.

(ii) There was a tendency to repeat information given in part **(i)** and to comment that recycling avoided these problems. The advantage of recycling plastic waste is to conserve petroleum or to save energy.

Question 7

(a)(i) $Zn(OH)_2 = ZnO + H_2O$

Mistakes were:

$Zn(OH)_2 = ZnO + H_2$

$ZnOH = ZnO + H_2$

$2Zn(OH)_2 + O_2 = 2ZnO + 2H_2O$

(ii) A correct description would include one of the following – it would melt or it does not decompose or it does not react. No change was not accepted, it would melt.

Many thought that there would be a violent reaction or that sodium hydroxide followed the pattern of most metal hydroxides when heated.

$2NaOH = Na_2O + H_2O$

(b) The three observations are a blue solid changes to a black solid and a brown gas formed. Hardly anyone mentioned that copper nitrate is blue, the most frequently awarded mark was for the black solid, obviously followed by the mark for a brown gas.

It was not uncommon to see the comment "it turned white", presumably thinking of copper sulphate.

(c) The correct solution for this calculation is given below:

number of moles of $Fe_2(SO_4)_3$ = 1/40 *or* 0.025

number of moles of Fe_2O_3 formed = 1/40 *or* 0.025

mass of iron(III) oxide formed = 0.025 x 160 = 4 g

number of moles of SO_3 produced = 3/40 *or* 0.075

volume of sulphur trioxide at r.t.p. = 0.075 x 25
= $1.8dm^3$

The only systematic error noted was the inclusion of integers derived from the equation – 1, 1, 160, 3, 72. No marks were allocated for this tactic. The usual outcome was that candidates were awarded 5/5, 4/5 or 0/5.

Question 8

(a)(i) The formula is C_6H_{12}. Most were awarded this mark but very few managed to earn the boiling point mark which was given for a temperature between 60 to 65°C. Perhaps candidates were not familiar with this type of reasoning. The differences in boiling points are +54, +41, +37°C. They are converging so a sensible estimate, but not necessarily the experimental value, would be in the range 30 to 35°C giving a boiling point 60 to 65°C. Candidates either got in this range or were significantly above or below it.

(ii) A very well answered question with the right formula, $C_{12}H_{24}$, on most scripts together with the working.

(b) The two familiar tests involve the addition of bromine water or of potassium manganate(VII). The problems are perennial – not giving the initial colour of the reagent or believing that clear and colourless have the same meaning. However, in fairness the majority of the entry scored 2/3 or 3/3.

(c)(i) Very good standard of response, from some Centres, 100% of their candidates correctly named the class of compounds – alcohols.

(ii) A formula for 2-chlorobutane was needed – $CH_3–CH_2–CHCl–CH_3$. This proved to be very demanding, frequently the chlorine was in the wrong place or there too many chlorine atoms per molecule or the suggested product was not even a derivative of butane.

(iii) The formula for the polymer is a variant on the following: $–CH(CH_3)–CH(CH_3)–$. Correct formulae were very rare, the usual attempt was the formula of poly(ethene), another version was the polymer from but-1-ene.

Paper 0620/04
Coursework

General comments

As is usually the case, only a few Centres submitted coursework for moderation in the November session. The majority of these Centres were new and, although the standard of the work submitted was satisfactory, there were issues concerning the putting together of a sample for moderation. Not all of the problems listed below applied to all Centres but all had at least one problem. It is helpful if Centres stick to the instructions given in the syllabus, this enables Moderators to be fair when judging the relative achievements of candidates. Moderators do not wish to be put in the position of penalising candidates because of lack of information from the Centre.

Problems this November included:

- Instruction sheets and mark schemes for *all* investigations used in assessment should be included. Not just those for investigations included in the sample.
- Where a Centre has more than ten candidates it is necessary to send twenty seven separate scripts, nine for each of skills C2, C3 and C4. These scripts should be; three at a high level of achievement, three at an intermediate level and three at a lower level. The complete work of nine candidates, three at each level, is not an acceptable alternative.
- Mark schemes should be linked to the investigation concerned and not a copy of or rewording of the syllabus criteria.
- It is important that the mark sheet be filled in properly with the mark out of 48 achieved. This is used to record the marks of the candidate in CIE's system and incorrect completion can result in results being delayed.
- All other forms: Individual candidate record card, Coursework assessment summary form and Experiment form, should be completed and included with the sample.

Paper 0620/05

Practical Test

General comments

The majority of the candidates successfully attempted both questions. A few Centres failed to submit a copy of the Supervisor's results for both questions. It is important that Supervisor's results are included with the scripts as they are used to assess the accuracy of the candidates' responses. The overall standard of scripts was an improvement on previous years with candidates scoring high marks on **Question 1**.

Comments on specific questions

Question 1

The majority of candidates successfully completed the five experiments and thus the table of results. In **(a)** the points were generally well-plotted. However, best-fit straight lines were often missing. Part **(b)** was well-answered and the units usually given. In **(c)** exothermic was a common incorrect answer. Part **(d)** was a good discriminator. Only the better candidates referred to the temperature changes being less. Commonly references to rate of reaction were given. Parts **(e)** and **(f)** were generally well-answered. In **(g)** changes to the apparatus were often meaningless. Correct responses included reference to insulation or use of a burette/pipette instead of a measuring cylinder.

Question 2

This question discriminated well. In **(b)** correct descriptions of sublimation were only given by the better candidates. Descriptions of changes to the damp indicator paper were often omitted. In **(c)** a pH value was often not given – a colour is not a pH value. In **(d)** the tests produced a variable response. Some candidates are still referring vaguely to milky/cloudy instead of white precipitates. In part **(iii)** some bleaching of indicator was incorrectly described.

Part **(f)** was a good discriminator. Correct responses referred to ammonia and/or acid gas evolved with a reference to sublimation. In **(g)** a few candidates referred to the presence of nitrate ions, presumably confusing the presence of ammonia.

Paper 0620/06

Alternative to Practical

General comments

The majority of candidates successfully attempted all of the questions. The overall performance varied. Some candidates had not covered the material in **Question 3** and consequently scored few marks for this question. Overall, the degree of difficulty of the paper was thought, by Examiners, to be similar to those from previous years.

Comments on specific questions

Question 1

Generally well-answered. Some candidates labelled the funnel and not the hydrochloric acid. A minority of candidates reversed **A** and **B**. In **(c)** a large number of glowing splints were seen instead of lighted splints.

Question 2

A significant number of candidates joined all of the points and did not draw a smooth line graph. In **(c)** many candidates lost the mark because 'completely reacted' was an incorrect response.

Question 3

Some candidates did not know the test for an alkene. In **(d)** vague answers referring to hot apparatus were prevalent e.g. 'do not touch the hot tube.'

Question 4

The majority of candidates scored maximum marks for completing the table. A few missed the 0.5 readings and rounded up the answer. The graph was well-plotted and straight lines were common and often correctly extrapolated. The unit was often correctly given in **(b)**. In **(c)** exothermic was a common incorrect answer. Part **(d)** was a good discriminator. Only the better candidates referred to the temperature changes being less. References to rates of reaction were common. Parts **(e)** and **(f)** were well-answered. In **(g)** changes not referring to the apparatus were common. Correct answers included using a burette/pipette instead of a measuring cylinder and lagging the reaction vessel.

Question 5

This question was a good discriminator and not as well-answered as in previous years. Yellow precipitates were common in **(c)(ii)**. Chlorine was a common incorrect answer in **(d)**.

Question 6

Part **(a)** was poorly attempted. A large number of candidates mentioned a positive effect of aqueous sodium chloride to indicators e.g. litmus turns red. The solution is, of course, neutral.

Part **(b)** was well answered. Part **(c)** was a good discriminating question. Good answers involved heating or adding dilute acid/barium chloride solution

Question 7

This planning question was well-answered. Candidates were capable of describing chromatography in detail. Marks were often lost for omitting the solvent or failing to compare the result at the end.