

OCR A-LEVEL CHEMISTRY B (SALTERS) • H433

CHEMISTRY



EXAM QUESTION PACK

CHEMICAL LITERACY

SCORE

/102

PERCENTAGE

%

STEMUP

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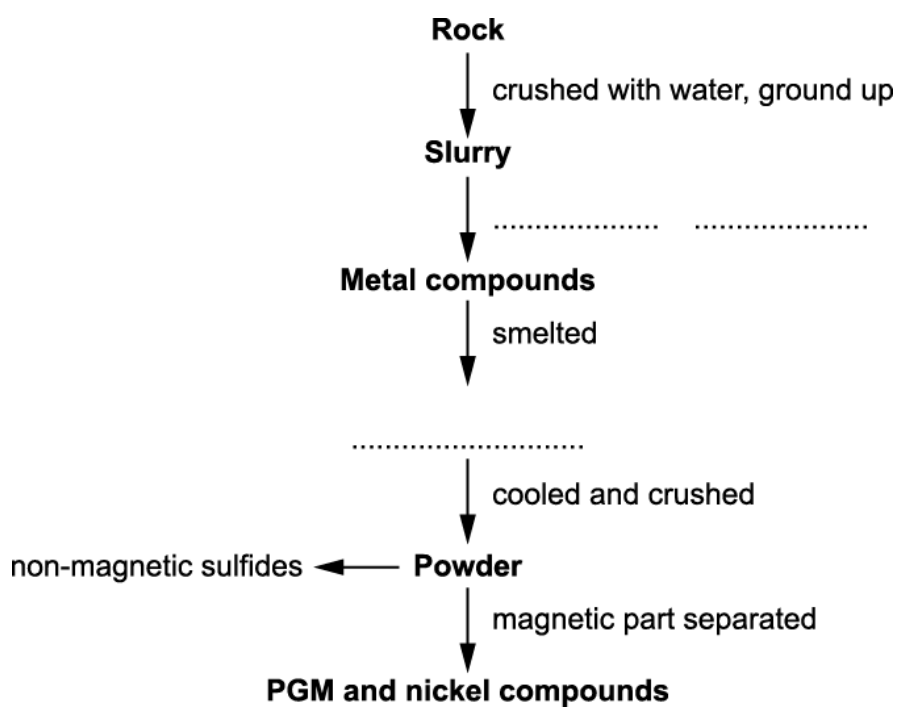
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1(a) This question is based on the article *The Platinum Group Metals* which is included as an insert to this paper.

- (i) Write words on the dotted lines to complete the flowchart below to summarise the extraction of PGM from rocks.



[1]

- (ii) Suggest an equation for the reaction of one of the 'non-magnetic sulfides' with sulfuric acid to form a sulfate.

[1]

- (iii) How is the metal obtained from the solution of its sulfate?

[1]

(b)

- (i) Suggest **two** reasons why PGM are used in catalytic converters rather than other equally effective catalysts.

----- [1]

- (ii) Write the equation for a reaction in which both CO and NO are removed from exhaust gases in a catalytic converter.

[1]

- (c) Complete the electron configuration of Rh^{3+} , by comparison with Co^{3+} .

[Kr] ----- [1]

(d)

- (i) $[\text{Ru}_2\text{OCl}_{10}]^{4-}$ has an oxygen atom connecting two Ru atoms.

Draw a three-dimensional diagram to suggest the shape of this ion. Give the co-ordination number of Ru in your structure.

co-ordination number ----- [2]

- (ii) Suggest a **name** for the shape of $[\text{AuCl}_4]^-$.

----- [1]

- (e) Give the formula of a 'bulky organic monocation' from the article and explain why three such species are needed by $[\text{MC}_6]^{3-}$.

----- [2]

(f) Estimate how much faster $[\text{Ag}(\text{H}_2\text{O})_2]^+$ exchanges chloride ions compared with $[\text{Ru}(\text{H}_2\text{O})_6]^{3+}$.

----- [1]

(g) Give the equation for a ligand exchange reaction of copper involving ammonia. Give the starting and finishing colours involved.

[2]

(h) A student says that silver(I) salts are colourless because the d subshells are not split by the ligands.

Discuss this statement. (Ag has the same outer electron configuration as Cu.)

----- [3]

- [6]

2(a) This question refers to the *Practical Insert* that is provided as an insert to this paper.

- (i) Suggest and explain a mistake in the student's procedure which may have led to the titre values in the first set of results showing an increase.

----- [2]

- (ii) Choose suitable values from the student's second set of titration results to calculate the concentration of the original sulfamic acid solution.

Give your answer to **two** significant figures.

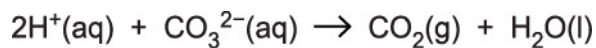
concentration = _____ mol dm⁻³ [4]

- (iii) The concentration of sulfamic acid solution given on the bottle of limescale remover is slightly lower than the student's value.

Suggest how the sodium hydroxide solution may have caused this difference.

----- [2]

(b) In **Part B** of the experiment, sulfamic acid reacts with excess carbonate as in the equation below.



(i) Use the data from the results section in **Part B** of the insert to calculate the M_r of the sulfamic acid.

You may assume that all the acid reacts and that the reaction takes place at room temperature and pressure.

$M_r =$ _____ [4]

(ii) The measuring cylinder used to collect the carbon dioxide has an uncertainty of $\pm 1 \text{ cm}^3$. Calculate the percentage uncertainty in the volume of CO_2 measured.

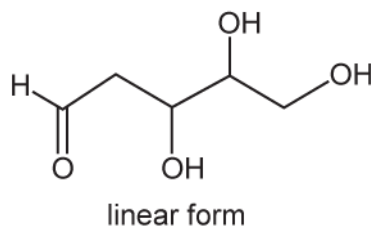
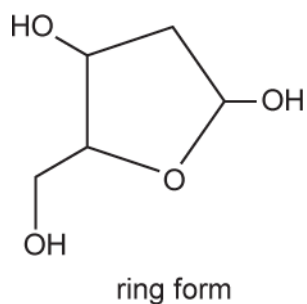
percentage uncertainty = _____ % [1]

(iii) Suggest one procedural error that could result in the student's value being higher than the accurate value of 97.1.

_____ [1]

3(a) Deoxyribose, $C_5H_{10}O_4$, has a vital role in our biochemistry as a component of DNA.

Deoxyribose exists in solution as several forms, two of which are shown below.



(i) Circle **all** the chiral centres on **both** structures above.

[1]

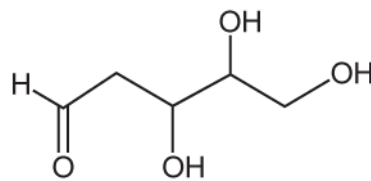
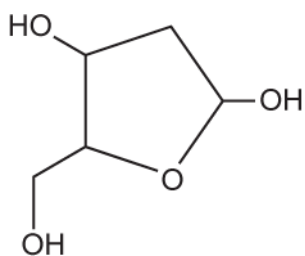
(ii) Name the functional group that is present in the linear form only.

-----[1]

(iii) Describe a laboratory test for the functional group identified in (a)(ii).

-----[2]

(iv) Circle a primary alcohol group on each structure below, giving a reason for your choice.



Reason

[2]

- (v) Explain why the reaction in which the linear form changes to the ring form is **not** condensation.

[1]

- (vi) Complete the equation that shows the reaction when the linear form changes to the ring form.
 $\text{--CHO} + \text{HO--} \rightarrow$

[1]

- (b) In DNA, deoxyribose is always present as the ring form.

The primary alcohol group in the ring form of deoxyribose and the alcohol group on the adjacent carbon condense with phosphate groups.

A sugar-phosphate backbone is formed.

Draw a section of the sugar-phosphate backbone.

Show one deoxyribose and two phosphate groups.

[2]

This question is based on the article **Saving paper** from *Education in Chemistry*, March 2013, published by the Royal Society of Chemistry which comes as an insert with this paper.

The article describes several methods of neutralising the acidity in paper. One of these is 'washing in a bath of mild alkali'.

Describe **two other** methods given in the article.

Write equations where appropriate.

[2]

5(a) This question concerns the article The Strange Story of Napoleon's Wallpaper that is supplied as Insert for H433/02, June 2018.

One reason arsenic is poisonous because it reacts with –SH groups in amino acids.

Suggest how the removal of –SH groups might interfere with the way these amino acids form proteins.

----- [1]

(b) Arsenate(V) can replace phosphate(V) in nucleic acids.

Draw the skeletal formula of a DNA nucleotide containing thymine and with As instead of P.

(c) Write an equation for the reaction of a solution of As^{3+} with hydrogen sulfide. Show state symbols. [2]

[2]

(d) A Marsh test is carried out for arsenic in a sample of As_2O_3 .

(i) Draw a labelled diagram of a suitable apparatus, showing the reactants and products.

[3]

(ii) Write equations for the formation and decomposition of arsine in the apparatus.

[2]

(e) The structure of Scheele's green can be represented as $\text{Cu}^{2+}(\text{AsO}_2\text{OH})^{2-}$.

(i) Suggest a '*dot-and-cross*' diagram for the anion in Scheele's green.

[2]

(ii) State which part of Scheele's green is responsible for the green colour.

-----[1]

(f) State and explain the C–As–C bond angle in trimethylarsine.

[4]

(g) Summarise the evidence that Napoleon was killed by his wallpaper.

[3]

6 Please refer to the Article 'Clearing the air around smoke formation' in **Insert for H433/02 June 19**.

Fig. 2 in the Article shows the formation of naphthalene from benzene.

Suggest the first step in the formation of a larger PAH from naphthalene.

----- [1]

7 Fig. 2.2 shows some information found on a bottle of ethanoic anhydride.

The students use the information in Fig. 2.2 to write a risk assessment for ethanoic anhydride.

Ethanoic anhydride	Hazards
	Flammable Harmful by inhalation and if swallowed Corrosive – causes burns

Fig. 2.2

Suggest **three** precautions that the students should take when using ethanoic anhydride.

1 _____

2 _____

3 _____

[3]

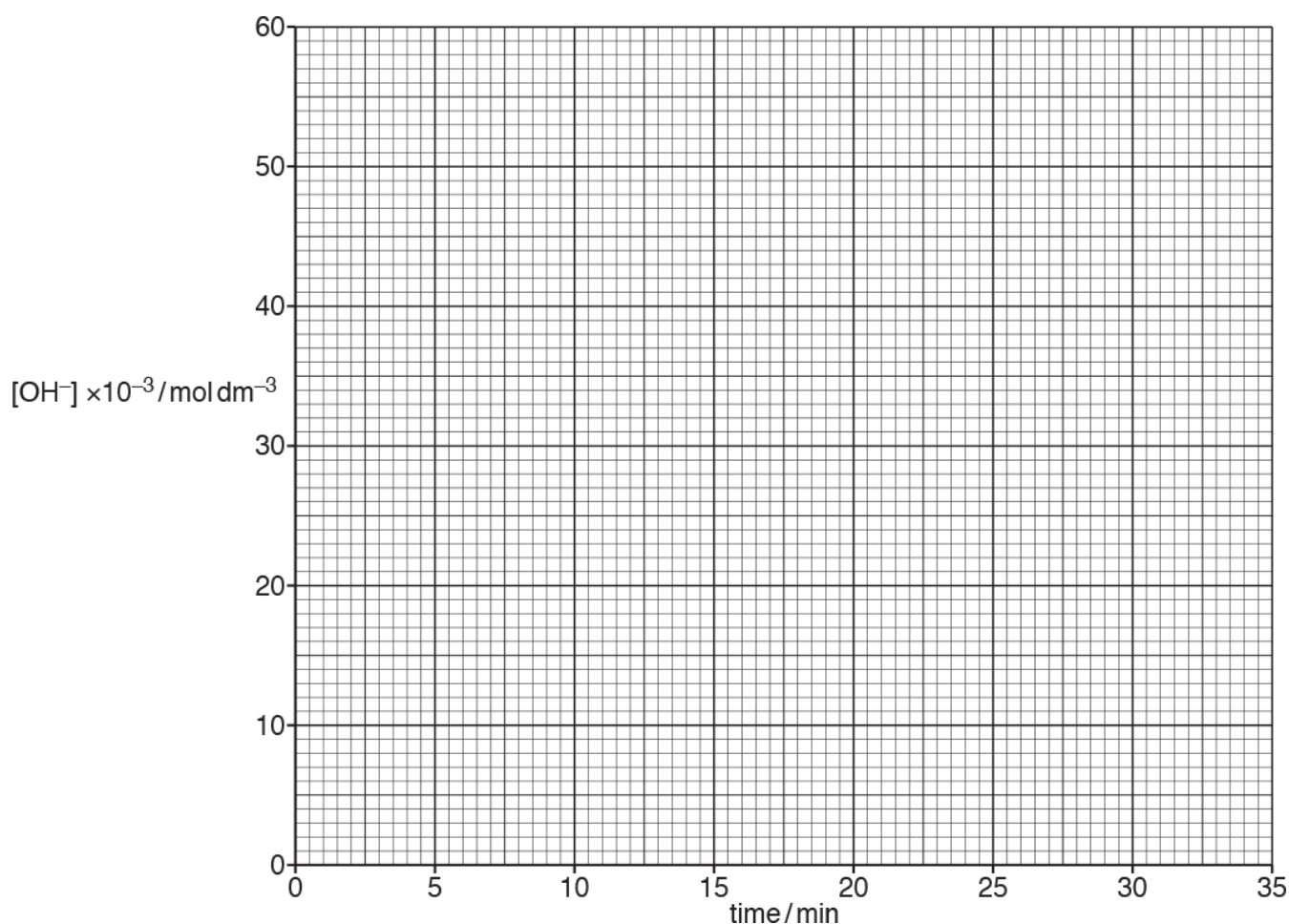
8(a) * **Method 1** uses a series of titrations to determine the concentration of hydroxide ions at specific time intervals.
The reaction is complete in about 30 minutes.

Suggest the procedure needed for the titrations using **Method 1**, starting from when the reagents are mixed.
Include how to calculate the data shown in **Table 4.1**.

(b) Please refer to Insert H433-03 Nov 2020 to answer this question.

(i) Using the data from Table 4.1 in the Insert, plot a graph on the grid below.

Include a curve of best fit.



[2]

(ii) Use your graph to calculate the time taken for the concentration of hydroxide ions to fall from 40×10^{-3} to 20×10^{-3} and from 20×10^{-3} to $10 \times 10^{-3} \text{ mol dm}^{-3}$.

Show your working on the graph.

Time taken to fall from 40×10^{-3} to $20 \times 10^{-3} \text{ mol dm}^{-3}$ = ... min

Time taken to fall from 20×10^{-3} to $10 \times 10^{-3} \text{ mol dm}^{-3}$ = ... min

[2]

(iii) Explain how the graph shows that the **overall** order of the reaction is first order.

[2]

(iv) A student is told that the reaction followed using **Method 1** goes by **mechanism B**.

The student says that the first reaction in **mechanism B** must be the rate-determining step. This accounts for the overall first order of the reaction.

Comment on the student's statement.

[2]

(c) Please refer to Insert H433-03 Nov 2020 to answer this question.

- (i) Use the data in **Table 4.2** to determine the order of reaction with respect to 1-bromobutane and hydroxide ions in **Method 2**.

Give your reasoning.

[2]

- (ii) Complete the rate equation for the reaction in part (i).

Rate = [1]

9(a) Satraplatin was designed to be taken by mouth as it is soluble.

(i) Name the shape of a satraplatin molecule around the Pt atom.

-----[1]

(ii) Give the co-ordination number of Pt in satraplatin.

-----[1]

(iii) Suggest, in terms of intermolecular bonds, why satraplatin is soluble whereas cisplatin is not.

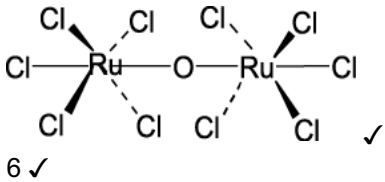
-----[3]

(b) * Give the **disadvantages** of using cisplatin as an anti-cancer drug and give examples of how newer platinum-based drugs attempt to overcome these disadvantages.

[6]

END OF QUESTION PAPER

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
1	a	i	froth/detergent flotation AND matte ✓	1	
		ii	$\text{NiS} + \text{H}_2\text{SO}_4 \rightarrow \text{NiSO}_4 + \text{H}_2\text{S}$ OR $\text{CuS} + \text{H}_2\text{SO}_4 \rightarrow \text{CuSO}_4 + \text{H}_2\text{S}$	1	IGNORE state symbols
		iii	electrolysis	1	
	b	i	high melting AND unreactive	1	
		ii	$2\text{CO} + 2\text{NO} \rightarrow \text{N}_2 + 2\text{CO}_2$	1	ALLOW halves or multiples IGNORE state symbols
	c		$4d^6$	1	
	d	i		2	ALLOW bridging oxygen bonding in axial or equatorial positions IGNORE brackets and charges.
		ii	square planar OR tetrahedral	1	
	e		R_2NH_2^+ ✓ 3 + balances 3– (AW) ✓	2	
	f		$10^7 - 10^{10}$ or any value in that range ✓	1	
	g		$[\text{Cu}(\text{H}_2\text{O})_6]^{2+} + 4\text{NH}_3 \rightarrow [\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+} + 4\text{H}_2\text{O}$ ✓ (light)blue dark blue/violet/purple/mauve ✓	2	ALLOW $[\text{Cu}(\text{H}_2\text{O})_6]^{2+} + 6\text{NH}_3 \rightarrow [\text{Cu}(\text{NH}_3)_6]^{2+} + 6\text{H}_2\text{O}$ IGNORE state symbols
	h		Wrong: d subshells still split ✓ Ag^+ is d^{10} OR Ag has full d subshell ✓ so no movement possible (AW) ✓	3	

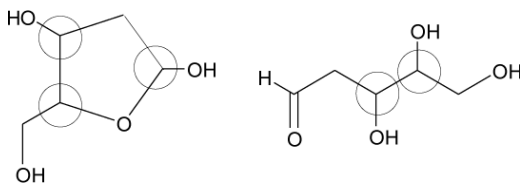
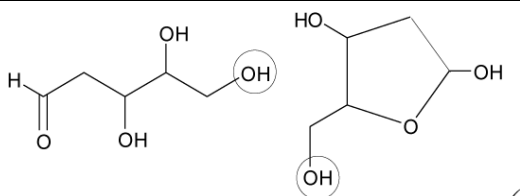
Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	i	<i>*Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.</i> Level 3 (5–6 marks) Describes in detail the methods of extraction and gives chemical details from the article of all three compounds. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) Describes in detail the methods of extraction of all three compounds AND Gives the chemical details from the article for either Pd, Pt or Os <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1–2 marks) Outlines the methods of extractions for of all three compounds AND Gives the chemicals details from the article for either Pd, Pt or Os. OR Describes in detail the method of extraction for one of the compounds and gives chemical details from the article concerning this compound. <i>The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.</i> 0 marks No response or no response worthy of credit	6	Indicative Scientific points include: Description of extraction of Pd: - extracted by ligand exchange - followed by dissolving in organic solvent Chemical details from article concerning Pd: - equation, eg $[\text{Pd}(\text{H}_2\text{O})_6]^{2+}(\text{aq}) + 4\text{Cl}^-(\text{aq}) \rightarrow [\text{PdCl}_4]^{2-}(\text{aq}) + 6\text{H}_2\text{O}(\text{l})$ - this reaction is much slower for other PGMs Description of extraction of Pt: - anion exchange - reacted with $\text{R}_2\text{NH}_2^+ \text{Cl}^-$. Chemical details from article concerning Pt: $2[\text{R}_2\text{NH}_2^+ \text{Cl}^-] + [\text{PtCl}_6]^{2-}(\text{aq}) \rightleftharpoons (\text{R}_2\text{NH}_2^+)_2 [\text{PtCl}_6]^{2-} + 2\text{Cl}^-$ $(\text{R}_2\text{NH}_2^+)_2 [\text{PtCl}_6]^{2-}$ is soluble in organic solvents whereas the equivalent salts of other PGMs have lower solubility. Description of extraction of Os: - oxidation - oxide volatile and can be removed by heating Chemical details from article concerning Os: - oxidised to OsO_4 - may be mixed with RuO_4
		Total	23	

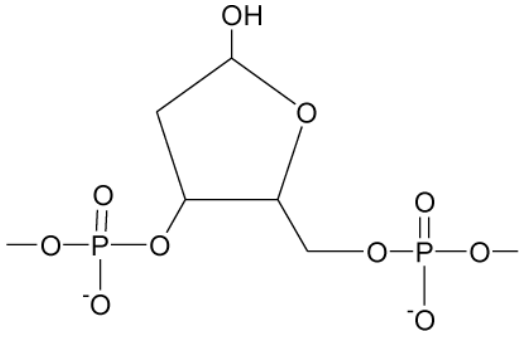
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
2	a	i	did not mix/invert sulfamic acid solution ✓ solution more concentrated at bottom ✓	2	
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.087 (mol dm ⁻³) award four marks takes average of two concordant results (= 21.825)✓ calculates moles of hydroxide (= 2.183 × 10 ⁻³)✓ uses eqn to determine moles of acid (= 2.183 × 10 ⁻²) ✓ calculates concn. (i.e. mol per dm ³) to 2sig figs = 0.087 (mol dm ⁻³)✓	4	
		iii	solid absorbs water so mass/ concentration of sodium hydroxide actually dissolved is less✓ titre value therefore greater giving high result ✓	2	
	b	i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 98.6/99 award four marks moles of CO ₂ produced 146/24000 = 6.083 × 10 ⁻³ ✓ uses eqn. to determine moles of acid (above ans. × 2) = 1.217 × 10 ⁻² ✓ 1.217 × 10 ⁻² moles = 1.20g ✓ scales mass up to give mass of 1 mole of acid i.e. 1.20/1.217 × 10 ⁻² = 98.6(03)g✓	4	
		ii	1/146 × 100 = 0.68(...)/0.7 (%)✓	1	DO NOT ALLOW ecf's
		iii	some of gas lost when putting on bung OR some of gas dissolves	1	
			Total	14	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance										
3	a	i		1	All 5 Carbon atoms must be circled Examiner's Comment: The most common error here involved candidates failing to identify that the carbon atom bonded to the OH group of the pentose ring was also a chiral centre and so did not score this mark.										
		ii	aldehyde ✓	1	NOT carbonyl here Examiner's Comment: Most candidates scored this mark with the only common error was identification of the functional group as a carboxylic acid rather than an aldehyde.										
		iii	<table border="1"><tr><td colspan="2"><i>one form</i></td></tr><tr><td>test 1 mark ✓</td><td>result linked to appropriate test 1 mark ✓</td></tr><tr><td>heat with Fehling's / Benedicts solution</td><td>(brick) red ppt</td></tr><tr><td>add Tollens' reagent and warm</td><td>silver mirror / AW</td></tr><tr><td>heat with acid dichromate</td><td>goes green</td></tr></table>	<i>one form</i>		test 1 mark ✓	result linked to appropriate test 1 mark ✓	heat with Fehling's / Benedicts solution	(brick) red ppt	add Tollens' reagent and warm	silver mirror / AW	heat with acid dichromate	goes green	2	Reagents may be specified (eg 'silver nitrate and ammonia' for Tollens') Examiner's Comment: Many candidates scored at least 1 mark, with the most common error being to incorrectly identify the reaction conditions associated with the tests, however where the test was identified the correct result was given and scored the appropriate mark.
<i>one form</i>															
test 1 mark ✓	result linked to appropriate test 1 mark ✓														
heat with Fehling's / Benedicts solution	(brick) red ppt														
add Tollens' reagent and warm	silver mirror / AW														
heat with acid dichromate	goes green														
		iv	 OH / it is attached to a C with 2H / one C-C bond / attached to a carbon that is only bonded to one other carbon / R group ✓	2	Both OH groups must be circled Examiner's Comment: Well answered. Candidates correctly identified the correct OH groups and explained why these groups were primary alcohol groups.										
		v	Water / a small molecule is not produced / both have same molecular formula	1	Examiner's Comment: Again, a well answered question. The vast majority of candidates recognised that water / a small molecule was not a product of the reaction.										
		vi	–CHO + HO– → –CH(OH)–O–	1	ALLOW any unambiguous representation Examiner's Comment: Very few candidates scored this mark, and many left the space for the answer blank.										

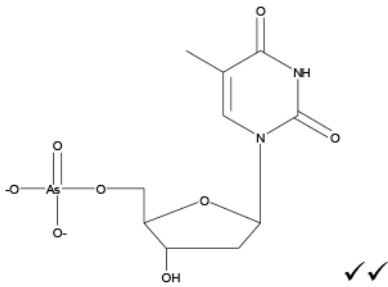
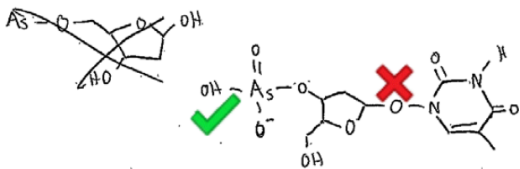
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b		 correct bonding in phosphates ✓ correct connection of phosphates AND correct ring structure ✓	2	Examiner's Comment: This question was attempted by the majority of candidates, however, very few candidates scored more than one mark, with a significant number scoring 0. The most common error was the failure of candidates to realise that when the phosphate groups bond to the deoxyribose ring that all of the hydrogen atoms are lost in the formation of water, and therefore when candidates left OH groups attached to the central phosphorous atom this cost them one mark. However, it was pleasing to note that they did know where the phosphate groups bonded to the ring and so the second mark for showing the correct connection of the phosphate groups to the pentose ring was often awarded.
			Total	10	
4			Use of diethyl zinc/ (C₂H₅)₂Zn ✓ Adding nanoparticles / microparticles of MgO / Mg(OH)₂/Ca (OH)₂/metal hydroxides ✓ (C₂H₅)₂Zn + 2H⁺ → Zn²⁺ + 2C₂H₆ OR Ca(OH)₂ + 2H⁺ → Ca²⁺ + H₂O OR Mg(OH)₂ + 2H⁺ → Mg²⁺ + H₂O ✓	3	Examiner's Comment: Most candidates scored 2 marks here, with many scoring all 3 marks. The only reason for marks being lost was in failing to either give an appropriate equation for either the use of diethylzinc gas, or the use of magnesium (or calcium) hydroxide nanoparticles, or in discussing the use of bleaching agents.
			Total	3	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
5	a		will not allow formation of S-S bonds	1	ALLOW idea that As interferes with sulfur bridges / S-S bonds in the protein Examiner's Comments Question 5 required that centres had given candidates time and opportunity to study the pre-release article "The Strange Story of Napoleon's Wallpaper". It was anticipated that teachers would have spent some time discussing some of the chemistry within the article. The focus of the article should have prompted teachers to guide candidates towards looking at the properties and reactivity of Group V elements, nitrogen and phosphorous. These could be used to predict some of the reactions and properties of arsenic by extending the group trend(s). In part (a) most candidates recognised that the removal of the –SH groups would interfere with the ability of the protein to form the correct tertiary structure. However, to score the mark here they had to make it clear that the arsenic was preventing the formation of S—S bonds (disulfide bridges). It was pleasing to see that in the vast majority of responses that this was the answer given.

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
b		2	ALLOW arsenate group partially, or fully protonated bonded to either OH group on the ribose ring for 2 marks Correct structure with one error scores 1 mark <u>Examiner's Comments</u> In part (b) candidates needed to make use of the relevant section from the Data Sheet provided. They needed to select the appropriate sugar structure (deoxyribose) and derive the structure of thymine. Finally they needed to substitute As for P in the phosphate group and then join the fragments together in order to produce the correct structure. Many candidates succeeded in this and scored both of the marks available. The two most commonly seen errors were the inclusion of a bridging O atom between the thymine molecule and the deoxyribose ring, or the omission of the C=C within the thymine structure. Exemplar 11  Exemplar response showing the incorrect depiction of a bridging O between thymine and the deoxyribose ring

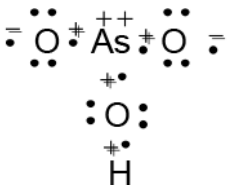
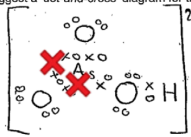
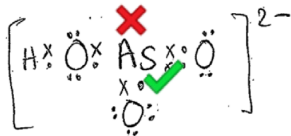
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	c		$2\text{As}^{3+}(\text{aq}) + 3\text{H}_2\text{S}(\text{g})/(\text{aq}) \rightarrow \text{As}_2\text{S}_3(\text{s}) + 6\text{H}^+(\text{aq})$ balanced equation ✓ Correct state symbol for As_2S_3 ✓	2	<u>Examiner's Comments</u> This was found difficult by candidates, with. Most candidates did not realise the need to balance the charges within the equation and so gave $3\text{H}_2(\text{g})$ as a product rather than $6\text{H}^+(\text{aq})$, losing 1 mark. Many gave the formula of $\text{As}_2\text{S}_3(\text{s})$ in an unbalanced equation, and this was allowed for 1 mark.
	d	i	generating flask containing zinc, sulfuric acid and As_2O_3 ✓ heated tube leaving flask ✓ silvery-black film / Arsenic (metal) labelled ✓	3	ALLOW 'sample' for As_2O_3 IGNORE closed tube <u>Examiner's Comments</u> This was a well answered question and most candidates scored full marks. There were some examples of apparatus that, whilst being impractical or potentially dangerous, did match to the description given in the pre-release material. The marks were not for designing something that would meet today's Health and Safety requirements, but for recognising candidates' ability to extrapolate a description into a suitable diagram of a set up that might work. Therefore sealed tubes, or open tubes with hydrogen escaping near a naked flame, did not result in the loss of any marks. The only common error evident was in failing to label the apparatus appropriately (e.g. failing to label where the arsenic metal would be deposited, or failing to label the heating of the glass tube leaving the reaction flask) Marks were lost through carelessness rather than an inability to produce a suitable diagram..

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	$\text{As}_2\text{O}_3 + 6\text{H}_2 \rightarrow 2\text{AsH}_3 + 3\text{H}_2\text{O} \checkmark$ $2\text{AsH}_3 \rightarrow 2\text{As} + 3\text{H}_2 \checkmark$	2	ALLOW $\text{As}_2\text{O}_3 + 6\text{Zn} + 6\text{H}_2\text{SO}_4 \rightarrow 2\text{AsH}_3 + 3\text{H}_2\text{O} + 6\text{ZnSO}_4$ for equation 1 IGNORE state symbols <u>Examiner's Comments</u> Many candidates did not write a balanced equation for the formation of arsine in the reaction vessel, but were able to write a balanced equation for the decomposition of arsine to form arsenic and hydrogen as the products and so scored 1 mark here. In the first equation a common error that was observed was the inclusion of oxygen gas, O_2, as one of the products of an otherwise balanced equation, which resulted in the mark not being credited.

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
e i	 8 electrons around As atom ✓ completely correct including lone pair on As ✓	2	ALLOW 'spare' electrons on oxygen as different symbol or the same as others on that oxygen IGNORE overall charge of 2- Examiner's Comments A number of candidates identified the anion present in <i>Scheele's Green</i>, but were unable to then draw the appropriate dot and cross diagram. The most common errors were to produce diagrams containing double bonds to one or more oxygen atom giving ten or more electrons around the central As atom, failing to include a lone pair of electrons on the As atom, and failing to check that each oxygen atom satisfied the octet rule. Exemplar 12 (e) The structure of Scheele's green can be represented as $\text{Cu}^{2+}(\text{AsO}_2\text{OH})^{2-}$. (i) Suggest a 'dot-and-cross' diagram for the anion in Scheele's green.  Commonly seen incorrect dot and cross diagram for bonding of Scheele's Green anion. Exemplar 13 (e) The structure of Scheele's green can be represented as $\text{Cu}^{2+}(\text{AsO}_2\text{OH})^{2-}$. (i) Suggest a 'dot-and-cross' diagram for the anion in Scheele's green.  No lone pair on central As atom, but each atom has its full complement of electrons around its outer shell arrived at by drawing a double bond to one of the oxygen atoms.

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		ii	Cu^{2+} (ion) ✓	1	ALLOW Copper(II) / copper ion <u>Examiner's Comments</u> Most candidates scored this mark as they recognised that coloured substances usually contain a transition metal ion, and so gave Cu^{2+} or copper(II) as their answer. The only common errors were the omission of the charge on the ion, or the omission of the oxidation state after the name of the element.
	f		107.5 (°) ✓ Four pairs of electrons (around As) ✓ Repel and get as far away as possible / move apart to minimise repulsion ✓ Lone pair : bond pair repulsion > bond pair : bond pair repulsion / lone pair repels more (than bond pair) / lone pair takes up more room (AW) ✓	4	ALLOW 107 – 108 ALLOW 'areas of electron density'/'groups of electrons' for 'pairs of electrons' / 3 bonding pairs AND 1 lone pair must be clear that it is electrons repelling to score third mark <u>Examiner's Comments</u> Most candidates scored at least three marks here, and many went on to score all four marks. The only common omission was in failing to make it clear that the lone pair of electrons present on the central arsenic atom had a stronger repulsion on the bonding pairs of electrons and that this produced the bond angle of 107.5°.

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	g		Any three from: arsenic found in Napoleon's hair ✓ wallpaper (might have) contained arsenic /contained Scheele's Green ✓ Dampness / mould on the wallpaper released toxic arsenic vapours ✓ wallpaper poisoned others ✓	3	ALLOW (wallpaper) linked to Gosio's Disease <u>Examiner's Comments</u> Most of the candidates were able to provide a response here that scored two if not all three marks. They had clearly studied the pre-release material appropriately and were able to summarise the three key pieces of evidence accurately. Where candidates only scored two marks was often a result of omitting marking point 1 – that traces of arsenic were found in the sample of Napoleon's hair. Most candidates made the link between the Scheele's Green pigment found in the wall paper sample, and that the island environment would have caused the paper to become mouldy. This would then result in releasing toxic arsenic compounds as a vapour that Napoleon would have been exposed to over a period of time.
			Total	20	

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6			Abstraction/removal of hydrogen from naphthalene ✓	1(AO2.5)	DO NOT ALLOW steps before abstraction IGNORE any further steps that grow PAH <u>Examiner's Comments</u> Where candidates had prepared well this was a well answered question as they readily identified that the first step was the abstraction (removal) of a hydrogen atom from naphthalene. However, there were some instances of responses that seemed to indicate that the candidates had not spent sufficient time on the article and so they gave more generalised responses such as 'bond breaking', addition of acetylene, or even leaving this blank. Where a candidate correctly identified the first step and then followed it up with a suggested second step, this was ignored whether it was correct or not as the question only required them to identify the first step in the reaction. However, if they gave some indication of a process happening before the hydrogen atom is removed then this was marked as incorrect even if they gave the removal of hydrogen as a second step (e.g. addition of acetylene followed by hydrogen abstraction scored 0, both processes do occur in the growth of PAH molecules, but the order given is incorrect).
			Total	1	

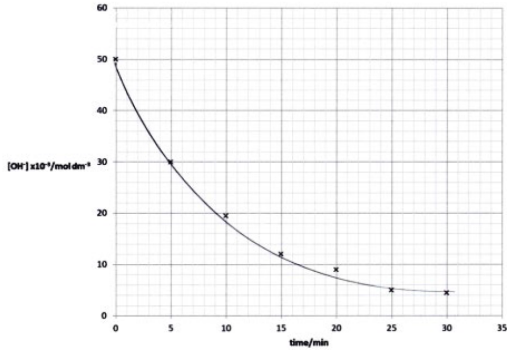
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
7			Keep away from flames ✓ AW Use in fume cupboard/well ventilated lab ✓ Wear (protective) gloves ✓	3(AO 3.2 x3)	Allow (lit) Bunsen burners/sparks IGNORE goggles <u>Examiner's Comments</u> Most candidates showed a good knowledge of appropriate safety precautions, although the suggestion of using a 'gas mask', as suggested by a small but significant proportion of candidates, was a disproportionate precaution relative to the hazard presented by ethanoic anhydride.
			Total	3	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
8	a	<i>Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.</i> Level 3 (5 – 6 marks) Detailed procedure given on how to sample, quench and titrate. AND A detailed method for how to calculate the data in Table 4.1. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3 – 4 marks) Outline procedure given on how to sample, quench and titrate. OR Detailed procedure given for either sample OR quench OR titrate, with a second procedure given in outline. OR Detailed procedure given for either sample OR quench OR titrate. AND A detailed method for how to calculate the data in Table 4.1. <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1 – 2 marks) Outline procedure given on how to sample OR quench OR titrate. OR An outline method for how to calculate the data in Table 4.1. <i>There is some attempt at a logical structure with a line of reasoning. The information present is in the most part relevant.</i> Level 0 (no marks) <i>No response or no response worthy of</i>	6 (AO3.3 ×2)(AO3.4 ×3)(AO2.8 ×2)	indicative scientific points may include: Sampling and quenching reaction • extract fixed volume of reaction mixture at regular time intervals • use a graduated / volumetric pipette • one method of quenching reaction, eg: ◦ rapid cool by adding to ice ◦ add to large volume of water ◦ adding to a fixed volume of excess acid of known concentration Titration either: • titrate sample with acid e.g hydrochloric acid • standard solution of acid OR • back titrate using standard solution of sodium hydroxide • standard solution of NaOH • In both cases a suitable acid base indicator must be used • colour change at end-point • drop by drop near end point Calculation (2.8) • $c_1V_1 = c_2V_2$ • c_1 is conc of acid and c_2 is unknown $[\text{OH}^-]$ • V_1 is titre and V_2 is pipette volume

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			<i>credit</i>		
	b	i	 points ✓ best fit ✓	2 (AO2.8 ×2)	points Allow +/- half squares best fit ALLOW Any sensible curve even those hand drawn!
		ii	7min and 7.5min / readings based on student graph ✓ working on graph ✓	2 (AO2.4 ×2)	ALLOW ecf on <u>student graph</u>
		iii	must be overall order because both concentrations are decreasing with time ✓ first order because half-lives / $t_{1/2}$ are same ✓	2 (AO2.7) (AO1.2)	Mark separately from (ii)
		iv	rds is slowest step in mechanism ✓ mechanism B has only one 'species' in the first step / If second step were rds, kinetics would be second order ✓	2 (AO3.1) (AO3.2)	
	c	i	first order wrt each ✓ quintupling OH^- conc. (with haloalkane constant) quintuples rate and when haloalkane conc. doubled rate doubles (with OH^- constant) ✓	2 (AO2.8 ×2)	
		ii	Rate = $k[1\text{-bromobutane}][\text{OH}^-]$ ✓	1 (AO2.4)	ALLOW ecf from (i) ALLOW a formula instead of '1-bromobutane' ALLOW bromobutane
			Total	17	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
9	a	i	octahedral ✓	1 (AO2.1)	
		ii	6 ✓	1 (AO2.1)	
		iii	Satraplatin also has ethanoate / ester/C=O groups/(4) O atoms (in addition to NH₃ groups that cisplatin also has) ✓ (These form more) H-bonds with water(ORA for cisplatin) ✓ and (more than) compensate for 'insoluble' (AW) ring OR H-bonds broken in water ✓	3 (AO3.1 × 3)	Oxygen MOLECULES is CON Examiner's Comments In (iii) most candidates recognised that satraplatin formed more hydrogen bonds with water than cisplatin, but some did not state why this was happening, and very few candidates could explain why this resulted in greater solubility compared to cisplatin.
	b		<i>Refer to marking instructions on page 5 of mark scheme for guidance on marking this question.</i> Level 3 (5 – 6 marks) Considers disadvantages of cisplatin, with most examples of both toxicity and cell resistance. AND Identifies most examples of how new drugs attempt to overcome the disadvantages of cisplatin. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3 – 4 marks) Considers disadvantages of cisplatin, with some examples of both toxicity and cell resistance. OR Gives a detailed treatment of either toxicity OR cell resistance AND Attempts to provide examples of the ways new drugs attempt to overcome the disadvantages of cisplatin. <i>There is a line of reasoning presented with some structure.</i>	6 (AO3.1 × 3) (AO3.2 × 3)	Indicative scientific points include: Disadvantages: toxicity • damaging to the kidneys / gastrointestinal tract / nervous system. • targets all cells • difficulty of administration cell resistance • influx slower / method of entry slowed / prevented • efflux faster / method of exit accelerated • removed before it can act on DNA • improved cell repair mechanism • cancer cells evolve • improved methods of DNA repair New Drugs attempting to overcome disadvantages • carboplatin less toxic • satraplatin / picoplatin different structure and overcame resistance • formulae of some of above • bulky group in picoplatin helps overcome resistance • satraplatin soluble / administered orally

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Question			Answer/Indicative content	Marks	Guidance
			<i>The information presented is relevant and supported by some evidence.</i> Level 1 (1 – 2 marks) Considers disadvantages of cisplatin, with examples of toxicity OR cell resistance. OR Attempts to provide examples of the ways new drugs attempt to overcome the disadvantages of cisplatin <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant and correct.</i> 0 marks No response or nothing of value		
			Total	11	