CHEMISTRY (US)

Paper 9185/11
Multiple Choice

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

General Comments

This examination paper provided a difficult challenge to the candidates with many pleasing performances.

Sixteen questions can be said to have been found to be easier. 50% or more of candidates chose the correct responses to each of **Questions 4, 7, 10, 11, 12, 16, 17, 19, 20, 21, 22, 23, 24, 27, 28,** and **32**.

Six questions can be said to have been found to be particularly difficult. Fewer than 31% of candidates chose the correct responses to each of **Questions 2, 15, 29, 31, 33** and **40**.

Comments on Specific Questions

Question 2

26% of candidates chose the correct answer, **B**. The most commonly chosen incorrect answers were **A**, chosen by 30% of candidates, and **C**, chosen by 33% of candidates. This question requires candidates to insert the data in the question into *pV=nRT*, and then to rearrange the expression to find T. Answer **A** arises if candidates do not appreciate that iodine vapour consists of I_2, with an M_r of 254. Answ[illegible] if candidates do not convert the volume 1.247 dm^3 into 1.247 x 10^{-3} m^3.

Question 15

30% of candidates chose the correct answer, **B**. The most commonly chosen incorrect answer was **C**, chosen by 39% of candidates. Although calcium is directly below magnesium in the Periodic Table it does not burn with a purely white flame. The flame seen when calcium burns is red.

Question 29

9% of candidates chose the correct answer, **C**. Choices **A**, **B** and **D** were each chosen by an approximately equal number of candidates. It was hoped that candidates would draw structures on their examination paper to help them and ideally these would have been skeletal formulae. This exercise probably produces four diagrams which can be called “cis-cis”, “cis-trans”, “trans-cis”, and “trans-trans”. However it can be seen that the “cis-trans” and “trans-cis” diagrams actually represent the same structure. Therefore, hex-2,4-diene has three geometrical isomers.

Question 31

28% of candidates chose the correct answer, **C**. Choices **A**, **B** and **D** were each chosen by an approximately equal number of candidates. The only reasonable structure for N_2F_4 is F_2N-NF_2. The reaction is therefore $N_2F_4 \rightarrow 2NF_2$ and it involves the breaking of the N-N bond. Statement 1 is therefore false. Statement 2 can be verified in the *Data Booklet*. Statement 3 can be verified with the help of a ‘dot-and-cross’ diagram.

Question 33

27% of candidates chose the correct answer, **D**. The most commonly chosen incorrect answer was **A**, chosen by 31% of candidates. Statement 1 is true; the activation energy of a chemical reaction has an effect on the reaction rate. Statement 2 is false; the size of the enthalpy change does not affect the reaction rate. Statement 3 is false; an equilibrium constant is a calculated value based on experimental observations made under certain conditions, it is not a “factor” that influences other properties.

Question 40

28% of candidates chose the correct answer, **A**. Choices **B**, **C** and **D** were each chosen by an approximately equal number of candidates. The three alcohols given are isomeric so 74.00 g is 1.00 mol in each case. The question therefore rests on whether the given mass represents 0.62 mol of the given product. Since this *is* true for choices 1, 2 and 3 the answer is **A**.

CHEMISTRY (US)

Paper 9185/13
Multiple Choice

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

General Comments

This examination paper provided a suitable challenge to the candidates with some pleasing performances.

Ten questions can be said to have been found to be easier. 70% or more of candidates chose the correct responses to each of questions **4**, **6**, **7**, **8**, **16**, **22**, **23**, **31**, **32** and **36**. Six questions can be said to have been found to be particularly difficult. Fewer than 43% of candidates chose the correct responses to each of questions **17**, **20**, **21**, **26**, **35** and **37**.

Comments on Specific Questions

Question 17

15% of candidates chose the correct answer, **A**. The most commonly chosen incorrect answer was **B**, chosen by 46% of candidates. Chlorine will react with an excess of hot NaOH(aq) to form $NaClO_3$. The equation is $3Cl_2 + 6NaOH \rightarrow 5NaCl + NaClO_3 + 3H_2O$. Therefore 0.6 moles of Cl_2 gives 0.2 moles of $NaClO_3$ which has a mass of 21.3 g. Candidates who chose **B** may have done so assuming the product was NaClO.

Question 20

42% of candidates chose the correct answer, **A**. The most commonly chosen incorrect answer w chosen by 34% of candidates. Candidates are encouraged to draw out the formula given on their quest paper to enable them to see the residue of butane-1,4-dioic acid in the centre of the molecule.

Question 21

41% of candidates chose the correct answer, **C**. The most commonly chosen incorrect answer was **A**, chosen by 48% of candidates. In the free radical substitution reaction between ethane and chlorine a number of radicals are formed, including $C_2H_5\bullet$, ethyl radicals. Two ethyl radicals can join together to form a molecule of butane, hence the answer **C**. Answer **A**, CH_3Cl, would only be correct if C-C bonds were broken in the reaction which does not happen.

Question 26

33% of candidates chose the correct answer, **A**. The most commonly chosen incorrect answer was **C**, chosen by 54% of candidates. **A** is correct because H_2 + Ni will reduce an alkene to an alkane and will also reduce an aldehyde to a primary alcohol. **C** is incorrect because $NaBH_4$ will reduce an aldehyde to a primary alcohol, but it is not capable of the reduction of an alkene to an alkane.

Question 35

40% of candidates chose the correct answer, **B**. The most commonly chosen incorrect answer was **D**, chosen by 30% of candidates. It can be inferred from this that for many candidates the choice of answer rested on the truth, or otherwise, of statement 2. Statement 2 is correct. The conversion of alcohols to acids is an oxidation reaction, since SO_2 is a reducing agent and an anti-oxidant it will help to prevent these reactions. SO_2 also helps to inhibit microbial growth, this will also contribute to the prevention of the oxidation of alcohols to acids.

Question 37

40% of candidates chose the correct answer, **C**. The most commonly chosen incorrect answer was **A**, chosen by 30% of candidates. It can be inferred from this that for many candidates the choice of answer rested on the truth, or otherwise, of statement 1. Statement 1 is incorrect. If 2,4-dinitrophenylhydrazine is added to propanal, the familiar reaction, giving an orange crystalline product, takes place at room temperature and no heating is required.

CHEMISTRY (US)

Paper 9185/21
AS Structured Questions

Key Messages

Candidates should be reminded to read questions carefully and check their answers thoroughly.

Candidates ought to be clear about the transition of physical and chemical properties of elements/compounds across Period 3, and should be particularly careful in their use of chemical terminology, e.g. ions as opposed to molecules. Careful attention is also required with respect to organic reactions and mechanisms, where small slips can often invalidate answers.

Candidates should also be reminded that all working in calculations should be shown to ensure that due credit can be awarded.

General Comments

This paper tested candidates' knowledge and understanding of important aspects of AS Level Chemistry. Careful reading of questions would have been of particular benefit in **Question 3(a)**, where the identity of atoms and ions were tested, with accompanying balanced equations. **Question 4(b)** highlighted the same issue.

Comments on Specific Questions

Question 1

This question combined an assessment of candidates' knowledge of atomic structure with some Period 3 Chemistry. There were good answers to **(a)**, **(b)** and **(e)**, although **(c)** and **(d)** were less well answered; many candidates struggled with the calculation of A_r and with the identification of the differing behaviour of the chlorides of sodium and silicon.

(a) Most candidates were able to identify the loss of an electron as a process of ionisation, but references to a molar enthalpy and gas-phase species were less frequently given.

(b) (i) The group to which **A** belongs was frequently correctly identified, but the accompanying explanation sometimes lacked a clarity of expression that would have correctly highlighted the large difference between the fifth and sixth ionisation energies.

(ii) This part was generally well answered, although some candidates incorrectly gave electronic configurations for atoms in Period 3.

(c) (i) Candidates' recall of this definition was not particularly secure, and the choice of terminology undermined some answers. Many wrote correctly of an average mass, but then did not relate that either to atoms of an element, nor make mention of the carbon-12 scale.

(ii) A number of different methods were employed here to good effect. Common errors included omitting to count <u>two</u> chloride ions in the compound and not giving answers to three significant figures. A significant number of candidates incorrectly attempted the calculation by pre-determining the element they guessed Z to be.

(d) (i) Candidates were often able to correctly identify the reaction(s) between $SiCl_4$ and water, but many suggested that NaC*l* is hydrolysed to give NaOH and HC*l*.

(ii) Following from **(d)(i)**, some candidates were unable to score credit in this part. R s required both to the structure <u>and</u> bonding of the compounds; many answers referred being giant covalent.

(e) This question was generally answered well.

Question 2

This question was generally answered well, although the latter parts of **(b)** elicited guesses about the value of *x*, which then led to circular calculations being performed.

(a) (i) Candidates' attention should be drawn to the wording of the question, which asks for the meaning of *oxidise* in the context of the statement, not for a definition of oxidation.

(ii) A large variety of answers were observed here.

(b) (i) There were many correct answers given to this part.

(ii) There were many correct answers given to this part.

(iii) Many candidates did not use their answer to **(ii)** in the calculation, opting instead to use a constructed answer from **(iv)**.

(iv) Where candidates had not managed to obtain a correct answer to **(iii)**, the value of *x* was guessed (often as 1), incorrectly to derive M_r = 151.8.

(v) Candidates who had followed **(i)** to **(iv)** correctly answered this well; others ended up performing circular calculations for which credit could not be awarded.

Question 3

Part **(b)** of this question was largely answered well, whereas very few candidates secured full credit in any of the three parts of **(a)**, perhaps revealing a lack of knowledge of the properties and reactions of group 7 elements and compounds.

(a) (i) **K** was rarely correctly identified as chlor<u>ide</u>, although many candidates were awarded credit for their equation (common errors included a lack of balancing and/or the use of $NaSO_4$ as a wrong formula) and explanation.

(ii) Neither Iodide, I^-, nor the colour of its precipitate with silver, were rarely correctly identified, but candidates tended to give the equations successfully.

(iii) This question was correctly answered by many candidates, although many also omitted to give reference to the number of electrons and the intermolecular forces involved.

(b) (i) Many candidates answered this question very well. There was some confusion observed between the products at the anode and cathode.

(ii) There were many correct answers seen for this part. Near-correct answers were often let down by the lack of balancing or the misplacement of electrons.

Question 4

This question tested a wide range of topics within organic chemistry. Candidates' recall of conditions and mechanism names was good, but answers often lacked further depth.

(a) Many answers contradicted the question stem by stating that alkanes do not react with bromine, and were unable, therefore, to gain credit for highlighting the (reasons for) different conditions required for reaction.

(b) (i) This question was answered well.

(ii) This question was answered well.

(iii) This question was not generally answered well. Many candidates omitted some/all of the th[ree] necessary pieces of information: that it was a termination step within the bromination of ethane, producing a hydrocarbon.

(iv) Again, candidates' knowledge of free-radical mechanisms was poor. Only the most able candidates scored credit here.

(c) (i) This question was answered well.

(ii) Most candidates scored some credit here. Common errors included an incorrectly displayed dipole on Br—Br and imprecisely drawn curly arrows, both in the reactants and from the lone pair of Br^- to the carbocation intermediate.

(d) This question was answered well, although some candidates drew too many chlorine substituents, or opted to draw a hexane derivative rather than a polymer.

(e) (i) The identification of NaOH (or KOH) as the reagent was generally given correctly. The need for alcoholic conditions for heat/reflux was often omitted as a second piece of information.

(ii) Although many candidates were awarded credit for this, the skeletal representation of ethanol was generally poor. Candidates should be reminded to draw full-length bonds at 120° where possible.

(iii) Only the most able candidates scored well here. The most common error with the displayed formula was to not show the cyanide/nitrile group fully (—C≡N). Contractions of the name propanenitrile, e.g. "propanitrile", often invalidated the answer.

CHEMISTRY

Paper 9185/23
AS Structured Questions

Key Messages

Candidates are to be reminded to read questions carefully and check answers thoroughly. In this paper, candidates would have benefitted from this particularly in **Question 1(c)**, where there was often a lack of continuity between the answers offered; **Question 3(a)(ii)**, where answers included unbalanced equations; and in **Question 4(e)(ii)**, where specific guidance was given as to the features to be included in the mechanism.

Candidates need to ensure that any equations given are balanced and are also reminded that their working in calculations should be shown to ensure that due credit can be awarded.

Candidates are recommended to make sure that keywords and definitions are learnt thoroughly; not only so that questions such as **1(a)** can be answered correctly but also so that the correct basic principles of chemistry can be applied. This is especially true when explaining ideas such as trends in physical and chemical properties.

General Comments

This paper tested a range of recall and application skills from across the AS syllabus and discriminated effectively between candidates from across the ability range. There were, however, some recurrent weaknesses which candidates would be well-advised to address. These include areas such as organic nomenclature, for example in **Question 1(c)**; and characteristic reactions of particular elements, for example in **Question 4**, where the recall of halogen / halide reactions was expected.

Comments on Specific Questions

Question 1

This question included a definition, a calculation sequence and some organic reactions.

(a) This was one of the most poorly answered questions on the paper and highlights the importance of candidates thoroughly learning keywords and definitions.

(b) (i) More than half of candidates gained full credit here.

(ii) Full credit was obtained by the majority of candidates. The nature of many of the incorrect responses, which did not fully take into account information provided by the question, reinforces the importance of reading all the information given before attempting an answer.

(iii)–(v) Calculating the volume of oxygen used up was not well attempted by many candidates but most were able to earn credit in **(b)(iv)** and **(b)(v)** as errors were carried forward ("ecf") from the earlier sections of the question.

(c) (i) It is recommended that candidates plan their answers to sequential questions such as this, perhaps using a rough flow diagram so that the relationships between the different compounds can be seen. This should reduce the lack of continuity in some candidates' answers. For example, in this case, a significant number of candidates offered a primary halogenoalkane as their answer for **X** and then a secondary or tertiary alcohol as their answer for **Z**.

(ii) A large number of candidates produced a response containing the mnemonic "t... stronger" but it should be remembered that this is only an aid to remembering the outc... reaction and does not actually constitute an explanation of why it happens. To gain full ... this question, a clear reference to the greater stability of the tertiary carbocation or to the ind... effect of three (rather than one) alkyl groups was needed, but was not offered by many candidat...

Question 2

This proved to be by far the easiest question on this paper although there were again some problems with a lack of continuity between the answers offered by candidates. For example, in **(b)(ii)** candidates were told that the amount of NaOH calculated was equal to the amount of HC*l* left in excess, but many were unable to use this idea to calculate the answer to **(b)(iii)**.

Question 3

This question involved some introductory questions on atmospheric chemistry followed by calculations based on a gaseous equilibrium.

(a) (i) Very few candidates offered the expected answers of lightning, causing reaction between atmospheric nitrogen and oxygen, and car engines, where the high temperature causes some reaction between nitrogen and oxygen.

(ii) This equation was not well remembered by candidates and was poorly attempted. Many candidates offered $NO_2 + H_2O \rightarrow HNO_3$ despite this equation being unbalanced.

(iii) By contrast, this question was much better attempted and most candidates were able to earn credit for $SO_3 + H_2O \rightarrow H_2SO_4$. Fewer candidates were able to include both the other equations required.

(b) (i) Most candidates used the correct powers and terms in the relationship. However, many candidates did not finally gain credit as a result of including square brackets, which should only be used in an expression for K_c and never in an expression for K_p.

(ii) The key in questions of this type is to remember that there are potentially three quantitative pieces of information about each species in the equation: initial amounts, final amounts and the amounts reacting or being produced. Crucially, the stoichiometric ratio shown in the equation only applies to the last of these. In this case initial amount of N_2O_4 is 2.00 mol, initial amount of NO_2 is 0.00 mol, and final amount of N_2O_4 is 1.84 mol. From this it can be deduced that 0.16 mol of N_2O_4 has reacted during the reaction. As the ratio of NO_2:N_2O_4 is 2:1, the amount of NO_2 produced is twice this, i.e. 0.32 mol.

(iii) Candidates should remember that, despite being called a "mole fraction", the conventional way of presenting this information is as a decimal, rounded to an appropriate number of significant figures; in this case the expected answers were therefore 0.852 (or 0.85) and 0.148 (or 0.15).

(iv)(v) Given the possibility of carrying errors forward, most candidates were able to earn credit in these sections. Candidates must be alert for any instruction to give an answer to a specific number of significant figures.

Question 4

This question focused on halogen chemistry both from the point of view of Group VII and halogenoalkanes.

(a) (i) There was evidence of confusion here with some candidates discussing the trend in reactivity of the hydrogen halides instead of the reactivity of the halogens themselves. Despite this, the majority of candidates was able to earn credit for stating that reactivity decreases down the group.

(ii) Most candidates earned some credit here for a correct reference either to the halogen-halogen bond strength **or** to the halogen-hydrogen bond strength, but very few were able to combine the two ideas into a coherent argument for full credit.

(b) (i) This was correctly answered by the vast majority of candidates.

(ii) Very few candidates were able to offer an adequate explanation for using a differe method.

(iii) Following on from **(b)(ii)**, this proved to be one of the most challenging questions on the pap candidates as the oxidation of the halide ion by concentrated sulfuric acid was not w remembered.

(c) (i) It was pleasing to see that this question was one of the best answered on the paper. Most candidates avoided drawing the same structure twice.

(ii) Naming caused difficulties for many candidates. There was also a lot of variation in the manner of drawing three-dimensional structures. To be sure of communicating the correct idea, candidates should use the conventional approach illustrated in section 10.1 of the syllabus.

(d) This proved a difficult question for many candidates. Some candidates were able to earn credit for appreciating that the precipitate was due to halide ions liberated from the halogenoalkane, but very few were able to explain the order of appearance of the precipitates in terms of the trend in carbon-halogen bond strengths.

(e) (i) This question was mostly well answered by candidates.

(ii) The conventional representations of the principle organic reaction mechanisms must be learnt thoroughly and, unfortunately, few candidates seemed to have done so in the case of nucleophilic substitution. Candidates should remember that a curly arrow will always begin either at a lone pair or at a line representing a bond.

(f) (i)(ii) Recall of these ideas related to atmospheric chemistry was generally good.

CHEMISTRY (US)

Paper 9185/31
Advanced Practical Skills 1

Key Messages

- Candidates should practise reading scales on apparatus to an appropriate level of precision. The data should then be recorded to reflect this precision.
- Candidates should practise recording errors and improvements in their quantitative lab work carried out over the whole course.
- Candidates should be careful to obey instructions given in the exam paper, to quote answers to an appropriate number of significant figures and to be careful to round these answers correctly.
- Candidates should be reminded to complete the Session and Laboratory boxes on the front of the paper.

General comments

The Examiners thank Supervisors at Centres who supplied experimental data for **Questions 1** and **2** for each Session/Laboratory. Centres are reminded that the following documentation for each session and for each laboratory within a session should be included in the script packet:

- a list of the candidates present and a seating plan for the laboratory;
- a copy of the examination paper with the Supervisor's experimental results.

If candidates are not to be disadvantaged it is important that every candidate can be linked to a particular session/laboratory and to a corresponding set of Supervisor's results. Where this data is missing and unobtainable candidates may be disadvantaged as a consequence.

This paper proved accessible to most candidates and wide range of credit was awarded. Almost all candidates completed the paper indicating that there were no time constraints.

Comments on specific questions

Question 1

The majority of the candidates successfully completed the practical work and were able to gain credit both for accuracy and in the calculation.

(a) Candidates should be reminded to record burette readings for the rough titration even though these do not need to be to the same level of precision as those generating values for the accurate titres. A significant minority of candidates did not record accurate burette readings to 0.05 cm^3 and lost the credit available for concordant titres by carrying out further titrations that were more than 0.10 cm^3 from others. Candidates should be encouraged to continue with the rest of the paper once they have achieved two titres within 0.10 cm^3. Many candidates completed the titration well and so gained full credit for accuracy.

As in most titration questions set, the quantities given were intended to produce titre values that were in the mid-range of the burette. Some Centres recorded Supervisor values that were very small (less than a few cm^3) and others recorded values that meant that the burette would have had to be refilled. In either case the Centre should check the chemicals used, since very small or very large titres can make it difficult for candidates to access the credit available for accuracy.

(b) The majority of candidates calculated a suitable value for the volume of **FA 1** to b[illegible]e calculation. Candidates should be reminded that they must indicate which titres they a[illegible] their calculation and record their answers correct to two decimal places.

(c) Most candidates correctly calculated the number of moles of potassium manganate(VII) in **(i)** a[illegible] many then went on to use the stoichiometry of the equation to find the concentration of the hydrogen peroxide in **(iii)**. Even less able candidates could write an equation for the decomposition of hydrogen peroxide in **(iv)**, but only the most able could interpret the information on 'volume strength' to correctly complete **(v)**.

Question 2

(a) Most candidates drew a table and successfully carried out the practical to record reaction times. A small number, however, did not include all the required volumes of solutions used and a significant number did not, as given in the instructions, 'record this reaction time to **the nearest second**'. In this case rates quoted to two or three significant figures were accepted but a number who had clearly calculated the value could not be awarded credit when they rounded their answers incorrectly.

(b) It was not necessary to attempt to quote the exact mathematical relationship between 'rate of reaction' and concentration, but answers had to make it clear in which direction the effect of changing the concentration affected the rate.

(c) This part was not well answered with only the most able candidates gaining credit. Since the question asked for the effect of changing the concentration of potassium iodide it was the volume of **FA 4** that had to be altered. Many candidates recognised this but few also recognised that the total volume of solution must be kept constant so that the volume of **FA 4** used had to be less than $20\,cm^3$.

(d) Acceptable responses to questions asking about errors and improvements must be specific to the actual example. Some responses clearly recognised a problem, but the suggested solutions were too imprecise. Examples of this include the idea that changing the temperature would have an effect and then trying to correct this problem by keeping it constant without specifying a practical method, such as a water bath, for actually doing so.

(e) (i) Many candidates correctly calculated the percentage error using the expression 1/time from **Experiment 1**.

(ii) This was less well done since a number of candidates assumed that, as the concentration increased, the rate would be higher and the time less. However, since the colour change occurred when all the thiosulfate had been used up, a higher concentration actually meant that the reaction time was greater.

Question 3

Although many candidates gained the majority of the available credit, some ignored the instruction to give the full name or formula of any reagent selected for a test. Use of the Qualitative Analysis Notes helps with the descriptions of precipitates formed and should remind candidates that, in the investigation of cations, it is necessary to add excess reagent.

(a) (i) Most candidates recognised that it was necessary to use aqueous sodium hydroxide and aqueous ammonia, and a large number gave all observations correctly to identify the presence of Zn^{2+} and thus score full credit. A number, however, did not unambiguously give observations when first a small volume and then excess of these reagents were added.

(ii) Most candidates clearly recognised that the tests were designed to show the presence of a halide and then sulfate / sulfite. To conclude that the halide was bromide, the precipitate formed with silver nitrate must be described as being cream.

(b) In this part the descriptions of observations had to be precise to be awarded credit. In **(i)** the original precipitate had to be given as being green but, since the instruction stated that the test should be left for a few minutes, it was also necessary to state that it then went brown.

In **(ii)** no reaction was expected but answers that gave a yellow or green solution w
In **(iii)** the formation of a precipitate of iron(III) hydroxide was recognised by ma
candidates noted the effervescence that also occurred, and even fewer identified the gas b
a glowing splint.

Many candidates correctly recognised the reaction as being redox in **(iv)** but a small numbe
suggested just oxidation, neutralisation or displacement.

Answers to **(v)** which focused either on the formation of oxygen from the hydrogen peroxide or oxidation of iron(II) to iron(III) were accepted and credit was often awarded.

CHEMISTRY (US)

Paper 9185/35
Advanced Practical Skills 1

Key Messages

- Candidates should practise reading scales on apparatus to an appropriate level of precision. The data should then be recorded to reflect this precision.
- Candidates should practise recording errors and improvements in their quantitative lab work carried out over the whole course.
- The overwriting in pen of answers in pencil should be discouraged as the difficulty of reading may lead to the candidate being unnecessarily penalised. In the case of crossed out answers any subsequent work should be clearly set out for marking.
- Candidates should be reminded to complete the Session and Laboratory boxes on the front of the paper.

General comments

The Examiners thank Supervisors at Centres who supplied experimental data for **Questions 1** and **2** for each Session/Laboratory. Centres are reminded that the following documentation for each session and for each laboratory within a session should be included in the script packet:

- a list of the candidates present and a seating plan for the laboratory;
- a copy of the examination paper with the Supervisor's experimental results.

If candidates are not to be disadvantaged it is important that every candidate can be linked to a particular session/laboratory and to a corresponding set of Supervisor's results. Where this data is missing and unobtainable candidates may be disadvantaged as a consequence.

This paper proved accessible to most candidates and wide range of credit was awarded. Almost all candidates completed the paper indicating that there were no time constraints.

Comments on specific questions

Question 1

Very few candidates were unable to complete the practical work, and most were able to gain credit both for accuracy and in the calculation. This question was answered well by a large majority of candidates.

(a) Candidates should be reminded to record burette readings for the rough titration even though these do not need to be to the same level of precision as those generating values for the accurate titres. A significant minority of candidates did not record accurate burette readings to 0.05 cm^3 and lost the credit available for concordant titres by carrying out further titrations that were more than 0.10 cm^3 from others. Candidates should be encouraged to continue with the rest of the paper once they have achieved two titres within 0.10 cm^3. The credit awarded for accuracy tended to be Centre-dependent with many candidates from some Centres gaining the majority of the available credit.

(b) The majority of candidates calculated a suitable value of the volume of **FA 3** to be used in the calculation. Candidates should be reminded that they must indicate which titres they are using in their calculation and record their answers correct to two decimal places.

(c) The calculation was straightforward and many candidates gained full credit. The majority gave final answers correct to three or four significant figures.

(d) Many candidates found this section difficult and in **(i)** only a minority realised that a volu would involve two burette readings, or that the answers should be to two decimal places as the question. Only a minority of candidates were able to link the lower volume of **FA 2** greater concentration of calcium hydroxide. Some candidates attempted to answer the questio terms of percentage error.

(e) The responses tended to be Centre-dependent. A number of candidates suggested that the calcium hydroxide would react with oxygen in the air.

Question 2

This question was generally answered well by a large majority of the candidates.

(a) Candidates should ensure they record all data stipulated in the instructions with full and unambiguous headings. Most candidates recorded balance readings to a consistent number of decimal places and gave units in the accepted format. However, many candidates ignored the instruction to record their observations on heating and cooling the solid. Many candidates gained credit for accuracy.

(b) A large majority of candidates answered **(i)** correctly with most of these showing the correct use of 44 and 125.4 in **(ii)**. Most candidates used the mass of **FA 4** (before heating) in **(iii)** and so gained most of the available credit.

(c) Many candidates specified heating to constant mass in part **(i)**, indicating that they were familiar with this type of procedure, although some did not explain the reason for this sufficiently clearly.

Question 3

Careful reading of the introductory paragraphs would have helped some candidates attain more marks. The marks ranged widely with some excellent responses from candidates who carried out the instructions carefully and used the Qualitative Analysis Notes to good effect.

(a) Most candidates gained some credit for **(i)**. Some needed to realise that larger than normal volumes of aqueous sodium hydroxide and ammonia would be needed to test for the second cation in **FA 5** owing to the presence of excess nitric acid in the solution. However, the majority of candidates achieved some credit for this section.

(b) The instruction in **(i)** to heat gently and then strongly implied that two observations were needed but not all candidates gave these. However, many tested successfully for ammonia. Many candidates recorded the expected results in test **(ii)**, but fewer completed **(iii)** as they did not test the gas evolved on adding nitric acid, contrary to the instructions at the start of the question. Again, many candidates gained at least partial credit for the identities of the ions present.

CHEMISTRY (US)

Paper 9185/41
A2 Structured Questions

Key Messages

- Candidates would benefit from an increased familiarity with drawing structural formulae, especially three-dimensional diagrams for octahedral, square planar and tetrahedral structures.
- Many candidates should be reminded of the distinguishing tests for the different functional groups in organic chemistry.
- Candidates should set out calculations which clearly explain what the numbers refer to.

Candidates should also be reminded of the need to re-visit and revise AS material while preparing for the A Level examination, particularly in the key definitions as seen in **Questions 2(a)(i)** and **3(c)(i)**, and organic chemistry.

Candidates need to read the questions carefully before answering them; questions where this often appeared not to have been done were:

Question 2(a)(ii) – required a three-dimensional structure to be drawn,

Questions 7(b)(i)-(ii), 7(c) and **7(d)** – answers to this question tended to be very good from candidates who were familiar with NMR, or quite poor from candidates who resorted to an amount of guesswork.

General Comments

This paper gave candidates of all abilities the opportunity to demonstrate their knowledge and understanding of a wide range of chemistry topics. Candidates who were well-prepared for the examination were able to tackle all of the questions. There was no evidence that candidates had insufficient time to complete the paper.

The questions in ***Section B*** were generally answered well, and the overall neatness and legibility of answers was good. This was not always the case however, and candidates are reminded to make sure that their desired final answers are legible and obvious to the Examiner.

The arithmetical working in calculation questions should be set out clearly, to allow Examiners to award 'error-carried-forward' marks wherever possible.

Candidates are also reminded of the importance of careful, thorough reading of the question before attempting to answer it, underlining key words or phrases on the question paper to ensure that it is answered in the correct manner.

This report should be read in conjunction with the published mark scheme for this paper.

Comments on Specific Questions

Section A

Question 1

(a) (i) Most candidates answered this correctly.

(ii) Only a few candidates managed to explain these differences correctly. For high melting point, few candidates mentioned about more delocalised electrons. For density, many candidates referred to mass instead of atomic mass, and often the link to atomic/ionic radius was omitted.

(b) (i) This was generally answered well, although some candidates erroneously included a battery in their circuit. A number did not include or label a salt bridge.

(ii) Most candidates scored some credit here. Many mentioned $1\,mol\,dm^{-3}$, but some called the solutions "Cu(II)/Cu and Fe(II)/Fe". Another common error was to suggest platinum as one or both of the electrodes.

(iii) Most candidates carried out the calculation correctly.

(iv) This question was more challenging, with only the more able candidates giving a well argued answer. Some candidates gained partial credit for explaining their E_{cell} change in terms of the $Fe^{2+} + 2e^- \rightleftharpoons Fe$ (or $Cu^{2+} + 2e^- \rightleftharpoons Cu$) moving to the right hand side.

Candidates were expected to state how the $E_{electrode}$ changes and relate this to their E_{cell}.

(c) (i) Few candidates knew that the end point of the reaction is given by the first appearance of a pale pink colouration when one drop of $KMnO_4$ is added in excess. A common error was to give the colour change as from purple to colourless.

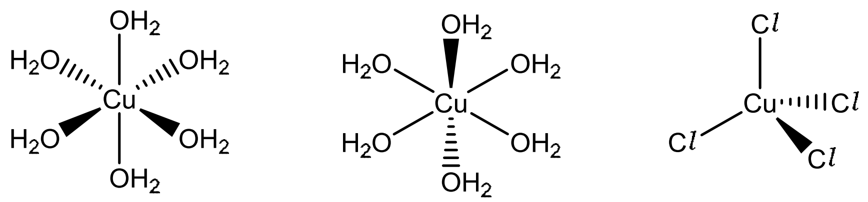
(ii) Most candidates scored some credit here. The final molar mass was found to be more challenging than the other two parts.

Question 2

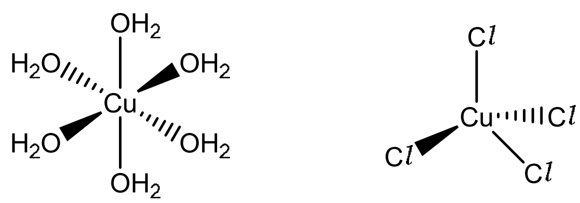
(a) (i) This was generally answered well, although a number of candidates did not specify (central) atom or ion in their definition of a complex.

(ii) This question was not answered well. Some poor three-dimensional diagrams were drawn as well, as there were many square planar instead of tetrahedral structures of $CuCl_4^{2-}$.

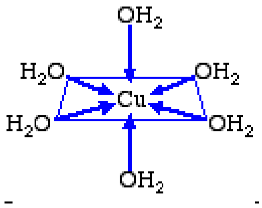
Some examples of correct three-dimensional diagrams of $(Cu(H_2O)_6)^{2+}$ and $(CuCl_4)^{2-}$ are shown below.



Common incorrect structures included:



A small number of octahedral structures were given that showed two vertical perspectively-drawn square planar of 4 H_2Os. These structures did not normally include plane bonds, so this structure gained no credit.



(iii) This was generally answered well. Geometrical was accepted as an alternative to cis-trans. Some candidates incorrectly suggested optical isomerism or stereoisomerism.

(b) (i) A significant number of candidates were not awarded credit here; a common error was filling the 4s orbital either fully or partially.

(ii) This seemed to be Centre-specific. The first part of the explanation was standard bookwork. Some very good answers were seen but equally quite a number of candidates did not mention the splitting of the d-orbitals by the ligand field or/and the promotion of an electron from a lower to a higher level by the absorption of visible light. For the second part, it was expected that the candidates would state that the d subshell is full or that there are no unpaired electrons in a d-orbital; common incorrect answers included statements that the energy gap between the d-orbitals is too large or that they have a full d-orbital.

(c) (i) This was answered well. Common incorrect answers included –212 (incorrect subtraction), +178.8 (omitting to multiply by 2), and –393.8 or +79.2 (one incorrect sign), all of which were partially credited.

(ii) Many candidates performed well here and the application of le Chatelier's principle in the second part was good.

Question 3

(a) Few candidates gave the correct reagents and conditions for this hydrolysis, with most omitting the water or heating.

(b) (i) A number of candidates failed to recognise that there were four isomers of piperic acid.

(ii) Fewer candidates were able to draw a *cis* isomer of piperic acid. Many candidates gave the same isomer of piperic acid as given in the question.

(iii) This proved to be a difficult question and was not answered well. Candidates needed to draw the two products from the oxidative cleavage of the two C=C bonds using hot concentrated acidified $KMnO_4$.

(c) (i) This was answered very well. The expression $K_w = K_a \times K_b$ was **not** accepted since the ionisation of water should be defined as $K_w = (H^+(aq))(OH^-(aq))$.

(ii) Many candidates carried out this calculation correctly.

(iii) This proved difficult for many candidates. Answers were often too vague such as stating that NaOH is more basic, and candidates did not mention that piperidine was a poorer proton acceptor or only partly ionised.

(iv) Many candidates also found this difficult. Only the more able recognised that the piperidine was more basic due to the presence of the electron donating alkyl groups.

(d) (i) Many candidates calculated the starting n(HC*l*) instead of the remaining n(HC*l*).

(ii) Only occasionally could error-carried-forward credit be awarded. Many candidates divided their answer to **(d)(i)** by 0.02 rather than 0.03, or just took the pH = –log(n(HC*l*)).

(iii) A reasonable number of candidates scored full credit for the graph, although ma included an error-carried-forward for the pH at 20 cm^3. The most common error was su that the end-point was 10 cm^3 instead of 15 cm^3.

(iv) A number of candidates correctly identified B as the most suitable indicator.

Question 4

(a) Most candidates correctly identified three functional groups here.

(b) (i) This proved difficult for many candidates with only the more able gaining full credit. For the first part, only a few recognised that **Z** was a cyanohydrin. The analogous benzyl alcohol and benzoic acid were common errors. In the second part, most omitted a base or NaCN with the HCN reagent, and Sn + HC*l* was a common error for the reductant.

(ii) Most candidates described the correct colour change or formation of a white precipitate, but far fewer managed to suitably brominate the ring, with the OHs often undergoing replacement.

(c) (i) This was generally answered well, although many candidates formed the sodium alkoxide as well as the two phenoxides.

(ii) Fewer candidates were able to draw the correct product of noradrenaline with HC*l*(aq). A common error was substitution of one or both OHs by C*l*.

(iii) The reaction with CH_3COCl was much better known by candidates, and many gained some credit. However, only the more able realised that three ester and one amide groups would be formed with excess CH_3COCl.

(d) Only a minority of candidates scored full credit here, although most correctly identified the ester.

Question 5

(a) (i) This was correctly answered by most candidates.

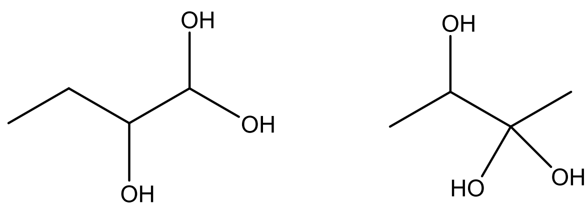
(ii) This too was mostly answered correctly.

(iii) This was less well known, with many candidates suggesting a secondary alcohol which was not sufficient.

(b) In this part, candidates were expected to use their answers from **(a)(i)-(iii)** to suggest structures for **V** and **W**. Often their answers did not tally with the groups suggested. A common error was drawing an enol for one or both structures.

(c) Most candidates scored full credit here, although many of these included error-carried-forward for cis-trans and corresponding isomers of their enol suggested in **(b)**.

(d) This proved difficult for many candidates, with only the more able gaining full credit. A number of gem-diols were incorrectly suggested.



Section B

Question 6

(a) This part was straightforward, and most candidates scored full credit.

(b) This question was answered well. Common errors seen were thyamine/thiamine (instead of thymine) and cysteine (instead of cytosine).

(c) (i) Most candidates gave the correct answer here.

(ii) This was generally answered well. It was expected that candidates would mention that hydrogen bonds are weak so are easy to break; a number did not give a full explanation.

(d) Many candidates gave the correct answer here.

Question 7

(a) Candidates showed a good understanding of how to calculate the number of carbon atoms from the mass spectrum peak height ratio.

(b) (i) This question required the use of the *Data Booklet* and the splitting pattern, which is so characteristic of the ethyl group. These seemed to be ignored by a lot of candidates. Common errors were (δ 2.2) RCH_2R and (δ 11.8) OH.

(ii) This proved a challenging question with only the more able candidates gaining full credit. Only about half of the candidates correctly identified the peak at δ 11.8. There seemed to be a poor understanding of hydrogen-deuterium exchange.

(iii) This question proved to be difficult with only the stronger candidates drawing the correct structural formula of **G**, CH_3CH_2COOH. A small number suggested the acceptable amide alternative, $CH_3CH_2CONH_2$. Many candidates did not suggest a viable structure that only had three different proton environments, or a structure that had a group that would undergo hydrogen-deuterium exchange.

(c) (i) Only a few candidates gave one of the acceptable structures, methyl ethanoate being the most common. Most incorrect answers suggested had three, instead of two, different proton environments.

(ii) This was marked conditionally of **(c)(i)**. Full credit was rarely awarded.

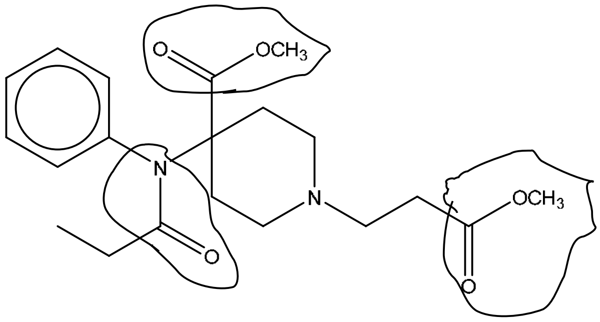
Question 8

(a) (i) This part was generally well answered. A common incorrect answer was amine.

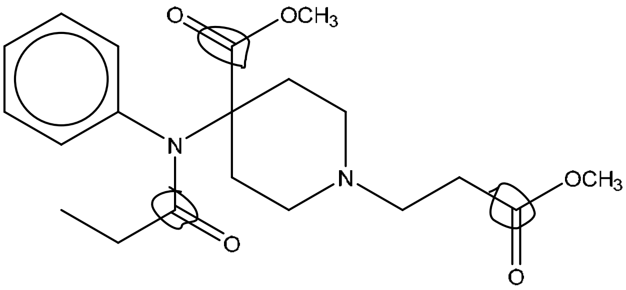
(ii) Fewer candidates managed to state that the type of reaction is hydrolysis. A variety of incorrect answers were seen including condensation, neutralisation and reduction.

(iii) This part was answered well.

(iv) This was marked conditionally of **(a)(iii)**. It was expected that candidates would circle three functional groups, two methyl esters and the amide.



Many circled two groups only and the amide was commonly forgotten. Many only circled the C of the C=O and did **not** include the singly-bonded heteroatom either. In this case partial credit was awarded.



(b) (i) Most candidates identified the correct location, **Q**, and gave a suitable explanation here.

(ii) There were many good answers to this part. Some candidates stopped short with only a reference to its hydrophilic nature.

(c) (i) Most candidates gave a correct response here.

(ii) Fewer candidates scored here and it usually depended on whether they mentioned 'cells' or 'tissues'. A number of vague references to causing harm and comparing the size of the nanocage to the wavelength of the radiation were seen.

CHEMISTRY (US)

Paper 9185/43

A2 Structured Questions

Key Messages

- Candidates would benefit from an increased familiarity with drawing structural formulae, especially three-dimensional diagrams for octahedral, square planar and tetrahedral structures.
- Many candidates should be reminded of the distinguishing tests for the different functional groups in organic chemistry.
- Candidates should set out calculations which clearly explain what the numbers refer to.

Candidates should also be reminded of the need to re-visit and revise AS material while preparing for the A Level examination, particularly in the key definitions as seen in **Questions 2(a)(i)** and **3(c)(i)**, and organic chemistry.

Candidates need to read the questions carefully before answering them; questions where this often appeared not to have been done were:

Question 2(a)(ii) – required a three-dimensional structure to be drawn,

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General Comments

This paper gave candidates of all abilities the opportunity to demonstrate their knowledge and understanding of a wide range of chemistry topics. Candidates who were well-prepared for the examination were able to tackle all of the questions. There was no evidence that candidates had insufficient time to complete the paper.

The questions in ***Section B*** were generally answered well, and the overall neatness and legibility of answers was good. This was not always the case however, and candidates are reminded to make sure that their desired final answers are legible and obvious to the Examiner.

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Comments on Specific Questions

Section A

Question 1

(a) (i) Most candidates answered this correctly.

(ii) Only a few candidates managed to explain these differences correctly. For high melting point, few candidates mentioned about more delocalised electrons. For density, many candidates referred to mass instead of atomic mass, and often the link to atomic/ionic radius was omitted.

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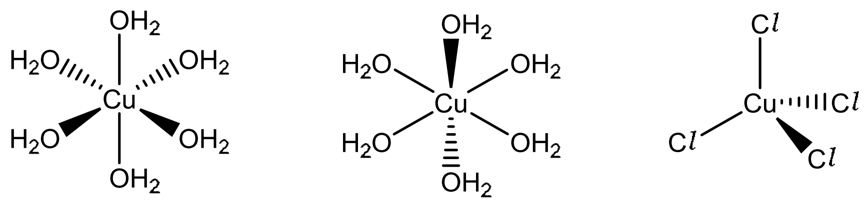

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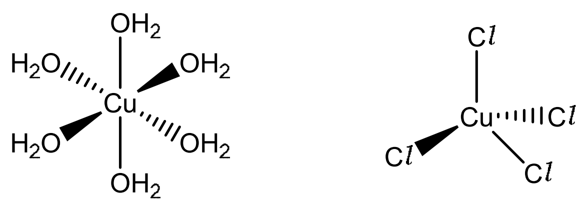

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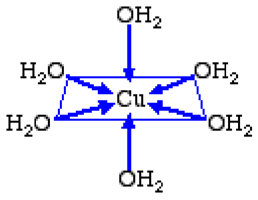

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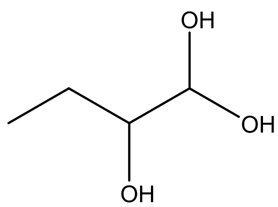

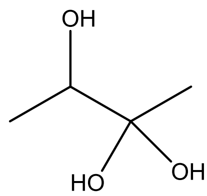

Section B

Question 6

(a) This part was straightforward, and most candidates scored full credit.

(b) This question was answered well. Common errors seen were thyamine/thiamine (instead of thymine) and cysteine (instead of cytosine).

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Question 8

(a) (i) This part was generally well answered. A common incorrect answer was amine.

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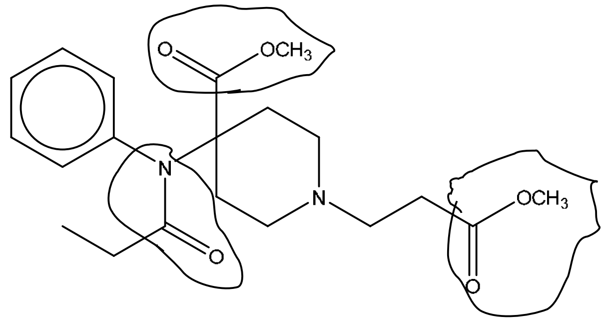
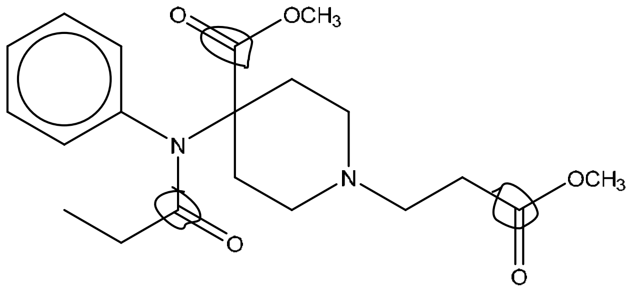


Many circled two groups only and the amide was commonly forgotten. Many only circled the C of the C=O and did **not** include the singly-bonded heteroatom either. In this case partial credit was awarded.



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(c) (i) Most candidates gave a correct response here.

(ii) Fewer candidates scored here and it usually depended on whether they mentioned 'cells' or 'tissues'. A number of vague references to causing harm and comparing the size of the nanocage to the wavelength of the radiation were seen.

CHEMISTRY (US)

Paper 9185/51
Planning, Analysis and Evaluation

Key Messages

- An increased familiarity with experimental techniques and experience of carrying out practical procedures would be of benefit to candidates.
- Candidates should be reminded that useful information is often given in the question introduction which needs to be considered before answering.

General Comments

The basis of **Question 1** was the determination of the stoichiometric relationship for the thermal decomposition of magnesium nitrate(V). Candidates struggled with formulae and with drawing suitable equipment for gas collection.

In **Question 2** candidates were required to handle electrode potential data and manipulate the Nernst equation, the latter proving difficult for some candidates. The drawing of the graph was much improved on previous years' performances, possibly because of the introduction of labelled axes on which candidates plotted their points.

Comments on Specific Questions

Question 1

(a) (i) Despite being given the reactants and products, many candidates were not able to state correct equations for the thermal decomposition of magnesium nitrate(V). The formulae of magnesium nitrate(V) and nitrogen(IV) oxide were common problems. It should be emphasised that the skills involved here are fundamental in chemistry and provide the basis for much subsequent understanding.

(ii) Most candidates calculated a correct relative molecular mass for magnesium oxide. Many candidates were successful in calculating molar volumes even if their equation in **(a)(i)** was incorrect, provided they correctly used the molar ratios given by their equation. Candidates should be reminded to make sure they have fully answered the question; in this case all values were required. Units should always be given.

(b) (i) Experience of practical experimental procedures was necessary to produce a diagrammatic representation of equipment that would carry out the required process. The question required that the nitrogen(IV) oxide absorbance and oxygen collection be done separately and sequentially. Many candidates had two output tubes from the reaction vessel leading to two syringes or one tube that split into two and onto two syringes. In both these cases the candidates assumed that each syringe would collect one of the gases alone. Some drawings of oxygen collection over water did not function. Various nitrogen(IV) oxide absorbers were proposed and although the question stated that the nitrogen(IV) oxide was acidic and reacts completely with alkalis, many did not include an alkali (or base) in their absorber. Many attempts were made which included an alkali but would not properly work. These included having cotton wool soaked in alkali in the upper part of the tube, having the magnesium nitrate(V) heated in an alkali solution, having various U tubes that would not allow the passage of gas and passing the gas stream over solid alkali in a tube. Often the diagrams were not sufficiently labelled or the apparatus was not drawn as airtight. Very few candidates received full credit on this question which is significant since confidence in experimental set up details of this nature are fundamental to practical chemistry.

(ii) In order to successfully state the volume of the gas collector, candidates needed to be fa[…] the equipment available in a common school laboratory. Some candidates proposed ve[…] (e.g. 50 dm^3) collectors which were impractical or sizes that lacked a unit.

In order to calculate an appropriate mass of magnesium nitrate(V) to be used, a number o[…] operations were required. These included converting the proposed volume of the gas collector to moles of oxygen, then using their mole ratios from the answer to **(a)(i)** along with the relative molecular mass of magnesium nitrate(V). Many candidates made a good attempt at this calculation and most of those were successful. As a generality in a multistage calculation it is best not to round values during the calculation but to do so at the final answer (if necessary). On occasion the unit was missing or incorrect. Some candidates confused magnesium nitrate(V) and magnesium oxide.

(c) Most candidates had some idea of the measurements of the reactant and products required for the verification of the equation, but the answers were mostly incomplete. There was a requirement for the starting **and** finishing mass; this was often omitted.

(d) (i) There are many observations (e.g. no bubbles in the trough or syringe plunger stops moving) that could be used to indicate the end of the reaction; simply saying ‘no more gas is produced’ does not indicate how this would be observed. Some candidates who gave ‘until no more solid in the tube’ did not take account of the solid nature of the magnesium oxide product. Others incorrectly surmised there may be a colour change at the end.

(ii) In experiments involving measurement of gas volumes, the temperature and/or pressure conditions are crucial to having accurate results. Too many answers did not refer to this, instead referring to having a syringe set to zero, empty or in a vacuum.

(e) The majority of the candidates understood that a response in terms of mole ratios was required but often became confused. In order to maintain clarity in responses requiring more than one piece of information, candidates may find it helpful to use bullet points.

(f) The hazard data given in the question concerned the dangers of inhaling nitrogen(IV) oxide, thus ways of preventing that were required, such as masks or guards of various descriptions or fume cupboards that would prevent gas escape into the laboratory.

Question 2

There was a substantial amount of background information concerning the cell set up which needed to be considered before attempting answering the questions. A feature of the calculations in this question was the significance of the negative sign which was often ignored by candidates.

(a) The data calculation was very straightforward and the vast majority of the candidates gained full credit here. Most of the errors were in decimal place typically 1.00 and 2.00 being given as 1 and 2 respectively. Sometimes there was evidence of truncation rather than correct rounding, e.g. the last value of -3.699 given a -3.69 rather than -3.70.

(b) The candidates were not required, as in past years, to draw, label and scale the axes which made good graphical representation much more straightforward. All the candidates used the given axes without alteration and coped well with the negative log scale.

The nature of the values of the data and scaling of the axes meant that all of the points were on the intersection of two grid lines. As a consequence the plotting of the data was very well done. There were only a few mis-plots, notably the point (-0.30,0.94) which was often plotted at (-3.00,0.94). Some candidates’ plots were very faint and difficult to see, for example a dot plot often gets obscured by the drawn line. Some candidates with a dot or cross plot had a small circle around them making them more obvious (any anomaly would then have a double circle to identify it).

The line of best fit was mostly done very well with the best line going through five points and just missing points 3, 5 and 7. There was some evidence that a few candidates did not use a ruler or had a line composed of more than one line.

(c) It was apparent that most candidates were expecting there to be anomalous points [illegible]d those that were just off the line as anomalous. However those points were well within th[illegible] that could be expected in the data so were not anomalous. A minority of candidates [illegible] reported no anomalies. Even fewer gave a reason for that based on the rounding of the log v[illegible] and the measurement of the cell potential to two decimal places leading to some variability in [illegible] data.

(d) (i) Most candidates drew satisfactory construction lines on their graphs. For the calculation of the slope most candidates correctly read the co-ordinate values typically using data points that were on the line and correctly calculated the slope. However, some candidates gave some inversion of co-ordinate values i.e. $(y_1 - y_2)/(x_2 - x_1)$ whist others did not give the slope as negative which should have been apparent to candidates by way of the negative slope of the line.

The calculation of a value for n proved difficult for many candidates, even though the equation given could be rearranged into the form $y = mx + c$. Some candidates with a good value for n did not round to the nearest whole number.

(ii) The simplest way of determining $E^\ominus$ is from the line equation $y = mx + c$ where the intercept on the y axis (at $x = 0$) is $E^\ominus$ and if the line was produced back to that axis it would give 0.931 V. As the data was given to two decimal places then 0.93 V was acceptable. Some candidates calculated $E^\ominus$ from the Nernst equation using the value of n from **(d)(i)** and one set of data. If a reasonable value of n was used this approach was usually successful.

(e) Only a minority of candidates used a correct calculation in this part. The most common deviations were the inversion of the calculation and the loss of the important negative sign. Also required was the identity of M from the $E^\ominus$ value which had to be a metal but was often given as an ion.

(f) The required equation was often given incorrectly here. Common errors were having the reverse reaction or not balancing the equation, particularly in the number of silver atoms in the products.

(g) (i) It was very pleasing to see that many candidates were aware that the salt bridge allows the movement of ions rather than electrons.

(ii) This question was not well answered; the solubility of potassium and nitrate compounds and the insolubility of lead and silver chlorides were not well known. Many candidates attempted explanations in terms of electrode potential.

CHEMISTRY (US)

Paper 9185/53
Planning, Analysis and Evaluation

Key Messages

- An increased familiarity with experimental techniques and experience of carrying out practical procedures would be of benefit to candidates.

- Candidates should be reminded that useful information is often given in the question introduction which needs to be considered before answering.

General Comments

The basis of **Question 1** was the determination of the stoichiometric relationship for the thermal decomposition of magnesium nitrate(V). Candidates struggled with formulae and with drawing suitable equipment for gas collection.

In **Question 2** candidates were required to handle electrode potential data and manipulate the Nernst equation, the latter proving difficult for some candidates. The drawing of the graph was much improved on previous years' performances, possibly because of the introduction of labelled axes on which candidates plotted their points.

Comments on Specific Questions

Question 1

(a) (i) Despite being given the reactants and products, many candidates were not able to state correct equations for the thermal decomposition of magnesium nitrate(V). The formulae of magnesium nitrate(V) and nitrogen(IV) oxide were common problems. It should be emphasised that the skills involved here are fundamental in chemistry and provide the basis for much subsequent understanding.

(ii) Most candidates calculated a correct relative molecular mass for magnesium oxide. Many candidates were successful in calculating molar volumes even if their equation in **(a)(i)** was incorrect, provided they correctly used the molar ratios given by their equation. Candidates should be reminded to make sure they have fully answered the question; in this case all values were required. Units should always be given.

(b) (i) Experience of practical experimental procedures was necessary to produce a diagrammatic representation of equipment that would carry out the required process. The question required that the nitrogen(IV) oxide absorbance and oxygen collection be done separately and sequentially. Many candidates had two output tubes from the reaction vessel leading to two syringes or one tube that split into two and onto two syringes. In both these cases the candidates assumed that each syringe would collect one of the gases alone. Some drawings of oxygen collection over water did not function. Various nitrogen(IV) oxide absorbers were proposed and although the question stated that the nitrogen(IV) oxide was acidic and reacts completely with alkalis, many did not include an alkali (or base) in their absorber. Many attempts were made which included an alkali but would not properly work. These included having cotton wool soaked in alkali in the upper part of the tube, having the magnesium nitrate(V) heated in an alkali solution, having various U tubes that would not allow the passage of gas and passing the gas stream over solid alkali in a tube. Often the diagrams were not sufficiently labelled or the apparatus was not drawn as airtight. Very few candidates received full credit on this question which is significant since confidence in experimental set up details of this nature are fundamental to practical chemistry.

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