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Group III
Sciences

CHEMISTRY

Paper 0620/01
Multiple Choice

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General comments

The mean mark for this Paper was 30.0, with a standard deviation of 6.3. The reliability coefficient for the items in the Paper was 0.85. All of these statistical parameters show that the Paper worked effectively in discriminating between the candidates.

Questions 1 and **2** were both quite easy but this is in line with having straightforward easy starters to help candidates settle down. Other questions found quite easy were **8**, **13**, **16** and **32**. The most demanding questions were **19**, **24** and **34**. Comments on these latter and other questions are given below.

Comments on specific questions

Question 4

The most popular incorrect choice was **A**. Perhaps these candidates did not read the question carefully enough in that they may merely have associated “paraffin” with “cracking”.

Question 5

In this case, **D** was the most popular incorrect choice. Isotopes, of course, have equal numbers of protons, not neutrons and candidates choosing **D** may be confused about which particle is which.

Question 6

A third of the candidates wrongly chose **D**. Was this because **D** was the odd man out in being an rather than an *H* atom? Response **B** also had a nucleon number to proton number ratio of 2. **Question 5**, some candidates may be confused about the terms nucleon, neutron and proton and so fa to make the necessary subtraction to identify the key.

Question 13

This item proved to be rather easy for this ‘full subject’ syllabus in Chemistry.

Question 15

A third of the candidates chose **B**. Did they not realise that combustion is an exothermic process?

Question 18

This proved slightly harder than expected. The statistics hint at candidates either knowing the answer or merely guessing.

Question 19

Candidates found this harder still than **Question 18** but the ‘guessing’ comment above may apply here as well. This is somewhat surprising as the question is based on an identification test that is in the syllabus.

Question 20

About a quarter chose **C**. It is a common mistake made year by year that copper reacts with dilute mineral acids.

Question 24

A hard question but one that discriminated well. A third chose **A** rather than **B**. Extra care is needed when attempting to answer questions of the “*not*” variety.

Question 27

This question should have been one of simple recall but a third of candidates chose **A**.

Question 30

Candidates were not readily fooled by **B** but about 20% went for **A** and for **C**. The gas NO_2 is a pollutant present in car exhaust fumes but it comes from the reaction of nitrogen and oxygen due to the high temperature of the fuel combustion but not from the fuel itself.

Question 34

Only 45% answered correctly and nearly as many chose **C**. This seems to suggest that many candidates do not appreciate that acetylene is a hydrocarbon with a combustion product of carbon dioxide.

Paper 0620/02

Core Theory

General comments

Many candidates tackled the Paper well and there were many good answers showing a thorough grasp of the subject matter. The rubric was generally well interpreted and few candidates misinterpreted the instructions or did not read them carefully enough. However, a minority did not grasp exactly what was required and, for example, wrote part symbol equations in place of word equations or explained things which were unrelated to the question. A good example of not reading instructions arose in **Question 3 (c)(ii)**, where some candidates included fluorine or potassium in the list despite being instructed to choose from bromine, chlorine and iodine. Molecular structure was generally well known even with low scoring candidates but simple particle theory seemed to cause many problems. As has been commented on in previous reports, there were a few instances where candidates disadvantaged themselves by giving multiple answers e.g. **Question 5 (f)(iii)** and **Question 6 (f)(iii)**. If candidates give one correct and one incorrect answer, they will not get the mark because it indicates that they are hoping to get the correct answer by chance. It was encouraging to note that the majority of candidates were able to write correct formulae in the appropriate places and to name compounds correctly. Many candidates still appear to have difficulty in answering, questions based on environmental problems associated with Chemistry, correctly e.g. **Question 5 (f)(iii)**. The quality of the answers to questions on organic Chemistry was disappointing and few candidates seemed to be able to write a correct molecular formula. A significant minority of candidates experienced difficulties with questions involving charged particles e.g. **Question 2 (e)** and **Question 6 (f)**. The difference between ions and electrons often seemed muddled in the minds of the candidates. Questions of a more generalised nature, requiring a greater freedom of response, such as **Questions 5 (e)(i)** and **5 (f)(ii)** still pose a problem for some candidates. Many tended to respond rather vaguely. Most candidates attempted every part of each question but some left spaces in places where it mattered e.g. in **Question 2(f)**, where both ticks and crosses were required. The Examiners cannot assume that the lack of a tick means a cross. The standard of English was generally good, most candidates answering in whole sentences where required.

Comments on specific questions

Question 1

In general, this was a fairly high scoring question although few candidates scored full marks. The most difficult parts seemed to be related to the properties of ammonia.

(a)(i) This was practically always answered correctly, even by the weakest candidates. Alkene was the commonest mistake.

(ii) The formula for methane was well known and although a few candidates unnecessarily drew dot and cross diagrams, a few of these were incorrect and so failed to gain the mark. A few candidates drew the structure of ethane.

(iii) The required answer of 'natural gas', was given by about 60% of the candidates. Many candidates were satisfied with vague answers such as 'the ground' or thought, incorrectly, that most methane came from petroleum or from cracking.

(b)(i) The correct percentage of nitrogen in air was not always well known, with many candidates believing that the figure was around 60 or 70%. A not insignificant minority of candidates gave values that were very low e.g. 20%, presumably mistaking it for oxygen.

(ii) Most candidates chose either oxygen or carbon but quite a few candidates incorrectly gave an element in the same Group, phosphorus being the most common error. A number of candidates appeared not to read the stem of the question and chose a metal rather than a non-metal.

(c)(i) It is encouraging that most candidates were able to define a catalyst in terms of a substance that speeds up a reaction. However a handful of candidates still use the words 'alter the rate' which is not acceptable because of its vagueness. Negative catalysts are generally called inhibitors.

(ii) Most candidates realised that the rate of reaction increases when the temperature increa

(d)(i) A considerable number of candidates did not answer this question, presumably because looked straight down to the first dotted line. Candidates should be encouraged to go through Paper checking off questions in order (a), (b), (c) etc, so that they do not miss short questions such as this. Those who did answer this question, invariably got it correct, 3 being the commonest incorrect answer.

(ii) Most candidates gave a good explanation of a reversible reaction or an equilibrium reaction.

(e) The idea of the arrangement of the particles in a liquid was little known. It may be that some candidates did not read the question properly and assumed that ammonia was in the gaseous form. However, the wording of the question is unambiguous and further evidence suggests that many candidates think, incorrectly, that the particles in a liquid are at least one molecule's distance apart. The evidence comes from the considerable number of candidates who annotated their diagrams and put phrases such as 'liquid particles are apart from each other'. Candidates should be encouraged to draw particles in a liquid which are touching or much less than a molecule's distance apart as well as being randomly distributed.

(f) Most candidates gave a correct test for ammonia but a few gave the incorrect colour changes or suggested, incorrectly that a white precipitate (rather than white fumes) would be formed when hydrogen chloride vapour is put near ammonia. The addition of sodium hydroxide and sometimes aluminium was occasionally incorrectly included in the answers.

(g)(i) Many candidates gave a satisfactory answer to this question but, as is usual with environmental type questions, some gave very vague answers such as 'for growth' or 'so it gets the right minerals'. There was often a focus on the soil rather than on plant growth.

(ii) This question was surprisingly poorly done, the correct answer of sulphuric acid only being seen in about 60% of the cases. Some candidates wrote 'hydrogen sulphate' as a near approximation to the correct name, but potassium sulphate, copper sulphate and sulphur and oxygen were commonly seen incorrect answers.

Question 2

This question was the best answered on the Paper, most candidates scoring at least two thirds of the marks available. The idea of filtration was well known and the equation in part **(c)** was usually balanced correctly. The most problems were caused by part **(a)**, where the concept of an ion was either little understood or badly explained.

(a) Many candidates gave good answers such as 'an atom or group of atoms which has lost or gained electrons'. Credit was given for the idea that an ion is a charged atom/molecule, even though strictly speaking an atom or molecule is neutral. However, a large number of candidates merely referred to charged particles, which could encompass electrons and protons as well as ions. Indeed, some candidates thought that electrons were examples of ions.

(b) About two thirds of the candidates correctly identified calcium as the positive ion with the highest concentration. A large number of candidates failed to read the question carefully enough and did not notice that the hydrogencarbonate ion is negatively charged.

(c) Most candidates gained the mark for balancing the ionic equation.

(d) This question was generally answered well by all but the weakest candidates. Although calcium hydrogencarbonate would decompose on even gentle heating (there are even doubts about its true existence as a solid), candidates are not expected to know this, so this compound was accepted as well as the decomposition product (carbonate). The weakest candidates failed to realise what to do in the question, despite the example and potassium compounds were occasionally seen although there was no potassium in the table.

(e) Only about 50% of the candidates obtained the mark for the correct formula, $CaCl_2$. Candidates who wrote an ionic form, invariably failed to gain the mark because of the incorrect ion e.g. Cl_2^- which was written. Others just counted up the ions and either put a large number in front or did not simplify the formula to its lowest possible ratio of calcium and chloride.

(f) Most candidates obtained at least one of the two marks available. The most com... were to suggest that calcium liquid did not conduct electricity and that calcium chlori... conduct.

(g) Most candidates scored all three marks. The standard of drawing was generally good and m... candidates took great care to explain the separation procedure. One of the most commo... mistakes was to not mention the filter paper, some candidates suggesting that the funnel by itself served as a filter.

Question 3

Most candidates scored at least half marks on this question but few scored full marks, each part of the question posing its own problems for individual candidates. As has been stated in the 'General comments' section, many candidates do not seem to read the stem of the questions with sufficient care.

(a) The four boxes were generally all filled in, but a few candidates appeared to miss out putting colours on the left. The colour of chlorine was generally well known, although a few candidates suggested that it was white, presumably because of its bleaching action. The colour of solid iodine was less well known, purple (muddling with the vapour) or blue were common incorrect answers. The states of fluorine and bromine were often not known and it appeared that many candidates did not use the information from the melting and boiling points to help them. Many candidates thought, incorrectly that bromine was a solid.

(b) This was poorly done, many candidates suggesting negative boiling points. A wide range of values was accepted around the actual boiling point (184^{o}C) but despite having the value of the melting point (114^{o}C) in the table, a sizeable proportion, opted for values less than this. The candidates who were most successful tended to compare the difference in the melting points and boiling points and use the trend to calculate the boiling point of iodine. A number of candidates mistakenly believed that iodine has no boiling point because they suggested that it sublimes. This is incorrect. Careful heating of solid iodine results in a liquid that is clearly visible. The problem with the sublimation idea arises from the fact that iodine crystals are seen to be formed directly from the gas when iodine vapour condenses on the cold parts of the test tube after heating.

(c)(i) About two thirds of the candidates wrote the word equation correctly. Those who did not, either rewrote one of the reactants as the products or used potassium iodide in place of potassium bromide. Candidates should be advised not to write symbol equations where word equations are requested. If the symbol equation is correct full marks are obtained, but candidates all too often make mistakes in symbol equations such as Br instead of Br_2 or KCl_2. Such mistakes cannot be given credit.

(ii) Most candidates were able to rank the halogens in order of their reactivity but a surprising number placed fluorine or even potassium amongst the three requested or put two on one line.

(d) Most candidates gained the mark for either disinfecting swimming pools or for water purification. Candidates should note, however, that vague statements such as 'for cleaning' or 'plastics' will not gain credit. Specific uses are always required e.g. 'for making PVC' is a good answer.

(e) About two thirds of candidates realised that hydrogen chloride is a covalently bonded molecule. The most common incorrect answer was 'ionic'.

Question 4

As stated in the 'General comments', many candidates found this question difficult and did not appear to have a good grasp of Organic Chemistry. This has also been commented on in previous reports.

(a) Many candidates had a reasonable idea of what constitutes an organic compound but often found it hard to put into words. Many candidates disadvantaged themselves by claiming that organic chemicals were hydrocarbon or contained carbon and hydrogen <u>only</u>. The definition as a compound found in living things, although a 19th century definition, is rather too vague a statement for modern Chemistry, in a world of synthetic polymers and man-made drugs.

(b) Many candidates correctly identified the two carboxylic acids as belonging to the same homologous series, but a surprising number gave incorrect combinations.

(c) Ethene was generally identified as the unsaturated hydrocarbon.

(d) **D** (ethanol), was not always identified as the alcohol and **E** was a common incorrect answer.

(e) This question was surprisingly poorly done, many candidates thinking that **D** (ethanol), was formed by cracking paraffins.

(f)(i) The term exothermic was generally explained by most candidates as a reaction which gives out heat.

(ii) A wide variety of answers were given here. Many candidates only gained one mark here, commonly for carbon dioxide and less often for water. A great number of candidates suggested that hydrogen was a product of combustion or that carbon monoxide was formed, despite the stem of the question mentioning excess air.

(iii) In keeping with the poor performance of some candidates in part **(ii)**, many candidates suggested, incorrectly, that carbon dioxide is formed when organic compounds are combusted incompletely. Some candidates failed to gain the mark because they put down two compounds, one of which was not a carbon compound.

(g) Only about one third of the candidates wrote the molecular formula correctly, and a considerable number of half structural and half molecular formulae were seen. A minority of candidates even wrote full displayed formulae.

(h) The correct answer for the relative molecular mass was 88, and some candidates, despite writing the correct molecular formula, missed off 1 or 2 hydrogen atoms in their calculations. Candidates should also be advised that relative molecular mass does not have a unit because it is a ratio.

(i) Chromatography was correctly identified by the majority of the candidates as the method for separating coloured pigments. The most common mistake was to suggest that distillation or filtration could be used. Spelling of chromatography was often poor but a reasonable allowance was made for this.

Question 5

This question posed a number of problems for the candidates in terms of the understanding of terminology in parts **(a)**, **(c)(ii)** and **(d)(ii)** and in their ability to explain processes in terms of particle (kinetic) theory. Although many candidates scored half marks for this question, very few obtained high marks.

(a) The idea of a metal ore was not well understood, the commonest suggestion being that it was just a compound or a form of metal. Marks were gained by those candidates who suggested some link with rocks or the earth.

(b) Limestone was almost always seen as the (correct) answer. Limewater was the most common incorrect answer.

(c)(i) Many candidates found the word equation unexpectedly difficult. The most common mistake was to suggest that CO is carbon dioxide. This, together with the evidence from **Question 4 (f)(ii)** and **(iii)** suggests that candidates are unsure of the difference between these two gases. Candidates should be reminded that putting numbers as well as words in a word equation is unacceptable – it is neither one thing nor another. A large number of candidates failed to gain the mark by incorrect copying of the (III) in the iron(III) oxide, this being replaced by a (II). Similarly, a large number of candidates disadvantaged themselves by putting iron(II) as a product rather than simply iron. Candidates should be advised to simply write out the word equation without the oxidation states if they are not sure what they mean.

(ii) Although many candidates had a reasonable grasp of the term reduction, there were some very vague or contradictory answers. An answer such as 'removal of oxygen and loss of electrons' will not score any marks because of the contradiction. Candidates would be advised to stick to one answer, preferably the most straightforward. A number of candidates failed to gain the marks for removal of oxygen because the oxygen was being 'removed from an element'.

(d)(i) There were a wide variety of answers here, but it was encouraging to note that a good f the candidates obtained the mark for this question, where the answer was not immediate

(ii) More candidates had difficulty in describing endothermicity than exothermicity, but most cand gained this mark.

(e)(i) There were a variety of answers accepted here and most candidates obtained at least one mark. Some candidates failed to get the marks because they described the processes in the blast furnace rather than those in the oxygen converter.

(ii) Most candidates gave a suitable answer here, most choosing the use 'for making car bodies'.

(f)(i) Although some candidates gave full answers, many did not access the question and concentrated on the acidity, failing to mention the pH. The candidates were expected to make a correlation between pH and corrosion and if this was not done, the mark was not gained. It was clear that many candidates did not realise that a higher pH meant greater acidity. Candidates should also be encouraged to write answers in the form : 'the ….. the pH the …. the corrosion', otherwise it is not clear what relationship is being considered. An answer such as 'the corrosion increases' is not acceptable, as no relationship is obvious.

(ii) More candidates gained this mark in comparison with part **(i)** but a considerable number tried to tie in pH with temperature, which resulted in confused answers. For the explanation most candidates gained at least one of the two marks, but some showed a lack of thought in suggesting that it was the steel particles which moved faster as the temperature rose (as opposed to vibrate faster).

(iii) Many candidates failed to access the marks through not choosing a gas. Sulphuric acid, nitric acid and lead were incorrect answers which were often seen. Candidates should be advised to choose a specific source for their answers rather than rely on vague answers such as 'factories'.

Question 6

This was one of the best attempted questions on the Paper apart from part **(f)**, which posed conceptual problems (see 'General comments' above). Most candidates scored at least two thirds of the marks available.

(a) Most candidates correctly wrote distillation. The commonest answer which was judged incorrect was 'condensation'.

(b) Most candidates recognised the flask, although there were many variants on this e.g. conical, Buchner, volumetric. Candidates should be advised to stick to the simplest single word.

(c) It was pleasing to note that even many of the weakest candidates obtained both marks here.

(d)(i) Most candidates realised that the pH of pure water was 7, the commonest error being to think that it was 6 or 1!

(ii) Most candidates obtained the mark here, although a few omitted the units and thus forfeited the mark.

(e)(i) The correct answer (24g) was given by about 70% of the candidates. A not inconsiderable number of candidates multiplied by 6 and got the incorrect answer 1080 or made incorrect mathematic calculations to get 18g.

(ii) This was practically always correct.

(iii) This was practically always correct.

(iv) A wide variety of responses were elicited. Those candidates who knew the test for calcium generally gained all three marks. A good number of candidates failed to select the correct precipitating agent, silver nitrate being a common example. Some candidates disadvantaged themselves by selecting sulphuric acid as an agent to dissolve the calcium sulphate.

(f)(i) Fewer than half the candidates obtained both marks here, common mistakes bei… f electrons carrying the charge and the lack of statements about the movement (of the ion…

(ii) Many candidates identified chlorine as a product at the positive electrode but fewer ide… sodium as being formed at the anode in the absence of water. Many candidates failed to rea… that the melt was not a solution and so put hydrogen as a cathode product.

(iii) Most candidates identified carbon or platinum as suitable electrodes, although a large minority incorrectly suggested that iron or copper would be suitable.

Paper 0620/03

Extended Theory

General comments

Teachers might like to pass to their candidates the following general advice, none of which is new, but every year some candidates fail to act in accordance with these constructive suggestions and consequently do not realise their full potential in terms of marks and grades.

The request to complete the following equations implies in the same format as the part equation that has been written on the Paper. Word equations should be completed by writing the names of the other reagents or products, similarly a symbol equation must completed by writing formulae and then balanced. Hybrid equations, that is names and formulae, should be avoided.

At this level, it is not acceptable to omit hydrogen atoms from structures, neither is an isolated hydrogen atom, that is one in the appropriate position but without a bond between hydrogen and carbon, considered to be correct.

Probably the oldest piece of advice offered to examination candidates throughout the ages is – read the question, think what is required and read the question again to be certain of the type of response that will be awarded the marks and only then start to write.

It is essential that if a candidate redrafts the answer on the blank pages, then the original answer must be deleted and reference made to new version. These blank pages can be used for rough work or for redrafting answers, the candidate must make it clear which answer is to be marked.

The advice about handwriting remains unchanged, if the Examiner cannot decipher poor handwriting then the marks cannot be awarded. The writing on some scripts seems to deteriorate at the point when the candidate is uncertain about the Chemistry, Examiners will not interpret uncertainties in meaning due to writing bordering on illegibility, in favour of the candidate.

In every year since the inception of this examination, for some candidates who have been entered for Paper 3, it presents an inappropriate test of their skill and knowledge and they attain very low marks or hand in blank scripts. From 2004, candidates can only be entered for Paper 2 or Paper 3 and not both as in the past. In the future, candidates should be entered for Paper 3 only if they expect to achieve grade D or higher. Being entered for this higher and more demanding Paper could reduce an individual's chances of attaining their optimum grade, as Paper 2 is designed to allow candidates expected to gain a C or below to show their skills better and to concentrate on core concepts. Candidates who are correctly entered should find preparing for and sitting the examination a more positive and rewarding experience that best allows them to demonstrate their abilities to the full.

Comments on specific questions

Section A

Question 1

(a)(i) Most candidates could recall the correct temperature, that is one in the range 300 to 600°C, and many knew that the catalyst was vanadium(V) oxide. The marking scheme did not require the oxidation state to be correct. Few gave an appropriate value for the pressure and even fewer could quote the volume ratio for the reacting gases, that is 2:1 sulphur dioxide to oxygen or possibly a slight excess of oxygen compared with the stoichiometric ratio.

A common error was to confuse this process with the Haber Process and name the catalyst as iron and quote a pressure of hundreds of atmospheres.

(ii) Many thought that the yield of sulphur trioxide would increase with increasing temperature and tried to justify this incorrect belief by a discussion of reaction rate. Those who answered the question correctly usually followed the conventional argument – an increase in temperature favours the reaction that takes in energy/heat, that is the back reaction, the endothermic one. The position of equilibrium moves to the left decreasing the yield. The introduction of a discussion of relative rates only served to confuse the candidate.

(iii) The majority were able to describe how sulphur trioxide was changed into sulphuric acid. Typical errors were to give dilute rather than concentrated sulphuric acid or to imagine that the conversion was carried out using just water.

(b) The required answers and usual mistakes were:

- sodium carbonate or hydroxide or hydrogen carbonate – sodium metal or sodium oxide was the most frequent mistake.
- zinc oxide or hydroxide or carbonate – quite a range of errors, zinc salts, such as sulphate, and zinc metal, this reaction is redox not neutralisation.
- any soluble barium salt, such as chloride or nitrate or even barium hydroxide which is sufficiently soluble to participate in a precipitation reaction.
- neutralisation – many gave methods that were not given above.

(c)(i) Most could answer this part – copper(II) sulphate or anhydrous copper(II) sulphate. Some ignored the instruction to name the powder and gave its formula. The term "unhydrated" was frequently used instead of anhydrous, it was accepted but hopefully the correct word "anhydrous" will get greater emphasis in the future.

(ii) Almost the entire entry realised that the mixture would turn blue.

(iii) The black powder was correctly recognised by most of the candidates as being copper(II) oxide, a minority thought it was carbon or soot.

(iv) Moles of $CuSO_4.5H_2O$ = 5/250 = 0.02
Mass of one mole of CuO = 80g
Mass of copper(II) oxide = 80 x 02 = 1.6g

An alternative route is to calculate the mass of SO_3 and subtract that from 3.2g.

The most common errors were:
5.0 – 3.2 = 1.8g
or to calculate the mass of copper metal, 64 x 0.02 = 1.28g
or to think that the formula of the oxide was CuO_2
or that the black powder was copper(II) sulphide.

Question 2

(a)(i) Two properties selected from the following list were needed.

- hard metal
- high melting or boiling point
- coloured compounds or coloured ions
- ability to form complex ions

There was a tendency to repeat information given in the question, catalytic activity and more than one oxidation state or to give typical metallic properties e.g. good conductor of electricity.

(ii) The electron distribution is 2 + 8 + 13 + 2. The most frequent response was 2 + 8 + 8 + 2 closely followed by 2 + 8 + 43 + 2. The number 43 being derived from 55 –12

(b)(i) Magnesium instead of manganese was the only systematic error. Most candidates were able to give this word equation.

(ii) Very few gave both manganese(III) oxide and manganese(IV) oxide. Many recognised that the amphoteric oxide would react but did not realise that the acidic oxide also reacted with the alkali.

(c)(i) The majority gave "increase" presumably confusing the volume of the gas with the rate of reaction. A typical response was – at first the rate of reaction increased then it levelled off and stayed constant. There were other erroneous ideas – the reaction stopped because the catalyst was used up. The required comments were that the rate decreased with time because the concentration of the hydrogen peroxide was decreasing; partial credit was gained by the comment – the hydrogen peroxide was being used up.

(ii) Whereas most correctly sketched the graph with a higher initial slope, only a few realised that the final volume of oxygen would be doubled.

(iii) This question had to address the shape of the graph, many gave information that was correct but did not relate their answer to the shape of this new graph. Its initial gradient would be less but the final volume of oxygen would be the same.

It seems from the evidence derived from the attempts at answering this question that many candidates cannot relate the theory of reaction rates to the interpretation of graphs of this type. Future candidates could well be advised to practise this type of question.

Question 3

(a)(i) Many did not understand the term "oxidation state" and attempted to explain its increase in terms of reactivity rather than the number of electrons in the outer energy level.

(ii) Most realised that these atoms gained electrons hence the negative charge but ignored the rest of the question and failed to explain why the oxidation state decreased. The required response was the number of electrons in the outer level increased so the atoms across the period needed to gain fewer electrons to complete the level. In fairness, some candidates produced excellent answers to these two parts.

(b) This question was well answered, candidates usually had both formulae correct. Typical mistakes were to try to include oxygen or to think that the valency of phosphorus is 5 and that the formula for silicon phosphide is P_4Si_5 .

(c) Candidates did not realise that the choice of element had to confined to Period 3. Most of the candidates gained at least some marks for this part, a significant proportion were awarded the three marks.

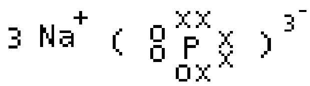
(i) Silicon(IV) oxide could not be accepted although it has the requisite structure – it is not an element.

(ii) Most knew that the element was sodium, others offered potassium or less und… magnesium. Although this element is in Period 3 it certainly does not react violent… water.

(iii) Either sulphur or chlorine was accepted.

(d) All that was needed was – argon is unreactive. There are more sophisticated reasons that relate to the choice of argon, a gas is needed in the bulb, if it were evacuated this would promote the sublimation of the filament but the basic reason remains the low reactivity of this gas.

(e) In recent years there has been a marked improvement in the standard of these diagrams. However this year there has been a relapse, the overall quality was disappointing. Many thought that the compound was covalent, others did not represent the formula as Na_3P but the biggest problem was to offer a jumble of diagrams that might include all the marking points. All the necessary information can be included in a single diagram.



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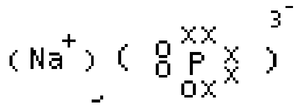


It is not necessary to include diagrams of the separate elements or details of the inner energy levels. The unnecessary detail greatly increases the risk of error and ambiguities. When answering questions of this type, candidates should be advised to include the stoichiometric ratio, the ionic charges and the arrangement of valency electrons around the anion.

(f) The solution to this problem is as follows.
moles of Na = 11.5/23 = 0.5
therefore moles of S reacted = 0.25, that half of the above since the mole ratio is 2Na:1S.
mass of sulphur reacted = 0.25 x 32 = 8g
mass of sulphur left unreacted = 10 – 8 = 2.0g

There were many incorrect versions of this calculation, most caused by not following the structure in the question or by not appreciating that sulphur was the reagent in excess.

moles of Na = 11.5/23 = 0.5
moles of S reacted = 10.0/32 = 0.3
mass of sulphur reacted = 0.3 x 32 = 9.6g
mass of sulphur left unreacted = 10 – 9.6 = 0.4g

moles of Na = 11.5/23 = 0.5
moles of S reacted = 10.0/32 = 0.3
mass of sulphur reacted = 5.75g being 11.5/2. This was quite common despite the mass of 11.5 refers to sodium not sulphur.
mass of sulphur left unreacted = 10 – 5.75 = 4.25g

moles of Na = 2
moles of S reacted = 1
mass of sulphur reacted = 5.0g being 10/2 = 5
mass of sulphur left unreacted = 10 – 5 = 5g

Question 4

(a)(i) There are relatively few uses of copper metal. Many of the uses given by the candidates were of alloys – coinage, door knobs, ornaments etc. Acceptable uses of this metal are wires or cable, pipes, utensils, for roofing, bimetallic strips. The statement – a good conductor, does not characterise a use but rather a property, similarly electric wires and telephone cables can only count as one use.

(ii) A simple diagram was expected that included circles of a different sizes to represe these arranged in a pattern and some indication of the presence of delocalised elec latter was almost invariably omitted.

(b)(i) Usually correct.

(ii) A minority thought that the sulphate ion was discharged.

(iii) Most of the candidates could write this equation. The most frequent mistake was to include an extra 2.
Cu^{2+} + 2e = 2Cu

(iv) The colourless gas was often identified as hydrogen and the solution was described a colourless, this was a repeat of the information given in the question.

(c) The following are acceptable statements about a cell.
The reaction in a cell is exothermic.
A cell produces electrical energy.
In a cell reactions produce electricity.
In a cell chemical energy is changed into electrical energy.

Comparable statements regarding electrolysis are:
The reaction in electrolysis is endothermic.
Electrolysis uses or requires electrical energy.
During electrolysis electrical energy is changed into chemical energy.

A popular misconception was that in electrolysis, there was the movement of ions but in a cell there was the flow of electrons. Both electrochemical processes involve the movement of ions in the electrolyte and the flow of electrons in the external circuit. Another fallacy was that the electrodes in electrolysis are made from the same material but in a cell they have to be different. Carbon electrodes, one in bromine water and the other in aqueous iron(II) sulphate constitute a cell. Another half-truth was that the reaction in electrolysis *has* to be simple decomposition. The electrolysis of aqueous sodium chloride involves an endothermic reaction but not decomposition. Another complication was the discussion of the direction of the electron flow with respect to the anode and cathode.

Those candidates who concentrated on the thermicity of the reaction or the direction of the energy flow gave correct and precise answers and were awarded both marks.

(d) All parts of this question were answered poorly, the majority of candidates could not recall these equations and resorted to futile guessing.

(i) Most of the equations did not balance.
$2CuO + C = Cu + CO_2$
$2CuO + 2H_2 = 2Cu + H_2O$

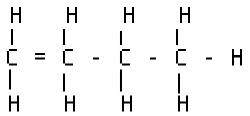
(ii) Hydrogen was given nearly as frequently as the actual product, water.

(iii) This equation has to be learnt, relatively few could recall the correct version. Some of the attempts included some very strange chemicals – CO_2, SO_2, N_2O_3, $Cu(NO_2)_2$. The nearest many got to the actual equation was the following popular but incorrect version $Cu(NO_3)_2 = Cu + 2NO_2 + O_2$

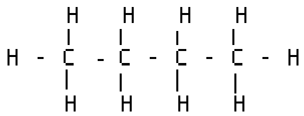
Question 5

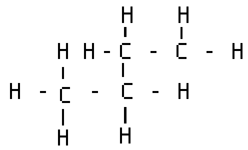
Many candidates gained their highest mark for this question. On most scripts the standard attained in this question was higher than that in the other questions.

(a) Those who chose C_4H_8, C_4H_{10} or C_4H_9OH had a reasonable chance of being awa
Unfortunately a significant proportion chose molecular formulae that did not have isome
C_3H_8 and C_3H_6. A very common mistake, particularly with the alkenes, was to draw pe
carbons in the structure.



The corresponding difficulty with alkanes was the belief that an additional right angle in the chain represented another isomer.





There were some surprising, but acceptable examples. Chloroalkanes, dichloroethenes and cyclic alkanes.

(b)(i) A few gave ethanoic acid but in general the addition product was correctly identified as ethanol. Writing the formula was more challenging, hydrogen atoms were omitted giving rise to a trivalent carbon atom.

(ii) Well answered, on most scripts the formula and the name were correct. A few thought that the product was a type of margarine.

(c)(i) There was a lack of precision in some of the explanations of the term *polymerise*. A large number of simple molecules, monomers, joined together to form a large complex molecule or macromolecule or chain. Those ideas or their equivalent were sufficient to be awarded both marks.

(ii) The essential difference between addition polymerisation and condensation polymerisation is that addition produces only one product, the polymer, but condensation produces the polymer and eliminates a simple molecule, usually water or hydrogen chloride. A popular misconception was that addition polymerisation only involved one monomer, co-polymerisation by addition involves two different unsaturated monomers. Similarly the idea that condensation must involve two different monomers is not correct, nylon 6 is produced from one monomer. The underpinning Chemistry that justifies the above criticism of the candidates' responses is above IGCSE Level but the above description of the difference between the two types of polymerisation is not. Candidates should have been able to recall this straightforward description and not try to offer incorrect alternatives.

(iii) The skill of deriving the structure of the polymer from that of the monomer was possessed by most of the candidates. Those who experienced difficulties either did not show continuation of the chain or drew the two chlorines on adjacent carbon atoms.

(d)(i) Provided the candidate addressed the nature of the polymer rather than the underlying steel, it proved relatively easy to make an acceptable suggestion – non-biodegradable or unreactive or impervious or flexible. The comment "it did not corrode" was not awarded the mark; only metals can experience corrosion.

(ii) Most gave the obvious, but correct reason, the iron is now exposed to air and water.

(iii) There are three reasons why galvanising is so effective at reducing the rate at which iron or steel rusts

The first is the strength of the metallic bond between zinc and the underlying iron. In this question, it is given that the layer of zinc has been broken so this is not a pertinent issue. The other aspect of this metallurgical reason is that at the interface there are iron/zinc alloys, the removal of the zinc layer does not necessarily expose steel. However these points are only peripheral to this question.

The second reason is that corrosion produces a coherent layer of zinc compounds th... offer the steel a degree of protection. Typical compounds that act in this way are zinc... and basic zinc carbonate, $2ZnCO_3.3Zn(OH)_2$; the former is slowly removed by leaching... water and the latter is removed by acid rain. Both zinc compounds can be replaced b... formation of zinc ions by the anodic reaction. The initial formation of these compounds and... maintenance of the protective layer is due the zinc acting as the sacrificial anode.

The third reason is sacrificial protection. Zinc, the more reactive metal, acts as an anode and zinc ions enter the water.

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

The electrons pass through the metals on to the iron/steel. It becomes the cathode (so it cannot be oxidised by electron loss) and at this electrode, hydroxide ions are formed.

$2H_2O + O_2 + 4e = 4OH^-$

The water now contains Zn^{2+} and OH^-, and depending on the humidity and ambient pollution levels, these ions can form;

ZnO or $Zn(OH)_2$ or $2ZnCO_3.3Zn(OH)_2$.

Acceptable responses to this question must derive from the fundamental reaction – that is anodic protection. The explanation can range from – zinc is the more reactive metal so it will react with oxygen/water in preference to steel reacting to ideas described above in the more sophisticated model of cell action.

Paper 0620/04
Coursework

General comments

There was only one Centre submitting coursework for this session. The practical assessment tasks selected by the Centre were largely appropriate to the skills being assessed and the standards applied were also satisfactory.

There were some problems in selecting an appropriate sample of coursework. Centres are reminded that the instructions in the syllabus referring to samples from low, middle and high achieving candidates apply to standards within the Centre not to the whole range of marks. Thus low refers to the lowest marks scored in that skill by candidates in the Centre. In all cases 27 pieces of coursework should be submitted for moderation. No samples of candidates work are required for skill C1 only detail of how marks were awarded.

Paper 0620/05
Practical

General comments

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

Comments on specific questions

Question 1

The majority of candidates completed the table of results. However the quality of answers showed significant variations. Many candidates did not describe all of their observations e.g. many did not record the result of testing the gas in *Experiment 3*.

In **(a)** two different reasons were required in part **(ii)**. *Experiment 5* was generally we[...] Observations were often vague and the question discriminated well. Part **(c)** required re[...] displacement or redox. Many vague descriptions of exothermic reactions were common. Part [...] generally well answered though some candidates reversed the order of reactivity.

Question 2

Liquid **F** was cyclohexane and liquid **G** was aqueous potassium iodide.

In part **(a)** frequent reference to clear or transparent was penalised. The correct description is colourless. Some candidates referred to the smell of liquid **G**, which is actually odourless.

In **(b)** only the better candidates referred to the dissolving of the crystal.

In **(c)** descriptions were often vague. Only the more able candidates described the flame in **(i)**.

In **(d)** and **(e)** some candidates are still referring to milky, cloudy etc instead of giving the colour of the precipitate.

In **(f)** credit was given to mention of organic or hydrocarbon. A number of candidates wrote at great length about alcohols, acids or esters.

Iodine or chloride were incorrect answers in **(g)**. Iodide or I^- gained credit.

Paper 0620/06

Alternative to Practical

General comments

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

Comments on specific questions

Question 1

In **(a)** many candidates were unable to identify the spatula **A** – many references to spoons. **C** was often described as a filter. In **(c)** the pH range was 6 to 7.

Question 2

Generally well answered. Discriminated well. Vague answers in **(c)** referred to masks and not touching the concentrated acid.

Question 3

Discriminated well. In **(a)** smooth line graphs were rare. A common answer in **(c)** referred to 'chemicals used up' and did not mention evolution of gas. Only the more able candidates suggested the purpose of the wool was to prevent loss of acid spray. Many referred to prevention of gases entering or leaving the flask.

Question 4

In **(a)** a significant number of candidates did not complete the results table from the diagram. Part **(c)** discriminated well. Only the better candidates referred to displacement or redox.

Question 5

The quality of answers varied. More able candidates realised the liquid **F** was organic and pr hydrocarbon.

Question 6

This question discriminated well. In **(a)** reference to beakers and measuring cylinders was common. Pipette or burette was the required answer. In **(b)** Universal Indicator was a common incorrect answer. Colour changes for a named indicator were frequently incorrect.

Part **(c)** discriminated well. Better candidates realised that the hydrochloric acid was more concentrated because less was used. Other candidates assumed that as the acid was dilute it was less concentrated than the alkali.

Knowledge of crystallisation procedure varied widely in **(d)**. Many candidates heated the solution to dryness.

Question 7

Discriminated well. A wide range of answers. Good answers referred to measuring the mass of fertiliser, volume and temperature of water with a method that worked. Other answers included reference to named fertilisers, observing the growth of plants and incorrect methods.

Units were often confused i.e. weigh 10g/100cm^3 of fertiliser.