CHEMISTRY

Paper 0620/11
Multiple Choice

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

General comments

Questions 2, **4** and **27** proved to be particularly straightforward with more than 90 % selecting the correct answer.

Questions 9, **19**, **25** and **33** proved to be the most difficult with less than half the candidates selecting the correct answer.

Comments on specific questions

The following responses were popular wrong answers to the questions listed.

Question 3 Response **A**.

Candidates misunderstood the question and opted for insoluble substances since the name of a solid was asked for.

Question 6 Response **C**.

Candidates realised that all the particles shown had to be the same but did not know the formula of hydrogen chloride.

Question 9 Responses **C** and **A**.

Response **C** was more popular than the correct answer; candidates mistakenly assuming that overhead power cables were made from copper. Response **A** was again slightly more popular than the correct answer because some candidates knew that overhead power cables were aluminium but missed the reference to inert electrodes.

Question 13 Response **D**.

Candidates knew the combustion products of ethanol and hydrogen but did not consider that butane is a hydrocarbon.

Question 14 Response **D**.

Candidates, on seeing a reversible reaction involving heating a compound, immediately thought of copper sulfate without properly reading the equation.

Question 17 Response **D**.

Clearly candidates did not realise that this is a neutralisation reaction and opted for oxidation as oxides were mentioned.

Question 18 Response **A**.

Maybe the candidates did not notice the ‘not’ and opted for **A** as it was a correct property.

Question 19 Response **D**.

Response **D** was more popular than the correct answer. Candidates were familiar with silver nitrate and barium nitrate from tests for ions and did not realise what the question was demanding in the way of reasoning.

Question 25 Response **B**.

Candidates knew that brass was formed from copper and zinc but did not realise that it was a mixture, not a compound formed by a chemical reaction.

Question 26 Response **B**.

Candidates knew that metals conduct when they are solid but assumed that they did not when liquid.

Question 29 Response **C**.

Candidates did not know of the use of lime in the basic oxygen process for the manufacture of steel.

Question 32 Response **C**.

Candidates knew that carbon dioxide is a greenhouse gas but not that methane is as well.

Question 33 Response **B**.

Response **B** was more popular than the correct response **D**. Candidates did not read the question carefully. The formation of stainless steel does, indeed, prevent rusting but not by excluding oxygen.

CHEMISTRY

Paper 0620/12
Multiple Choice

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

General Comments

Questions 1, **4**, **6**, **12**, **29** and **32** proved to be particularly straightforward with more than 90 % selecting the correct answer.

Questions 8, **20** and **35** proved to be the most difficult with less than half the candidates selecting the correct answer.

Comments on specific questions

The following responses were popular wrong answers to the questions listed.

Question 5 Response **A**.

Candidates misunderstood the question and opted for insoluble substances since the name of a solid was asked for.

Question 13 Response **D**

Candidates, on seeing a reversible reaction involving heating a compound, immediately thought of copper sulfate without properly reading the equation.

Question 20 Response **D**

Candidates were familiar with silver nitrate and barium nitrate from tests for ions and did not realise what the question was demanding in the way of reasoning.

Question 26 Response **B**

Candidates knew that brass was formed from copper and zinc but did not realise that it was a mixture not a compound formed by a chemical reaction.

Question 28 Response **C**

Candidates did not know of the use of lime in the basic oxygen process for the manufacture of steel.

Question 30 Response **B**

Candidates knew that metals conduct when they are solid but assumed that they did not when liquid.

Question 33 Response **C**

Candidates knew that carbon dioxide is a greenhouse gas but not that methane is as well.

Question 35 Response **B**

Response **B** was more popular than the correct response **D**. Candidates did not read the question carefully. The formation of stainless steel does, indeed, prevent rusting but not by excluding oxygen.

CHEMISTRY

Paper 0620/13

Multiple Choice

There were insufficient entries for this component for us to be able to produce a report.

CHEMISTRY

Paper 0620/21

Core Theory

Key messages

Questions requiring short answers and numerical answers (including equations) were well done.

Free response type questions require more focus and it is important that candidates read exactly what is asked in the stem of the question.

General comments

Some candidates tackled this Paper well, showing a very good knowledge of core Chemistry. Good answers were seen to most parts of **Question 2** and **Question 6**. Nearly all candidates were entered at the appropriate level and few candidates scored less than one quarter of the marks available. The rubric was only occasionally misinterpreted. For example, in **Questions 1(a)** to **1(f)** a small number of candidates thought that the question was a multiple choice type and ticked a single box rather than filling in each box separately. A considerable number of candidates left blank spaces in the calculations of **Questions 3(d)(iii)** and **3(f)(ii)** and in the questions about electronic structure, **5(e)(i)** and **5(e)(ii)**. A considerable number of candidates did not respond to **Question 7(c)(i)** which simply required the circling of the appropriate letter. Most candidates responded to questions requiring extended writing e.g. **7(b)(ii)** and **8(a)**.

The standard of English was good. Some candidates wrote their answers in the form of short phrases or bullet points. Candidates are less likely to write vague statements or contradict themselves if this is done. As in previous sessions, questions on quantitative analysis were not well known. For example, a considerable number of candidates were challenged by the questions on the tests for water, **Question 3(a)** and chlorine, **Question 5(e)(iii)**. The reactions occurring during steelmaking were also not well known, **Question 7(b)**.

Some candidates had a limited knowledge of organic chemistry. For example, few could complete the structure of ethanoic acid or name the products of the incomplete combustion of an organic compound. Many candidates did not answer questions on environmental issues such as acid rain with sufficient clarity. Many candidates had a fairly good knowledge of inorganic chemistry and many could interpret formulae and write equations, including symbol equations, correctly.

Comments on specific questions

Question 1

Many candidates scored reasonably well on this question although few were awarded full credit.

(a) The commonest incorrect response was to suggest that **B** (potassium nitrate) was an acidic oxide. A considerable number of candidates also suggested nitrogen trichloride.

(b) Most candidates recognised the ionic giant structure. The commonest error was to suggest nitrogen.

(c) Just under half the candidates recognised ammonia here. The commonest error was to suggest nitrogen trichloride, presumably because it has a similar structure to ammonia. Nitrogen dioxide was also a common incorrect answer.

(d) This was the least well answered part of **Question 1**, a wide variety of incorrect answers being seen, the commonest of which was nitrogen.

(e) Over half the candidates gained credit for recognising that nitrogen trichloride contains halogen atoms. The commonest errors were to suggest either nitrogen or ammonia.

(f) Just under half the candidates gained credit for recognising that potassium nitrate is a salt. The commonest error was to suggest nitrogen trichloride, presumably because it contains chlorine and the candidates are familiar with many salts containing chloride ions.

Question 2

This was the best answered question on the Paper, many candidates gaining full credit for **(b)** and **(c)**.

(a) A few candidates gave a definition of isotopes with the required detail. The essential comparison is atoms of the same element or atoms with the same number of protons rather than comparing elements or molecules (which may have different numbers of atoms). Many candidates realised that the numbers of neutrons or nucleons was different but did not give sufficiently precise answers or contradicted themselves.

(b) A majority of candidates gained full credit here. The commonest errors were to suggest 28 rather than 27 neutrons or 28 rather than 23 electrons.

(c) Most candidates gained full credit here too. The commonest errors were to suggest industry instead of medicine and to suggest influenza rather than cancer. A few candidates reversed the words medicine and cancer.

(d) Well over half the candidates were awarded full credit for this part. The fact that vanadium conducts electricity was well known. Fewer candidates identified vanadium as a transition element and consequently fewer obtained credit for 'compounds of vanadium are coloured'. The commonest error was to suggest that vanadium is less dense than sodium.

Question 3

This proved to be one of the most difficult questions on the Paper. A few candidates exhibited a good knowledge of qualitative tests and the steps in water purification. Others may need to revise these in more detail. Few candidates were able to explain the effects of acid rain in a convincing manner, many vague answers being given.

(a) Many candidates gave an answer relating to a physical test for water i.e. boiling point, rather than a chemical test. Those who were awarded credit suggested the test involving white copper sulfate. A few disadvantaged themselves by not mentioning the words white or anhydrous. Those candidates who opted for the test using anhydrous cobalt chloride were more likely to make errors. For example cobalt was often suggested as the test reagent and the colour change was suggested to be 'to blue'.

(b) About half the candidates gained credit for an industrial use of water. The commonest error was to suggest a domestic use such as drinking or washing without qualification. Washing of some sort of industrial equipment would have been acceptable but many candidates did not suggest this.

(c) Some candidates gave good answers for the definition of a solvent. Common errors were to confuse the solvent with the solute, to couch the answer in such a way that the Examiner was unsure whether the candidate was referring to the solute or the solvent e.g. 'it mixes well with another liquid', writing 'it is a liquid' with no further qualification and comments about neutralisation.

(d)

(i) Some candidates gave good answers by referring to the burning of fossil fuels or 'from volcanoes'. Some gave rather vague answers involving fossil fuels (without any indication of burning) or smoke from vehicles. Many candidates referred to acid rain as being a source of sulfur dioxide rather than the end result of the emissions.

(ii) A few candidates gave good answers relating to the erosion of buildings made of rocks containing carbonate. Many candidates gave rather vague answers. For example 'wearing away of buildings' does not apply to buildings made of wood or granite. Other common errors were references to soil erosion, vague reference to the effects on humans and animals e.g. ‘it is dangerous to humans’, vague reference to plants rather than trees where the effect is most keenly felt and reference to harming animals (which are able to move away from the danger). Harm to named water animals such as shrimps and water snail were credited.

(iii) Many candidates gained credit for the correct calculation of the relative molecular mass of sulfur dioxide. The commonest error was 48, obtained by simply adding 32 to 16 i.e. ignoring the fact that SO_2 has two oxygen atoms.

(e) Some candidates gave concise answers to this question e.g. ‘chlorine to kill bacteria and filtration to remove insoluble solids’. Other candidates wrote more vaguely about ‘removing bacteria’ or ‘using a filter to remove bacteria’. Others confused the process of screening to remove larger objects with the process of filtration. Since there are only two steps mentioned in the syllabus, candidates might be encouraged to focus on the filtration and chlorination aspects when they come to revise, rather than to include other steps as well.

(f)

(i) Many candidates realised that the air contains approximately 20 % oxygen. A significant minority confused oxygen with nitrogen and gave values in the region of 70-80 %. Another common error was to suggest a value of around a quarter e.g. 23-25 %.

(ii) Many candidates were successful in calculating the mass of hydrogen.

Question 4

This question was fairly well answered but **(b)(ii)** and **(c)** caused particular problems for some candidates.

(a)

(i) Over half the candidates recognised the formula for a polymer. The commonest error was to suggest **A** (propane), presumably because this had no double bonds or atoms other than carbon in it.

(ii) About two thirds of the candidates recognised the unsaturated hydrocarbon. The commonest error was to choose the saturated hydrocarbon, **A**.

(iii) About half the candidates recognised ethanol as the correct answer. The commonest error was to suggest the polymer, **D**.

(iv) This was generally answered correctly.

(b)

(i) Many candidates balanced the equation at least partially. Most of these gained credit for the 4 moles of water on the right. The commonest error was to misbalance the oxygen molecules, either by counting them as atoms (hence $10O_2$) or balancing with the carbon dioxide (hence $3O_2$).

(ii) Some candidates appeared to misread the question as ‘complete combustion’ rather than ‘incomplete combustion’ and consequently gave the answer carbon dioxide and water. Another common error was to suggest that hydrogen is formed rather than water.

(c) Some candidates completed the diagram perfectly to show the structure of ethanoic acid. A few candidates made an error with the double bond, placing the double bond between the hydrogen and oxygen rather than as a C=O group.

Question 5

Some parts of this question were well answered by most candidates but **(a), (e)(ii)** and **(e)(iii)** caused particular problems for others. Many candidates need to improve their knowledge of electronic structures of atoms and (especially) simple molecular structures.

(a) A few candidates gave good answers, explaining clearly that electrolysis is the breaking down of a substance by electricity. Other candidates wrote vague statements about the process of electrolysis for extracting metals or for electroplating. Other errors included the suggestion that substances were simply separated by electrolysis and giving a description of the components involved in electrolysis

(b) Most candidates recognised that the anode is the positive electrode. The commonest error was to suggest 'cathode' or 'cation'.

(c) About half the candidates correctly identified the gas given off at the negative electrode as being hydrogen. The commonest errors were to suggest oxygen, carbon dioxide, chlorine or hydrogen chloride. 'Cathode' was occasionally seen as an answer. This is clearly a misreading of the question as 'What is the name of the negative electrode?

(d) Many candidates gave a good answer to this question. The commonest error was to suggest magnesium as the electrode because it is reactive.

(e)

(i) Many candidates provided well drawn and correct electronic structures of a chlorine atom. Others left the question blank, drew several circles to represent atoms of gaseous chlorine or described a chlorine molecule in various ways.

(ii) A few candidates drew good diagrams to show the electronic structure of a chlorine molecule and most of these were awarded full credit.

(iii) The test for chlorine was not well known. Common errors included a suggestion that litmus turns blue, the use of silver nitrate (a confusion with the test for chloride ions) or 'to see if it purifies water' or 'kills bacteria'.

(f)

(i) The word equation was correctly written by the majority of candidates. The commonest error was to suggest that hydrogen was a product instead of water. Most candidates gave the correct name of the salt, calcium chloride.

(ii) Many candidates balanced the equation correctly and used H_2 as the correct formula for hydrogen. The commonest errors were to write 2H on the right hand side of the equation or suggest that water was formed.

Question 6

This question was answered very well by most candidates. Parts **(a)(ii)** and **(c)** caused particular problems for a minority of candidates.

(a)

(i) Most candidates answer this correctly. The commonest errors were to reverse the sequence or suggest that magnesium was more reactive than calcium.

(ii) Many candidates answered this correctly. The main errors were to suggest that iron reacted with cold water or to just use the word reacts or reacts more for the reaction of iron with steam.

(b) Most candidates constructed the correct word equation for the reaction. An error, which was only occasionally seen, was to suggest that H_2 was hydroxide rather than hydrogen.

(c) Many candidates could describe at least two general properties of metals. A minority suggested properties peculiar to transition metals. Those gaining full credit often referred to malleability and ductility.

(d)

(i) Most candidates estimated a suitable melting point for lithium.

(ii) Many candidates gave a good answer to this question. Some candidates did not answer the question and tried to relate the hardness to melting point or density. The simplest answer 'decreases' was sufficient to be awarded credit.

(iii) Most candidates estimated a suitable density for potassium. Very few answers were outside the range allowed (0.7 – 1.3 g per cm^3), most of these being above 1.3 g per cm^3.

Question 7

Many parts of this question were well answered by most candidates but **(b)(i)** and **(b)(ii)** caused particular problems for others. Many candidates need to improve their knowledge of the purpose of adding calcium oxide in the steelmaking process.

(a) This was very well answered, most candidates gaining full credit. The main error was to place the slag where the steel should be.

(b)

(i) About one third of the candidates obtained credit by referring to a gas. Many others gave vague answers such as 'free to move', 'less dense', 'the air pushes them out' or 'goes to the top'. A number of candidates suggested that there was a further reaction with oxygen or air.

(ii) Many candidates wrote about reduction, oxidation or displacement rather than focussing on the neutralisation reaction of a basic oxide and acidic oxide. Candidates scoring full credit on this question usually referred to the basic nature of calcium oxide or the fact that phosphorus oxides are acidic.

(c)

(i) Many candidates selected the correct depiction of an alloy. The commonest error was to suggest **C**, which was in fact lined up in a regular A, B, A, B arrangement. A significantly large number of candidates did not respond to this question.

(ii) Most candidates selected a suitable use for stainless steel. The commonest correct answer was cutlery. The commonest incorrect answer was cars (although credit would have been given for particular parts of cars such as radiator grilles).

Question 8

This question was answered well in parts. Other parts posed particular problems for individual candidates, especially **(a)** where extended writing was required, **(b)(i), (b)(ii)** and **(c)(iii)**.

(a) Most candidates wrote a considerable amount about the particles in liquids and vapours. The Examiners saw a lot of correct information which could not be awarded credit because the answers did not access the essential point of the question which was about the <u>comparison</u> between the arrangement and motion of the particles. For example there were statements about the arrangement of the particles in a vapour but no corresponding statement about a gas. In addition, many of the answers were rather vague and it was not always clear whether the liquid or vapour was being referred to. Many candidates gave a good account of the forces between particles being broken and the particles escaping as a vapour. Unfortunately, this did not answer the question.

(b)

(i) Some candidates gave good answers and included the word ion in their answers. Others confused the endings –ide and –ine. The commonest error was to write chlorine ions. Another common error was to write chloride molecules.

(ii) Some candidates gave a good explanation of the term volatile. Others gave rather vague statements about 'lower density' or 'going to the top'. A considerable number of candidates wrote about volatile substances being highly reactive or being easily oxidised by the air.

(c)

(i) Most candidates gave a good definition of the term catalyst.

(ii) About half the candidates gave a good explanation as to why the hydrogen peroxide is reduced. The best answers focused on the hydrogen from the hydrogen bromide being added or to oxygen being removed. Some candidates were not awarded credit because they just paraphrased the equation. For example: 'There is hydrogen peroxide on the left and it goes to water on the right'.

(iii) Many candidates gained partial credit for this question, often for carbon dioxide and water. Hydrogen was often seen instead of water. Fewer candidates were able to name the salt correctly, sodium bromine being a common error. A variety of strange bromine compounds were seen. Sodium chloride was not uncommonly written as the salt. This presumably arose from mistakenly carrying over the introductory paragraph to the question, which states that hydrobromic acid has similar properties to hydrochloric acid.

CHEMISTRY

Paper 0620/22
Core Theory

Key messages

Questions requiring short answers and numerical answers (including equations) were well done. Free response type questions require more focus and it is important that candidates read exactly what is asked in the stem of the question.

Comments on specific questions.

Question 1

(a) Most scored full marks, showing good understanding of basic electronic structures of atoms.

(b) (i) Most understood that a covalent bond is formed by a sharing of electrons between atoms.

(ii) Many correctly ticked the first box, a few the third box.

Question 2

(a) (i) Many arranged the metals the wrong way round putting aluminium as the least reactive metal.

(ii) Not many candidates realised that the temperature would have to be very high for reduction with carbon as aluminium is too high in the reactivity series.

(iii) Bauxite was often given but many put hematite.

(b) (i) Limestone was frequently given and calcium carbonate was also accepted. Stronger candidates also knew that air was needed.

(ii) Many could balance this equation and scored both marks.

(iii) Many candidates could not work out that carbon dioxide was reduced, those who could usually gave the correct reason.

(iv) Not many knew that carbon monoxide is toxic as it binds to haemoglobin.

(v) The definition of endothermic was given by the majority of candidates.

(c) (i) Many stated that an alloy is a combination of metals instead of a mixture.

(ii) Many scored here with a correct use for mild steel.

Question 3

(a) (i) Many did not know that 80 % of air is nitrogen.

(ii) Hydrogen was incorrectly given by many. Any of the noble gases would have scored.

(b) (i) Many thought that the volume increased, perhaps because they had never seen a similar experiment.

(ii) Most had a decrease in mass which would not be possible as copper oxide is being formed.

(c) Many correct responses giving electrical wires were seen.

(d) Some candidates did not fully understand electrolysis. Candidates did not realise that the electrolyte had to be a copper salt solution and that the spoon would be coated in copper. Care should be made when referring to anodes and cathodes.

Question 4

(a) (i) Carbon dioxide was seen but the main error was to give yeast.

(ii) Yeast and absence of oxygen scored quite often. The main error was to give the incorrect temperature.

(b) (i) Many correct structures were seen for both water and ethanol. The main errors were O-H-O for water and double bonds in ethanol.

(ii) Bromine water goes colourless was only met rarely.

(c) Many scored both marks with carbon dioxide and water.

(d) Many candidates knew that in a homologous series the compounds have similar chemical properties and contain the same functional group.

Question 5

(a) Most knew that diamond has a giant covalent structure and that chlorine is a diatomic, covalent molecule.

(b) The correct molecular formula was often given, but many gave the empirical formula.

(c) (i) Very few knew that chlorine gas is green, possibly having never seen the gas before.

(ii) A range of densities between 2.5 and 4.0 was obtained by many candidates, but many gave answers that were too close to chlorine.

(iii) Most scored this mark.

(d) (i) Many could not complete the word equation. The main error was to mix up bromine/bromide and iodine/iodide.

(ii) Most did not state that chlorine is more reactive than bromine.

(e) Most did not know that ionic compounds are water soluble and molecular ones are not and that molecular substances do not conduct whereas molten ionic ones do. Candidates must ensure that when answering this type of question a direct comparison is made.

Question 6

(a) Many candidates scored well on this question. However, heating to saturation point was less frequently given.

(b) (i) Oxidation state/number was known by the majority of candidates.

(ii) Many correctly gave sodium hydroxide and the correct result.

(iii) Stronger candidates realised that water was given off from the crystals when they were heated.

(iv) Most scored with the correct sign for a reversible reaction.

(c) (i) Most knew that acids turn blue litmus red. Many stated that bubbles were seen/ iron dissolved/ solution turned green.

(ii) A few candidates stated that crops would be killed, rather than the fact that most plants cannot grow well in soil that is too alkaline.

(iii) pH 8 was correctly given by the majority of candidates.

(iv) Calcium oxide/ lime/ limestone was given quite often, but so were many other incorrect substances, mainly nitrogen containing fertilisers.

Question 7

(a) (i) Most gave a correct answer within the required range.

(ii) Many scored the mark for the diffusion. The main error was not mentioning particles in the responses.

(b) Most could do M_r calculations.

(c) (i) Nitrogen, phosphorus and potassium were well known.

(ii) Many correct as most knew how to make ammonium sulfate.

(d) Most could do this simple scaling calculation and scored the mark.

CHEMISTRY

Paper 0620/31
Extended Theory

Key messages

Adequate preparation for the examination is essential. This includes learning the facts, possessing the necessary skills and practising on questions from past papers. Use the published mark schemes to identify the type of answer, both in content and length, required by different questions. Use the allocated number of marks to assist you in constructing your answer.

General Comments

There were some excellent responses seen to all parts of every question and candidates should be commended.

Centres should advise candidates about the importance of legible handwriting. Examiners will make every reasonable effort to determine the meaning but if it cannot be read then it cannot be marked.

It is essential that candidates read the question and respond specifically to that question. Frequently **Question 3(a)** was answered as a description of the chemistry of the blast furnace.

Comments on specific questions

Question 1

Most were able to match the appropriate separation techniques to the mixtures given in the question. Full credit was common and very few candidates were awarded no credit.

Question 2

(a)

(i) There was almost unanimous agreement that a process which can change light into chemical energy is photosynthesis. Alternative answers were photochemical reactions and photography.

(ii) Cell, fuel cell or battery were all accepted. A variety of devices were offered which were not acceptable – generators, electrolysis and photo-electric cells.

(b)

(i) Very well answered, most could draw a diagram which gave the formula of potassium selenide, showed the charges on the ions and gave the correct coded distribution of electrons around the selenide ion – 6x and 2o. All of this information should be given on one diagram not a diagram for each piece of information.

(ii) The general standard of the diagrams was good. Candidates ought to be reminded that including charges on the diagram of a covalent compound might suggest ionic bonding and negate the whole response.

For diagrams of this type, both covalent and ionic, there is no requirement to include all the electrons in the atom. This produces untidy diagrams and greatly increases the risk of errors.

(iii) There has to be comparison between the two types of bonding, for example ionic compounds are harder than covalent compounds. Credit was not awarded for a correct physical property of either class of compound. Density was not accepted as an example of a property where there are clear differences between the two types of compound.

Some candidates incorrectly gave the difference in physical properties between selenium and chlorine.

(c) The majority thought that the reaction was redox and that the selenide ion was an oxidant or a reductant. This ion accepts a proton and therefore it is a base. The more general term base was required; alkali was not accepted but then further credit could still be awarded for the reasoning.

Question 3

(a) A typical error was to confuse this process with the blast furnace and mention limestone and iron ore which are not present. The most frequent mistake was to state that silicon, not silicon(IV) oxide, reacted with calcium oxide to form slag.

(b)

(i) This was usually correctly answered; resistance to corrosion was accepted, steel does not rust was not.

(ii) Uses of the two alloys were generally correct. Very popular correct answers were car bodies for mild steel and cutlery for stainless steel.

(c) Candidates did not make full use of the information given in the question – a lattice of positive ions and a sea of electrons.

(i) Metals have high melting points because there are strong bonds or electrostatic attraction between the positive ions and negative electrons. The main reason for credit not being awarded was because of statements that the strong interaction was between ions or between negative and positive ions or between molecules or to identify the interaction as intermolecular forces.

(ii) A typical pleasing response was: the ions/cations are arranged in layers or rows or lattice and they can slide past each other. Becoming more popular is the comment that the metallic bond, although strong, is non-directional. Atoms, protons or nuclei were not accepted neither was the notion that the electrons slip or slide.

Question 4

(a)

(i) For some candidates, the balancing of the equation proved difficult.

(ii) Metals more reactive than zinc and carbon monoxide were accepted. Hydrogen was not. Most of the candidates could suggest at least one reductant.

(iii) The metals are separated because they have different boiling points and they distil or are collected in the order cadmium, then zinc and finally lead.

Many candidates referred to melting and evaporation rather than boiling or did not focus their explanation on the salient points given above.

(b) This answer needed planning to produce a coherent and precise explanation. Use of the words high, low, decrease and increase was essential for a successful answer.

Question 5

(a)

(i) This equation was usually correct.

(ii) Very common errors were zinc chloride or zinc hydroxide rather than zinc iodide.

(iii) The symbol equation proved more challenging than the word equation. Frequent mistakes were MgI and H_2 not H_2O.

(b) Credit was awarded for stating that reaction 1 is redox. This had to be followed by a valid reason of the type lithium is oxidised, it loses an electron to form Li^+ or the oxidation state of lithium increases from 0 to +1 for further credit to be awarded.

(c) Frequent errors were to state that for both iodide and bromide, bubbling was observed. Cream and yellow precipitates were given as observations; probably the candidates were thinking of precipitation tests for the halide ions.

(d)

(i) Many candidates were confused about the role of the acid. It was the sodium hydroxide, not the acid, that was used up at the maximum temperature increase.

(ii) The temperature decreases after the equivalence point because of the addition of cold acid or no more heat produced.

(iii) The common error was to give the reciprocal of the correct answer – 0.75 mol/dm^3.

Question 6

(a)

(i) Most believed that butene was obtained from petroleum by fractional distillation rather than by cracking. A pleasing proportion knew the exact reaction conditions for the hydration of an alkene.

(ii) The question asked for an explanation, in general terms, of fermentation. Almost all the responses were confined to one example – glucose to ethanol catalysed by the enzymes from yeast. A general description of the fermentation also scored and could include a selection of the following:

- biochemical reactions
- catalysed by <u>enzymes</u> from micro-organisms
- respiration
- cells
- energy for cellular activity.

(b) The acid was butanoic acid and its structural formula is CH_3-CH_2-CH_2-COOH. The usual mistake was to give the formula of pentanoic acid.

(c)

(i) The type of compound was an ester. The minority of candidates who were not awarded credit named an individual ester.

(ii) A few gave the molecular formula of glucose or a structural formula of an ester.

(iii) A pleasing proportion could draw the structural formula of butyl ethanoate showing the individual bonds and the expanded ester linkage. There were some carboxylic acids, a few aldehydes but the most frequent errors were incorrect esters – propanoates, pentanoate, ethyl and propyl esters.

Question 7

(a) This question illustrated the necessity of planning an answer. Many candidates deleted their first attempt and offered a second version. Almost all those who were awarded full credit did so on their first and only attempt.

(b) Despite being told that the same number of moles of each metal was used, many candidates based their answer on the idea that the numbers of moles of the metals were not the same. Some thought that the mass of the mole of each metal was relevant.

There are a number of acceptable arguments to explain why two of the metals form the same volume of hydrogen and the third metal forms a larger volume; the ratio moles of metal to moles of acid, valency, formulae of chlorides and ionic charge.

Question 8

(a) Many answers lacked structure and confused the terms monomer and polymer.

(b) The structural formula of poly(dichloroethene) was drawn correctly by the majority of the candidates.

(c) It proved to be difficult for candidates to deduce the structural formula of the monomer from the structural formula of the polymer PVA. Mistakes included drawing a segment of the polymer that was too long, omission of the double bond and the C-O involving the wrong oxygen atom.

(d) The structural formula of the condensation polymer had to include a correct amide linkage. Subsequent credit could only be awarded if this linkage was correct. The repeat units had to be correct. Boxes were not acceptable as the structural formulae of the monomers were given in the question. Finally the formula had to indicate continuation. There were some pleasing answers to this relatively demanding question.

CHEMISTRY

Paper 0620/32
Extended Theory

Key messages

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General comments

Candidates provided a wide range of quality of answers, as is typical of this paper. If a candidate decides to change an answer it is advisable to cross out the original answer and rewrite the new answer, rather than writing on top of the original answer. If the latter course of action is attempted it usually results in the final answer being illegible. Examiners always try and decipher handwriting which is difficult to read, but if the answer is genuinely illegible it cannot be awarded any credit.

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Abbreviations such as rxn, UI and br water (all of which were seen by Examiners) are not acceptable, because their meanings are not universally recognised. Correct terminology which is universally recognised can be found on the syllabus.

Comments on specific questions

Question 1

Most candidates answered all parts of this question extremely well. There were no common misconceptions.

Question 2

(a)

(i) This was answered very well by the majority of candidates. The reaction between Fe and Sn^{2+} was occasionally seen to produce 'compounds' such as the non-existent Fe_2Sn.

(ii) A wide variety of products were seen. The crystals were not referred to as being hydrated; therefore water could not be a product of heating.

(b)

(i) Tin was the product at the negative electrode and as it was the element tin it should not be followed by any oxidation state other than zero.

(ii) Hydroxide ions are discharged at the anode. It is not possible for O^{2-} ions to exist in aqueous solution. A wide variety of answers were seen for this response.

(iii) This was usually answered very well.

(c) Credit was awarded for saying that zinc is more reactive than iron and also that iron is more reactive than tin. Statements were often seen that referred to zinc being more reactive, but it was not made clear what zinc was more reactive than. The same applies to iron in its comparison with tin. There was no credit given for comparing the reactivities of zinc and tin, as this is not relevant to the question.

Rust is hydrated iron(III) oxide and therefore iron is the only metal that can form rust. Zinc reacts with oxygen and water in preference to iron, but zinc cannot form rust.

Some candidates seemed to assume that both the zinc and tin were coating the steel at the same time and that there was some sort of reaction between all three.

Question 3

(a)

(i) Large numbers of candidates mentioned that the purpose of making the volume the same in all the experiments was so that the test would be fair or that all four experiments could be comparable. A more complete answer is to state that the purpose is to make the volumes proportional to the concentrations of sodium thiosulfate in each of the four experiments or to ensure that the hydrochloric acid had the same concentration in all four experiments. The word 'accurate' was often used incorrectly by candidates to answer this response.

(ii) In experiments 1 and 3 the concentration of the sodium thiosulfate was halved, which meant that the time was doubled. Therefore in experiments 2 and 4 the concentration of sodium thiosulfate was divided by four and thus the time would be multiplied by four. Therefore the correct answer was 60 × 4 = 240 s. Many other attempts at achieving an answer by mathematical progression were made.

(iii) The question starts by asking' how ……does the speed of the reaction vary from experiments 1 to 4'. Many did not address this point. It was hoped that candidates would answer by stating that the speed of the reaction decreased as a result of the decrease in the concentration of the sodium thiosulfate. Many referred to volume or amount rather than concentration. It was also common for candidates to refer to time rather than speed, despite the wording of the question.

(b) There were some very good responses to this question, and it was not unusual for full credit to be awarded. Occasionally, as in **(a)(iii)** time was referred to instead of speed or rate.

Question 4

There were some very good responses to this question. It was not unusual for full credit to be awarded. As well as writing correct and balanced equations, it was hoped that candidates would write about redox, energy changes and removal of impurities, which they often did.

It is beneficial to Examiners if equations are written on one line, not spread across two lines. Equations must always be balanced. CO_2 reacting with more O_2 to form CO was commonly seen, instead of CO reacting with C. Very few referred to slag as a waste product. Silicon was often referred to as an impurity instead of silicon dioxide. Silicon dioxide and slag were often confused with one another.

Question 5

There seems to be a general misunderstanding concerning differences between cells and batteries on the one hand and electrolysis on the other. The question begins by stating 'the diagram shows a simple cell'. Therefore to consider that electrolysis is taking place is to miss the point of the question. Cells such as the one in the diagram are used to produce electricity from chemical reactions, whereas electrolysis uses electricity to carry out chemical reactions.

(a) Amongst those who realised that the reaction in the cell took place between zinc (the most reactive of the two metals) and the sulfuric acid, some very good equations were seen. These included ionic equations which are always acceptable as appropriate for an ionic reaction such as this. There were many equations which mistakenly included iron as a reactant.

(b) Some excellent answers stated that chemical energy was being converted into electrical energy. Other answers commonly stated that heat energy was released, which is not the purpose of a cell. An explanation of redox in terms of electron transfer or change in oxidation number was not as common as it might have been.

(c) The negative electrode is always the more reactive metal. In this case zinc is more reactive than iron. Bubbles of hydrogen are given off at the negative electrode in electrolysis, as opposed to in a simple cell.

(d) The voltage could be increased by replacing zinc with a more reactive metal such as magnesium, replacing iron with a less reactive metal such as copper or making the sulfuric acid more concentrated. Answers were often not specific concerning the metals that were to be replaced or the new ones to be used.

Higher temperatures would have random effects on the voltage and is not recommended as a method of increasing it. Increasing the surface area of the electrodes or using thinner or thicker electrodes would have no effect on the voltage, nor does changing the volume of the acid as opposed to changing the concentration.

Question 6

(a)

(i) The rate of forward and reverse reactions being equal was often given. It was hoped that candidates would comment on methanol being used up in the reverse reaction as fast as it was being reformed by the forward reaction, but methanol was rarely mentioned.

(ii) Temperature and pressure did not have to be known or specified. All that was expected was an application of Le Chatelier's principle to this particular equilibrium.

(iii) Candidates were expected to comment that low temperatures mean that reactions are too slow and high pressures are expensive or cause safety problems. Candidates often repeated their reasons for their answers to **(a)(ii)** rather than answer in the terms expected.

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(i) Ester was the required answer. Fats were seen more commonly than esters. Organic or covalent compounds were common answers but considered too vague.

(ii) Soap and more occasionally glycerol were correct answers that were seen from time to time. Margarine and butter were seen occasionally.

(iii) Many candidates realised that biodiesel and petroleum based diesel both produced carbon dioxide when they were used, but only extremely small numbers realised that biodiesel is said to be 'carbon neutral' because plants absorb carbon dioxide by photosynthesis during their growth. The word renewable was seen occasionally, and biodiesel is made from renewable resources, but unfortunately this does not answer this particular question.

There were a substantial number of candidates who thought that the carbon dioxide from biodiesel would be absorbed by plants after being produced unlike the carbon dioxide produced by fossil fuels.

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(i) Some excellent answers were seen. Double bonds were correctly shown in a variety of positions. Very few were seen with sticks.

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Question 7

(a) There were some excellent answers to this question. The most common error was not including all the lone pairs on the chlorine atoms. Many drew electrons in pairs which is what Examiners prefer.

(b)

(i) This was found to be easiest question on the paper. A small number used crossings out which meant that the final answer was impossible to decipher, but the majority were able to balance the equation.

(ii) 'Describe how you could show' means give a brief description of an experiment. It is impossible to see acids dissociating into ions. There are no observations (nothing visible occurs) when an acid reacts with an alkali, because two colourless solutions react to form another colourless solution. There is no effervescence, precipitation or colour change. However, the temperature increase could be measured. This would distinguish between strong and weak acids. The temperature increase would be greater using a strong acid, all other factors being equal. Strong and weak acids do not react with different amounts/volumes of alkali. Litmus does not measure pH/acid strength. It is merely used to distinguish between acids and alkalis. Using the same concentration of both acids was only mentioned by a very small number of candidates.

(iii) To make the soluble salt, the candidates needed an indication that a titration would be carried out, using either sodium hydroxide or sodium carbonate (solutions). The insoluble salt should be made by precipitation, using either calcium hydroxide, chloride or nitrate (solutions). Only a very brief description of the experimental technique was expected.

The elements sodium and calcium, instead of the appropriate solutions of the salts, were very much in evidence. Candidates should realise that these metals are extremely reactive and it would be highly dangerous to add either of them to an acid (even if the rest of the process was correct). Some suggested unnamed salts. Some did not realise that any other reagent had to be added. Some did realise that other reagents had to be added, but did not specify which one e.g. sodium salt or calcium salt.

The word filtrate (although it was accepted as an alternative to filter) is the name given to a liquid that passes through a filter paper, not the act of filtration. In some cases the words titration and filtration were difficult to distinguish, due to illegibility of the candidates' handwriting. The process of crystallisation was described in the first part rather than the technique of titration.

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(ii) Carbon dioxide is an acidic oxide which is why it dissolves and reacts with alkalis.

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The volume of CO_2 produced is 90 – 30 = 60 cm^3. Quite a large number achieved full credit here.

(iv) This question was based on the knowledge that the number of moles/molecules of each gas is directly proportional to their volumes, if all volumes are measured under the same conditions of temperature and pressure (e.g. r.t.p).

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(i) There were many good answers but some candidates wrote a balanced equation for the formation of 1-chlorobutane. Others drew branched structures and some substituted bromine or fluorine for chlorine.

It is not possible to produce branched chain halogenoalkanes from straight chain alkanes. This involves breaking and forming carbon–carbon bonds. Some chloroalkanes had five carbon atoms. Some redrew the same product. Chlorine atoms which were clearly shown as being bonded to two other atoms were not allowed. If in doubt, when representing structures, it is best to draw displayed formulae, showing all atoms and bonds. These are acceptable when structural formulae are requested.

(ii) Ultra violet (UV **is** an acceptable abbreviation in this case) was known by some, but those who attempted to refer to heat (200 ^{o}C) or catalyst (lead tetraethyl) were usually not specific enough.

(iii) Many candidates did not mention alkanes or petroleum or hydrocarbons being broken down or decomposed. Alkenes were commonly mentioned as the starting material. Conditions and uses of products were most frequently missed out. Candidates usually stated that products were useful rather than giving specific uses. There were some good equations that were seen.

CHEMISTRY

Paper 0620/33
Extended Theory

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CHEMISTRY

Paper 0620/04
Coursework

General comments

Most of the Centres which entered for the coursework alternative were Centres which had entered previously and there were few problems with the standards applied by the staff concerned.

There were problems with a small number of new Centres which clearly had not read the requirements for assessment in the syllabus sufficiently carefully.

Each skill must be assessed on at least two occasions and two marks must be recorded for each skill. Centres which submit only one mark for a skill can only achieve half of the possible marks even if the work is excellent.

Skill C1 involves the following of instructions usually in the form of a worksheet. It is, therefore impossible to assess from a task which assess skill C4 which requires candidates to plan their own work.

Centres are reminded that they should send details of the investigations used together with the candidate instruction sheets and mark schemes. It is also very helpful if a 'tick list' is included to show how marks were awarded for skill C1 as this forms the only evidence for the accuracy of this marking.

There is still a clear difference in the difficulty of the tasks used by different Centres. The use of a demanding task does not mean that higher marks can be scored and can disadvantage candidates who do not fully comprehend it. As long as the task allows candidates to demonstrate the full range of skills it is acceptable. See comments on specific skills for guidance as to what opportunities the task should provide.

Some Centres have successfully used the same tasks over a number of years and there is, clearly, no need to change these. However, if you are considering introducing a new task the comments below may help.

Comments on specific skills

Skill C1 Using and Organising Techniques, Apparatus and Materials.

To gain maximum marks here candidates need to follow instructions successfully. The task needs to have a number of steps which need to be followed in sequence. At some point there must be a situation where a candidate has to make a choice between two alternative courses of action (this could be as simple as whether or not to stop heating).

Candidates are not required to modify the method they are using, this is part of skill C4.

Skill C2 Observing Measuring and Recording.

The tasks set should allow candidates both to take measurements and to make other observations, though not necessarily in the same task.

Visual observation should be detailed and complete. Measurements should be as accurate as is feasible using the apparatus available to the candidate.

Observations and measurements should be recorded appropriately (usually in a table) in a manner designed by the candidate. The provision of an outline table or detailed instruction on how to record results limits the maximum mark available.

Skill C3 Handling Experimental Observations and Data.

The processing part of this skill refers to data and the most common form of processing is a graph. Graphs should be of sufficient size, ideally A4, and should occupy most of the grid. Small graphs are less accurate and are not deserving of the highest marks. Computer drawn graphs are acceptable but they must be to the same standard as hand drawn ones with a best-fit line or curve. For the highest marks there should be no plotting errors and axes should be labelled with quantities and units.

Where calculations are involved (e.g. in titration exercises) any assistance given decreases the mark available.

Conclusions given in answer to leading questions are rarely worth high marks although a question prompting the candidate to give a conclusion is fair.

At the highest level conclusions should describe and explain patterns/trends found in the results and should comment on any results which do not fit the pattern.

Skill C4 Planning, Carrying Out and Evaluating Investigations.

This is the skill where the selection of an appropriate task is most important. To gain access to the higher marks it is essential that a number of variables are involved. Very simple investigations are unlikely to give access to the highest marks.

The most obvious examples are concerned with speed of reaction where a number of variables could affect the speed. Explaining how these variables will be controlled, varied or measured is key to performing well. Another good example would be comparing the amount of heat produced by different fuels.

It is also essential that candidates perform the investigation which they have planned as indicated in the title for this skill. A candidate who does not carry out the investigation has not fully complied with even the criteria for 2 marks.

This is the most difficult skill to score well on. It is not recommended that C4 tasks should be the only way of assessing C2 and C3 as a poor plan can adversely affect these marks.

It is impossible to assess C1 and C4 on the same task since one involves following instructions and the other involves writing them.

CHEMISTRY

Paper 0620/51

Practical

Key messages

Candidates must make sure that the recorded observations in **Question 2** are specific and in sufficient detail. All observations should be recorded.

General comments

The majority of candidates successfully completed both questions and there was no evidence that candidates were short of time. Centres reported very few problems with the requirements of the examination. However, a wide range of results showed that some of the solutions for **Question 1** were not made to the specified concentrations. Solutions of potassium manganate(VII) need to be made well in advance as it is difficult to see whether the crystals have all dissolved. Candidates were not penalised as Supervisors' results were considered when marking the scripts. There were still a minority of Centres, which did not submit a copy of the Supervisor's results with the candidates' scripts. The Examiners use Supervisors' results when marking the scripts to check comparability.

Some candidates noted the initial burette readings in **Question 1** as 50.0 cm^3 with the difference recorded in the final reading box and the final reading in the difference box. Centres who use burettes with an initial reading of 50.0 cm^3 instead of 0.0 cm^3 should inform the Examiner on the Supervisor's report.

Comments on specific questions

Question 1

(a)(b) The majority of candidates carried out the two experiments and correctly recorded the volume of potassium manganate(VII) required to react with the acidic solution **C** in both experiments.

The table of results was generally fully and successfully completed. A minority of candidates did not record the volumes to one decimal place.

Some candidates had results which were not comparable to the Supervisor's results.

(c) Experiment 3 was attempted by all candidates and proved to be a good discriminating question. References to black were ignored and 'gas given off' is not an observation and scored no credit. Similarly the mention of oxygen present without any reference to effervescence or the test carried out scored no credit. The use of a glowing splint and correct test result was often implied but unless written down cannot be awarded credit. A significant number of candidates used a lighted splint and recorded a pop, while others described the smell of ammonia.

(d) The most common incorrect answers were hydrogen, carbon dioxide and ammonia.

(e)

(i) Only the minority of candidates scored credit for the correct colour change i.e. pink to colourless or vice versa. Many incorrect answers referred to the original colour as clear and the colour change as from purple to pink.

(ii) A good discriminating question. The fact that an indicator was not needed because potassium manganate is self-indicating was only correctly realised by a minority of candidates. Vague answers concerned the idea of an indicator interfering with the reaction or results.

(f)

(i) Despite the expected volumes recorded in the table, the experiment that used the greatest volume of potassium manganate was often incorrectly identified.

(ii) The fact that twice as much potassium manganate solution was used in Experiment 1 was often missed despite appropriate volumes being obtained and recorded. Vague references to more or less solution or a simple restatement of the volumes from the table were common responses.

(iii) A good differentiating question. Only the more able candidates could explain the differences in volumes in terms of concentration or strength of the solutions. Many candidates mistakenly thought that using a greater volume of solution indicated that it was **more** concentrated than using a smaller volume of solution. Vague references to reactivity or acidity of the solutions were common.

(g) Generally well answered though lots of answers lacked the necessary detail to score full credit. The unit was often missing.

(h) This question was not well answered. Many candidates thought that an advantage of using a measuring cylinder was its accuracy or that you could measure large volumes of liquids. The idea of ease of use or quicker to use was often missed. The disadvantage was often cited as inaccuracy or that some of the solution would remain in the cylinder after use. The fact that the latter would apply to a pipette or burette was ignored or not known.

Question 2

(a) Some candidates did not describe the colour of the liquids. Colourless scored credit while references to clear or transparent did not. In **(ii)** either the smell or the colour was omitted when both were required.

(b)

(i) A good discriminating question. Detailed answers listed the burning of the liquid **M** and the colour of the flame. Some candidates referred to glowing splints and the liquid evaporating.

(ii) A number of candidates recorded that nothing happened or nothing was observed. The fact that the lighted splint was extinguished was not given.

(c)

(i)(ii) The formation of coloured solutions was recorded accurately by most candidates. Poor attempts referred to observations such as variously coloured precipitates.

(iii) Detailed descriptions were often missing. The liquids were immiscible and the idea of layers was often missed. The colour of iodine in the organic layer was often incorrectly described as red instead of pink or purple.

(d)

(i) A number of candidates obtained a white/yellow precipitate when nitric acid and silver nitrate was added to the liquid. No reaction/change was the expected observation here as the substance being analysed was an organic compound.

(ii) A minority of candidates gave several answers and described the precipitate as green/cream/white combined with yellow. The use of the term ‘solid’ instead of precipitate should be discouraged.

(e) This was generally well answered. The majority of candidates were able to describe a coloured precipitate and a range of responses were allowed depending on when the observation was made.

(f) Only the more able candidates recognised the presence of an organic compound. Some candidates qualified their answer and mentioned alcohols, hydrocarbon and flammability and scored credit. Many wild guesses involving the presence of metallic ions e.g. iron(III) ions and acids were seen.

(g) Some candidates concluded wrongly that liquid **N** was a chloride. A common incorrect response was iodine as opposed to iodide ions or I^-.

CHEMISTRY

Paper 0620/52
Practical

Key messages

Candidates must make sure that the recorded observations in **Question 2** are specific and in sufficient detail. All observations should be recorded.

General comments

The majority of candidates successfully completed both questions and there was no evidence that candidates were short of time, indeed, some candidates had time to complete repeat runs in Experiment 1 (although this is neither required nor expected). Few problems were reported with either Experiment 1 or 2. Most Centres obtained results within the expected range in Experiment 1. However, there were cases where the gas volume produced was either far too large or far too small. The Confidential Instructions stated the expected gas volumes after three minutes and Centres should check well before the examination that the chemicals the candidates will use do give the expected results. Candidates were not penalised as Supervisors' results were considered when marking the scripts. However, this can only be done if Centres provide a copy of the Supervisor's results. The Examiners use Supervisors' results when marking the scripts to check comparability. The results obtained by some Centres suggested that the magnesium ribbon used was coated in a thin layer of corrosion – it would be a good idea to clean magnesium ribbon with abrasive paper prior to using it for a quantitative task.

Comments on specific questions

Question 1

(a)(b) The majority of candidates carried out the two experiments and correctly recorded the volume of gas produced in each experiment.

The table of results was generally fully and successfully completed. A small minority of candidates did not record the cumulative gas volume but instead recorded the calculated volume of gas collected in each 30 second interval.

Most candidates obtained results comparable to the Supervisor's results, although a small number did not collect any gas at all, or collected very low volumes – probably due to not inserting the bung firmly into the conical flask.

(c) Pleasingly few errors were seen in the plotting of the points on the graph, but credit could not be awarded where lines were not labelled or not drawn smoothly. Full credit could be obtained by either drawing a straight line or a curve of best fit, but lines which just join each point to the next are not considered to be smooth line graphs.

(d)

(i) Almost all candidates could identify which reaction was the fastest.

(ii) This question discriminated well, better candidates gave answers based on acid concentration but many weaker candidates gave answers which explained how they knew which reaction was faster rather than why the reaction was faster.

(e) The most common error was to state that all the magnesium had reacted, despite having been told at the very start of **Question 1** that the magnesium was in excess.

(f) While the vast majority of candidates indicated correctly on the graph how they read off the time required, many found the scale very difficult and so gave incorrect times.

(g) This was poorly answered with many candidates focusing on the need to avoid collecting the first few bubbles of gas as they would be air. It is true that the first bubbles are air, but this has been displaced by the hydrogen produced and so the volume of air displaced will be the same as the volume of hydrogen left in flask at the end – hence its volume needs to be included.

(h) It was common for candidates to answer the question based on the collection of the gas rather than on the measuring of the volume of the acid. While many candidates realised that measuring cylinders were quick to use but not very accurate, others thought the opposite. Some candidates were concerned with evaporation of the acid (which will be minimal in the time the experiment takes) or that measuring cylinders will react with acids (which they will not).

Question 2

(a) Almost all candidates observed that the solid was white.

(b) Credit was most commonly awarded for the pH of the gas. While many noticed the white smoke, very few commented on the deposition of the white solid further up the test tube. References to the smell of the gas were rare.

(c)

(i) Most candidates gained full credit, however, some did not use the expected term "precipitate" (just stating "cloudy white") and some contradicted themselves by stating the precipitate was soluble.

(ii) This was generally well answered, although a few candidates claimed to have made an acidic gas.

(iii) Many candidates seemed reluctant to report a negative test result (which can be just as informative as a positive result). Hence, what should have been a colourless solution was sometimes described as either forming a precipitate or fizzing.

(d) Rather than give detailed observations, a number of candidates simply wrote down the name of the gas produced. Impossible test results were often seen, including positive identification tests for hydrogen, oxygen and chlorine. Candidates should be encouraged to report what they observe rather than guess what they think should have happened.

(e)

(i) Most candidates obtained a white precipitate, although some incorrectly claimed this redissolved in excess. A few candidates reported seeing fizzing – this is not possible on the addition of sodium hydroxide to the solution.

(ii) Many reported the expected result, although some reported the formation of thick white precipitates.

(f) This was often well answered, although there was sometimes confusion between "ammonia" and "ammonium". A minority of candidates mixed up solids **W** and **V**, giving the conclusions the wrong way round.

(g) The metal ion was often wrongly identified as zinc.

CHEMISTRY

Paper 0620/61

Alternative to Practical

Key messages

Questions requiring few words in the answer were generally well attempted, whereas longer question answers needed more detail and explanation. Candidates should be guided by the number of marks allocated to each question.

General comments

The vast majority of candidates successfully attempted all of the questions. The paper discriminated successfully between candidates of different abilities but was accessible to all.

Candidates found parts of **Questions 4** and **5** to be the most demanding. The majority of candidates were able to complete a table of results from readings on diagrams as in **Question 4**, and plot points successfully on a grid as in **Question 6**. A minority of candidates did not attempt **Question 7**.

Comments on specific questions

Question 1

(a) Most candidates scored credit on this question. The most common error was to identify the beaker as a flask or measuring cylinder.

(b) Generally well answered. Common incorrect answers included unlabelled arrows and misdirected arrows i.e. the indication of heat not under the shaded solid. The arrow labelled heat was often under the beaker and the arrow labelled water often above the level of ice in the test-tube.

(c) Most candidates understood that the purpose of the ice was cooling, though some did not detail what was being cooled while others referred to the cooling of the zinc sulfate or a solution.

(d) Many candidates used chemical tests such as anhydrous copper sulfate or cobalt chloride or tested for pH and scored no credit.

Question 2

(a) Generally well answered. The common correct responses referred to temperature or the volume/amount of acid/sodium thiosulfate. Some candidates wanted to keep the time intervals the same.

(b) A minority of candidates drew a straight line which did not touch all of the points, including the origin, apart from the anomalous point. Some lines were drawn freehand when a ruler was required and others joined all of the points together.

(c) Vague answers such as ‘not an accurate experiment’ or ‘measured wrongly’ were common. Good answers referred to changes in temperature, errors in measuring the volume of the acid and plotting/recording errors. A significant number of candidates discussed the changing of the concentration of the sodium thiosulfate solution which was the variable in this investigation.

(d) The scale on the *y*-axis caused some candidates problems. Construction lines were drawn in the wrong place or drawn correctly and incorrectly read.

(e) A good differentiating question. Weaker candidates did not give a reason and just stated that higher concentration makes the reaction faster. A number of candidates thought that higher concentration makes the particles moved faster. Reference to more particles and hence more collisions was given by the most able candidates.

(f) Generally correct with a sketch line to the left of the original graph. Some joined the lines together at both ends.

Question 3

(a) Mostly correct but a few answers referred to filtration or distillation.

(b) Most common error was to state that the solvent was ethanol despite being given information that the dyes were water-soluble.

(c) Vague descriptions such as 'the starting line' and 'solvent line/front' were penalised. References to pencil lines were also common.

(d) A good differentiating question. Most candidates realised that sweet **C** had more colours than **D**. Only the better answers described that two colours were the same in both sweets and that **C** had 4 colours and **D** had 3 colours. Vague references to concentration and darkness of the spots was ignored.

Question 4

(a)(b) The table of results was usually completed although few candidates were awarded full credit. Errors were seen in not recording the volumes to one decimal place and recording the initial volume in Experiment 1 as 25.

(c) The majority of answers were correct. The most common error was hydrogen.

(d)

(i) Many incorrect responses referred to purple to pink and vice versa.

(ii) Vague answers mentioned the interference effect of adding an indicator. Good answers stated that an indicator was not necessary as the manganate solution was itself coloured and acted as an indicator.

(e)

(i) Despite correct readings in the table of 32.0 cm^3 for Experiment 1 and 16.0 cm^3 for Experiment 2 candidates often wrote Experiment 2 as the answer. A number gave 'Experiment 3' as the answer despite nothing being measured in this experiment.

(ii) Many answers contradicted the answer to **(i)**. Many candidates did not realise that double/half was required and just wrote 'more was used'.

(iii) Few candidates were able to express a coherent explanation in terms of concentration or strength of the solutions. Many candidates thought that using more volume of a solution meant it was more concentrated. Some answers were erroneously based on reactivity or temperature.

(f) Generally well answered by most candidates. However, a significant number referred to the wrong experiment. Other confused responses thought that the total volume must be constant or that with less hydrogen peroxide more manganate solution must be used to keep the speed the same.

(g) Some good answers but many candidates stated that the advantage was the accuracy of use. Confused answers included fears that the measuring cylinder could be easily broken, large volumes of liquid could be measured and that liquid remained in the cylinder after use.

Question 5

(a) This was not well answered. Some candidates described the substance as being a solid or a precipitate and few considered its smell.

(b) Most candidates assumed that the liquid would burn despite being given information that it was aqueous. Lilac flames were common and vague responses such as 'no change' or 'nothing happens' were prevalent.

(d) Generally well answered.

(e) A significant number of candidates identified the presence of sodium ions assuming that the yellow flame was responsible. Only a minority of candidates realised that the liquid was an organic compound. Credit was given for recognising the possible presence of an alcohol or hydrocarbon.

Question 6

(a) The quality of the diagrams drawn was often poor. Many diagrams lacked either a filter paper or a funnel and labels were frequently absent. Many candidates had little idea as to what was required.

(b) The majority of answers were correct.

(c) The plotting of the points was often good. A significant number of candidates often missed the horizontal straight line and many drew two straight lines going from left to right upwards.

(d) Usually correct but guesses were evident and 2.35 was a common wrong answer.

Question 7

(a) A named indicator with the correct observation was often correctly stated. Incorrect answers described the use of lighted splints or acids to neutralise the alkali. Candidates opting to show formation of coloured precipitates, using appropriate metal ions, often just used the metal e.g. copper or zinc and scored no credit. Heating sodium hydroxide with ammonium(sic) also scored no credit.

(b) Recognition that acids in the drink could react with the cleaner to produce chlorine scored credit. Many vague answers discussed fires or explosions.

(c) The idea of cleaning the container to prevent health and safety or environmental problems was realised by most candidates.

(d) Many correct responses. However, a significant number of candidates described the test for chloride ions using aqueous silver nitrate and scored no credit.

CHEMISTRY

Paper 0620/62
Alternative to Practical

Key messages

Preparation for this paper should include as much experience of practical chemistry as possible, either by participation or observation, so that candidates are familiar with techniques such as those used in all questions. They should be able to read instruments (**Questions 2** and **4**) and draw graphs using smooth lines of best fit, using a ruler or drawing a curve as appropriate. They need to learn analytical tests and their results (**Question 5**).

General comments

The vast majority of candidates successfully attempted all of the questions. The paper discriminated successfully between candidates of different abilities but was accessible to all.

Candidates found **Questions 5** and **6** to be the most demanding.

The majority of candidates were able to complete tables of results from readings on diagrams and plot points successfully on a grid as in **Questions 2** and **4**.

Comments on specific questions

Question 1

(a) Surprisingly, with a choice of two responses, about half of the candidates selected the measuring cylinder and the other half chose the burette. The latter did not see the significance of the approximate volume of 70 cm^3, nor the fact that it was greater than the capacity of common burettes.

(b) The majority of candidates successfully identified all three pieces of apparatus. The most difficult was the evaporating basin. Similarly most realised that **A** was the most suitable for obtaining pure water from a solution.

(c) Nearly all of the candidates realised that the solution needed heating or evaporating. Fewer candidates realised that this must stop before complete dryness if crystals were required.

Question 2

(a) Most candidates knew how to read a thermometer correctly and could also calculate the temperature rises.

(b) The majority of candidates correctly plotted the points and drew a straight line, with a ruler, missing the anomalous point.

(c) This was well answered with nearly all candidates identifying the inaccurate point, even if their line in **(b)** was incorrect.

(d) Very few candidates failed to extrapolate the graph correctly to obtain the answer of 24 ^{o}C. Most extrapolated it through the origin as well.

(e) This was the first part of this question that candidates found difficult. Too many answers were of the type 'a gas is formed', which is not an observation. Many named the products of the reaction which are also not observations.

Question 3

(a) The observations here were far better than in the previous question. A few candidates gave two very similar answers, such as 'bubbles are given off at the anode' and 'bubbles are given off at the cathode'. Credit was awarded for bubbles given off, so these candidates were awarded partial credit, having omitted the obvious lit bulb.

(b) Most candidates correctly gave carbon, graphite or platinum. The commonest incorrect answer was copper.

(c) Generally well answered and most candidates identified hydrogen.

(d) Two very similar answers, based on safety clothing, were common, e.g. 'wear goggles' and 'wear gloves', which only earned partial credit. The second marking point was looking for the idea of ventilation or the use of a fume cupboard.

Question 4

(a) The table of results was usually completed correctly.

(b) The table of results was similarly usually completed correctly.

(c) Most candidates plotted the points correctly and labelled the lines. The quality of the curves was very variable, with too few smooth curves. Candidates should not join the points using a ruler.

(d) The first part was very well answered, but too often instead of an explanation, a description was given for the second part, e.g. 'the second graph went up faster'. This did not gain credit. Neither did the suggestion that acid **X** was more reactive. The desired answer was that acid **X** was more concentrated or stronger than acid **Y**.

(e) Candidates often thought that the magnesium ribbon had run out, despite mentioning in their answers that it was in excess. There were too many vague answers such as 'the reactants have run out'.

(f) Answers generally showed the correct working, but sometimes got the scale wrong.

(g) Most knew that a disadvantage of a measuring cylinder was its limited accuracy. Less gave its speed or ease of use as an advantage.

Question 5

(b) Most realised that a white precipitate would form in **(i)**, although a few went on to spoil their answers by saying that it would be soluble in excess. In **(ii)** most candidates realised that the indicator paper would turn blue, but could not add anything, such as the pH or pungent smell, for further credit.

A disappointing minority of candidates correctly realised that there would be no reaction/changes in **(iii)**. The formation of a variety of coloured precipitates showed a lack of knowledge and understanding.

(e) The formation of carbon dioxide was well known by all but the weakest candidates.

(f) More able candidates had no problems here; the weaker candidates struggled to identify calcium carbonate.

Question 6

This was a good discriminating question. About half the candidates gave a basically correct answer, the most common error being the omission of a constant volume of water. However, the other half did not know what to do with the apparatus they had been given. Common errors were heating the fuels, mixing the fuels with water, or burning the fuel in the spirit burner in the can of water. Some described fractional distillation and fermentation.

Good answers referred to a fair test. Details such as needing to measure masses/volumes of water and fuels, temperatures of the water before and after burning the fuel, repeating the experiment and comparing the results of the two fuels were listed in good responses.

CHEMISTRY

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