CHEMISTRY

Paper 5070/11
Multiple Choice

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

General comments

There was a mixed performance on the paper with some candidates who answered very well across the paper, while other candidates found some questions challenging. Candidates seemed particularly familiar with macromolecules in the human body and answered the question on this well. Questions concerning the preparation of salts proved problematic.

Comments on specific questions

Question 3

The strongest candidates chose the correct option **B**. However a significant number chose **A** or **D**, and a large number selected **C.** It seemed that many candidates did not realise that barium carbonate is insoluble.

Question 7

A large number of candidates gave the correct answer of **B** but almost as many selected **D**. This shows the importance of reading the question carefully. Whilst statement **D** is clearly a correct fact, it does not show that "graphite and diamond are different forms of the same element".

Question 9

Many candidates gave the correct answer of **C**. However a significant minority selected **B**. It would appear that the latter group had not understood the different reasons for conductivity in metals and in ionic substances.

Question 10

This question proved challenging despite being recall of syllabus material. The strongest candidates selected **D** but a majority of candidates chose **A**.

Question 13

While the stronger candidates gave the correct answer of **C**, a large number of candidates selected the incorrect option of **A**. The choice of **A** suggests that candidates recognised that the existence of isotopes means that the compound will have different relative molecular masses but failed to consider the effect of there being three chlorine atoms present.

Question 24

This question, unlike **Question 3**, was based on choosing a suitable method for preparing an insoluble salt. In this case some confusion was evident since only the strongest candidates correctly chose **B** whilst a large number thought that a reaction between lead and hydrochloric acid was suitable (option **D**).

Question 25

Many candidates realised that after the addition of sodium chloride, the solution would remain acidic and hence gave the answer **B**. A large number of weaker candidates however, apparently looked only at the sodium chloride and therefore suggested that the solution would have a pH of 7 (option **C**).

Question 33

Most candidates chose either option **A** or **D**. As in **Question 13**, the incorrect choice of **A** could perhaps be due to candidates not considering the effect of the presence of more than one of the potentially reacting atoms in a molecule of the reactant and the large excess of chlorine.

Question 34

The strongest candidates correctly gave **D** but many suggested **B**. Since this choice involves alcohols containing the hydroxide ion, OH^-, it suggests that many candidates did not appreciate the difference between covalently and ionically bonded OH.

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Paper 5070/12
Multiple Choice

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

General comments

General comments

There was a mixed performance on the paper with some candidates who answered very well across the paper, while other candidates found some questions challenging.

Candidates seemed particularly familiar with methods involved in titrations, following the rate of a reaction, flow charts for manufacturing processes and cracking of hydrocarbons and performed well on **Questions 2, 26** and **39**.

Comments on specific questions

Question 7

A large number of candidates gave the correct answer of **B** but many selected **D**. This shows the importance of reading the question carefully. Whilst statement **D** is clearly a correct fact, it does not show that “graphite and diamond are different forms of the same element”.

Question 8

In this case many candidates gave the correct response, **C**. However a significant number of candidates gave each of the other three options in almost equal number, presumably having mis-counted the protons and then guessed at one of the other responses.

Question 10

Whilst many candidates gave the correct answer, **A**, a significant minority gave **D**. It would appear that candidates in the latter group considered the information that ammonia (an alkali) reacts with carbon dioxide (an acid) and therefore were looking for the formation of a salt. However this conclusion was not justified since the formula of this product did not correspond to the atoms that were specified as being present.

Question 16

This question proved challenging for many candidates. However stronger candidates gave the correct answer, **D**, since the bonding within both oil and water molecules is the same – covalent – making **D** the only incorrect statement. Many candidates gave **C** as their response. This is a correct statement as, although overall oil is less dense than water, in a mixture such as oil, there will be molecules with a large variety of relative molecular masses.

Question 20

This question was only answered correctly by the stronger candidates. Both **B** and **C** were chosen more frequently. To reach a valid conclusion candidates had to realise that, from the stoichiometry of the equation for one mole of each carbonate, the volume of carbon dioxide released would be the same but, that if insoluble sulfates were being formed, the reaction would not go to completion.

Question 30

A minority of candidates recognised that hydrated sodium carbonate loses water of crystallisation on heating to give the correct response, **B**. A large number of candidates, however, thought that the anhydrous compound further decomposed to release carbon dioxide. This led to **D** as an answer.

Question 34

This question was the most challenging on the paper. To reach the conclusion it was necessary to note, in the stem of the question, that the molecule had to be both unsaturated and a hydrocarbon. It is probable that the candidates who gave **B** as an answer did not notice that the first structure is not a hydrocarbon while those who gave **C** as answer merely looked for the presence of any double bond.

CHEMISTRY

Paper 5070/21
Theory

Key messages

- Candidates need to show all relevant working out when completing calculations.
- Candidates need to be able to construct ionic equations when required by the question.
- When it is relevant candidates must give comparative answers using words such as ‘highest’ or ‘smallest’ etc.
- Candidates must distinguish between rate of reaction and position of equilibrium when discussing and explaining the conditions used in industrial processes.

General comments

There was no evidence to suggest that candidates did not have sufficient time to complete all of the questions. Most candidates answered only three questions from **Section B** as required but a small proportion of candidates answered all four.

Comments on specific questions

Section A

Question A1

(a) Many candidates could identify poly(propene) as the polymer made from propene.

(b) Candidates were able to recognise that the incineration of PVC would form hydrogen chloride.

(c) Many candidates were able to recall that proteins are hydrolysed into amino acids.

(d) Many candidates were able to recall that starch is hydrolysed to form sugars.

(e) Candidates often recognised that *Terylene* or polyester contained an ester linkage, although a common incorrect answer was nylon.

Question A2

(a) Candidates often recognised that hydrogen sulfide would have a low melting and a low boiling point. Some candidates stated it was a gas but did not include a reference to room temperature and pressure as required.

(b) (i) Many candidates found this question quite challenging and sometimes did not include the charges on the ions or balance the equation.

(ii) Candidates often referred to incomplete dissociation or to partial ionisation but a common misconception was that strength was related to the number of hydrogen ions produced.

(c) The most able candidates were able to calculate the volume needed as 66.7 cm^3. In this question candidates needed to correctly round up their answer and some failed to do this giving an answer of 66.6. The best answers showed all the steps in the calculation. However some candidates just included a collection of isolated calculations that were not linked in any way.

(d) (i) The most common physical properties given were that magnesium sulfide dissolves in water and has a high melting or boiling point. Answers that referred to electrical conductivity often forgot to mention the state of the magnesium sulfide.

(ii) Candidates were often able to describe how a magnesium atom lost two electrons that were given to a sulfur atom. Some candidates were not sufficiently precise with their answers and referred to sulfide ions gaining electrons or magnesium ions losing electrons. Only a very small proportion of candidates described an electron transfer from sulfur to magnesium.

Question A3

(a) The possible uses for propyl ethanoate were well known by candidates with many referring to perfumes.

(b) Many candidates struggled to draw the displayed formula for the ester. Some candidates did not include the ester linkage and showed a ketone while other candidates showed ethyl propanoate. A common error was to show a hydroxyl group present in the molecule.

(c) (i) Many candidates gave good definitions for diffusion often referring to the movement of particles from a region of high concentration to a region of low concentration.

(ii) Candidates often linked the increase in speed of particles to the increased rate of diffusion.

(iii) Candidates often recognised methyl ethanoate as the ester that diffuses the fastest and related this to its relative formula mass. Candidates needed to be careful to include comparative statements e.g. “lowest relative formula mass” could be credited but “low relative formula mass” was not.

Question A4

(a) Many candidates could give two of the conditions for the Haber process but often got the third one incorrect. Candidates must ensure that they include the units for physical quantities particularly as in pressure it can be measured in a variety of units.

(b) Candidates typically gave answers that related to equilibrium rather than to rate of reaction. Those candidates that did refer to rate often did not mention particles and only mentioned more collisions rather than collision frequency. The idea that there were more particles per unit volume was poorly expressed and often candidates just referred to more particles.

(c) Many candidates appreciated that catalyst lower the activation energy for a reaction.

(d) Almost all candidates who attempted the question calculated the percentage of nitrogen in both fertilisers in order to show that urea contained a greater percentage by mass of nitrogen. A significant proportion of the candidates did not attempt this question.

Question A5

(a) The correct order was given by many candidates.

(b) Candidates could not always suggest an identity for **X**. The most common correct answer was zinc but some candidates gave aluminium because they did not use the formula of the oxide.

(c) Candidates could often write the equation of the oxide with magnesium. Many candidates used zinc oxide rather than **X**O in the equation. This was given full credit.

(d) Candidates often struggled to write the ionic equation and some gave the full formulae rather than the formulae of the relevant ions.

(e) A large proportion of candidates referred to covalent bonding, ionic bonding or intermolecular forces within their answer. Candidates rarely mentioned the strong electrostatic attraction between the positive ions and the sea of electrons to explain the high melting point. Candidates often appreciated that the electrons are mobile and so metals conduct electricity.

Question A6

(a) (i) Many candidates were able to refer to global warming or climate change and only a small proportion of candidates referred to ozone depletion.

(a)(ii) Candidates could often recall a source of atmospheric methane.

(iii) Candidates often referred to ozone depletion.

(b) Candidates were often able to draw the correct 'dot-and-cross' diagram.

(c) (i) Many candidates answered the question with an equation involving the direct combination of nitrogen with oxygen. A common misconception was that the nitrogen came from the gasoline rather than the air. A significant proportion of candidates did not attempt this question.

(ii) The best answers gave either two equations or one equation showing the oxidation of carbon monoxide and the reduction of nitric oxide. A significant proportion of candidates did not attempt this question.

(d) Candidates often could deduce the formula as HNO_2. Many of these candidates did this by writing a balanced equation.

Section B

Question B7

(a) There were some very good answers given that included the reaction of excess silver oxide with hot dilute nitric acid. Other candidates reacted silver oxide with metal nitrate solutions rather than nitric acid and then filtered off either a precipitate of the excess silver oxide. The idea of crystallisation was often well described even with preparations that used incorrect reagents. A significant proportion of the candidates did not attempt this question.

(b) (i) Many candidates appreciated that a white precipitate would be made.

(ii) Candidates found this ionic equation quite demanding and often did not use Ag^+ and Cl^- in their equation.

(c) (i) Candidates often recognised that silver would be formed at the cathode although some candidates gave hydrogen instead.

(ii) Only the most able candidates were able to give the equation to show the discharge of hydroxide ions. Candidates often neglected to show the electrons or had them on the wrong side of the equation.

(d) Candidates could often use the formulae of the products given to write an equation.

Question B8

(a) (i) Candidates found it difficult to give a precise meaning of the term saturated. Some candidates referred to the presence of carbon-carbon single bonds or the lack of double bonds within the molecule. The idea that all the carbon-carbon bonds in the molecule were single bonds was required.

(ii) The term hydrocarbon was often partially correct with the vital 'only' often missing from the reference to hydrogen and carbon.

(b) The most able candidates were able to construct the equation however a significant number of candidates made minor errors in balancing.

(c) Candidates often gave HCl as one of the formula but did not always substitute one or more of the hydrogen atoms with chlorine atoms to give $C_6H_{11}Cl$.

(d) Many candidates calculated the correct answer of 252 g. The best answers calculated the moles of hexane and then used this to calculate the moles of cyclohexane.

(e) (i) Candidates often showed how to deduce an empirical formula and showed all of the relevant steps.

(ii) Some candidates were able to draw the structure for cyclobutane but others tried to give a straight chain hydrocarbon rather than a cyclic compound. A significant proportion of candidates did not attempt this question.

Question B9

(a) This question was well answered and candidates often gave well-structured answers with no contradictions. A small proportion of candidates thought that bond forming requires energy.

(b) Some candidates found this calculation straight forward and got 1310 kJ but other candidates did not attempt the question.

(c) (i) Some candidates could use Le Chatelier's principle and often used the idea of either molar volumes or number of moles in their explanations. Candidates did not always appreciate that the equation had solids and gases and that their answer had to be based on the moles of gases.

(ii) Most candidates could use Le Chatelier's principle although many were sometimes imprecise about the use of the term exothermic reaction and did not specify if it referred to the forward or the backward reaction.

(d) (i) Some candidates recognised that making carbon monoxide was a problem since it was poisonous. A number of candidates did not refer to the high temperature needed for this reaction.

(ii) Candidates found this question challenging and often gave vague answers about the availability of carbon and/or petroleum (crude oil). The simplest correct answer was that petroleum would be saved.

Question B10

(a) (i) Some candidates were able to calculate that a volume of 0.24 dm^3 of hydrogen would be made. The best answers calculated the moles of zinc present and then deduced the moles of hydrogen made. Other candidates did not organise their working out in a logical fashion.

(ii) Some candidates appreciated that even though the mass was the same there was a different amount in moles. The best candidates explained this was due to having different relative atomic masses.

(b) Many candidates found this question quite demanding and were not always able to deduce the observations that a green precipitate of iron(II) hydroxide is formed along with a white precipitate of zinc hydroxide that eventually redissolved in excess aqueous sodium hydroxide. Candidates often only mentioned the two precipitates but were not able to identify them. Some candidates did not attempt this question.

(c) (i) Candidates often referred to electrons in their answer, but the best answers recognised the change of oxidation number from + 2 to + 3 to explain why oxidation had taken place. Some candidates tried to give answers based on oxygen gain.

(ii) Some candidates were able to describe a chemical test for sulfur dioxide with the use of acidified potassium manganate(VII) and potassium dichromate both stated.

CHEMISTRY

Paper 5070/22
Theory

Key messages

- Many candidates need more practice in writing about metallic bonding and weak intermolecular forces between molecules.
- The construction of ionic equations needs more practice.

General comments

Some candidates tackled this paper well. Most candidates gave answers to the appropriate level of detail for questions involving free response. Others gave answers which were far too vague or not related to what was expected from the stem of the question, e.g. in **Question A4(b)** many candidates did not realise that the question was about rate of reaction and not about equilibrium and in **Question B10(c)** many candidates did not use the information in the stem of the question that manganese(IV) oxide is a catalyst.

Some candidates' knowledge of structure and bonding was good. Others got confused between ionic, covalent structures and metallic structures, often referring to metallic structures as being covalent or ionic. In addition, some candidates referred to intermolecular forces between metal atoms. Many candidates did not realise that the low melting point of liquids are due to weak forces between the molecules and not between the atoms.

Some aspects of organic chemistry were well answered e.g**. Question A1** and **B8**.

The writing of balanced equations was not always successful. **Questions A2(b)(i)** and **B7(b)** caused particular challenges to candidates in terms of identifying the ions and in terms of balancing the molecular equation.

Many candidates answered the rate question **A4(b)** in terms of equilibrium rather than rate of reaction. Many candidates need more practice in interpreting whether the question relates to one or other of these topics.

Practical aspects of chemistry as in **Question B7(a)** on salt preparation and purification, posed a challenge for many candidates. Better performing candidates carefully considered the different states of the components in each system. Many candidates also need more revision on qualitative tests, such as seen in **Questions 10(d)** and **(e)**.

Some candidates performed well in questions involving calculations, showing appropriate working, clear progression in each step of the calculation and clear indications about what each number referred to. Candidates should be encouraged to follow this method. Some candidates gave no explanation of what they were doing or the relevant units: g or mol or mol dm^{-3}.

Comments on specific questions

Section A

Question A1

This was the best answered of the ***Section A*** questions, the exceptions being part **(b)** where many did not recognise the use of poly(ethene) in making plastic bags and part **(e)** where many did not recognise the difference in the direction of the linkage between a protein and nylon.

(a) Most candidates recognised **C** and **H**. A common misconception was to suggest polymers **A** and **G**.

(b) Polymer **B** was the commonest correct answer; a wide range of incorrect answers were also seen.

(c) Candidates often recognised an addition and a condensation polymer. Polymer **B** was the commonest addition polymer recognised. A common error was to write down two condensation polymers.

(d) Most candidates recognised structure **B** to be a polymer of an unsaturated hydrocarbon.

(e) Many candidates thought that polymer **A** was a protein, not realising that the structure of amino acids is such that they form links with the amide linkage running in the same direction: CONH…CONH.

Question A2

This question was generally well answered. The exception was in part **(b)(i)** where few candidates were able to construct the simple equation for the dissociation of hydrogen fluoride.

(a) The most common physical property of hydrogen fluoride given was 'low melting point' or 'low boiling point'. A minority of candidates suggested that the compound does not conduct electricity. Others suggested that the melting point was high and that hydrogen fluoride conducts because it is an ionic compound. Many candidates referred to hydrogen fluoride being a gas or liquid without reference to room temperature.

(b) (i) A minority of candidates gave the correct equation. Some appreciated that H^+ and F^- ions are formed but included water in the equation so that it was not balanced. Very few balanced it by writing H_3O^+ as a product. Other common errors included giving hydrogen, fluorine or oxygen as products.

(ii) Many candidates recognised the importance of H^+ ions in determining the acidic properties of hydrogen fluoride. Common errors included writing about rates of dissociation and pH values.

(c) Candidates often gave the correct answer, typically quoted as 33.3 or 33.33. Some rounded their answers too far and gave the answer as 30. A common error involved the incorrect calculation of the relative formula mass of HF, typically 19. Other candidates used the relative formula mass of calcium hydroxide in their calculations. Many candidates did not show clear working. Others confused the mole ratio and used either 1:1 or 1:2 for the $HF:Ca(OH)_2$ ratio.

(d) (i) The commonest physical property given was having a high melting point. The electrical conductivity of solid, molten and aqueous magnesium fluoride was often well understood. A common error was to describe an ionic lattice rather than to give a property.

(ii) Some candidates were not very precise in their answers and did not specify whether the electrons were gained by a chlorine atom or a chlorine molecule. The idea that magnesium lost electrons was generally well understood but some candidates referred to fluoride or F^- gaining electrons. A small number of candidates illustrated their answers with 'dot-and-cross' diagrams.

Question A3

This was the least well answered question from ***Section A***. The structure of ethyl ethanoate in part **(a)** was not well known and many did not give a good enough account of evaporation in parts **(b)(i)** and **(b)(ii)**.

(a) Some candidates were able to draw the displayed formula for ethyl methanoate. Others made simple errors such as drawing a carboxylic acid rather than the ester. Other errors were drawing a ketone rather than an ester; drawing the formula for ethyl ethanoate or the presence of an OH group in the structure. A few candidates omitted one or more C – H bonds.

(b) (i) Many candidates explained evaporation in terms of kinetic particle theory rather than giving a simple definition of evaporation.

(ii) Many candidates did not explain their answer well enough and many referred, incorrectly, to differences in concentration of molecules. Better performing candidates referred to molecules moving more slowly but many did not go on to explain the decrease in evaporation in terms of molecules leaving the surface of the liquid.

(iii) Many candidates either chose pentyl ethanoate or methyl ethanoate. There was not sufficient comparison of relative molecular mass with all the other esters, some referring to higher rather than highest.

Question A4

This question was generally well answered, except for part **(b)** where candidates often focussed on equilibrium aspects of sulfur trioxide formation instead of the kinetic aspect which was asked for.

(a) Some candidates knew the conditions for the contact process. Others made simple errors such as not including the units for temperature and pressure. Other common errors included incorrect oxidation number for the vanadium in the vanadium oxide catalyst; pressure well outside the range (often 100 or 200 atmospheres); a temperature of 300 °C.

(b) Many candidates gave an answer related to equilibrium rather than to rate of reaction. Those candidates who did refer to rate often did not mention particles or only mentioned ‘more collisions’ instead of ‘higher frequency of collisions’. The idea that there were more particles per unit volume was often poorly expressed. Common errors for this included ‘more particles’ (unqualified) or ‘more reactants’.

(c) The most common correct answer referred to a reduction in cost. Some candidates just referred to the reaction being faster or that the catalyst could be reused.

(d) Most candidates calculated the percentage of potassium by mass correctly. The commonest incorrect answers involved either not using two potassium atoms or incorrect calculation of the relative molecular mass of potassium sulfate.

Question A5

This question was generally well answered except for part **(d)**, where many candidates gave rather imprecise answers about metallic bonding.

(a) Many candidates gave the correct order. The main error was to place the reactivity of cobalt below that of silver.

(b) The equation was correctly written by a majority of the candidates. The main errors were confusion of Co with CO; giving CO_2 as a product; giving the product as CoMg.

(c) Many candidates appreciated that carbon dioxide was produced. The formation of cobalt oxide was less well known, cobalt often being seen as one of the products. A minority of candidates gave the correct equation for the decomposition and a few mentioned that this was a decomposition reaction.

(d) A significant proportion of the candidates incorrectly referred to covalent bonding, ionic bonding or intermolecular forces. Many candidates who showed cations and delocalised electrons often neglected to mention the electrostatic attraction between the two types of particles. Others mentioned the attractive forces but did not state that the electrons were delocalised. Candidates who used diagrams often did not label them sufficiently.

(e) The symbol for the isotope of cobalt-59 was generally written correctly. Common errors were to write C instead of Co or to give the incorrect proton number.

Question A6

Many candidates gave good answers to many parts of this question, especially to part **(b)** (eutrophication). Part **(d)** was less well answered; more candidates explained why water has a low melting point (part **(d)(i)**) than described how to show that water is neutral (part **(d)(ii)**).

(a) The 'dot-and-cross' diagram for carbon dioxide was often correctly drawn. Only a small number of candidates drew an ionic structure. Common errors included structures with only one oxygen atom and structure with a single pair of electrons between each carbon and oxygen atom with an extra lone pair on the carbon.

(b) (i) The source of fertilisers was generally well known. The commonest errors were to suggest 'from factories' or to try to relate the source to streams and rivers.

(ii) Most candidates correctly included the word 'eutrophication' in their answers. Some candidates referred to marine animals rather than (fresh-water) aquatic animals. The formation of an algal bloom was often explained as a layer of algae blocking the light. A common misconception was that the fertilisers in the water poisoned the fish directly. The idea of bacteria feeding off dead plants and using up the oxygen was less well known. Some candidates suggested that the algae used up the oxygen.

(c) Many answers gave more than three processes. Descriptions involving screening, filtration and sedimentation were often vague and did not refer to the removal of insoluble particles. A common misconception was to suggest that chlorine removed bacteria (physically) rather than killing them. The use of charcoal in removing odours was generally well answered. Many answers referred to processes which do not occur in a water treatment works, e.g. desalination or distillation.

(d) (i) Many candidates mentioned weak intermolecular forces; this was often contradicted by reference to the forces being 'between the atoms'. Many referred incorrectly to weak covalent bonds.

(ii) Most candidates recognised the use of Universal Indicator but most answers did not refer to the colour green. Others indicators were occasionally suggested and some candidates suggested the use of litmus. Those who did suggest litmus often only referred to red litmus or blue litmus alone. Other common errors included describing electrical neutrality or using boing point or chemical tests for water.

Section B

Question B7

This was the one of the least popular of the ***Section B*** questions to be chosen. In part **(a)** many candidates gave incorrect methods for describing how to prepare lead nitrate crystals and in part **(b)** few were able to construct a suitable ionic equation. Part **(c)** was generally well answered but only a minority of candidates were able to construct the equation in part **(d)**.

(a) Some candidates gave good answers. Others suggested that lead oxide could be reacted with a metal nitrate solution rather than with nitric acid. Some candidates suggested a titration method and many did not take note of the information in the stem of the question that lead oxide is insoluble in water. Some candidates omitted the filtration stage or filtered the incorrect compound. The crystallisation stage was often well described but a few candidates wrote vague statements about this stage.

(b) A minority of the candidates were able to construct the correct ionic equation and even when the formulae were correct, the equation was often incorrectly balanced. Some candidates gave the 'molecular' equation rather than the ionic equation. The state symbols were often incorrect, either because the formulae were incorrect or because the lead iodide was considered to be aqueous.

(c) (i) Most candidates realised that the products of the electrolysis were hydrogen and oxygen. A small number of candidates reversed this order. A few candidates suggested lead as a product at the cathode or nitrogen or nitrogen oxides at the anode.

(ii) Many candidates wrote a correct half-equation for the reaction at the cathode. The commonest errors were to reverse the equation; to put an incorrect charge on the hydrogen ion; lack of balance in the equation, with generally a single H^+ ion.

(d) Few candidates wrote a correctly balanced equation. The most common error was to write $2NO_2$ on the right hand side instead of $4NO_2$.

Question B8

This was the most popular of the ***Section B*** questions to be chosen. Many candidates gave good answers to most parts. The exception was part **(e)(ii)** asking candidates to draw the structure of a cycloalkane with a relative molecular mass of 68.

(a) (i) The term 'unsaturated' was well known; some candidates did not refer to carbon-carbon double bonds.

(ii) Many candidates gave a suitable definition of the term 'hydrocarbon'. Others missed the important word 'only' (carbon and hydrogen) from their descriptions.

(b) Candidates often realised that the products of the reaction were carbon dioxide and water but many did not balance the equation correctly. Some used fractions to balance which is acceptable.

(c) (i) Many candidates did not appreciate that this was an addition reaction and so gave formulae that gave a substitution instead. Others only wrote a single bromine atom in their formula.

(ii) The colour change when bromine is added to an unsaturated compound was well known. Only a small number of candidates gave the incorrect answer 'goes clear' or suggested that there was no colour change.

(d) The answer 246 was given by many candidates. The commonest error was to muddle the relative formula masses of hexane and cyclohexane.

(e) (i) Many candidates calculated the correct molar ratio but did not then show how the correct formula could be obtained. A small proportion of the candidates showed how to calculate the percentage composition and a few used algebraic methods to determine the molecular formula.

(ii) Some candidates drew the structure of cyclopentene carefully and neatly. Others half superimposed their structures over working out so that it was difficult to disentangle the working from the final structure. Many candidates drew chain structures instead of a ring structure.

Question B9

Most parts of this question were well answered. The best answers were seen in part **(b)** (energy/ mole calculation) and in part **(d)** (deduction of the carboxylic acid needed to make an ester).

(a) Many candidates explained why the reaction was exothermic in terms of bond breaking and bond making. A minority wrote sentences incorporating bond breaking and bond making together which often led to incorrect statements about both bond making and bond breaking releasing energy or both bond making and bond breaking absorbing energy.

(b) Most candidates found the calculation straightforward and gave the correct answer.

(c) (i) Many candidates were able to use Le Chatelier's principle correctly and often used the idea of either molar volumes or numbers of moles in their explanations. Others muddled this with the effect of temperature on equilibrium and wrote about the reaction being exothermic.

(ii) Many candidates gave a good explanation of the effect of temperature on equilibrium and related the position of equilibrium to favour the backward reaction because the reaction is exothermic. Those who focussed on the endothermic reaction often got muddled and did not make it clear enough that the backward reaction was endothermic.

(d) (i) Many candidates correctly suggested 'butanoic acid'. Common errors included 'butanol' or 'butane'. A few candidates suggested 'methanoic acid'.

(ii) The use of sulfuric acid a catalyst was fairly well known. Some candidates gave phosphoric acid instead. A minority of candidates chose metal catalysts such as nickel or iron.

Question B10

This was the least popular of the ***Section B*** questions to be chosen. Most parts were answered reasonably well. The exception was part **(c)** where many candidates did not realise that manganese(IV) oxide was a catalyst even though this was mentioned in the stem of the question.

(a) Some candidates gave good answers to explain the oxidation of chloride ions into chlorine molecules. Others confused chloride ions with chlorine (molecules). The best answers often referred to changes in oxidation state (where the oxidation numbers were usually correct).

(b) The idea of manganese(IV) oxide being a limiting reagent was not often stated. A small number of candidates used the idea that the volume of chlorine is proportional to the mass of manganese(IV) oxide. Most candidates stated that when there was more manganese(IV) oxide, there was a greater volume of chlorine.

(c) Many candidates did not realise that manganese(IV) oxide was a catalyst even though this was mentioned in the stem of the question. Some did calculations and came up with incorrect answers such as 0.6 and 0.96.

(d) Better performing candidates referred to the correct colour of the precipitates. Some candidates did not refer to a precipitate. Many candidates did not include equations in their answers.

(e) Many candidates knew that litmus paper is bleached by chlorine. A significant minority gave the test for a chloride ion (aqueous silver nitrate) rather than a test for chlorine.

CHEMISTRY

Paper 5070/31
Practical Test

Key messages

There were a significant number of candidates who are able to produce consistent titres but their results were not in good agreement with the supervisor's.

General comments

The overall standard was good and in general candidates performed equally well in both questions. It is vital that the advice issued in the Confidential Instructions, including checking the requirements, is followed.

Supervisor results were provided by most Centres.

Comments on specific questions

Question 1

(a) Nearly all candidates completed the results table correctly by recording readings to one or two decimal places, accurately subtracting them to determine the volumes of **Q** used and then ticking two or more titration results that did not differ by more than 0.2 cm^3. There were a number of candidates, regardless of whether they had ticked results or not, who calculated the average volume of **Q** by using all their titres. Securing at least two titres within 0.2 cm^3 of the supervisor's value proved challenging for some and there were a number who performed five or more titrations, using up valuable time.

In the calculations that followed, candidates generally attempted all the parts and provided clear working. A good number successfully answered every question.

(b) Most candidates knew how to calculate the concentration of sodium carbonate in **P** but not all of these gave a value to three significant figures. Three decimal places e.g. 0.049 was the most common source of error. Mistakes in the calculation arose from not using the ratio in the equation, inverting the volumes of **P** and **Q**, and employing 20 cm^3 as the volume of **P** despite using a 25 cm^3 pipette.

(c) This was the most successfully completed part. In processing the data, there were some who increased their chances of error by carrying out more steps than necessary, often determining the mass of sodium carbonate in the pipetted volume before working out the mass in 1 dm^3.

(d) While most candidates correctly chose to subtract their answer in **(c)** from 7.85, there were a few who divided by 7.85 or calculated a different mass of sodium carbonate before the subtraction.

(e) There were a good number of candidates who knew how to calculate the value of **x**. Many of these took the route of calculating the number of moles of hydrogen peroxide and then dividing this by their answer from **(b)**; there were other correct methods employed which usually involved determining the relative mass of sodium percarbonate.

Question 2

There were very few candidates who did not complete this question. There were some very good answers produced by well-prepared and capable candidates. Candidates who performed less well sometimes did not following the instructions provided. Incomplete answers and inaccurate recording were also seen. When a gas is observed e.g. by the bubbling of a liquid, the gas should be tested and identified.

Providing the name of a gas is not considered an observation. The instruction in a test to add a reagent until no further change occurs means the written observation must record clearly what happens e.g. precipitate insoluble in excess. Better performing candidates made full use of the qualitative analysis notes supplied on the last page of the examination paper. The terminology and method of reporting shown in these notes are a model for the successful recording of observations.

R was sodium sulfite **S** was potassium manganate(VII)

Test 1 Many candidates reported that the iodine solution turned colourless; there were some who mistakenly used the term clear. The addition of a solid to a solution also caused some confusion, in this and in other tests, prompting descriptions of a precipitate.

Test 3 With the exception of those who used descriptions such as the liquid turns milky or cloudy, candidates recorded a white precipitate on addition of the solution of **R**. There were few candidates who stated that the solid remained in nitric acid; answers which did not indicate the disappearance of the solid e.g. cloudy solution forms or solution turns colourless were not sufficient.

Test 4 The white precipitate formed by adding aqueous **R** was generally found to dissolve in excess. A few did not see any solid formed, presumably because the solution was added too quickly.

Test 5 This proved to be a challenging test for those candidates who did not follow the instructions. Not dissolving the solid added in **(a)** led to descriptions of coloured precipitates in **(a)** and sometimes in **(b)** as well. The addition of plenty of aqueous sodium hydroxide in **(c)** produced a precipitate but there were a number who did not report the formation of any solid at all. Candidates successful in all parts of the test often forgot to state that the precipitate in **(c)** was insoluble in excess of the alkali.

Test 6 The results here were very similar to those with **Test 1**. Better performing candidates understood the difference between the terms clear and colourless.

Test 7 There was some good reporting of the presence and identification of a gas; there were some examples which simply stated 'a gas produced' or 'oxygen given off' which was not sufficient. The test for oxygen gas also provides problems for candidates who do not distinguish between a glowing splint and a lighted or burning splint. In addition, for these candidates, a 'pop' caused by the vigorous relighting of a glowing splint can lead to the incorrect conclusion that the gas is hydrogen. Only the more careful observers noted the formation of a brown precipitate, resulting from the reduction of the manganate(VII) ions.

Test 8 Virtually all candidates made an observation consistent with the production of iodine in **(a)**. Precipitates were incorrectly reported on a number of occasions and there were a few mentions of purple being seen in **(b)**.

Test 9 Candidates generally answered correctly; some candidates omitted an observation.

Conclusions

Some candidates suggested that both **R** and **S** were either oxidising or reducing agents; there were many more who decided that there was one of each type of agent.

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Conclusions

Some candidates suggested that both **R** and **S** were either oxidising or reducing agents; there were many more who decided that there was one of each type of agent.

CHEMISTRY

Paper 5070/41
Alternative to Practical

Key messages

- In questions involving one or more calculations, candidates should always show all of their working. If no working is shown and the final answer is incorrect no credit for any correct stages of working can be awarded.
- In calculations based on titrations answers should be given to three significant figures except when the third figure is zero or the second and third figures are both zero.
- In questions involving the drawing of a graph, the points should be joined as instructed in the question. The curve or line should be extended where appropriate to pass through zero. It should be noted that this is only required when on extension it would naturally pass through zero.

General comments

The Alternative to Practical Chemistry paper is designed to test the candidate's knowledge and experience of practical chemistry. Skills include recognition and calibration of chemical apparatus and their uses, recall of experimental procedures, handling and interpretation of data, drawing of graphs, analysis of unknown salts and calculations.

The majority of candidates showed evidence of possessing many of the skills mentioned above. Most were able to plot points accurately on graphs and join the points as instructed. Calculations were generally completed accurately.

Comments on specific questions

Question 1

(a) The question involved the use of laboratory apparatus and was well answered.

(b) Most candidates knew how an insoluble gas would be collected but some failed to recognise the significance of density relative to air in collecting soluble gases.

Question 2

(a) The colour of litmus paper in hydrochloric acid was almost always correct but pH scale was often incorrectly given as a method of measuring pH. The value stated for the pH of dilute hydrochloric acid was sometimes too high.

(b) Most candidates gave a correct observation for the reaction between sodium carbonate and an acid and could correctly explain the difference in the rates of reaction in terms of the relative strength of the acids.

(c) The identity of the gas was generally correct but some candidates confused the test for hydrogen using a lighted splint, with that for oxygen where a glowing splint is used. The equation was sometimes not balanced correctly or the formula of magnesium chloride was incorrect.

Question 3

Many candidates failed to recognise that only **(b)** and **(d)** would pass the gas through the acid and that **(d)** would expel the acid from the tube.

Question 4

This calculation was generally correct.

Question 5

Enthalpy change and activation energy were sometimes confused but most candidates recognised that the reaction was exothermic.

Question 6

In distillation, the thermometer should be placed alongside the entrance to the condenser to show the temperature of the vapour passing into the condenser. The water vapour entering the condenser would have a temperature of 100 °C.

Question 7

(a) The mass of **V** was almost always correct.

(b) Most candidates gave the correct colours as stated in the question. A few had the colours the wrong way around however.

(c) The titration results were generally correct. The average volume should have been calculated from the closest two titres. Some candidates used all three titres in calculating this volume.

(d) – (l) Many candidates were able to work through the question answering most parts well, and deduced values for **x** and **y** in **(k)** but the structure of the ester linkage required in **(l)** was not well known.

Question 8

The observations in tests **(a)** to **(c)** were generally correct.

In **(d)** a test for the presence of iodine rather than iodide ions was sometimes given. A few candidates gave an incorrect colour of the precipitate formed.

(e) and **(f)** were well answered.

Question 9

(a) The gas syringes were generally read correctly.

(b) The points were usually plotted accurately and joined with smooth curves. Some candidates failed to extend their curves to the origin and a few joined the points with straight lines.

(c) (d) Candidates needed to read the volume of gas at the stated times from the graph and perform the necessary calculations in **(d)**.

(e) The function of the copper(II) oxide was well known and most candidates gave a clear explanation of its use in their answer.

(f) Most candidates correctly explained why the final two readings were the same. A few stated that all the copper(II) oxide had reacted.

(g) This question was answered well by many candidates and nearly all candidates obtained partial credit for one or two correct steps in their working. Candidates could either work in volumes and masses throughout or in moles and convert into masses at the end.

CHEMISTRY

Paper 5070/42
Alternative to Practical

Key messages

In calculations, candidates are advised to give their answers to more, rather than fewer, significant figures. Rounding down or rounding up to too few significant figures often leads to answers being given to an insufficient degree of accuracy. If in doubt, candidates should give their answers to a minimum of three significant figures.

Comments on specific questions

Question 1

(a) Many candidates obviously recognised what the errors were, but found it difficult to express their answers in a clear manner. Common incorrect or insufficient answers included:-

- water in and water out were the wrong way round on the Liebig condenser
- the thermometer was in the wrong position (without giving a positive statement about what the correct position should be)
- the flask had a bung in it without reference to which flask the candidate was referring to. (A bung is essential on the distillation flask)

(b) (i) This was answered well, although “fractionation column”, “fractionalating column” or “fractional column” were often seen.

(ii) The purpose of a fractionating column is separation. Answers occasionally focused on the high surface area of the glass beads rather than concentrating on the purpose of the apparatus.

(iii) This was usually correct, although condenser was often incorrectly spelt.

(iv) Some candidates indicated that water is the liquid which collects as the distillate as opposed to being used as a coolant. Others realised that the vapour was being cooled, although there was no reference to the effect of the cooling which was to turn the vapour into a liquid.

(c) (i) (ii) A large majority of candidates answered both of these parts correctly.

(d) Candidates should be aware that the majority of organic liquids are flammable and that direct heat from a flame should not be used. Alcohols were occasionally mentioned instead of alkanes. Several suitable alternative methods of heating were suggested by candidates, although uniform heating was often given as the reason instead of flammability.

Question 2

(a) Many candidates were fully aware of how to carry out a test for nitrates and how to recognise a positive result. Heat was occasionally absent.

(b) Most candidates gained partial credit for this question. In some cases evaporation to dryness was chosen. Washing the crystals was usually absent. There was no requirement to make the salt or to make the aqueous solution.

(c) (i) This was answered very well, although a small number of candidates entered the readings the wrong way round.

(ii) If there is a fall in temperature in this type of experiment is evidence of endothermic change. Exothermic was seen often.

Question 3

(a) (i) (ii) (iii) Candidates generally answered these parts well.

(iv) This part was also answered well. In a small number of cases it was unclear how the final answer was arrived at from the working out.

(b) Hydrogen was usually identified correctly. The test was occasionally carried out with a glowing splint instead of a burning splint. In a very small number of cases a flame was completely absent.

Question 4

This was answered well.

Question 5

This was answered very well.

Question 6

This was answered less well than the other two multiple choice questions.

Question 7

(a) Although there were two colours mentioned in the question, a small number of candidates ignored these two colours and used other ones. A small number reversed the colours.

(b) This was answered well. Only a very small number of candidates misread the burettes giving, for example, 29.9 instead of 28.1.

(c) Some candidates used their mean titre in this question instead of the data given.

(d) This was answered correctly by the majority of candidates.

(e) This question was the most challenging on the paper. Those who used the right method usually rounded their answer to 0.090 or even 0.1(0) instead of the correct answer of 0.0909.

(f) There were many correct answers to this question.

(g) Although many candidates answered this question correctly, a significant number gave no answer. Structural formulae were usually given instead of molecular formulae but these were accepted. Those who evaluated **n** correctly often named the carboxylic acid using the value of n instead of n + 1 e.g. $C_3H_7CO_2H$ was named as propanoic instead of butanoic acid.

Question 8

All parts to this question were answered extremely well by the majority of candidates. Aluminium ions were occasionally seen with either 1 or 2 positive charges. Incorrect reference to calcium ions was occasionally seen. In **(e)** the chlorine atom was often seen in brackets.

Question 9

(a) This was usually answered correctly.

(b) This was almost always completely correct.

(c) Not all candidates extended the left hand line to go through the origin. Instead of drawing two intersecting lines as requested, some candidates drew a curve or three lines. 2.9 was occasionally plotted instead of 2.8 and then read as 2.8 in **(d)(ii)**.

(d) (i) This was usually answered correctly. The most common error was to read the graph at 1.1 instead of 1.2

(ii) This was almost always answered well.

(iii) This was often correct, although some gave 10.0 as their answer instead of using the volume at which the two lines intersected.

(e) A wide variety of methods were seen in answer to this calculation as well as a wide variety of answers. Some incorrect rounding to 1.39 (instead of 1.40) was seen.