Higher Chemistry Past Papers 2021-23

September 2023

1. About this study aid...

This document has been designed to make revision and self-marking easy for students studying Higher chemistry in Scotland.

The information in this publication has been reproduced to support SQA qualifications only on a noncommercial basis and can only be shared on that condition.

2. How to use...

The following two pages contain tables which cross-reference the course topics with SQA question numbers for the years 2021-23.

The first table is for multiple choice questions; the second accesses Section 2 questions. Each question number is hyperlinked to the SQA question and clicking it will take you there. The question pages have further hyperlinks taking you either back to the topic grid (top) or to the SQA marking instructions (bottom).

Of course, you can always just treat it as a succession of question papers with marking instructions. This will be useful for end-of-course timed revision.

Updated to 2021-2023 by Mr Shepherd, St. Ambrose High School

Full credit goes to Mr Sinclair, Vale of Leven Academy for making the original 2015-2019 hyper-linked question paper

Cf	E Higher Past Pap	ers - Sect	ion 1 Mult	tiple Choi	ce Qs	
	Торіс	2021	2022	2023		
	Periodicity	26	2	8		
nit 1	Structure and Bonding	35	1 3	129		
	Oxidising and Reducing Agents	4	45	14		
7	Systematic Carbon Chemistry	7	8 9 13	21 25		
Unit	Alcohols, Carb acids, Esters, Fats and Oils	8 11 13	7 11	3 13 20		
	Soaps, Detergents and Emulsions		12	18		
	Proteins	12		11		
	Oxidation of Food	9 10 14	10 14 15	10 15 22		
	Fragrances		17			
	Skincare	15				
	Controlling the rate	16 17 18	18 21	4 5 6		
m	Getting the most from reactants	19 20	19	23		
Init	Equilibria	21 25	20			
	Chemical Energy		22	7 12 17		
	Chemical Analysis	1 22 23 24	16 23 24 25	16 19		
	Problem Solving		6	24		

Cf	E Higher Past Pap	ers - Sectio	on 2 Questi	ons	
	Торіс	2021	2022	2023	
	Periodicity	1a 1biii	1a-bii	1a-bii	
nit 1	Structure and Bonding	1c 4diiiB 2ai-ii 4ciii 7c	1c 6bii 7eii	2a 2biii 7ci 9a	
	Oxidising and Re-ducing Agents	4cii 6bii	5bi-ii	1biii 6d	
7	Systematic Carbon Chemistry	2aiii 11bi	8dii	9b 9e	
Unit	Alcohols, Carb. acids, Esters, Fats and Oils	5c 8a 9di 11bii	4a 4bii 5a 11a	3ai 3aiii 3d 5biiC	
	Soaps, Detergents and Emulsions	7e	4c	3c 7ai-ii	
	Proteins	6c 9aii	6ai-iii	3b	
	Oxidation of Food	8ci 9cii	5biii-vi 6bi	3aii 5bi 9d	
	Fragrances	8cii 9b-ci	8di	5biiA-B	
	Skincare	4di 4diiiA	10b	9c	
~	Controlling the rate	4eiiB 7d	2bii 2biv 8ai	6ai 6b	
Unit 3	Getting the most from reactants	2b 4ci 4eiiA 6biv 7a 8bii 9dii	2a 2bi 7c 8b	2bii 5ai 6aii-iii 6ciiB 10c	
	Equilibria	4ei	7d 8aii	6ci-iiA	
	Chemical Energy	2c 4a 4dii 5a-bi 7b	2biii 7a-b 7ei	2bi 7cii	
	Chemical Analysis	4b 6bi 6biii 8bi 9aiii 11a	2c 6aiv 11b-d	3aiv 7aiii 7b 10a-bii 10d	
	Open ended	3 10	39	4 8	
	Problem Solving	1bi-ii 5bii 6a 8ciii 9ai 11biii 9diii 12	4bi 6c 8c 10a 10c	5aii 5c	



National Qualifications

X813/76/12

Chemistry Paper 1 — Multiple choice

Duration — 40 minutes

Total marks — 25

Attempt ALL questions.

You may use a calculator.

Instructions for the completion of Paper 1 are given on *page 02* of your answer booklet X813/76/02.

Record your answers on the answer grid on *page 03* of your answer booklet.

You may refer to the Chemistry Data Booklet for Higher and Advanced Higher.

Space for rough work is provided at the end of this booklet.

Before leaving the examination room you must give your answer booklet to the Invigilator; if you do not, you may lose all the marks for this paper.





Total marks — 25 Attempt ALL questions

1. Aluminium carbonate can be produced by the following reaction.

 $2AlCl_3(aq) + 3K_2CO_3(aq) \rightarrow Al_2(CO_3)_3(s) + 6KCl(aq)$

The most suitable method for separating the aluminium carbonate from the mixture is

- A filtration
- B distillation
- C evaporation
- D collection over water.
- 2. The difference in the size of sodium and chlorine atoms is mainly due to the difference in the
 - A mass of each atom
 - B number of electrons
 - C number of neutrons
 - D number of protons.
- 3. Solid carbon dioxide is known as 'dry ice'. It changes directly to a gas when it is heated.

$$CO_2(s) \rightarrow CO_2(g)$$

The strongest bonds broken in this process are

- A polar covalent bonds
- B London dispersion forces
- C non-polar covalent bonds
- D permanent dipole-permanent dipole interactions.
- 4. Which of the following statements is correct?
 - A Elements with high electronegativities tend to be reduced
 - B Elements with high electronegativities tend to act as reducing agents
 - C Elements with low electronegativities tend to gain electrons
 - D Elements with low electronegativities tend to act as oxidising agents

5. The viscosities of two liquids, X and Y, were investigated by dropping a metal ball into a tube of each liquid.

The diagram shows the position of the metal balls after 10 seconds.



Which line in the table correctly describes the viscosity and relative strengths of the van der Waals forces in liquids X and Y?

	Х	Y
А	most viscous	strongest van der Waals forces
В	least viscous	weakest van der Waals forces
С	least viscous	strongest van der Waals forces
D	most viscous	weakest van der Waals forces

6. What is the enthalpy change, in kJ mol⁻¹, for the following reaction?

Be(g) \rightarrow Be²⁺(g) + 2e⁻

- A 900
- B 1757
- C 2657
- D 3514
- 7. Which of the following is an isomer of pentanoic acid?
 - A 2-methylpropanoic acid
 - B propyl methanoate
 - C 2-ethylbutanoic acid
 - D ethyl propanoate

8. The structures of two common painkillers are shown below.



Which of the following is true?

- A Both painkillers are ketones
- B Aspirin contains a carboxyl group and an ester link
- C Paracetamol contains a hydroxyl group and a carboxyl group
- D Neither painkiller contains an amide link
- **9.** Which two isomers would each produce an acid when warmed with acidified potassium dichromate solution?

1
$$CH_3 - CH_2 - CH_2 - CH_2 - OH$$

2 $CH_3 - CH_2 - CH_2 - CH_3$
3 $CH_3 - CH_3 - CH_2 - CH_3$
4 $CH_3 - CH_3 - CH_3$
CH₃ - CH₃
CH₃ - CH₃ - CH₃ - CH₃ - CH₃
CH₃ - CH₃ - CH₃ - CH₃ - CH₃
CH₃ - CH₃ - CH₃ - CH₃ - CH₃ - CH₃
CH₃ - CH₃

- A 1 and 2
- B 1 and 4
- C 2 and 3
- D 3 and 4

10. When an aldehyde is converted into the corresponding alcohol a reduction reaction takes place.

Reduction of 2-methylbutanal (GFM = 86) produces a compound with a GFM of

- A 70
- B 84
- C 88
- D 102.
- **11.** Which of the following compounds would react with sodium hydroxide solution to form the salt sodium propanoate?
 - A HCOOC₂H₅
 - B CH₃COOCH₃
 - C C₂H₅COOH
 - D C₃H₇COOH
- **12.** When a protein is denatured
 - A it is broken into amino acids
 - B hydrogen bonds are broken
 - C peptide links are hydrolysed
 - D water molecules are eliminated.
- 13. Compared with oils, fats are
 - A less saturated and have higher melting points
 - B less saturated and have lower melting points
 - C more saturated and have higher melting points
 - D more saturated and have lower melting points.
- 14. Vitamin C is an antioxidant used to preserve food and lengthen shelf-life.Which of the following does not describe an antioxidant?
 - A Electron donor
 - B Oxidising agent
 - C Reducing agent
 - D Free-radical scavenger

15. On exposure to UV light, methane and chlorine undergo a chain reaction.Which of the following is a propagation step in this reaction?

 $\begin{array}{rcl} \mathsf{A} & \cdot \mathsf{CH}_3 & + & \mathsf{Cl} \cdot & \rightarrow & \mathsf{CH}_3\mathsf{Cl} \\ \mathsf{B} & \mathsf{Cl}_2 & \rightarrow & 2\mathsf{Cl} \cdot \\ \mathsf{C} & \mathsf{H} \cdot & + & \mathsf{Cl} \cdot & \rightarrow & \mathsf{HCl} \\ \mathsf{D} & \mathsf{CH}_4 & + & \mathsf{Cl} \cdot & \rightarrow & \cdot \mathsf{CH}_3 & + & \mathsf{HCl} \end{array}$

16. A reaction was carried out at four different temperatures. The table shows the times taken for the reaction to occur.

Temperature (°C)	20	30	40	50
Time (s)	60	30	14	5

The results show that

- A a small rise in temperature results in a large increase in the rate of the reaction
- B the activation energy increases with increasing temperature
- C doubling the temperature of the reaction doubles the rate of the reaction
- D the reaction is slowing down with increasing temperature.

17. The graph shows the effect of increasing the concentration of potassium iodide solution on reaction rate.



concentration of potassium iodide (moll⁻¹)

What was the concentration, in mol l^{-1} , of the potassium iodide solution used in a reaction that took 5 s to complete?

- A 0.04
- B 0.20
- C 0.24
- D 0.96

[Turn over

18. Which of the following diagrams represents an exothermic reaction that is more likely to take place at room temperature?



19. Which of the following will result in the volume of the products being half the volume of the reactants?

A	$2SO_2(g) + O_2(g)$	\rightarrow	2SO ₃ (g)
В	$C(s) + O_2(g)$	\rightarrow	CO ₂ (g)
С	$C_2H_4(g) + 3O_2(g)$	\rightarrow	$2CO_2(g) + 2H_2O(\ell)$
D	$C(s) + H_2O(g)$	\rightarrow	$H_2(g) + CO(g)$

20. The ester ethyl ethanoate is produced by the following reaction.

$$CH_3COOH + C_2H_5OH \rightleftharpoons CH_3COOC_2H_5 + H_2O$$

Which of the following mixtures would produce 0.8 moles of ester if the yield was 80%?

	moles of CH ₃ COOH	moles of C ₂ H ₅ OH
А	0.4	0.4
В	0.5	0.5
С	0.8	0.8
D	1.0	1.0

[Turn over

21. The graph shows how the yield of product in a reversible reaction varies with pressure at two different temperatures.



From this information it can be concluded that

- A the reaction is exothermic
- B all reactants are converted to products at 250 °C and 300 atmospheres
- C increasing the temperature increases the yield
- D increasing the pressure above 200 atmospheres has no effect on yield.

22. $2KOH(aq) + H_2SO_4(aq) \rightarrow K_2SO_4(aq) + 2H_2O(\ell)$

How many moles of potassium hydroxide, KOH, neutralise 50 cm³ of $0.2 \text{ mol } l^{-1}$ sulfuric acid, H₂SO₄?

- A 0.01
- B 0.02
- C 0.10
- D 0.40

23. Four amino acids, P, Q, R and S were analysed by chromatography.Larger molecules travel a shorter distance from the base line.Less polar molecules travel a greater distance from the base line.



Which of the following statements is correct?

- A P is less polar than S
- B Q is a larger molecule than P
- C R is more polar than P
- D S is a smaller molecule than Q
- **24.** A student produced the following results for a redox titration.

Sample	Volume of solution added (cm ³)
1	21.0
2	20.3
3	20.7
4	20.4

The volume of solution, in cm³, that should be used in the titration calculation is

- A 20.35
- B 20.50
- C 20.55
- D 20.60

25. An equilibrium mixture of NO_2 and N_2O_4 in a sealed gas syringe has a pale brown colour.

$$2NO_2(g) \rightleftharpoons N_2O_4(g)$$

Increasing the pressure causes the mixture to become paler.

Increasing the temperature causes the mixture to become darker.

Which line in the table correctly identifies the colour of NO_2 and the enthalpy change for the forward reaction?

	Colour of NO ₂	Enthalpy change for the forward reaction
А	brown	exothermic
В	brown	endothermic
С	colourless	exothermic
D	colourless	endothermic

[END OF QUESTION PAPER]

	FOR OFFICIAL USE					
Lil	National Qualificati	ons			Marl	κ
X813/76/01					Che P	mistry aper 2
Duration — 2 hours 20 m	inutes			 	× X 8 1 3 7	7 6 0 1 *
Fill in these boxes and re	ead what is printed	l below.	Town			
Forename(s)	Surn	ame			Number	of seat
Date of birth Day Mont	n Year	Scottish ca	andidate	number		
Total marks — 95						

Attempt ALL questions.

You may use a calculator.

You may refer to the Chemistry Data Booklet for Higher and Advanced Higher.

Write your answers clearly in the spaces provided in this booklet. Additional space for answers and rough work is provided at the end of this booklet. If you use this space you must clearly identify the question number you are attempting. Any rough work must be written in this booklet. Score through your rough work when you have written your final copy.

Use blue or black ink.

Before leaving the examination room you must give this booklet to the Invigilator; if you do not, you may lose all the marks for this paper.











MARKS DO NOT WRITE IN THIS MARGIN



(b) Electronegativity values can be used to predict the type of bonding present in substances.

The type of bonding between two elements can be predicted using the diagram below.



(i) Using the information in the diagram, state the highest average electronegativity found in **ionic** compounds.

1



1.	(b)	(cont	inued)	MARKS	DO NOT WRITE IN THIS
		(ii)	The electronegativity values of magnesium and nitrogen are shown.		MARGIN
			Electronegativity of magnesium $= 1.2$		
			Electronegativity of nitrogen $= 3.0$		
			Draw an X on the diagram on <i>page 04</i> to show the position of magnesium nitride.		
			Show your calculations clearly.	2	
			(An additional diagram, if required, can be found on <i>page 38</i> .)		
		(iii)	Compounds with a difference in electronegativities of 1.5 can have ionic or covalent properties.		
			(A) The electronegativity difference between the elements in lithium sulfide is 1.5.		
			Write an ionic formula for lithium sulfide.	1	
			(B) A compound contains two non-metal elements with an		
			electronegativity difference of 1.5.		
			Suggest names for the two non-metal elements.	1	
	(c)	Fluor	ine has a greater attraction for bonding electrons than hydrogen.		
		State	the term used to describe the type of covalent bond in hydrogen	1	
		ituoi		1	

Γ



page 05

Go to Answers

MARKS DO NOT THIS 2. Carbon and its compounds are important in the chemical industry. (a) Carbon can exist in multiple forms. Two of these are fullerenes and diamond. (i) Name another form of carbon. 1 (ii) Both diamond and the fullerene, C_{60} , can change directly from a solid to a gas. This is called sublimation. For diamond this occurs at 3825 °C. The fullerene changes from a solid to a gas at approximately 550 °C. Complete the table below to show the strongest type of attraction broken when diamond and the fullerene sublime. 2 Strongest attraction broken Form of carbon diamond fullerene (iii) The fullerene, C₆₀, reacts with bromine solution in an addition reaction to produce the bromofullerene, $C_{60}Br_{24}$. Determine the number of double bonds present in a molecule of 1 C₆₀. (b) Carbon can combine with oxygen to make carbon monoxide, CO. Carbon monoxide is used in the production of iron from iron(III) oxide. 2Fe(ℓ) $Fe_2O_3(s)$ 3CO(g) $3CO_{2}(g)$ + +GFM = 159.6 g GFM = 28.0 gGFM = 55.8 g GFM = 44.0 gCalculate the atom economy for the production of iron. 2

X 8 1 3 7 6 0 1 0 6 *



* X 8 1 3 7 6 0 1 0 7 *

	Go to	Topic Gr	rid _	
•		MARKS	DO NOT WRITE IN THIS MARGIN	
3.	A teacher told a class that collisions were the key to chemical reactions.	2		
	Using your knowledge of chemistry, discuss this statement.	2		



Go to Answers





		Go to	Topic Gric	b
(cor	ontinued) • Nitrogen can react with lithium at room temperature to form the compound lithium nitride, Li ₃ N. • (i) A scientist prepared a sample of lithium nitride by reacting 0.9 litres of nitrogen gas with 0.5 g of lithium. $6Li(s) + N_2(g) \rightarrow 2Li_3N(s)$ GFM = 6.9 g Determine, by calculation, which of the reactants was in excess. Take the volume of 1 mole of nitrogen gas to be 24 litres. (Clearly show your working for the calculation.)		DO NOT VRITE IN THIS	
(c)	Nitro comp	for the nued) itrogen can react with lithium at room temperature to form the ompound lithium nitride, Li ₃ N. (i) A scientist prepared a sample of lithium nitride by reacting 0.9 litres of nitrogen gas with 0.5 g of lithium. $6Li(s) + N_2(g) \rightarrow 2Li_3N(s)$ GFM = 6.9 g Determine, by calculation, which of the reactants was in excess. Take the volume of 1 mole of nitrogen gas to be 24 litres. (clearly show your working for the calculation.)	<u></u>	MARGIN
	(i)	A scientist prepared a sample of lithium nitride by reacting 0.9 litres of nitrogen gas with 0.5 g of lithium.		
		$6Li(s) + N_2(g) \rightarrow 2Li_3N(s)$		
		<i>GFM</i> = 6·9 g		
		Determine, by calculation, which of the reactants was in excess.	3	
		Take the volume of 1 mole of nitrogen gas to be 24 litres.		
		(Clearly show your working for the calculation.)		

- (ii) Lithium nitride reduces copper(I) ions to copper atoms. Write the ion-electron equation to show the reduction of copper(I) ions.
- (iii) Lithium nitride is ionic. State the term used to describe the structure of solid ionic compounds like lithium nitride.

4.



Go to Answers

1

1



THIS



4.

(B) Suggest why a small shock or bump can cause nitroglycerin to react.







[Turn over



3

THIS

5. (continued)

- (b) Fats and oils release a large amount of energy when they are burned.
 - (i) A 1.00 g sample of the oil, triolein (GFM = 884 g) was burned in a bomb calorimeter.

The temperature rise in the 775 cm^3 of water was 11.9 °C.

Calculate the enthalpy of combustion, in kJ mol⁻¹, of triolein.

(ii) Foods with a lower respiratory quotient are better for people who find it difficult to obtain energy from food.

The respiratory quotient, RQ, is the ratio of carbon dioxide, CO_2 , produced to the oxygen, O_2 , consumed when a food is burned in the body.

Respiratory quotient = $\frac{CO_2 \text{ produced}}{O_2 \text{ consumed}}$

The equation for the combustion of triolein, $C_{57}H_{104}O_6$, is shown.

 $C_{57}H_{104}O_6(\ell) + 80 O_2(g) \rightarrow 57 CO_2(g) + 52 H_2O(\ell)$

Determine the respiratory quotient for triolein.



Go to Answers

1

1

1

5. (continued)

(c) Tristearin, $C_{57}H_{110}O_6$, is a saturated fat.

The table shows the viscosity of different saturated fats at 70 $^{\circ}$ C.

Fat	Molecular formula	Viscosity at 70 °C (units)
Tributyrin	C ₁₅ H ₂₆ O ₆	3.0
Tricaproin	$C_{21}H_{38}O_{6}$	5.9
Tricaprylin	$C_{27}H_{50}O_{6}$	8.8
Tricaprin	$C_{33}H_{62}O_{6}$	11.7
Trilaurin	C ₃₉ H ₇₄ O ₆	14.6

- (i) Predict the viscosity of tristearin at 70 °C.
- (ii) Edible fats and oils are molecules that contain three ester links.Explain why glycerol is able to form fats and oils.

[Turn over



Go to Answers









1

1

Go to Topic Grid MARKS DO NOT WRITE IN THIS MARGIN

(continued) 6.

(c) Seaweed is a major component of the diet of sheep living on the island of North Ronaldsay.

Sheep wool is made mainly of a protein. This protein contains the essential amino acids methionine and histidine.



methionine

histidine

- (i) State what is meant by an essential amino acid.
- (ii) When two amino acids are joined together by a peptide link, a dipeptide is formed.

Draw a structural formula for the dipeptide formed from methionine and histidine.











Go to Answers

1

1

1

THIS

7. (continued)

(d) The reaction that occurs in the reactor of the Contact Process is

 $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ $\Delta H = -192 \text{ kJ mol}^{-1}$

Circle the correct statement in each column of the table to show the effect of using a catalyst in the reaction.

Effect of catalyst on enthalpy change	Effect of catalyst on activation energy
increase	increase
stay the same	stay the same
decrease	decrease

- (e) One use of sulfuric acid is in the production of soapless detergents.
 - (i) State the advantage that soapless detergents have over soap when used with hard water.

(ii) Describe the key structural features of a soapless detergent molecule.

[Turn over



Go to Answers
1

1

1

THIS



- Sweets contain a wide variety of chemicals. 8.
 - (a) Many sweets contain esters.
 - (i) The structure of an ester used to produce a pear flavour in some sweets is



Name this ester.

(ii) Name the type of reaction used to form esters.

(b) Fizzy sweets can contain citric acid, $C_6H_8O_7$, and sodium bicarbonate, NaHCO₃.

When the sweets dissolve, the citric acid and sodium bicarbonate react together to make carbon dioxide gas.

(i) To calculate the mass of citric acid in a sweet, 5 sweets were dissolved in water and the resulting carbon dioxide was collected and measured.

Suggest why carbon dioxide can be collected over water.



Go to Answers

2



8. (b) (continued)

 (ii) In one experiment, 5 sweets were dissolved, and 55 cm³ of carbon dioxide gas was produced.

 $C_6H_8O_7(aq) + 3NaHCO_3(aq) \rightarrow 3CO_2(g) + 3H_2O(\ell) + C_6H_5O_7Na_3(aq)$ GFM = 192 g

Calculate the mass of citric acid, in g, in one sweet.

Take the volume of 1 mole of carbon dioxide to be 24 litres.





1

1

1

8. (continued)

(c) The distinctive smell of some sweets is due to molecules such as limonene, carvone and vanillin.



- (i) Vanillin is an aldehyde and carvone is a ketone.
 - (A) State the colour change that would be observed when aldehydes react with acidified potassium dichromate.
 - (B) Suggest a different chemical that could be used to distinguish aldehydes from ketones.
- (ii) Limonene is a terpene consisting of joined isoprene units.State the number of isoprene units in a limonene molecule.



Go to Answers





X 8 1 3 7 6 0 1 2 6 *

MARKS DO NOT WRITE IN THIS MARGIN

1

1

9. (continued)

(c) The mouthwash also contains menthol.



- (i) Menthol is based on isoprene units.State the systematic name for isoprene.
- (ii) Menthol can be oxidised to form a mint flavoured compound.State the type of compound formed when menthol is oxidised.

[Turn over



Go to Answers







Go to Answers

~			0.11
GO	to	lopic	: Grid



[Turn over













(ii) The alcohol that is made when propanone reacts with the same Grignard reagent is shown.



Name this alcohol.



Go to Answers

1





- DO NOT WRITE IN THIS MARGIN
- **12.** One of the problems with recycling plastics is identifying the type of plastic.

Infrared spectroscopy is a technique that can be used to identify the bonds present in plastics. A spectrum is produced for each sample analysed. The same bond always absorbs infrared radiation in the same range of wavenumbers, even in different molecules. For example C-H bonds absorb in the wavenumber range $2700-3300 \text{ cm}^{-1}$.

Four different types of plastic were analysed using infrared spectroscopy and the spectra produced are shown.







MARKS WRITE IN THIS MARGIN

1

12. (continued)

(b) The spectrum produced from poly(ethylene terephthalate) contains an absorption at a wavenumber of 1720 cm⁻¹.

Part of the structure of poly(ethylene terephthalate) is shown.



Using the information on page 14 of the data booklet, circle the bond in poly(ethylene terephthalate) that is responsible for this absorption.

(An additional diagram, if required, can be found on *page 40*.)



1

12. (continued)

(c) Polyacrylonitrile plastic has the following structure.



Using the information on page 14 of the data booklet, sketch the infrared spectrum you would predict for polyacrylonitrile, showing only the absorptions within the range $3500-2000 \text{ cm}^{-1}$.



(An additional diagram, if required, can be found on page 40.)

[END OF QUESTION PAPER]



Go to Answers



National Qualifications

X813/76/12

Chemistry Paper 1 — Multiple choice

Marking Instructions

Please note that these marking instructions have not been standardised based on candidate responses. You may therefore need to agree within your centre how to consistently mark an item if a candidate response is not covered by the marking instructions.



Question	Response	Mark
1.	А	1
2.	D	1
3.	В	1
4.	А	1
5.	C	1
6.	C	1
7.	D	1
8.	В	1
9.	В	1
10.	C	1
11.	C	1
12.	В	1
13.	С	1
14.	В	1
15.	D	1
16.	А	1
17.	D	1
18.	В	1
19.	C	1
20.	D	1
21.	А	1
22.	В	1
23.	С	1
24.	А	1
25.	А	1

[END OF MARKING INSTRUCTIONS]



National Qualifications

X813/76/01

Chemistry Paper 2

Marking Instructions

Please note that these marking instructions have not been standardised based on candidate responses. You may therefore need to agree within your centre how to consistently mark an item if a candidate response is not covered by the marking instructions.



Q	Question		Expected response	Max mark	Additional guidance
1.	(a)	(i)	Increases (across period)	1	
		(ii)	They don't form (covalent) bonds	1	Accept: They (noble gases) are unreactive.
					They are noble gases is not acceptable.
		(iii)	Screening increases so less attraction (of nucleus/protons for the bonding/outer/shared electrons)	1	Shielding is acceptable in place of screening.
			OR		'Screening/shielding effect' by itself is not acceptable.
			Covalent radius/atomic size/number of shells increases so less attraction (of nucleus/protons for the bonding/outer/shared electrons)		Information in brackets is not required but if included, the direction of attraction must be correct.
	(b)	(i)	2·8 ± 0·05	1	
		(ii)	Cross at (2·1, 1·8) on graph 2 marks Partial mark	2	A point other than (2·1, 1·8) plotted with no calculated values is worth 0 marks.
			For calculation of both average electronegativity (2·1) and difference (1·8) (1 mark)		
			OR		
			For correctly plotting the point for the values candidate has calculated (1 mark)		
		(iii) A	(Li ⁺) ₂ S ²⁻ Both charges must be shown. Brackets are required for Li ⁺ .	1	
		В	Carbon fluorine Sulfur fluorine Boron oxygen	1	Accept correct symbols. If candidate states name of a compound then it must be correct.
					Accept germanium and oxygen.
	(c)		Polar (covalent)	1	

Question		n	Expected response		Max mark	Additional guidance
2.	(a)	(i)	Graphite		1	
		(ii)			2	Mention of molecular would cancel the mark for covalent bonds for diamond. Accept LDFs for London dispersion forces. Treat each mark separately.
			Form of carbon	Strongest attrac	ction br	oken
			Diamond	covalent (network) bond(s)		(1 mark)
			fullerene	London dispersion forces (1 mark)
		(iii)	12		1	
	(b)		45.81/45.8/46(%) (2 marks) A partial mark can be awarded for any one of the following: Correct use of atom economy relationship without correct use of stoichiometry (working must be shown). (1 mark) OR Correct working with no correct final answer. (1 mark)		2	No units required. Only 1 mark can be awarded for the correct answer if wrong unit is given. (Wrong units would only be penalised once in any paper).

Question		on	Expected response	Max mark	Additional guidance
2.	(c)		 +250 kJ mol⁻¹ (2 marks) Partial marks Treat as two concepts. Either would be acceptable for 1 mark. Evidence of understanding of reversal of first and second enthalpy values must be seen ie +283 and +286 (or positive multiples of either/both). The third enthalpy value (regardless of value) must be negative, or this partial mark cannot be awarded. OR Evidence of understanding of multiplying the second enthalpy value by 3 (shown as 3 x +/-286 or +/- 858) Multiplication of any other enthalpy value by any factor is taken as cancelling of this partial mark. 	2	If correct answer is shown, award 2 marks. Only 1 concept mark can be awarded if the final answer is incorrect. If answer given is -250, maximum of 1 mark can be awarded. No units required. Only 1 mark can be awarded for the correct answer if wrong unit is given. (Wrong units would only be penalised once in any paper). kJ is acceptable in place of kJ mol ⁻¹ (KJ or Kj or KJ mol ⁻¹ or Kj mol ⁻¹ accepted).

Question	Expected response	Max mark	Additional guidance
3.	Award 1 mark where the candidate has demonstrated, at an appropriate level, a limited understanding of the chemistry involved. They have made some statement(s) which are relevant to the situation, showing that they have understood at least a little of the chemistry within the problem. Award 2 marks where the candidate has demonstrated, at an appropriate level, a reasonable understanding of the chemistry involved. They make some statement(s) which are relevant to the situation, showing that they have understood the problem. Award 3 marks where the candidate has demonstrated, at an appropriate level, a good understanding of the chemistry involved. They show a good comprehension of the chemistry of the situation and provide a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the problem. The answer does not need to be 'excellent' or 'complete' for the candidate to gain full marks. Award 0 marks where the candidate has not demonstrated, at an appropriate level, an understanding of the chemistry involved. There is no evidence that they have recognised the area of chemistry involved, or they have not given any statement of a relevant chemistry principle. Award this mark also if the candidate merely restates the chemistry given in the question.	3	Zero marks should be awarded if: The student has demonstrated, at an appropriate level, no understanding, of the chemistry involved. There is no evidence that the student has recognised the area of chemistry involved or has given any statement of a relevant chemistry principle. This mark would also be given when the student merely restates the chemistry given in the question.

(Question		Expected response	Max mark	Additional guidance
4.	(a)		Bond enthalpy is high (945)/has the highest bond enthalpy value (in the data booklet)	1	(Bond(s)) take(s) a lot of energy to break/are very strong would not be accepted on its own but would not be cancelling.
	(b)		Diagram shows a workable method for removing carbon dioxide - must include label for KOH (solution) (1 mark)	2	Treat each mark separately.
			Diagram shows a workable method for passing gas over heated copper - must include label for heated copper (1 mark)		

Q	Question		Expected response	Max mark	Additional guidance
4.	(c)	(i)	2 marks for correct calculations AND 1 mark for a statement which follows on from the calculation stating that nitrogen is in excess or that lithium is the limiting reactant. Partial marks By calculating number of moles: 1 mark for the correct calculation of number of moles of Li and N ₂ . 1 mark for correct application of the mole ratio. This can be shown by dividing a calculated number of moles of Li by 6 or multiplying a number of moles of N ₂ by 6. 1 mark awarded for a correct statement following on from the candidate's calculations. OR By proportion: 1 mark for 41.4 g → 24 litres 1 mark for follow through from incorrect multiples of 6.9g or 24 l 1 mark awarded for a correct statement following on from the candidate's calculations.	3	Correct calculation of moles of lithium = $0.07/0.072/0.0725$ moles and nitrogen = $0.04/0.038/0.0375$ moles The values in the tables shown provide guidance as to whether 1 mark or 2 marks for calculations should be awarded. 2 marks can be awarded for any one of the following paired values in the table obtained by applying the mole ratio $\frac{have need}{0.5 \text{ g Li} 0.29 \text{ l N}_2}$ $\frac{0.9 \text{ l N}_2 1.55 \text{ g Li}}{0.99 \text{ l N}_2 0.29 \text{ l N}_2}$ $\frac{0.99 \text{ l N}_2 0.29 \text{ l N}_2}{0.0375 \text{ mol Li} 0.225 \text{ mol Li}}$ $\frac{1 \text{ mark can be awarded for any oneof the following paired values in thetable obtained without applying moleratio\frac{1 \text{ mark can be awarded for any one}{0 \text{ f the following paired values in the}{10.0375 \text{ mol N}_2 0.012 \text{ mol N}_2}\frac{1.74 \text{ l N}_2}{0.99 \text{ l N}_2 0.26 \text{ g Li}}\frac{0.99 \text{ l N}_2 1.74 \text{ l N}_2}{0.5 \text{ g Li} 0.26 \text{ g Li}}\frac{0.92 \text{ l N}_2 1.74 \text{ l N}_2}{0.5 \text{ g Li} 0.26 \text{ g Li}}This mark can only be awarded if thecandidate shows appropriatecalculations to justify the statement.$

Question		on	Expected response	Max mark	Additional guidance
4.	(c)	(ii)	$Cu^{+}(aq) + e^{-} \rightarrow Cu(s)$		State symbols not required but if given must be correct. Accept electron without a negative sign.
		(iii)	(ionic) lattice/network	1	Covalent network is not acceptable
	(d)	(i)	atoms/molecules with an unpaired electron	1	
		(ii)	676 (kJ mol ⁻¹) -676 would be worth 1 mark Partial marking, 1 mark can be awarded for candidate correctly retrieves both of the relevant bond enthalpy data (945, 498) and attempts to use this with 91 OR calculation carried out correctly with one error in retrieval of bond enthalpy	2	No units are required but award only 1 mark for correct answer if incorrect unit is given. (Wrong units would only be penalised once in any paper). kJ is acceptable in place of kJ mol ⁻¹ (KJ or Kj or KJ mol ⁻¹ or Kj mol ⁻¹ accepted)
		(iii) A	termination	1	
		В	H - O - N = O or $H - N$	1	

Question		on	Expected response	Max mark	Additional guidance
4.	(e)	(i)	Decreasing temperature favours the exothermic reaction/increasing temperature favours endothermic reactions (1 mark) Increases the yield of ammonia (1mark)	2	
		(ii) A	$\begin{array}{rcl} C_{3}H_{5}N_{3}O_{9} & \rightarrow \\ & 3CO_{2}+2!_{2}H_{2}O+1!_{2}N_{2}+!_{4}O_{2} \\ \\ & \textbf{OR} \\ & \text{correct multiples} \end{array}$	1	
		В	The shock/bump provides the activation energy/E _A OR the shock/bump provides sufficient/enough energy to start the reaction OR the reaction has a low activation energy/E _A	1 If candidate uses "it" in respons this can be taken as "the shock/bump".	

Q	Question		Expected response	Max mark	Additional guidance
5.	(a)		 mark for any correct feature and explanation as shown: Contains oxygen to ensure complete combustion Sample is surrounded by water so all energy transferred/reduce heat loss to surroundings Sealed container prevents/ reduces heat loss to the surroundings Stirring to ensure accurate temperature (measurement) 	1	
	(b)	(i)	-34 078 (kJ mol ⁻¹) Partial marks 1 mark for a demonstration of the correct use of the relationship $E_h=cm\Delta T$ as shown by (4·18 × (an order of magnitude of 0·775) × 11·9) (ignore units for this partial mark) 1 mark for evidence of the knowledge that enthalpy of combustion relates to 1 mole, evidenced by the scaling up of a calculated value of energy released. 1 mark for correct arithmetic. This mark should be awarded if the candidate has obtained the 2 partial marks above but has applied correct early rounding within the calculation resulting in an answer that differs from -34 078).	3	Maximum of 2 marks can be awarded if negative enthalpy sign is not shown in final answer. Units not required. Only 2 marks can be awarded for the correct answer if wrong unit is given. (wrong units would only be penalised once in any paper). kJ is acceptable in place of kJ mol ⁻¹ (KJ or Kj or KJ mol ⁻¹ or Kj mol ⁻¹ accepted).
		(ii)	0.71/0.713/0.7125	1	
	(c)	(i)	23.3	1	Ignore any units
		(ii)	Glycerol has 3 hydroxyl groups.	1	Accept glycerol is propan(e)-1,2,3- triol/an alcohol with 3 hydroxyl (- OH) groups

Question		on	Expected response		Max mark	Additional guidance
6.	(a)		Mass (1 mark) 0.00113 1.13 1130	Unit (1 mark) kg g mg	2	As no unit is specified, the correct answer can be expressed with any appropriate unit (as shown in table). Any correct rounding accepted e.g. 1.1278/1.128/1.13 g
			Any correct line ir marks) Correctly calculat without units Appropriate units	n the table (2 ed mass of iodine (1)		Partial mark for appropriate units can only be awarded when the order of magnitude of an incorrectly calculated mass matches the unit. If the candidate's working is unclear then the mark for units cannot be awarded.
	(b)	(i)	Measuring the mass of container + seaweed/sample and subtracting the mass of the container		1	Taring the balance with container and then adding the seaweed/ sample is accepted "use of Tare function" on its own is not accepted.
		(ii)	I ⁻ /iodide (ions) A solution of accurately/exactly/ precisely known concentration		1	
		(iii)			1	
		(iv) A	0.00013 (moles)		1	Units not required, but if present, must be correct. Wrong units are only penalised once per paper.
		В	0·03299g/0·033 g,	/0·03 (g)	1	To award this mark, the candidates answer to part B must be correct for their use of their answer to part A (i.e. answer to part $A \ge 253 \cdot 8$). Units not required, but if present, must be correct. Wrong units are only penalised once per paper.

Question			Expected response	Max mark	Additional guidance
6.	(c)	(i)	Amino acid that must be acquired/obtained from the diet.	1	Amino acid that cannot be made by the body is accepted.
		(ii)	Correctly drawn structure for dipeptide. H H O H I O H H C C C N C C O H C H ₂ H C H ₂ O C H ₂ H C H ₂ O H C H ₂ C 3 N ₂ H ₃	1	Shortened structural formula accepted. All atoms and bonds must be present as shown. However, in the side chains only , bonds drawn from C (or S) to H (or N) would not be penalised.
			OR H = H = 0 = H = 0 H = 0		

Question		n	Expected response	Max mark	Additional guidance
7.	(a)		1 mark for: sulfur furnace furnace sulfur dioxide + oxygen reactor with catalyst sulfur trioxide sulfur trioxide to sulfur dioxide sulfur dioxide sulfur catalyst sulfur dioxide to sulfur dioxide sulfur catalyst sulfur dioxide to sulfur dioxide to sulfur dioxide to sulfur dioxide to sulfur dioxide to sulfur dioxide to sulfur catalyst sulfur catalyst to sulfur dioxide to sulfur dioxide to sulfur dioxide to sulfur dioxide to sulfur catalyst to sulfur dioxide to sulfur catalyst sulfur catalyst to sulfur dioxide to sulfur catalyst to sulfur catalyst	2	1 mark for correct top half (4 responses) and 1 mark for correct bottom half (4 responses). Accept correct chemical formula in place of names. Accept "air" for "excess air".

Question			Expected	response	Max mark	Additional guidance
7.	(b)		Require heat to be prevent the tempe rising).	e removed (to erature from	1	
	(c)	(i)	 mark for description forces of attraction temporary dipoles dipoles) mark for an exploration exploration for temporary distribution electron wobble/melectrons in the meteodology 	otion of LDFs as n between (and induced lanation of the y dipoles in terms tion of electrons/ novement of olecule	2	Attraction involving permanent dipoles cancels this mark
		(ii)	 1 mark Sulfur/S has more oxygen/O 1 mark These forces are si sulfur structure be oxygen is O2 	electrons than tronger due to ng S₀ whereas	2	The structure of S ₈ and O ₂ must be evidenced in answer (molecular formula, structural formula) for the second mark to be awarded. Correctly calculated number of electrons (16, 128) would also be
	(d)		Effect of catalyst on enthalpy change Increase stay the same decrease	Effect of catalyst on activation energy increase stay the same decrease	1	
	(e)	(i)	Do not form scum.		1	
		(ii)	Both parts of mole described. Head Hydrophilic Polar Ionic Water soluble Any term to descri the table can be u from the table to o	Tail Hydrophobic Non-polar Non-polar Fat soluble be the head from sed with any term describe the tail.	1	If answer mentions head and/or tail, then it must be correct ie head is hydrophilic.

uestic	n	Expected response	Max mark	Additional guidance
3. (a) (i)		pentyl ethanoate	1	
	(ii)	condensation/esterification	1	
(b)	(i)	Carbon dioxide is (relatively) insoluble/has very low solubility	1	
	(ii)	0.029 (g) 2 marks Partial marks Correctly calculated number of moles of carbon dioxide divided by 3 to give number of moles of citric acid e.g. moles of citric acid = 0.00076 (1 mark) Calculated number of moles of citric acid x 192 divided by 5 (1 mark) OR by proportion $192 g \rightarrow 72 l (1 mark)$ $0.147 g \rightarrow 0.055 l$	2	Units not required, but if present, must be correct. Wrong units are only penalised once per paper. Allow follow through from incorrect application of mole ratio or correct mole ratio applied to incorrectly calculated number of moles of CO ₂
		0·147/5 = 0·029 (g) (1 mark) Allow follow through from incorrect multiple of 24 l		
(c)	(i) A	orange to green/blue-green/ blue	1	
	В	Tollens' reagent OR Fehling's solution	1	Benedict's/ Schiff's reagent would be accepted.
	(ii)	2	1	
	(iii)	1 pence/ £0.01 (2 marks) Partial marks 1 mark can be awarded for: cost per mg of vanillin = £0.00105 OR cost per g of vanillin = £1.05 OR cost of 0.184 g of vanillin = £0.1932 OR	2	Candidates final answer must be in a correct monetary number.
	(c)	uestion (a) (i) (b) (i) (b) (i) (b) (i) (b) (i) (c) (c) (c) (c) (c) (c) <td>Expected response(a)(i)pentyl ethanoate(ii)condensation/esterification(b)(i)Carbon dioxide is (relatively) insoluble/has very low solubility(b)(ii)0.029 (g) 2 marks(iii)0.029 (g) 2 marksPartial marksCorrectly calculated number of moles of carbon dioxide divided by 3 to give number of moles of citric acid e.g. moles of citric acid = 0.00076 (1 mark)(iii)Calculated number of moles of citric acid x 192 divided by 5 (1 mark)(iii)Calculated number of moles of citric acid x 192 divided by 5 (1 mark)(iii)DR by proportion192 g \rightarrow 72 l (1 mark) 0.147 g \rightarrow 0.055 l(iii)192 g \rightarrow 72 l (1 mark) 0.147 g \rightarrow 0.055 l(c)(i)(ii)orange to green/blue-green/ blue(c)(ii)BTollens' reagent OR Fehling's solution(c)(iii)2(iii)1 pence/ £0.01 (2 marks)(iii)1 pence/ £0.01 (2 marks)(iii)1 pence/ £0.01 (2 marks)(iii)1 pence/ £0.01 (2 marks)(c)OR Cost per mg of vanillin = £0.00105 OR Cost of 0.184 g of vanillin = £0.1932(o)OR Cost of 0.184 g of vanillin = £0.00102 a</td> <td>uestExpected responseMax mark(a)(i)pentyl ethanoate1(ii)condensation/esterification1(b)(i)Carbon dioxide is (relatively) insoluble/has very low solubility1(ii)0·029 (g) 2 marks2(iii)0·029 (g) 2 marks2(iii)Correctly calculated number of moles of citric acid x 192 divided by 5 (1 mark)(iii)192 g \rightarrow 72 l (1 mark) 0·147 g \rightarrow 0·055 l(iii)192 g \rightarrow 72 l (1 mark) 0·147 g \rightarrow 0·055 l(iii)192 g \rightarrow 72 l (1 mark) 0·147 g \rightarrow 0·055 l(iii)10·147/5 = 0·029 (g) (1 mark)(iii)10/147 g \rightarrow 0·055 l(iii)2(iii)2(iii)2(iii)2(iii)1(iii)2(iii)1(iii)1(iii)1(iii)1(iii)1(iii)1(iii)1(iii)1(iii)1(iii)1(iii)1(iii)1(iii)1(iii)1(iii)1(iii)<t< td=""></t<></td>	Expected response(a)(i)pentyl ethanoate(ii)condensation/esterification(b)(i)Carbon dioxide is (relatively) insoluble/has very low solubility(b)(ii)0.029 (g) 2 marks(iii)0.029 (g) 2 marksPartial marksCorrectly calculated number of moles of carbon dioxide divided by 3 to give number of moles of citric acid e.g. moles of citric acid = 0.00076 (1 mark)(iii)Calculated number of moles of citric acid x 192 divided by 5 (1 mark)(iii)Calculated number of moles of citric acid x 192 divided by 5 (1 mark)(iii)DR by proportion192 g \rightarrow 72 l (1 mark) 0.147 g \rightarrow 0.055 l(iii)192 g \rightarrow 72 l (1 mark) 0.147 g \rightarrow 0.055 l(c)(i)(ii)orange to green/blue-green/ blue(c)(ii)BTollens' reagent OR Fehling's solution(c)(iii)2(iii)1 pence/ £0.01 (2 marks)(iii)1 pence/ £0.01 (2 marks)(iii)1 pence/ £0.01 (2 marks)(iii)1 pence/ £0.01 (2 marks)(c)OR Cost per mg of vanillin = £0.00105 OR Cost of 0.184 g of vanillin = £0.1932(o)OR Cost of 0.184 g of vanillin = £0.00102 a	uestExpected responseMax mark(a)(i)pentyl ethanoate1(ii)condensation/esterification1(b)(i)Carbon dioxide is (relatively) insoluble/has very low solubility1(ii)0·029 (g) 2 marks2(iii)0·029 (g) 2 marks2(iii)Correctly calculated number of moles of citric acid x 192 divided by 5 (1 mark)(iii)192 g \rightarrow 72 l (1 mark) 0·147 g \rightarrow 0·055 l(iii)192 g \rightarrow 72 l (1 mark) 0·147 g \rightarrow 0·055 l(iii)192 g \rightarrow 72 l (1 mark) 0·147 g \rightarrow 0·055 l(iii)10·147/5 = 0·029 (g) (1 mark)(iii)10/147 g \rightarrow 0·055 l(iii)2(iii)2(iii)2(iii)2(iii)1(iii)2(iii)1(iii)1(iii)1(iii)1(iii)1(iii)1(iii)1(iii)1(iii)1(iii)1(iii)1(iii)1(iii)1(iii)1(iii)1(iii) <t< td=""></t<>

Question			Expected response	Max mark	Additional guidance
9.	(a)	(i)	1·575/1·58/1·6(g)	1	Units not required. 0 marks should be awarded for the correct answer if wrong unit is given. (Wrong units would only be penalised once in any paper).
		(ii)	Protein(s)	1	
		(iii)	pipette and burette	1	Volumetric flask would not be taken as cancelling.
	(b)		essential oils	1	
	(c)	(i)	2-methylbuta-1,3-diene	1	
		(ii)	ketone	1	accept terpenoids
	(d)	(i)	methanol	1	A correct structure would also be accepted H H H C H H
		(ii)	79·24/79·2/79 (%) (2 marks) Partial marking for 1 mark Theoretical yield = 31·17 (g) OR Allow follow through from incorrect calculation of theoretical yield.	2	Units not required, but if present, must be correct. Wrong units are only penalised once per paper. Rounding of a calculated theoretical yield to 31 g gives 77.68/79.7/80 (%) which would be accepted.
		(iii)	6·5 (cm ³)	2	Units not required.
			Partial marking for 1 mark For correct calculation of toxic dose = 9.1 g OR For calculation of the volume of oil of wintergreen containing 0.14 g of methyl salicylate = 0.1 cm ³		Only 1 mark can be awarded for the correct answer if wrong unit is given. Wrong units would only be penalised once in any paper. Allow follow from incorrect first step of candidate's calculation.

Question	Expected response	Max mark	Additional guidance
10.	Award 1 mark where the candidate has demonstrated, at an appropriate level, a limited understanding of the chemistry involved. They have made some statement(s) which are relevant to the situation, showing that they have understood at least a little of the chemistry within the problem. Award 2 marks where the candidate has demonstrated, at an appropriate level, a reasonable understanding of the chemistry involved. They make some statement(s) which are relevant to the situation, showing that they have understood the problem. Award 3 marks where the candidate has demonstrated, at an appropriate level, a good understanding of the chemistry involved. They show a good comprehension of the chemistry of the situation and provide a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the problem. The answer does not need to be 'excellent' or 'complete' for the candidate to gain full marks. Award 0 marks where the candidate has not demonstrated, at an appropriate level, an understanding of the chemistry involved. There is no evidence that they have recognised the area of chemistry involved, or they have not given any statement of a relevant chemistry principle. Award this mark also if the candidate merely restates the chemistry given in the question.	3	Zero marks should be awarded if: The student has demonstrated, at an appropriate level, no understanding, of the chemistry involved. There is no evidence that the student has recognised the area of chemistry involved or has given any statement of a relevant chemistry principle. This mark would also be given when the student merely restates the chemistry given in the question.

Question			Expected response	Max mark	Additional guidance
11.	(a)	(i)	Reactants/solvent is flammable/ catches fire with a flame	1 accept products	
		(ii)	condenser	1	
	(b)	(i)	addition	1	
		(ii)	2-methylbutan-2-ol	1	
		(iii)	A correct structural formula for 3-methylhexan-3-ol e.g. a full structural formula or a shortened structural formula	1	A mixture of full and shortened structural formula is accepted, e.g. H H CH_3 H—C—C—C—OH H H CH_2 CH_2 H_3C
Go to Topic Grid

Question		on	Expected response	Max mark	Additional guidance
12.	(a)		Poly(phenylethene)	1	
	(b)		C=O circled	1	accept 'C=O stretch'
	(c)		2 single absorptions (peaks) required 1 for C-H within the range 2700-3300 cm ⁻¹ and 1 for C=N within the range 2260-2215 cm ⁻¹ increasing absorption 3500 3000 2500 2000 wavenumber (cm ⁻¹)	1	Ignore the intensity of the absorptions. Ignore the width of the absorptions so long as the peak maximum is defined and within the given range.

[END OF MARKING INSTRUCTIONS]

Exemplification of Marking Instructions

Exemplification of Question 2 b

$$\frac{55.8}{(159.6+28)} \times 100 = 29.3 \%$$

1 mark

1 mark for correct use of atom economy relationship

Example 2

1 mark

1 mark for correct working shown with no final answer

Example 3

$$\frac{55.8 \times 2}{159.6 + (3 \times 28)} \times 100 = 45\%$$

mark
 mark for correct working with wrong final answer

Exemplification of Question 2 c

Example 1

283 + 858 - 891 = 250

2 marks

Example 2

849 + 286 - 891 = 244

1 mark

1 mark for evidence of reversing first and second equation

Example 3

-283-858-891 = -2032

1 mark

1 mark for evidence of multiplying second equation by 3

Example 4

283 + 858 + 891 = 2032

1 mark

1 mark for evidence of multiplying second equation by 3

Example 5

283 + 286 + 891 = 1460

0 marks

Reversal of first and second equation cancelled by reversal of third equation

Exemplification of Question 4 b

Example 1

0 marks

no top on container, not workable for gas collection



potassuum hydnoxide solution



Example 3



1 mark

Example 4



Exemplification of Question 4 c i

Example 1

Li + N_2 6.9 -> 24 0.5 -> 1.742

0 marks Statement incorrect

need 0.92 got 1.742 ... Nz in excess

Example 2

Li
$$\frac{0.5}{6.9} = 0.072$$

 $N_2 \frac{0.9}{24} = 0.0375$
Li > N₂ :. Li in excess

1 mark

1 mark for correct calculation of number of moles of Li and N_2

Example 3

Li $0.5 = 0.07 \times 6 = 0.42$ $N_2 \frac{0.9}{24} = 0.0375$ Li 0.42 > 0.0375 :. Li in exess

1 mark

1 mark for correct calculation of number of moles of Li and N_2

Example 4

Li 0.072 $N_2 \ 0.0375 \times 6 = 0.225$ $\therefore 0.225$ moles Li needed 0.225 > 0.072 not enough Li $\therefore N_2$ in excess

3 marks

1 mark for correct calculation of number of moles of Li and N_2

1 mark for correct use of mole ratio

1 mark for correct statement of excess

Exemplification of Question 4 d ii

Example 1

bonds broken $\triangle H$ 945 91 498 945 + 498 - NO = 91 NO = 1352

1 mark

1 mark for correct retrieval of bond enthalpy data and use of this with the reaction enthalpy change

Example 2

945 + 498 - N0 = 91N0 = 1352

1 mark

1 mark for correct retrieval of bond enthalpy data and use of this with the reaction enthalpy change

Example 3

$$945 + 498 + 91 = 1534$$

1 mark

1 mark for correct retrieval of bond enthalpy data and use of this with the reaction enthalpy change

Example 4

945 + 498 - 91 = 1352

1 mark

1 mark for correct retrieval of bond enthalpy data and use of this with the reaction enthalpy change

Example 5

bonds broken
$$\Delta H$$

945 91
489
945 $-2 \times NO = 91$
 $NO = 671.5$
1 mark
1 mark for correct calculation with 1
error in the bond enthalpies retrieved
(489 for 498))

Exemplification of Question 5 b ii

Example 1

$$E = 4.18 \times 1 \times 11.9$$

= 49.742
49.742 = 19
43972 = 8849

1 mark

1 mark for evidence of knowledge that enthalpy of combustion relates to 1 mole

Example 2

$$E = 4.18 \times 775 \times 11.9$$

= 38550
$$Ig = 38550$$

884g = 34078244.2

2 marks

0 marks

1 mark for demonstration of correct use of $E_h = cm\Delta T$ 1 mark for evidence of knowledge that enthalpy of combustion relates to 1 mole

Example 3

$$E = 4.18 \times 1 \times 11.9$$

= 49.742

Go to Topic Grid

Exemplification of Question 6 a

Example 1

$$0.133 = 1 \text{ kg}$$

 $0.15 = 1.13 \text{ kg}$

1 mark

1 mark for correct calculated mass of iodine

Example 2

0.133	=	1000
0.15	=	1127.8

1 mark 1 mark for correct calculated mass of iodine

Example 3

0.133	=	100 g
0.12	=	112.78 9

1 mark 1 mark for correct calculated mass of iodine

Example 4

0.133 g	Ξ	10009
19	=	75189
1000 mg		7518 9
0.15 mg	=	1.129

1 mark

1 mark for correct unit for incorrectly rounded calculated mass

Exemplification of Question 6 b i

Example 1

Put beaker on balance, press to zero, add seawead to mass required. 1 mark Example 2

Place container on balance, set to zero, add seaweed.

1 mark

Exemplification of Question 6 b iv

Example 1

(A) n = 0.00026 moles I_2 (B) $0.00026 \times 126.9 = 0.0339$

Part A 0 marks

Part B **0 marks** Incorrect answer for candidates answer to Part A as incorrect GFM for iodine used

Example 2

(A) n = 0.00013(B) 0.00013 x 126.9 = 0.01659

Part A 1 mark

Part B 0 marks Incorrect GFM for iodine used

Example 3

```
(A) n = 0.00026
(B) 0.00026 \times 253.8 = 0.0669
```

Part A 0 marks

Part B **1 mark** for follow through from Part A

Example 4

A)
$$0.000 13$$

B) $M = 0.0013 \times 253.8$
= 0.33 g

Part A 1 mark Part B **0 marks** Incorrect number of moles used

Exemplification of Question 6 c

Example 1



Example 2



Example 3



Example 4



0 marks

Missing bond in the C=O in amide link

Example 5



Exemplification of Question 7 c i

Example 1



Example 2



Exemplification of Question 7 e ii

Example 1

nead On tail

0 marks

1 mark

Example 2

The head is polar and the tail is fat soluble.

Example 3

The tail dissolves in water and the head dissolves in oil.

Example 4

One part is hydrophobic and one port is ionic.

1 mark

0 marks

Exemplification of Question 8 b ii

Example 1

 $(0_2 \frac{55}{24} = 2.29 \text{ moles})$ $1 \longrightarrow 3$ $0.76 \leftarrow 2.29$ mass = $0.76 \times 192 = 146.679$ $\div 5 = 29.39$ **1 mark** 1 mark for calculated number of moles x 192 divided by 5

Example 2

(02	0.055 = 24	0.00	229 moles
Ľ	0.00229 X 192	mole	citric acid
	0.449	÷S	= 0.088 9

1 mark

0 marks

1 mark for calculated number of moles x 192 divided by 5

Example 3

 $192 \longrightarrow 24$ $0.44_3 \leftarrow 0.055$

Example 4

192	\rightarrow	24
0.44	E	0.055
5 = (0.088	,

1 mark 1 mark for calculation without applying mole ratio

Exemplification of Question 8 c iii

Example 1

	1000 9	=	¥ 1050	
	0.184g	=	0.1932	r
	0.1932	Ŧ	100	
ę	0.00966	G	5	

1 mark 1 mark for calculation with answer not rounded for a monetary unit

Example 2

$$\frac{1000g}{0.184g} = \frac{0.184 \times 1050}{1000} = \frac{0.184 \times 1050}{1000} = \frac{0.1932}{1000}$$
$$100 \text{ cm}^{3} = \frac{1000}{1000} = \frac{1000}{1000}$$

1 mark

1 mark awarded for calculation of £0.1932 as step in calculation with incorrect final answer

Example 3

100 cm3	z	0.1849
5cm3	5	0.00929

1 mark

Example 4

1

10000	= \$1050	1 mark
g		1 mark awarded for calculation with answer
0.00929	= f 0.00966	not rounded for a monetary unit

Exemplification of Question 9 d ii

Example 1

т. Ү.		1389	\rightarrow	1529		1 mark 1 mark for correct theoretical yield
		28·3g	->	31.29		
10	=	28.3	x 100	= 90.7	°/0	
		31.2				

Example 2

T.Y.	138	3	152	2 marks
	28.3	7	31-29	
° /₀	24-7 31-2	X 100	= 79 %	

Example 3

Τ.Υ.	138)	152	
	28.3)	319	
010	24.7 × 1	00	= 80%	

2 marks

Correct early rounding of theoretical yield to 31 gives 79.67/79.7/80 %

Exemplification of Question 9 d iii

Example 1

 $5 \text{ cm}^3 \longrightarrow 7 \text{ g}$ $0.1 \text{ cm}^3 \iff 0.14 \text{ g}$

Example 2

 $65 \times 0.14 = 9.1g$

1 mark

1 mark

Example 3

$$65 \times 0.14 = 7.84g$$

 $7g = 5cm^{3}$
 $7.84g = 5.6cm^{3}$

1 mark

1 mark for follow through from incorrect first step of calculation

Example 4

79		5 cm	3	2	
0.149	=	0.12	L cn	1	2
0.120	m3 >	< 65	=	7.8	спи

1 mark

1 mark for follow through from incorrect first step of calculation



National Qualifications 2022

X813/76/12

Chemistry Paper 1 — Multiple choice

FRIDAY, 29 APRIL 9:00 AM – 9:40 AM

Total marks — 25

Attempt ALL questions.

You may use a calculator.

Instructions for the completion of Paper 1 are given on *page 02* of your answer booklet X813/76/02.

Record your answers on the answer grid on *page 03* of your answer booklet.

You may refer to the Chemistry Data Booklet for Higher and Advanced Higher

Space for rough work is provided at the end of this booklet.

Before leaving the examination room you must give your answer booklet to the Invigilator; if you do not, you may lose all the marks for this paper.





Total marks — 25 Attempt ALL questions

- An element contains covalent bonding and London dispersion forces. The element could be:
 - A boron
 - B neon
 - C sodium
 - D sulfur.
- 2. The graph below shows the relative quantities of energy equivalent to successive ionisation energies for an element.



The most stable ion formed from an atom of this element has a charge of:

- A 2+
- B 3+
- C 2–
- D 3-
- **3.** HCl has a higher boiling point than H_2 because:
 - A the polar covalent bonds in HCl are stronger than the covalent bonds in H_2
 - B the polar covalent bonds in HCl are stronger than the van der Waals' forces in H₂
 - C the van der Waals' forces in HCl are stronger than the van der Waals' forces in H_2
 - D the van der Waals' forces in HCl are stronger than the covalent bonds in H_2 .

- Gains or loses electronsElectronegativityAgainslowBloseslowCgainshighDloseshigh
- 4. Which line in the table would best describe elements that act as reducing agents?

5. The correct redox equation for the reaction of iron(II) ions with acidified dichromate ions is:

А	Cr ₂ O ₇ ^{2–} (aq)	+	14H ⁺ (aq)	+	Fe ²⁺ (aq)	\rightarrow	2Cr ³⁺ (aq)	+	7H ₂ O(ℓ)	+	Fe(s)
В	Cr ₂ O ₇ ^{2–} (aq)	+	14H ⁺ (aq)	+	Fe ²⁺ (aq)	\rightarrow	2Cr ³⁺ (aq)	+	7H ₂ O(ℓ)	+	Fe ³⁺ (aq)
С	Cr ₂ O ₇ ^{2–} (aq)	+	14H ⁺ (aq)	+	6Fe ²⁺ (aq)	\rightarrow	2Cr ³⁺ (aq)	+	7H ₂ O(ℓ)	+	6Fe(s)
D	$Cr_2O_7^{2-}(aq)$	+	14H ⁺ (aq)	+	6Fe ²⁺ (aq)	\rightarrow	2Cr ³⁺ (aq)	+	7H₂O(ℓ)	+	6Fe ³⁺ (aq)

6. A mixture of magnesium bromide and magnesium sulfate is known to contain 3 moles of magnesium ions and 4 moles of bromide ions.

How many moles of sulfate ions are present?

- A 1
- B 2
- C 3
- D 4

7.



The correct name for this ester is:

- A butyl propanoate
- B propyl butanoate
- C pentyl propanoate
- D propyl pentanoate.

8. The structural formula for a compound is shown.

Which of the following is **not** an isomer of this compound?

- A octan-4-one
- B 2-ethylhexanal
- C 2-ethylhexan-1-ol
- D 5-methylheptan-3-one
- 9. Gabapentin is a medicine that can be used to treat nerve pain.



Which line in the table shows the two functional groups present in this compound?

A	amine	carboxyl
В	amine	hydroxyl
С	hydroxyl	carboxyl
D	hydroxyl	carbonyl

10. Prenol is a compound that occurs naturally in citrus fruits.



Which line in the table correctly describes the reaction of prenol with bromine solution and with hot copper(II) oxide?

	Reaction with bromine solution	Reaction with hot copper(II) oxide
А	no reaction	no reaction
В	no reaction	brown solid formed
С	decolourises	brown solid formed
D	decolourises	no reaction

11. The iodine number of an oil is the mass of iodine, in grams, that will react with 100 g of oil and is a measure of the degree of saturation.

Olive oil has an iodine number of 84 and palm oil has an iodine number of 48. Which of the following statements is correct?

- A Palm oil is more saturated and has a lower melting point than olive oil.
- B Palm oil is more saturated and has a higher melting point than olive oil.
- C Palm oil is less saturated and has a lower melting point than olive oil.
- D Palm oil is less saturated and has a higher melting point than olive oil.

[Turn over

12. The structure of a soapless detergent molecule is given below.



Which line in the table describes a step in the cleansing action of a soapless detergent?

	Head section	Tail section
А	The hydrophobic head dissolves in water.	The hydrophilic tail dissolves in oil.
В	The hydrophilic head dissolves in water.	The hydrophobic tail dissolves in oil.
С	The hydrophobic head dissolves in oil.	The hydrophilic tail dissolves in water.
D	The hydrophilic head dissolves in oil.	The hydrophobic tail dissolves in water.

- **13.** Which of the following is a secondary alcohol?
 - A 2-methylbutan-1-ol
 - B 2-methylbutan-2-ol
 - C butan-1-ol
 - D butan-2-ol

14. The compounds below are examples of flavour molecules found in some plants.





cucumber flavour

vanilla flavour

 H_2

 H_2

H₃C



ginger flavour

orange flavour

CH₃

CH

CH

 CH_2

CH₂

Which line in the table shows the solubilities of these compounds in water and in oil?

	Water soluble	Oil soluble
Α	cucumber and ginger	orange and vanilla
В	cucumber and orange	ginger and vanilla
С	ginger and vanilla	cucumber and orange
D	orange and vanilla	cucumber and ginger

15. The structural formula for a compound is shown.



The product of oxidation of this compound is:

- A 2-methylpentan-4-one
- B 4-methylpentan-2-one
- C 2-methylpentanal
- D 4-methylpentanal.
- **16.** Which of the following describes how to fill a burette with acid and take the initial reading in a titration?
 - A Rinse the burette with the acid. Fill to above the scale with acid. Drain some of the acid and read from the top of the meniscus.
 - B Rinse the burette with deionised water. Fill to above the scale with acid. Drain some of the acid and read from the bottom of the meniscus.
 - C Rinse the burette with the acid. Fill to above the scale with acid. Drain some of the acid and read from the bottom of the meniscus.
 - D Rinse the burette with deionised water. Fill to above the scale with acid. Drain some of the acid and read from the top of the meniscus.

Tomato juice contains a mixture of terpenes including lycopene and beta-carotene.
 Terpenes can be separated using chromatography.



Which of the following is the most suitable solvent to separate lycopene and beta-carotene?

- A Ethanol
- B Pentane
- C Propanoic acid
- D Water

[Turn over

18. The graph shows how the rate of a reaction varies with the concentration of a reactant.



When the concentration of the reactant is $0.06 \text{ mol}l^{-1}$, the reaction time is:

- A 0.004 s
- B 0.09 s
- C 17 s
- D 250 s.
- **19.** Butene reacts with oxygen as shown.

 $\mathsf{C_4H_8(g)} \hspace{.1in} + \hspace{.1in} \mathsf{6O_2(g)} \hspace{.1in} \rightarrow \hspace{.1in} \mathsf{4CO_2(g)} \hspace{.1in} + \hspace{.1in} \mathsf{4H_2O(g)}$

100 cm³ of butene was reacted with excess oxygen.

Compared with the total volume of gases before reaction, what would be the total volume of gases after complete reaction?

- A 100 cm³ more
- B 100 cm³ less
- C 300 cm³ more
- D 300 cm³ less

20. In aqueous solution ethanoic acid forms an equilibrium mixture with its ions.

 $CH_3COOH(aq) \rightleftharpoons H^+(aq) + CH_3COO^-(aq)$

Which of the following solutions, when added to the equilibrium mixture, would favour the forward reaction?

- A NaCl(aq)
- B HCl(aq)
- C NaOH(aq)
- D CH₃COONa(aq)

[Turn over

21. Some energy values associated with a chemical reaction are shown in the table.

Enthalpy of	Activation energy of	Activation energy of			
reactants	forward reaction	reverse reaction			
(kJ mol ⁻¹)	(kJ mol ⁻¹)	(kJ mol ⁻¹)			
30	110	70			

Which of the following correctly shows the potential energy diagram for the above conditions?



22. Consider the reaction pathway below.



According to Hess' law, the ΔH value, in kJ mol⁻¹, for reaction Z to Y is:

- A –74
- B +74
- C –346
- D +346
- **23.** 50.0 cm³ of 0.100 mol l⁻¹ ammonia solution was transferred to a 250 cm³ volumetric flask. The flask was made up to the mark with deionised water.

The final concentration, in $mol l^{-1}$, of the ammonia solution is:

- A 2.0×10^{-2}
- B 2.5×10^{-2}
- C 4.0×10^{-2}
- D 5.0×10^{-2}
- 24. An experiment involves reacting 0.02 moles of silver ions with ions of a group 7 element to form 2.868 g of precipitate.

Which of the following is the precipitate?

- A Silver(I) fluoride
- B Silver(I) chloride
- C Silver(I) bromide
- D Silver(I) iodide

[Turn over

25. A titration experiment was carried out to determine the concentration of vitamin C in orange juice.

A sample of the orange juice solution was pipetted into a flask and 10 cm³ water was added to dilute the sample. Starch indicator was added to the flask. The mixture was then titrated in the flask using iodine solution of known concentration.

Which line in the table shows the most appropriate apparatus to use when carrying out this procedure?

	To add water	Type of flask
Α	measuring cylinder	conical flask
В	beaker	conical flask
С	measuring cylinder	volumetric flask
D	beaker	volumetric flask

[END OF QUESTION PAPER]

	FOR OFFICIAL US	E				
	National Qualificat 2022	tions			Mark	
813/76/01					Chem Pap	ist per
RIDAY, 29 APRIL						
):10 AM – 12:30 PM				*	X 8 1 3 7 6	0 1
ull name of centre			Town			
prename(s)	Sur	name			Number of	seat
Date of birth						
	h Year	Scottish	candidate	number		
Day Mont						

Attempt ALL questions.

You may use a calculator.

You may refer to the Chemistry Data Booklet for Higher and Advanced Higher.

Write your answers clearly in the spaces provided in this booklet. Additional space for answers and rough work is provided at the end of this booklet. If you use this space you must clearly identify the question number you are attempting. Any rough work must be written in this booklet. Score through your rough work when you have written your final copy.

Use **blue** or **black** ink.

Before leaving the examination room you must give this booklet to the Invigilator; if you do not, you may lose all the marks for this paper.





Total marks — 95 Attempt ALL questions	MARKS	DO NOT WRITE IN THIS MARGIN						
Elements and compounds can exist as diatomic molecules.(a) The seven elements that exist as diatomic molecules are shown in the periodic table below.	:							
$\frac{1}{H}$ $\frac{2}{He}$ $\frac{3}{L}$ $\frac{4}{Be}$ $\frac{5}{B}$ $\frac{6}{C}$ $\frac{7}{N}$ $\frac{8}{P}$ $\frac{10}{10}$ $\frac{11}{Na}$ $\frac{14}{Mg}$ $\frac{15}{2}$ $\frac{12}{27}$ $\frac{24}{27}$ $\frac{25}{26}$ $\frac{27}{27}$ $\frac{28}{28}$ $\frac{29}{20}$ $\frac{20}{20}$ $\frac{26}{64}$ $\frac{26}{26}$ $\frac{28}{33}$ $\frac{28}{8}$ $\frac{38}{8}$ $\frac{85}{86}$ $\frac{86}{86}$ $\frac{55}{5}$ $\frac{56}{8}$ $\frac{77}{17}$ $\frac{73}{74}$ $\frac{75}{75}$ $\frac{76}{77}$ $\frac{77}{78}$ $\frac{79}{79}$ $\frac{80}{80}$ $\frac{81}{81}$ $\frac{82}{82}$ $\frac{83}{84}$ $\frac{85}{86}$ $\frac{86}{86}$ $\frac{55}{5}$ $\frac{56}{8}$ $\frac{104}{105}$ $\frac{105}{106}$ $\frac{107}{107}$ $\frac{108}{109}$ $\frac{110}{100}$ $\frac{111}{112}$ $\frac{113}{114}$ $\frac{115}{115}$ $\frac{116}{117}$ $\frac{116}{116}$ $\frac{7}{F}$ $\frac{8}{R}$ $\frac{104}{R}$ $\frac{105}{5g}$ $\frac{58}{Bh}$ $\frac{109}{Hs}$ $\frac{110}{D5}$ $\frac{111}{R}$ $\frac{110}{R}$ $\frac{111}{R}$ $\frac{110}{R}$ $\frac{111}{R}$	1							
(b) First ionisation energies decrease going down a group.(i) State what is meant by the term <i>first ionisation energy</i>.								

1. Elements



Go to Answers

page 02

Go to Topic Grid

1

	MARKS	DO NOT WRITE IN
		THIS MARGIN
1. (b) (continued)		
(ii) Explain why the first ionisation energy of the group 7 elements decreases going down the group.	s 1	
 (c) Hydrogen halides are diatomic molecules formed between hydrogen and the elements fluorine, chlorine, bromine and iodine. The boiling points of the hydrogen halides are shown on the graph below. 		
⁵⁰ ²⁵ ¹⁰⁰ ¹		
1 2 3 4 period		
 (i) Hydrogen fluoride, HF, has the highest boiling point of the hydrogen halides. State the name of the strongest type of intermolecular force found between hydrogen fluoride molecules and explain how this type of intermolecular force arises. 	2	
[Turn ove	r	
Go to Answer * X 8 1 3 7 6 0 1 0 3 *	rs	

MARKS DO NOT WRITE IN THIS MARGIN (c) (continued) 1. (ii) The table shows the boiling points of hydrogen chloride, hydrogen bromide and hydrogen iodide. Boiling point (°C) Hydrogen halide Hydrogen chloride -85 Hydrogen bromide -66 Hydrogen iodide -35 Explain fully why the boiling point increases from hydrogen chloride to hydrogen iodide. 2



Go to Topic Grid

2.	Fire salt	works s.	conta	ain a range	e of che	emicals i	incluc	ling a fu	el, o	xidising	agents a	and metal	MARKS	DO NOT WRITE IN THIS MARGIN
	(a)	One react	oxidis s with	ing agent 1 aluminiu	used in m meta	firewor al and pr	ks is roduc	potassiu es a brig	m pe sht fl	erchlora ash.	te, KClO	₄ . This		
		The	equati	on for the	e reactio	on is								
				KClO ₄	+	Al	\rightarrow	KC	l	+	Al_2O_3			
		Balar	nce thi	is equatio	n.								1	
	(b)	Firev	vorks v ClO ₃ -,	were tradi as an oxic	tionally lising ag	v made u gent.	using	compou	nds	contain	ing the c	hlorate		
		(i)	Chlor	rate ions r	elease	oxygen	when	they de	com	pose.				
			Potas	ssium chlo	orate, K	ClO ₃ , (G	FM =	= 122.6 g) rea	acts as s	hown.			
					2K	ClO ₃ (s)	\rightarrow	30 ₂ (g)	+	2KCl(s)				
			Calcu potas	ılate the v ssium chlo	olume o orate de	of oxyge compos	en pro ses.	oduced,	in lit	res, wh	en 4.6 g	of	2	
			Take	the volum	ne of 1 n	nole of o	oxyge	en gas to	be 2	4 litres.				
												[Turn over		
					∭ ∗ ×	8 1 3	76	0 1 0 1	. 5 *		Go	to Answer	S	
				MARKS	DO NOT WRITE IN									
----	-----	--------	--	-------	--------------------									
2.	(b)	(cont	inued)		MARGIN									
	()	(00111												
		(ii)	The decomposition of potassium chlorate can be speeded up by the addition of a catalyst.											
			State the effect of adding a catalyst on the enthalpy change for this reaction.	1										
		(iii)	A firework containing 5.5 g of potassium perchlorate ($GFM = 138.6$ g) releases 103 kJ of energy.											
			Calculate the energy, in kJ, released per mole of potassium perchlorate.	1										



Go to Answers



		MARKS	DO NOT WRITE IN THIS
3.	Atoms of different elements have different attractions for bonding electrons. Electronegativity is a measure of the attraction an atom involved in a bond has for the electrons in the bond.		MAKGIN
	Using your knowledge of chemistry , discuss the importance of electronegativity in bonding, structure and properties of compounds.	3	



Go to Answers





(i) Using the graph **and** the information in the table, predict the number of carbons in glyceryl trilaurate.

Name	Molecular formula	Melting point (°C)
Glyceryl tricaprylate	C ₂₇ H ₅₀ O ₆	10
Glyceryl tricaprate	C ₃₃ H ₆₂ O ₆	31
Glyceryl trilinoleate	C ₅₇ H ₉₈ O ₆	-5



Go to Answers

				MARKS	DO NOT WRITE IN
4	(h)	(cont	tinued)		MARGIN
т.	(0)	(com			
		(ii)	Identify the compound listed in the table which is the most unsaturated.	1	
	(c)	Edibl	e oils such as coconut oil can be used to make emulsifiers.		
		(i)	State how emulsifiers are made from edible oils.	1	
		(ii)	Explain fully how emulsifiers prevent non-polar and polar liquids from		
		()	separating into layers.	2	
			[Turn over		



Go to Answers

				MARKS	DO NOT WRITE IN THIS
5.	Fus is a	el oil i mixtu	s formed as a by-product during the production of bioethanol for fuel. It are of several alcohols.		MAKGIN
	(a)	The s is sho	shortened structural formula of one of the alcohols contained in fusel oil own.		
			CH ₃ CH(CH ₃)CH ₂ CH ₂ OH		
		State	the name of this alcohol.	1	
	(b)	Prop	an-1-ol is also found in fusel oil.		
		Prop	an-1-ol is reacted with an oxidising agent to produce propanal.		
		(i)	Complete the ion-electron equation for the oxidation reaction.	1	
			$C_{3}H_{7}OH \rightarrow C_{3}H_{6}O$		
		(ii)	Acidified potassium dichromate can be used as the oxidising agent and reacts as shown below.		
			$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \rightarrow 2Cr^{3+}(aq) + 7H_2O(\ell)$		
			Suggest why the potassium dichromate must be acidified.	1	



Go to Answers

5.	(b)	(cont	tinued)	MARKS	DO NOT WRITE IN THIS MARGIN
		(iii)	State the colour change that would be observed when propan-1-ol reacts with acidified potassium dichromate.	1	
		(iv)	The equation for the reduction of another oxidising agent that could be used to oxidise propan-1-ol is shown below.		
			$Ag^+(aq) + e^- \rightarrow Ag(s)$ Name the reagent that provides this oxidising agent.	1	
		(v)	State why 2-methylbutan-2-ol cannot be oxidised using these oxidising agents.	1	
		(vi)	In the reaction of butan-1-ol to butanal, oxidation can be identified by an increase in the oxygen to hydrogen ratio.		
			and butanal.	1	
			Oxygen to hydrogen ratio]	
			Butan-1-ol		
			Butanal		
			[Turn over	r	

Γ







			M	ARKS	DO NOT WRITE IN THIS
6.	(a)	(ii)	(continued)		MARGIN
			(C) State what is meant by the term essential amino acid.	1	
			(D) Name the type of reaction that takes place when amino acids join to form proteins.	1	
		(iii)	As sweet potatoes are cooked, the ability of catalase to break down hydrogen peroxide decreases.		
			Explain fully what happens to the enzyme structure to cause this reduction in activity.	2	

ľ

[Turn over



Go to Answers

6	(2)	(cont	tiqued)	MARKS	DO NOT WRITE IN THIS MARGIN
0.	(a)	(iv)	Hydrogen peroxide is broken down by catalase to produce water and		
			An experiment was carried out to determine how much oxygen was produced from the breakdown of hydrogen peroxide by a sample of sweet potato.		
			Draw a diagram showing assembled apparatus that could be used to react hydrogen peroxide solution with sweet potato and measure the volume of oxygen produced.		
			Your diagram should include labels showing the names and positions of the reactants and the collected product.	3	
	(৮)	<u>Current</u>	t active a read course of the optionident vitemin C		
	(D)	(i)	Antioxidants like vitamin C are added to food.		
			Explain why antioxidants are added to food.	1	
-			Go to Answe	rs	

MARKS DO NOT WRITE IN THIS MARGIN (b) (continued) 6. (ii) The structure of vitamin C is shown. Н n 50≤ н ·H н n 2 Explain fully why vitamin C is soluble in water. (c) Unlike sweet potatoes, white potatoes contain the chemical solanine, that can be toxic to humans in large doses. A dose of 3 mg per kg of body weight can cause toxic symptoms. A typical white potato can contain 0.2 mg per g of solanine. Calculate the mass of white potato that could produce a toxic dose to an adult 3 weighing 65 kg. [Turn over





3

(a) Methane, CH_4 , can be used as a fuel.

In an experiment, methane was burned to raise the temperature of 100 $\rm cm^3$ of water by 27 °C.

Using the enthalpy of combustion of methane (891 kJ mol⁻¹), calculate the mass of methane, in g, burned in this experiment.

(b) The equation for the combustion of methane is shown.

 $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$

Bond enthalpies can be used to calculate a theoretical enthalpy change for this reaction.

Using bond enthalpies from the data booklet, calculate the enthalpy change, in $kJ mol^{-1}$, for the combustion of methane.



7.	(cor	ntinued)	MARKS	DO NOT WRITE IN THIS MARGIN
	(c)	Methane reacts with steam to produce hydrogen.		
		$CH_4(g) + H_2O(g) \rightarrow CO(g) + 3H_2(g)$ $GFM = 16 \text{ g} \qquad GFM = 18 \text{ g} \qquad GFM = 28 \text{ g} \qquad GFM = 2 \text{ g}$		
		Calculate the atom economy for the formation of hydrogen.	2	
	(d)	Another naturally occurring gas is nitrogen dioxide, NO ₂ . Nitrogen dioxide exists in equilibrium with dinitrogen tetroxide, N ₂ O ₄ .		
		$2NO_2(g) \rightleftharpoons N_2O_4(g) \qquad \Delta H = -58 \text{ kJ mol}^{-1}$		
		Complete the table to show the conditions that would maximise the yield of nitrogen dioxide .	1	
		Condition High/Low		
		Temperature		
		Pressure		
		[Turn ove	er	

L



MARKS DO NOT WRITE IN THIS MARGIN

2

7. (continued)

(e) (i) In the United States Space Shuttle, dinitrogen tetroxide was reacted with methylhydrazine.

 $4CH_3NHNH_2(\ell) + 5N_2O_4(\ell) \rightarrow 4CO_2(g) + 12H_2O(g) + 9N_2(g)$

Calculate the enthalpy of this reaction, in kJ, by using the data shown below.

 $C(s) + 3H_2(g) + N_2(g)$ $CH_3NHNH_2(\ell)$ $\Delta H = +54 \text{ kJ mol}^{-1}$ \rightarrow $N_2(g) + 2O_2(g)$ $N_2O_4(\ell)$ $\Delta H = -20 \text{ kJ mol}^{-1}$ \rightarrow $C(s) + O_2(g)$ CO₂(g) $\Delta H = -394 \text{ kJ mol}^{-1}$ \rightarrow H₂O(ℓ) $\Delta H = -286 \text{ kJ mol}^{-1}$ $H_2(g) + \frac{1}{2}O_2(g)$ \rightarrow $H_2O(l)$ $H_2O(g)$ $\Delta H = +41 \text{ kJ mol}^{-1}$ \rightarrow

(ii) Draw the full structural formula for methylhydrazine, CH₃NHNH₂.





Go to Answers

page 20



2

1

- 8. Fizzy drinks are made by adding carbon dioxide gas, preservative, colouring and flavouring to water.
 - (a) Carbon dioxide for fizzy drinks can be produced using the water-gas shift reaction.

$$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$$

(i) A catalyst for this reaction is copper(II) oxide.

Complete the table by circling one option on each line to show the effect of copper(II) oxide on the reaction.

(An additional table can be found on page 33.)

Feature of reaction	Effect of catalyst
Rate of forward reaction	increase/decrease/no effect
Rate of reverse reaction	increase/decrease/no effect
Position of equilibrium	moves to right/moves to left/no effect

(ii) The water-gas shift reaction is exothermic.

Draw a line on the axes below to show how the yield of carbon dioxide would vary with increasing temperature.

(An additional diagram can be found on *page 33*.)



[Turn over



8.	(continued)	MARKS DO NOT WRITE IN THIS MARGIN	4 N
	(b) A preservative added to some fizzy drinks is made by reacting sorbic acid a potassium hydroxide.	and	
	In an experiment, 7 g of sorbic acid, $C_6H_8O_2$, is reacted with 250 cm ³ of potassium hydroxide solution, concentration 0.5 mol l ⁻¹ .		
	$C_6H_8O_2(s)$ + KOH(aq) \rightarrow H ₂ O(ℓ) + C ₆ H ₇ O ₂ K(aq) GFM = 112 g		
	Show, by calculation, that sorbic acid is the limiting reactant.	2	



Go to Answers

page 22





MARKS WRITE IN THIS MARGIN (continued) 8. (d) Ginger root is used as a flavouring for some fizzy drinks. (i) Ginger oil is an essential oil obtained from ginger root. Zingiberene is one of the main components in this essential oil. CH₃ CH₃ CH₂ СН СН H₂C zingiberene (A) State one property of an essential oil. 1 (B) Zingiberene is formed from isoprene units. (I) Name the type of compound formed when isoprene units join together. 1 (II) Isoprene is also called 2-methyl-1,3-butadiene. Draw a structural formula for isoprene. 1 1 (III) State the number of isoprene units in a zingiberene molecule.





(B) Name two functional groups present in gingerol and shogaol that are **not** present in zingiberene.

1

[Turn over



9. For a particular set of reaction conditions, the actual yield is the quantity of desired product made in a reaction.

Some examples of reactions with their desired products are shown.

Equation	Desired product
$Ba(NO_3)_2(aq) + Na_2SO_4(aq) \rightarrow BaSO_4(s) + 2NaNO_3(aq)$	BaSO ₄ (s)
$CH_3OH(\ell) + C_2H_5COOH(\ell) \rightleftharpoons C_2H_5COOCH_3(\ell) + H_2O(\ell)$	C₂H₅COOCH₃(ℓ)
$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$	H ₂ (g)

Using your knowledge of chemistry, describe how the actual yield in a reaction could be determined.

Your answer should include experimental procedures that could be used to determine the quantity of product made in reactions such as the examples shown in the table.

3



Go to Answers

page 26

MARKS DO NOT WRITE IN THIS MARGIN



- 10. A refrigerant is a chemical used in cooling processes. Some refrigerant compounds can damage the ozone layer.
 - (a) The ozone depletion potential (ODP) of a refrigerant compound is the relative amount of damage that it can cause to the ozone layer. The higher the number, the greater the damage.

	Refrigerant compound	Ozone depletion potential
1	$C_2F_4Br_2$	6.00
2	CF ₂ ClBr	3.00
3	C ₂ FCl ₅	1.00
4	C ₂ F ₃ Cl ₃	0.85
5	C ₂ F ₄ Cl ₂	0.58
6	C ₂ H ₃ Cl ₃	0.16

- (i) Describe a relationship between the formulae of refrigerant compounds 3, 4 and 5 and their ODP.
- 1

1

- (ii) Identify which pair of compounds should be used to show the effect of replacing chlorine atoms with bromine atoms in refrigerant compounds.
- (iii) The refrigerants carbon dioxide, CO₂, and ammonia, NH₃, have ODP values of 0.00.

1

Suggest why this is the case.



			MARKS	DO NOT WRITE IN THIS			
10.	(cor	ntinued)		MARGIN			
	(b)	The compound difluoromethane, CH_2F_2 , is also used as a refrigerant. It is made by reacting fluorine gas with fluoromethane, CH_3F , in a free radical chain reaction.					
		(i) State what is meant by a free radical.	1				
		(ii) The first step in the reaction involves splitting a fluorine molecule to produce two fluorine radicals.					
		$F_2 \rightarrow 2F \bullet$					
		(A) State the name given to this step.	1				
		(B) Write an equation for a possible propagation step in this reaction.	1				
	(c)	Household fridges use coolants made from refrigerant compounds. A common coolant is made from 50% difluoromethane, CH_2F_2 , ($GFM = 52$ g) and 50% pentafluoroethane, CF_3CHF_2 , ($GFM = 120$ g).					
		A typical fridge contains 0.05 kg of coolant.					
		Calculate the number of moles of pentafluoroethane required to make this mass of coolant.	1				
		[Turn over					
L		Go to Answers	;				

			MARKS	DO NOT WRITE IN THIS
11.	Spir	ach is a leafy green vegetable.		MARGIN
	(a)	Fertilisers containing copper(II) ethanoate are used to supply spinach with copper ions.		
		Copper(II) ethanoate can be made by reacting copper(II) carbonate with ethanoic acid.		
		(i) Name the other products of this reaction.	1	
		(ii) Write the ionic formula of copper(II) ethanoate.	1	
	(b)	Spinach is a source of oxalic acid.		
		A standard solution of oxalic acid can be used to determine the accurate concentration of a sodium hydroxide solution.		
		Given an accurately known mass of oxalic acid, describe fully how 250 cm ³ of a standard solution of oxalic acid could be prepared.	a 3	



Go to Answers



X 8 1 3 7 6 0 1 3 1 *



[END OF QUESTION PAPER]





2022 Chemistry

Higher Paper 1 - Multiple choice

Finalised Marking Instructions

© Scottish Qualifications Authority 2022

These marking instructions have been prepared by examination teams for use by SQA appointed markers when marking external course assessments.

The information in this document may be reproduced in support of SQA qualifications only on a noncommercial basis. If it is reproduced, SQA must be clearly acknowledged as the source. If it is to be reproduced for any other purpose, written permission must be obtained from <u>permissions@sqa.org.uk</u>.



Question	Response	Mark
1.	D	1
2.	А	1
3.	C	1
4.	В	1
5.	D	1
6.	А	1
7.	D	1
8.	C	1
9.	А	1
10.	C	1
11.	В	1
12.	В	1
13.	D	1
14.	С	1
15.	В	1
16.	С	1
17.	В	1
18.	D	1
19.	А	1
20.	С	1
21.	D	1
22.	В	1
23.	А	1
24.	В	1
25.	А	1

[END OF MARKING INSTRUCTIONS]



National Qualifications 2022

2022 Chemistry

Higher Paper 2

Finalised Marking Instructions

© Scottish Qualifications Authority 2022

These marking instructions have been prepared by examination teams for use by SQA appointed markers when marking external course assessments.

The information in this document may be reproduced in support of SQA qualifications only on a noncommercial basis. If it is reproduced, SQA must be clearly acknowledged as the source. If it is to be reproduced for any other purpose, written permission must be obtained from <u>permissions@sqa.org.uk</u>.



Question		on	Expected response	Max mark	Additional guidance
1.	(a)	(i)	 (The atoms/nuclei) have the same attraction for the bonding electrons. OR (The atoms have) same electronegativity/electronegativity values given OR Bonding electrons shared equally (between the atoms). 	1	Stating that it is a 'pure covalent bond' on its own is not sufficient. An unlabelled diagram on its own not sufficient
		(ii)	Increasing/greater/stronger/larger nuclear charge (holds electrons more tightly). OR Increasing number of/more protons.	1	Increased nuclear pull is not accepted on its own. Mention must be made of nuclear charge or number of protons. Increased attraction of the electron for the nucleus would be considered cancelling.
	(b)	(i)	The energy required to remove one mole of electrons from one mole of gaseous atoms.	1	
		(ii)	 (More shells) so increased/more screening/ shielding. OR Covalent radius increases/atom size increases/ more shells so attraction of the nucleus/ protons for the outer electron(s) decreases. 	1	'Shielding effect' by itself is not acceptable.

Question		on	Expected response		Max mark	Additional guidance
	(c)	(i)	 Hydrogen bonds/bonding Hydrogen bonds occurs between mo have hydrogen: bonded to N, O or F bonded to a strongly electronegative element bonded to an element with a large difference in electronegativity conto hydrogen in a highly polar bond. OR Answers relating to the attraction be opposite ends of the permanent dipermolecules containing hydrogen atom atoms of elements with high electronegativity/large difference in electronegativity 	(1 mark) lecules that tive e d ompared etween the ole in as and the (1 mark)	2	The first mark should not be cancelled by an incorrect explanation of how hydrogen bonding arises or an explanation of another type of bonding/interaction. All three of N, O and F must be listed.
		(ii)	Correctly identify that the London d forces become stronger/increase (in from HCl to HI). The number of electrons in the mole increases (from HCl to HI).	ispersion moving (1 mark) ecules (1 mark)	2	

Question		on	Expected response	Max mark	Additional guidance
2.	(a)		$3KClO_4 + 8Al \rightarrow 3KCl + 4Al_2O_3$	1	Correct multiples accepted.
	(b)	(i)	$1.4/1.35/1.351$ (litres)Partial markingMoles of KClO3 = 0.03752 moles(1 mark)A 2:3 ratio applied to an incorrectly calculated number of moles and multiplied by 24 (1 mark)OR by proportion245.2 g \rightarrow 72 litres(1 mark)Follow through from incorrect multiples of 122.6 or 241.4/1.35/1.351 (litres)	2	No units required. Only 1 mark can be awarded for the correct answer if wrong unit is given. (Wrong units would only be penalised once in any paper).
		(ii)	None/no effect	1	
		(iii)	2596/2595.6 (kJ)	1	Accept -2596/2595.6 Accept kJ per mole (kJmol ⁻¹) KJ/Kj is acceptable in place of kJ No units required. No mark can be awarded for the correct answer if wrong unit is given. (Wrong units would only be penalised once in any paper).
		(iv)	Increases the number of particles with energy equal to or greater than the activation energy OR Increases the number of particles with (sufficient) energy to form an activated complex/to react (1 mark) More successful collisions (1 mark)	2	'Activation' complex accepted.
	(C)		Sodium	1	

Question		1	Expected response	Max mark	Additional guidance
3.			This is an open-ended question. 1 mark: The candidate has demonstrated, at an appropriate level, a limited understanding of the chemistry involved. They have made some statement(s) that are relevant to the situation, showing that they have understood at least a little of the chemistry within the problem. 2 marks: The candidate has demonstrated, at an appropriate level, a reasonable understanding of the chemistry involved. They make some statement(s) that are relevant to the situation, showing that they have understood the problem. 3 marks: The maximum available mark would be awarded to a candidate who has demonstrated, at an appropriate level, a good understanding, of the chemistry involved. The candidate shows a good comprehension of the chemistry of the situation and provide a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the problem. The answer does not need to be 'excellent' or 'complete' for the candidate to gain full marks.	3	Award 0 marks where the candidate has not demonstrated, at an appropriate level, an understanding of the chemistry involved. There is no evidence that they have recognised the area of chemistry involved, or they have not given any statement of a relevant chemistry principle. Award zero marks also if the candidate merely restates the chemistry given in the question.

Question		on	Expected response	Max mark	Additional guidance
4.	(a)	(i)	Ester (link)	1	
		(ii)	О Н Н Н Н Н Н Н Ш H—O—C—C—C—C—C—C—C—H H H H H H H H	1	Accept correct shortened structural formula.
		(iii)	iii) Any correctly named alcohol with 7 carbons.		Position of OH must be given in name.
	(b)	(i)	35 - 45 inclusive	1	
		(ii)	Glyceryl trilinoleate	1	
	(c)	(i)	By reacting with glycerol.	1	Adding/combining/joining to glycerol not accepted.
		(ii)	 (ii) Correctly identifying that the emulsifier has two parts with different polarities or two parts that are hydrophobic/hydrophilic.		Reference to heads and tails as parts of molecule is accepted.

Question		on	Expected response		Max mark	Additional guidance
5.	(a)		3-methylbutan-1-ol		1	
	(b)	(i)	$C_3H_7OH \rightarrow C_3H_7OH$	$C_3H_7OH \rightarrow C_3H_6O + 2H^+ + 2e^-$		Ignore state symbols. Charge on electron not required.
		(ii)	To provide hydrogen ions		1	Ignore state symbols.
		(iii)	Orange to green		1	Accept blue or blue/green
		(iv)	Tollens' (reag	ent)	1	
		(v)	It is a tertiary	alcohol.	1	Correct description of tertiary alcohol accepted.
		(vi)			1	
				Oxygen to hydrogen ratio		
			Butan-1-ol	1:10		
			Butanal	1:8		

Q	Question		Expected response	Max mark	Additional guidance
6.	(a)	(i)	Biological catalyst	1	Biochemical catalyst/protein that acts as a catalyst are accepted.
		(ii) (A)	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	1	Any one correctly circled peptide link from those shown. Accept the C-N circled. Either the bond alone or including the C and N.
		(ii) (B)	any one of the following structures $\begin{array}{cccccccccccccccccccccccccccccccccccc$	1	Ignore incorrect connectivity in the side chains only.
		(ii) (C)	An amino acid that cannot be made in the body/must be obtained through diet.	1	
		(ii) (D)	Condensation	1	Condensation polymerisation accepted.
		(iii)	Enzyme becomes denatured/ enzyme changes shape (1 mark) Intermolecular/hydrogen bonds are broken (1 mark)	2	
		(iv)	Diagram showing closed reaction vessel with reactants in contact with each other (1 mark) A means of measuring and collecting gas from the closed vessel (1 mark) Correct labelling of hydrogen peroxide, sweet potato and oxygen. Oxygen must be labelled inside the gas collection apparatus. (1 mark)	3	Addition of catalase/water labels are regarded as non- cancelling. Graduations must be shown on gas collection apparatus. First mark not awarded if
					delivery tube passes through the side of a measuring cylinder.
Question		on	Expected response	Max mark	Additional guidance
----------	-----	------	---	-------------	--
6.	(b)	(i)	To prevent unwanted oxidation/to oxidise in place of the compounds they have been added to protect/to stop (oxidation of edible oils) food acquiring a rancid flavour.	1	To 'prevent oxidation' on its own is not sufficient. To stop food going rancid is accepted.
		(ii)	Vitamin C molecule is polar due to its hydroxyl groups. OR Vitamin C can form hydrogen bonds due to its hydroxyl groups. (1 mark) An explanation which links solubility of vitamin C to the polarity of water/hydrogen bonding of water. (1 mark)	2	Accept (-OH) for hydroxyl. 'like dissolves like' not sufficient on its own for 1 mark
	(c)		 975 (2) g (1) Partial marking 195 (mg) (of solanine) (1 mark) OR 15 (g) (1 mark) OR Correct scaling of a calculated mass of solanine to a mass of potato (1 mark) 	3	Allow alternative units of mass as long as these match the numerical answer eg 0.975 kg Units mark can only be awarded with wrong numerical answer as long as evidence of scaling is shown.

Question		n	Expected response	Max mark	Additional guidance
7.	(a)		0.2/0.20/0.203 g Partial marking Using cm Δ T with c = 4.18, m = a factor of 10 of 0.1 and Δ T = 27 (1 mark)	3	No units required. Only 2 marks can be awarded for the correct answer if wrong unit is given. (Wrong units would only be penalised once in any paper).
			Applying the concept that the combustion of 1 mole (16 g) of methane burns to produce 891 kJ (1 mark)		
	(b)		-816 (kJ mol ⁻¹)	2	+816 would qualify for 1 mark
			Partial marking		Bond breaking
		1 mark is available if either of the			(4 × 412) + (2 × 498) = 2644
			executed:		Bond forming
			Either		[(2 × 804) + (4 × 463)] = -3460)
			The four relevant values for bond enthalpies of the C-H, O=O, C=O, and O-H (or multiples thereof) are retrieved from the data booklet (412, 498, 804, 463 - ignore signs).		No units required. Only 1 mark can be awarded for the correct answer if wrong unit is given. (Wrong units would only be penalised once in any paper)
			OR		kJ is acceptable in place of kJ mol ⁻¹
		If only three correct values are retrieved, the candidate recognises that bond breaking is endothermic			(KJ or Kj or KJ mol ⁻¹ or Kj mol ⁻¹ accepted).
			and bond forming is exothermic and have correctly manipulated the bond enthalpies and multiples that they have used with working shown.		If less than three bond enthalpies are retrieved then no mark can be awarded.

Question		on	Expected	response	Max mark	Additional guidance
7.	(c)		17.647/17.65/17.6 Partial mark for co economy relational correct use of stoid (working must be s Partial marking Correct working wi answer given. $\frac{(3 \times 2)}{(16 + 18)} \times 100$ $\frac{6}{(16 + 18)} \times 100$ OR Incorrect use of stoid $\frac{2}{(16 + 18)} \times 100 = 5.3$ Answer and working 0.176	<pre>/18 (%) prrect use of atom hip without chiometry hown). ith no correct ith no correct sea g must be shown</pre>	2	No units required. Only 1 mark can be awarded for the correct answer if wrong unit is given. (Wrong units would only be penalised once in any paper).
	(d)		Condition	High/Low	1	
			Temperature	high		
			Pressure	low		

Question		on	Expected response	Max mark	Additional guidance
7.	(e)	(i)	-4632 (kJ)	2	
			[(-216) + (+100) + (-1576) + (-3432) + (+492)] = -4632 (kJ)		
			Partial marking		
			Either would be acceptable for 1 mark.		
	Evidence of understanding of reversal of first enthalpy value (ie -54 or -216 must be seen) and the second enthalpy value (ie +20 or +100 must be seen).				
	The other three enthalpy values (regardless of value) must not be reversed, or this partial mark cannot be awarded.				
			OR		
			Evidence of understanding of multiplying the first enthalpy value by 4 (+/- 216) and the second enthalpy value by 5 (+/1 100) and the third enthalpy value by 4 (+/- 1576) and the fourth enthalpy value by 12 (+/- 3432) and the fifth enthalpy value by 12 (+/- 492). Ignore the enthalpy signs associated with these numbers.		
		(ii)	H = H = H = H = H = H $H = H = H = H$ $H = H = H$	1	

Question		on	Expected response		Max mark		Additional guidance
8.	(a)	(i)	One mark for effect on rate (both responses needed), one mark for effect on equilibrium position.		2		
			Feature of reaction	Effect	of catal	yst	
			Rate of forward reaction	Inc	crease		
			Rate of reverse reaction	Inc	crease		
			Position of equilibrium	No	effect		
		(ii)	Graph should show decrease as temperature increases.	e in yield	1		
	(b)		Correctly calculates number moles of: Sorbic acid = 0.0625 Potassium hydroxide = 0.125 OR Working out that 14 g of sort would be needed to react w potassium hydroxide Statement demonstrating understanding of limiting reaction E.g. that there are fewer more sorbic acid therefore it is the limiting reactant OR there are more moles of pot hydroxide therefore it is in e OR that 0.125 moles of potassiun hydroxide would require 0.1 of sorbic acid	bic acid ith (1 mark) actant: oles of e cassium excess im 25 moles (1 mark)	2		

Question		on	Expected response		Max mark	Additional guidance
8.	(c)		2.52 × 10 ⁻⁵ (moles)			
			Partial marking			
			1/261.8 (0.00382) in 100 cm ³ 0.0126 in 330 cm ³	(1 mark)		
			Follow through from incorrectly calcul number of moles multiplied by 0.002	ated (1 mark)		
			OR	OR		
			$0.002 \times 3.3 = 0.0066$ (1 mark)			
			Follow through from incorrectly calcul divided by 261.8	ated mass (1 mark)		

Question		on	Expected response	Max mark	Additional guidance
8.	(d)	(i) (A)	Volatile/non-water soluble/aroma	1	
		(B) (I)	Terpene	1	
		(B) (II)	H C = C H	1	
		(B) (III)	3	1	
		(ii) (A)	Water/H ₂ 0	1	
		(ii) (B)	hydroxyl AND carbonyl	1	Formulae -OH/-C=O not accepted. Ether or benzene ring accepted.

Question		n	Expected response	Max mark	Additional guidance
9.			This is an open-ended question. 1 mark: The candidate has demonstrated, at an appropriate level, a limited understanding of the chemistry involved. They have made some statement(s) that are relevant to the situation, showing that they have understood at least a little of the chemistry within the problem. 2 marks: The candidate has demonstrated, at an appropriate level, a reasonable understanding of the chemistry involved. They make some statement(s) that are relevant to the situation, showing that they have understood the problem. 3 marks: The maximum available mark would be awarded to a candidate who has demonstrated, at an appropriate level, a good understanding, of the chemistry involved. The candidate shows a good comprehension of the chemistry of the situation and provide a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the problem. The answer does not need to be 'excellent' or 'complete' for the candidate to gain full marks.	3	Award 0 marks where the candidate has not demonstrated, at an appropriate level, an understanding of the chemistry involved. There is no evidence that they have recognised the area of chemistry involved, or they have not given any statement of a relevant chemistry principle. Award zero marks also if the candidate merely restates the chemistry given in the question.

Question		on	Expected response	Max mark	Additional guidance
10.	(a) (i) Less fluorine(s) (atoms) give a higher ODP.		1	Symbols F/Cl accepted in place of names.	
			OR More fluorine(s) (atoms) gives a lower ODP.		Use of fluorine/ chlorine 'molecules' would be considered cancelling.
			OR		
			Less chlorine(s) (atoms) give a lower ODP.		
			OR		
			More chlorine(s) (atoms) gives a higher ODP.		
		(ii)	1 and 5	1	$C_2F_4Br_2$ (1) and $C_2F_4Cl_2$ (5)
		(iii)	Carbon dioxide and ammonia do not contain halogen (atoms)/do not damage the ozone layer.	1	Accept names of halogens or group 7 elements Use of 'molecules' would be considered as cancelling.
	(b)	(i)	Species (atoms/molecules/particles) with unpaired electrons.	1	Use of 'element(s)' would be considered as cancelling.
		(ii) A	initiation	1	
		(ii) B	Any correct propagation step accepted, e.g.	1	
			$\begin{array}{l} F \bullet + CH_3F \to \bulletCH_2F + HF \\ \textbf{OR} \\ F_2 + \bulletCH_2F \to CH_2F_2 + F \bullet \\ \textbf{OR} \\ F_2 + \bulletCH_3 \to CH_3F + F \bullet \\ \textbf{OR} \\ \bulletCH_2F + HF \to CH_2F_2 + H \bullet \end{array}$		
	(c)		0.208/0.21/0.2 (moles)	1	No units required. No mark can be awarded for correct answer if wrong unit is given (Where no unit required, wrong units would only be penalised once in any paper).

Question		on	Expected response	Max mark	Additional guidance
11.	(a)	(i)	water and carbon dioxide	1	Formulae accepted.
		(ii)	(CH ₃ COO ⁻) ₂ Cu ²⁺	1	Brackets are required.
			0 H ₃ CC		
	(b)		Dissolve oxalic acid (in small volume of water) (1 mark) transfer quantitatively/with rinsings/washings (1 mark) fill/make up to the mark/line in a volumetric/standard flask. (1 mark)	3	If a solvent other than water is mentioned a maximum of 2 marks can be awarded.
	(c)	(i)	Diagram of graduated or bulb pipette. NOT dropping (Pasteur) pipette	1	Volumetric mark must be shown. End of pipette must narrow to a point.
		(ii)	pink to colourless	1	'Clear' is not accepted for colourless.
		(iii)	concordant	1	

Question		on	Expected response	Max mark	Additional guidance
11.	(d)		0.27/0.3 (mol l ⁻¹)	3	No units required. Only 2 marks can
			average titre = 26.75cm ³		wrong unit is given. (Wrong units
			n (oxalic acid) = 0.02675 × 0.126 = 3.3705 × 10 ⁻³ moles		would only be penalised once in any paper).
			n (sodium hydroxide) = $2 \times 3.3705 \times 10^{-3}$ =6.741 × 10 ⁻³ moles		
			concentration = $6.741 \times 10^{-3} \div 0.025$ = 0.27 (0.26964)moll ⁻¹		
			Partial marks can be awarded using a scheme of two "concept" marks, and one "arithmetic" mark.		
			1 mark for knowledge of the relationship between moles, concentration and volume.		
			This could be shown by one of the following steps:		
			Calculation of moles oxalic acid solution e.g. $0.02675 \times 0.126 = 3.3705 \times 10^{-3}$ moles		
			OR		
			calculation of concentration of sodium hydroxide e.g. $6.741 \times 10^{-3} \div 0.025$		
			OR		
			Insertion of correct pairings of values for concentration and volume in a valid titration formula		
			1 mark for knowledge of relationship between moles of oxalic acid and sodium hydroxide.		
			This could be shown by one of the following steps:		
			Calculation of moles sodium hydroxide from moles oxalic acid eg $2 \times 3.3705 \times 10^{-3}$ =6.741 × 10 ⁻³ moles		
			OR		
			Insertion of correct stoichiometric values in a valid titration formula		
			1 mark is awarded for correct arithmetic through the calculation. This mark can only be awarded if both concept marks have been awarded.		

[END OF MARKING INSTRUCTIONS]



National Qualifications 2023

X813/76/12

Chemistry Paper 1 — Multiple choice

FRIDAY, 12 MAY 9:00 AM – 9:40 AM

Total marks — 25

Attempt ALL questions.

You may use a calculator.

Instructions for the completion of Paper 1 are given on *page 02* of your answer booklet X813/76/02.

Record your answers on the answer grid on page 03 of your answer booklet.

You may refer to the Chemistry Data Booklet for Higher and Advanced Higher.

Space for rough work is provided at the end of this booklet.

Before leaving the examination room you must give your answer booklet to the Invigilator; if you do not, you may lose all the marks for this paper.





Total marks — 25 Attempt ALL questions

- 1. Which of the following compounds has the least ionic character?
 - A Sodium iodide
 - B Sodium fluoride
 - C Potassium iodide
 - D Potassium fluoride
- 2. In which of the following compounds would hydrogen bonding **not** occur?



- **3.** Fats are formed from glycerol molecules and fatty acid molecules. The mole ratio of glycerol molecules to fatty acid molecules is
 - A 1:2
 - B 2:1
 - C 1:3
 - D 3:1

4. A reaction was carried out as shown in the energy diagram.



Which of the following has a value of 150 kJ mol⁻¹?

- A Activation energy of the reverse reaction
- B Enthalpy change of the reverse reaction
- C Activation energy of the forward reaction
- D Enthalpy change of the forward reaction

[Turn over

5. The graph shows how the rate of a reaction varies with the concentration of one of the reactants.



What was the concentration, in $mol l^{-1}$, when the reaction time was 10 s?

- A 0.04
- B 0.10
- C 0.25
- D 0.40

6. The diagram represents the change in concentration of a reactant against time during a reversible chemical reaction.



In which diagram below does the dotted line show the result of repeating the reaction using a catalyst?



- 7. The enthalpy of combustion of methanol (GFM = 32.0 g) is -726 kJ mol⁻¹. What mass of methanol has to be burned to produce 145.2 kJ?
 - A 3.2 g
 - B 6.4 g
 - C 32.0 g
 - D 160.0 g
- 8. Which of the following statements is true?
 - A The sodium atom is larger than the sodium ion.
 - B The chloride ion is smaller than the chlorine atom.
 - C The magnesium ion is larger than the magnesium atom.
 - D The oxygen atom is larger than the oxide ion.
- 9. Which of the following structures is never found in compounds?
 - A Covalent molecular
 - B Covalent network
 - C Monatomic
 - D lonic
- 10. Which of the following carbon containing compounds is an isomer of hexanal?
 - A 2-methylbutanal
 - B 3-methylpentan-2-one
 - C 2,2-dimethylbutan-1-ol
 - D 3,3-dimethylpentanal

11. When two amino acids react in a condensation reaction, water is eliminated and a peptide link is formed.

Which of the following represents this process?



[Turn over

12. Which of the following equations represents an enthalpy of combustion?

13. Two flasks, A and B, were placed in a water bath at 40°C.



After several days, the contents of the flasks were analysed.

Which results would be expected?

- A Flask A contains ethyl ethanoate, water, ethanol and ethanoic acid; flask B is unchanged.
- B Flask A contains only ethyl ethanoate and water; flask B is unchanged.
- C Flask A contains only ethyl ethanoate and water; flask B contains only ethanol and ethanoic acid.
- D Flask A and flask B contain ethyl ethanoate, water, ethanol and ethanoic acid.

14. During a redox process in acid solution, iodate ions are converted into iodine.

 $2IO_3^{-}(aq) + 12H^+(aq) + xe^- \rightarrow I_2(aq) + 6H_2O(\ell)$

What value of *x* is required to balance the equation?

- A 12
- B 11
- C 10
- D 6
- **15.** A step in the synthesis of vitamin B_3 is shown.



What name is given to this type of reaction?

- A Condensation
- B Hydration
- C Reduction
- D Oxidation

[Turn over

16. A chemist analysed a mixture of four dyes, A, B, C and D, using gas-liquid chromatography.

The time taken to travel through the column (retention time) depends on the polarity of the molecule. The more polar the molecule the longer the retention time.

The following chromatogram was obtained.



increasing retention time

Which of the following compounds corresponds to peak Z?



17. The apparatus was used to measure the enthalpy of combustion of ethanol.



Which of the following would **not** improve the accuracy of the result?

- A Using a draught shield
- B Moving the thermometer
- C Using a glass beaker instead of a copper can
- D Stirring the water

[Turn over

18. Which line in the table best describes the ball-like structures formed when soap is added to an oil and water mixture?

	Diagram	Description
A	water	non-polar head dissolves in water, ionic tail dissolves in oil droplet
В	water	ionic head dissolves in water, non-polar tail dissolves in oil droplet
С	water	non-polar head dissolves in oil droplet, ionic tail dissolves in water
D	water	ionic head dissolves in oil droplet, non-polar tail dissolves in water

19. In an experiment, nickel oxide is added to sulfuric acid until no more nickel oxide reacts. The products are nickel sulfate and water.

The correct method to separate and collect a dry, pure sample of nickel sulfate is

- A evaporation
- B filtration
- C filtration followed by evaporation
- D evaporation followed by filtration.
- **20.** Which of the following compounds would react with sodium hydroxide solution to form a salt?
 - A CH₃CHO
 - B CH₃COOH
 - $C CH_3COCH_3$
 - D CH₃CH₂OH

21. Which structural formula represents a primary alcohol?



22. Reduction of 4-methylpentan-2-one to the corresponding alcohol results in the molecule

- A gaining 2 g per mole
- B losing 2 g per mole
- C losing 16 g per mole
- D not changing in mass.
- Which of the following gas samples has the same volume as 16.0 g of oxygen? (All volumes are measured at the same temperature and pressure)
 - A 21.0 g of carbon monoxide
 - B 44.0 g of carbon dioxide
 - C 46.0 g of nitrogen dioxide
 - D 46.0 g of dinitrogen tetroxide

- 24. The number of moles of positive ions in 0.25 moles of aluminium sulfate is
 - A 0.5
 - B 1.0
 - C 2.0
 - D 3.0
- **25.** Addition of hydrogen chloride, HCl, to an alkene can give a mixture of two products. The product produced in the greatest amount in the reaction is called the major product.

The major product is formed when the hydrogen atom of HCl attaches to the carbon atom of the double bond that has the greatest number of hydrogen atoms attached.



2-methylpent-2-ene

The major product in the reaction of HCl with the 2-methylpent-2-ene is



[END OF QUESTION PAPER]

	FOR OFFICIAL US	E						
Lil	National Qualificat 2023	National Qualifications 2023			Mark			
(813/76/01					Chemis Pape			
RIDAY, 12 MAY 0:10 AM – 12:30 PM								
ill in these boxes and r ull name of centre	ead what is printe	ed below.	Town					
orename(s)	Sur	name			Number of se			
Date of birth	h Year	Scottish	candidate	number				

Attempt ALL questions.

You may use a calculator.

You may refer to the Chemistry Data Booklet for Higher and Advanced Higher.

Write your answers clearly in the spaces provided in this booklet. Additional space for answers and rough work is provided at the end of this booklet. If you use this space you must clearly identify the question number you are attempting. Any rough work must be written in this booklet. Score through your rough work when you have written your final copy.

Use blue or black ink.

Before leaving the examination room you must give this booklet to the Invigilator; if you do not, you may lose all the marks for this paper.











* X 8 1 3 7 6 0 1 0 3 *

1.	(cor	ntinued)	MARKS	DO NOT WRITE IN THIS MARGIN
	(b)	Electronegativity is another property that has a periodic trend.		
		(i) State what is meant by the term electronegativity.	1	
		(ii) Explain fully why electronegativity decreases going down a group.	2	
		(iii) Suggest which of the group 2 elements is the best reducing agent.	1	
I		Go to Answer	5	





Go to Answers

page 05

2

2. (continued)

(b) (i) Silicon hydride, SiH_4 , can be formed by reacting silicon with hydrogen.

$$Si(s) + 2H_2(g) \rightarrow SiH_4(g)$$

Calculate the enthalpy change, in $kJ \mod^{-1}$, for this reaction using the following information.

$$\begin{split} \text{SiH}_4(g) &+ 2\text{O}_2(g) &\rightarrow \text{SiO}_2(s) &+ 2\text{H}_2\text{O}(\ell) & \Delta\text{H} = -1517 \text{ kJ mol}^{-1} \\ \text{Si}(s) &+ \text{O}_2(g) &\rightarrow \text{SiO}_2(s) & \Delta\text{H} = -911 \text{ kJ mol}^{-1} \\ \text{H}_2(g) &+ \frac{1}{2}\text{O}_2(g) &\rightarrow \text{H}_2\text{O}(\ell) & \Delta\text{H} = -286 \text{ kJ mol}^{-1} \end{split}$$



									MARKS	DO NOT WRITE IN
2.	(b)	(cont	inued)							MARGIN
		(ii)	One method of preparing silicon hydride involves reacting magnesium silicide, Mg ₂ Si, with hydrochloric acid, HCl.							
			15.32 g of magnesium silicide was reacted with excess hydrochloric acid. 2.56 g of silicon hydride was produced.					chloric acid.		
			4HCl +	Mg_2Si	\rightarrow	SiH_4	+	2MgCl ₂		
				<i>GFM</i> = 76.7	'g (GFM = 32.1 §	g			
			Calculate the perce	entage yield	of silicon	hydride.			2	
		(iii)	The table shows th	e melting po	oints of si	licon hydride	e, SiH₄, a	and silicon		
			oxide, SiO ₂ .				·			
					Meltin	g point (°C)				
				SiH ₄		-185				
				SiO ₂		1710				
			Evalain fully why a		h	ah high ay waa	14:0 a	int then		
			silicon hydride.		nas a mu	ch nigher me	etting po		3	
								[Turn ovei	-	



Go to Answers

page 07











3. (a) (continued)

(iii) Fatty acids can be converted into hydroxycarboxylic acids.An example of a hydroxycarboxylic acid is shown.



The two functional groups in a hydroxycarboxylic acid react together to form a cyclic ester.

An example of a cyclic ester is shown.



Draw a structural formula for the hydroxycarboxylic acid that can be used to produce this cyclic ester.

1







Go to Answers

page 11


- 3. (a) (iv) (continued)
 - (B) The following chromatogram was obtained from another sample of cheese. The concentration of a flavour molecule in cheese can be determined by calculating the area under the peak that corresponds to that molecule.



The concentration of flavour molecule 3 cannot be determined from this chromatogram.

Suggest what would need to be done to the sample to allow the concentration of flavour molecule 3 to be determined.





MARKS DO NOT WRITE IN THIS MARGIN

3. (continued)

(b) The main protein in cheese is called casein.

The diagram shows part of the structure of a casein molecule.



The table shows the relative proportions of the amino acids found in this section of protein.

Amino acid	Relative proportion
Aspartic acid	1
Glutamic acid	2
Isoleucine	1
Leucine	2
Valine	1

(i) Leucine and valine are amino acids that must be obtained through the diet.

State the term for this type of amino acid.

(ii) Using information from the diagram and the table, draw a structural formula for glutamic acid.

1

1



[Turn over

Go to Answers

page 13





		MARKS	DO NOT WRITE IN THIS
4.	Volumetric analysis involves using a standard solution in a reaction with a well-defined end point to determine the concentration of another substance. Correct use of the appropriate apparatus and solutions is essential to ensure accurate determination of concentration by titration.		MARGIN
	Using your knowledge of chemistry , describe the experimental procedures, including equipment, used to accurately determine the concentration of a substance by volumetric analysis.	3	

ľ

[Turn over













13760118*

X 8

	MARGIN
d	
1	
nt is	
2	
	d 1 nt is 2

ſ

[Turn over













6	(co)	otinuo	vd)							MARKS	DO NOT WRITE IN THIS MARGIN
0.	(00)	itinue	:u)								
	(c)	Amm proce	ionia ess.	used to pr	oduce amr	noniu	ım nitrate c	an be made b	by the Haber	r	
				3H ₂ (g)	+ N ₂ (g)	#	2NH ₃ (g)	$\Delta H = -92 \text{ kJ}$	mol ⁻¹		
		(i)	Reve dyna	ersible read amic equili	ctions, suc brium in a	h as t close	he Haber pi ed system.	rocess, can re	ach a state	of	
			State	e what is n	neant by th	ne ter	m dynamic	equilibrium.		1	
		(ii)	(A)	The ammo	onia produ	ced is	s continuou	sly removed.			
				Explain ho	ow this will	affe	ct the produ	uction of amm	nonia.	2	
									ſŦu	rn over	
									[Iu		



Go to Answers

page 23



1

6. (c) (ii) (continued)

(B) A flow diagram of the Haber process is shown.

One way to reduce costs in the process is to use a heat exchanger to transfer excess heat from one part of the process to use in another part of the process.



From the flow diagram, state another way that the manufacturing process maximises profit or minimises the impact on the environment.

* X 8 1 3 7 6 0 1 2 4 *

MARKS WRITE IN THIS MARGIN (continued) 6. (d) Ammonia is currently being investigated for use in fuel cells. The reactions taking place at the electrodes are $O_2 + 2H_2O + 4e^- \rightarrow 4OH^ 2NH_3 \ + \ 6OH^- \ \rightarrow \ N_2 \ + \ 6H_2O \ + \ 6e^-$ (i) Write the overall redox equation for the reaction taking place in the fuel cell. 1 (ii) Identify the reducing agent in the reaction taking place in the fuel cell. 1 [Turn over









7.

[Turn over



MARKS WRITE IN THIS MARGIN

7. (continued)

(b) Another ion found in tap water is manganese(II), Mn^{2+} .

The manganese(II) ions are oxidised to purple permanganate ions, MnO_4^- . The concentration of permanganate ions can be determined by measuring how much light is absorbed by the solution.

The higher the concentration of permanganate ions in the solution, the more light is absorbed.

The absorbances of several standard solutions of permanganate were measured, and the results plotted.



A water sample had an absorbance of 0.08.

Estimate the concentration of permanganate ions, in $mg l^{-1}$, in this sample.





MARKS DO NOT WRITE IN THIS MARGIN

2

(continued) 7. (c) Chlorine is added to tap water to make it safe to drink. The chlorine can react with substances in the water to produce trichloromethane, CHCl₃. (i) Trichloromethane is more soluble in water than tetrachloromethane due to the polarities of the molecules. Cl Н Cl ******* CL MILL C `Cl ัCเ trichloromethane tetrachloromethane Explain the difference in polarities of trichloromethane and tetrachloromethane molecules. [Turn over







Go to Answers

page 30

		MARKS	DO NOT WRITE IN THIS
8.	Dog food contains many different compounds including fats, vegetable oils, fatty acids, flavour and aroma molecules, proteins, water, antioxidants and emulsifiers.		MARGIN
	It is important that dog food has a long shelf life, retains its appearance and texture, as well as providing sufficient nutritional value.		
	Using your knowledge of chemistry, explain the role of different compounds in dog food.	3	

ſ





Go to Answers



9. Haloalkanes are alkane molecules that contain at least one group 7 atom.

Halaalkana	Boiling point (°C)					
Haludikane	X = Cl	$\mathbf{X} = \mathbf{Br}$	$\mathbf{X} = \mathbf{I}$			
CH ₃ -X	-24.2	3.6	42.4			
CH ₃ CH ₂ -X	12.3	38.4	72.3			
CH ₃ CH ₂ CH ₂ -X	46.6	71.0	102.0			

(a) The table shows information on the boiling points of some haloalkanes.

(i) Using the information in the table, describe **two** different trends in the boiling points.

(ii) Name the strongest type of intermolecular forces broken when bromoethane, CH_3CH_2Br , boils.

2







MARKS DO NOT WRITE IN THIS MARGIN

1

1

9. (continued)

(c) Alkanes can react with group 7 molecules in free radical reactions to form haloalkanes.

Reaction step	Name of step
$Br_2 \rightarrow 2Br \bullet$	Initiation
$\begin{array}{rcl} Br \bullet \ + \ CH_4 \ \longrightarrow \ HBr \ + \ \bullet CH_3 \\ \bullet CH_3 \ + \ Br_2 \ \longrightarrow \ CH_3 Br \ + \ Br \bullet \end{array}$	Propagation
	Termination

- (i) State what is required for initiation to take place.
- (ii) Complete the table to show a possible termination step.



9. (continued)

(d) Haloalkanes can react to form alcohols as shown.



Depending on the structure of the haloalkane used, the alcohol produced can be oxidised to form an aldehyde or ketone.

Compound **P** was converted to compound **R** in two steps.

$$\begin{array}{cccc} C_4H_9Br & \rightarrow & C_4H_9OH & \rightarrow & C_4H_8O \\ P & Q & R \end{array}$$

Compound **R** does not react with Tollens' reagent or Fehling's solution. Draw a structural formula for compound **P**.

[Turn over

1



MARKS DO NOT WRITE IN THIS MARGIN

9. (continued)

(e) The structures of two haloalkanes are shown.



The names of haloalkanes are derived from their structures using the following rules.

- 1. The name is based on the longest chain of carbon atoms.
- 2. The presence of group 7 atoms is shown by shortening the name of the group 7 atom.

Group 7 atom	Shortened name
fluorine	fluoro-
chlorine	chloro-
bromine	bromo-

- 3. The chain is numbered to assign numbers to the group 7 atoms. The numbers should be assigned so the lowest possible numbers are used.
- 4. If two or more of the same group 7 atoms are present, use the prefixes di, tri or tetra.
- 5. The shortened name of the group 7 atoms attached to the chain are listed alphabetically (ignoring the prefixes di, tri and tetra for alphabetical purposes).

Using these rules, name this molecule.





Go to Answers

1











Qualifications

2023 Chemistry

Higher

Finalised Marking Instructions

© Scottish Qualifications Authority 2023

These marking instructions have been prepared by examination teams for use by SQA appointed markers when marking external course assessments.

The information in this document may be reproduced in support of SQA qualifications only on a noncommercial basis. If it is reproduced, SQA must be clearly acknowledged as the source. If it is to be reproduced for any other purpose, written permission must be obtained from permissions@sqa.org.uk



Marking instructions for each question in Paper 1

Question	Answer	Mark
1.	А	1
2.	D	1
3.	С	1
4.	А	1
5.	С	1
6.	В	1
7.	В	1
8.	А	1
9.	С	1
10.	В	1
11.	С	1
12.	D	1
13.	D	1
14.	С	1
15.	D	1
16.	В	1
17.	С	1
18.	В	1
19.	С	1
20.	В	1
21.	D	1
22.	А	1
23.	D	1
24.	А	1
25.	В	1

[END OF MARKING INSTRUCTIONS]

Q	Question		Expected response	Max mark	Additional guidance
1.	(a)	(i)	Increasing greater/stronger/larger nuclear charge (holds electrons more tightly). OR Increasing number of/more protons.	1	Increased nuclear pull is not accepted on its own. Mention must be made of nuclear charge or number of protons. Increased attraction of electron for the nucleus would be considered cancelling.
		(ii)	b or j	1	A correct letter must be shown.
		(iii) (A)	Second ionisation energy involves removal of an electron from an electron shell that is inner/ full(whole)/(more) stable/closer to the nucleus. OR Second electron is removed from an electron shell that is inner/ full(whole)/(more) stable/closer to the nucleus. (1 mark)	2	Correct statements made about the 1 st ionisation energy/electron can also be credited. Stating that the 2 nd electron requires more energy than the 1 st electron is not sufficient on its own.
			The second electron is less screened/the second electron shell is less screened. OR The second electron is more strongly attracted to/pulled towards the nucleus. (1 mark)		Shielding is acceptable in place of screening. Increased attraction of the electron for the nucleus would be considered cancelling.
		(iii) (B)	11472 (kJ mol ⁻¹)	1	No units required. No mark can be awarded for correct answer if wrong unit is given (where no unit required, wrong units would only be penalised once in any paper). kJ is acceptable in place of kJ mol ⁻¹ (KJ or Kj or KJ mol ⁻¹ or Kj mol ⁻¹ accepted).

Question		on	Expected response		Additional guidance
1.	(b)	(i)	Electronegativity is the (measure of) attraction an atom/nucleus has for the electrons in a bond/shared electrons. (1 mark)	1	
		(ii)	(More shells so) increased screening/more screening. (1 mark) (Covalent radius increases/atom size increases/more shells so) attraction of the nucleus/protons for the (outer/shared) electron(s) decreases. (1 mark)	2	Shielding is acceptable in place of screening. Increased attraction of the electron for the nucleus would be considered cancelling.
		(iii)	Barium OR Radium OR Strontium	1	Correct symbols accepted.

Question		on	Expected response	Max mark	Additional guidance
2.	(a)	(i)	 (Intermolecular/van der Waals) forces increase (going down the group). (1 mark) LDFs are the forces (broken between the molecules). (1 mark) The more electrons the stronger the LDFs. (1 mark) 	3	
		(ii)	Hydrogen bonding	1	
	(b)	(i)	 (+) 34 (kJ mol⁻¹) [(+1517) + (-911) + (-572)] = (+) 34 (kJ mol⁻¹) Partial marks Treat as two concepts. Either would be acceptable for 1 mark. Evidence of understanding of reversal of first enthalpy value ie +1517 or 1517 must be seen. The other two enthalpy values (regardless of value) must be negative, or this partial mark cannot be awarded. OR Evidence of understanding of multiplying the third enthalpy value by 2. Ignore the enthalpy sign associated with these numbers. 	2	If answer given is -34, maximum of 1 mark can be awarded. No units required. Only 1 mark can be awarded for the correct answer if wrong unit is given. (wrong units would only be penalised once in any paper). kJ is acceptable in place of kJ mol ⁻¹ (KJ or Kj or KJ mol ⁻¹ or Kj mol ⁻¹ accepted).
		(ii)	39.9/ 40 (%) (2 marks) Partial marks Calculates theoretical mass = 6.4 (g) (1 mark) OR Correctly calculates no of moles reactant (0.2) and product (0.08) (1 mark)	2	

Question			Expected response	Max mark	Additional guidance
2.	(b)	(iii)	In SiO ₂ covalent bonds are broken. (1 mark)	3	
			In SiH₄ Van der Waals/LDFs/intermolecular forces are broken. (1 mark) Covalent bonds need more energy to break than van der Waals/LDFs/ intermolecular forces.		
			OR		
			Covalent bonds are stronger than van der Waals/LDFs/intermolecular forces. (1 mark)		A correct description of the relative strength of covalent bonds and van der Waals/LDFs/intermolecular forces is accepted for this mark.

Question			Expected response	Max mark	Additional guidance
3.	(a)	(i) (A)	propane-1,2,3-triol	1	propan-1,2,3-triol is accepted Apply general marking principle (o)
		(i) (B)	Condensation/ esterification	1	
		(ii) (A)	Carbonyl	1	
		(ii) (B)	heptan-2-one	1	
		(ii) (C)	Reduction	1	Accept hydrogenation
		(ii) (D)	(reaction) 1	1	
		(iii)	Н Н Н Н Н Н Н H—с—с—с—с—с—с—с—с H Н Н ОН Н Н Н	1	
		(iv) (A)	12 - 13 (minutes)	1	No units required. Only 1 mark can be awarded for the correct answer if wrong unit is given. (wrong units would only be penalised once in any paper).
		(iv) (B)	dilute sample/use less of sample	1	
	(b)	(i)	Essential (Amino acids)	1	
		(ii)	H ₂ N - C - C OH CH ₂ CH ₂ CH ₂ COOH	1	
		(iii)	(The protein) denatures/denatured	1	
	(c)		To prevent non-polar and polar liquids separating (into layers)	1	
	(d)		Calcium propanoate	1	

Question	Expected response	Max mark	Additional guidance		
4.	Award 1 mark where the candidate has demonstrated, at an appropriate level, a limited understanding of the chemistry involved. They have made some statement(s) which are relevant to the situation, showing that they have understood at least a little of the chemistry within the problem.	3			
	Award 2 marks where the candidate has demonstrated, at an appropriate level, a reasonable understanding of the chemistry involved. They make some statement(s) which are relevant to the situation, showing that they have understood the problem.				
	Award 3 marks where the candidate has demonstrated, at an appropriate level, a good understanding of the chemistry involved. They show a good comprehension of the chemistry of the situation and provide a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the problem. The answer does not need to be 'excellent' or 'complete' for the candidate to gain full marks.				
	Award 0 marks where the candidate has not demonstrated, at an appropriate level, an understanding of the chemistry involved. There is no evidence that they have recognised the area of chemistry involved, or they have not given any statement of a relevant chemistry principle. Award this mark also if the candidate merely restates the chemistry given in the question.				
Question			Expected response	Max mark	Additional guidance
----------	-----	------------	---	-------------	--
5.	(a)	(i) (A)	494.08, 494.1, 494 (litres) 494080, 494100 cm ³ Partial marking Calculating the mass of glucose in 16L ie 1852.8 (g). (1 mark) OR Number of moles of glucose in 16L 10.29 (moles) (or correctly calculated number of moles from incorrectly calculated mass of glucose). (1 mark) An incorrectly calculated number of moles of glucose × (2 × 24). (1 mark) OR by proportion 180g \leftrightarrow 48L (1 mark) Calculated mass \leftrightarrow Calculated mass × <u>48</u> of glucose of glucose 180 (1 mark) Failure to scale up to 16 litres of glucose solution but correct use of 50cm ³ and 5.79 g and 1:2 mole ratio will give an answer of 1.544 litres of carbon dioxide. This would be awarded 2 marks. (working must be shown)	3	No units required. Only 2 marks can be awarded for the correct answer if wrong unit is given. (Wrong units would only be penalised once in any paper).

Question		on	Expected response	Max mark	Additional guidance
5.	(a)	(i) (B)	51, 51.1 (%) Partial mark for correct use of atom economy relationship without correct use of stoichiometry (working must be shown). $\frac{46}{180} \times 100 = 25.6$ (1 mark) OR Partial mark for correct working with no correct answer given. $\frac{(2 \times 46)}{180} \times 100$	2	No units required. Only 1 mark can be awarded for the correct answer if wrong unit is given. (Wrong units would only be penalised once in any paper).
			0.51 (1 mark) OR Partial mark for correct use of atom economy relationship with correct use of stoichiometry (working must be shown) for carbon dioxide $2 \times \frac{44}{180} \times 100$ = 48.9 % (1 mark)		

Question			Expected response	Max mark	Additional guidance
5.	(a)	(ii)	12, 12.2, 12.22 (% / abv)	2	Ignore any units.
			Partial mark for correctly calculated change in specific gravity. 1.075-0.985 or 0.09. (1 mark) Partial mark for correctly calculated		
			value using an incorrect value for change in specific gravity. (1 mark)		
	(b)	(i)	Acidified dichromate changes from orange to green (blue-green/ blue) with methanol AND no colour change would be observed with propan-2- one. (2 marks) OR	2	Acidified dichromate (1 mark) Hot copper oxide (1 mark)
			Using hot copper oxide a brown solid forms/copper forms/colour change from black to brown would be observed with methanol AND no colour change would be observed with propan-2-one. (2 marks)		
		(ii) (A)	Terpene(s)	1	
		(ii) (B)	CH ₃ H ₂ C CH H ₂ C CH CH H ₂ C CH H ₂ C CH H ₂ C CH H ₂ C CH H ₂ C CH CH H ₂ C CH H ₂ C CH H ₂ C CH CH H ₂ C CH H ₂ C CH CH H ₂ C CH CH CH CH CH CH CH CH CH C	1	
		(ii) (C)	Ethanoic acid/acetic acid	1	
	(c)		2100 (1 mark) mg (1 mark) OR 2·1 (1 mark) g (1 mark) OR 0-0021 (1 mark) kg (1 mark)	2	If an incorrect mass is calculated but the units are appropriate to the calculation then 1 mark would be awarded. If the candidate's working is unclear in terms of what is being worked out then the mark for units cannot be

Question	Expected response	Max mark	Additional guidance
6. (a) (i) (A)	botential energy reactants products reaction progress	1	
(i) (B)	Activated complex	1	Accept activation complex or transition state.
	n HNO ₃ = 1316 x 9.5 = 12502 moles AND n NH ₃ = 220x10 ³ / 17 = 12941 (1 mark) 1:1 ratio therefore NH ₃ is in excess (1 mark) OR 12502 HNO ₃ moles requires 12502 moles NH ₃ but have 12941 moles therefore NH ₃ in excess. (2 marks) 	2	Accept correct statement for incorrectly calculated values using 1:1 ratio.

Question			Expected response	Max mark	Additional guidance
6.	(a)	(iii)	It has 100% atom economy OR Only has 1 product	1	
	(b)	(i) (A)	The total number of molecules/ particles.	1	
		(i) (B)	Second line displaced to right of original. Peak of curve should be further to the right and no higher than the original peak.	1	
		(ii)	A vertical line drawn at a lower kinetic energy than the original E_a shown on graph.	1	
	(c)	(i)	The rate of the forward reaction equals the rate of the reverse reaction.	1	
		(ii) (A)	(Removal of ammonia/product will) shift equilibrium to right hand side. (1 mark) OR Increases the yield of ammonia. (1 mark)	2	
			Decreases the rate of the reverse reaction. (1 mark) OR The rate of the forward reaction is then greater than the rate of the reverse reaction. (1 mark)		
		(ii) (B)	Recycles unreacted gases/ reactants. OR Uses a catalyst (to reduce energy costs). OR Air is a low cost/free resource.	1	
	(d)	(i)	$4NH_3 + 3O_2 \rightarrow 2N_2 + 6H_2O$	1	Any correct multiple is accepted.
					Ignore any state symbols if given.
		(ii)	Ammonia/NH ₃	1	

Q	Question		Expected response	Max mark	Additional guidance
7.	(a)	(i)	Hard (water)	1	
		(ii)	Hydrophilic	1	Polar is not accepted.
		(iii)	 0.000837 (mol l⁻¹) (3 marks) Partial marks can be awarded using a scheme of two "concept" marks, and one "arithmetic" mark. 1 mark for knowledge of the relationship between moles, concentration and volume. This could be shown by one of the following steps: Calculation of moles EDTA solution eg 0.0045 × 0.0093 = 0.00004185 Calculation of concentration of calcium ions eg 0.00004185 ÷ 0.05 Insertion of correct pairings of values for concentration and volume in a valid titration formula. If the relationship between moles, concentration and volume is used more than once, it must be used correctly every time. 1 mark for the relationship between a calculated number of moles of EDTA and calcium ions. OR Insertion of correct stoichiometric values in a valid titration formula. 1 mark is awarded for correct arithmetic through the calculation. This mark can only be awarded if both concept marks have been awarded.	3	No units required. Only 2 marks can be awarded for the correct answer if wrong unit is given. (Wrong units would only be penalised once in any paper).

Question			Expected response	Max mark	Additional guidance
7.	(b)		0.18 0.16 0.14 0.12 0.10 0.08 0.06 0.04 0.02 0 0 0 0 0 0 0 0 0 0 0 0 0	1	No units required. No mark can be awarded for the correct answer if wrong unit is given. (Wrong units would only be penalised once in any paper).
	(C)	(i)	Trichloromethane is polar and tetrachloromethane is non-polar. (1 mark) Trichloromethane has a permanent dipole and tetrachloromethane does not. (1 mark)	2	Correct description of a permanent dipole is accepted.
		(ii)	 -14 (kJ mol⁻¹) Partial marks: Evidence of the use of all the correct bond enthalpies (or correct multiples thereof) (338, 412, 431, 484, 570 (ignore signs). (1 mark) OR If only four values are retrieved, the candidate recognises that bond breaking is endothermic and bond formation is exothermic and correctly manipulates the bond enthalpy values they have used to give their answer. (1 mark) 	2	 (+)14 (kJ mol⁻¹) would be awarded 1 mark. No units required. Only 1 mark can be awarded for the correct answer if wrong unit is given. kJ is acceptable in place of kJ mol⁻¹ (KJ or Kj or KJ mol⁻¹ or Kj mol⁻¹ accepted). (Wrong units would only be penalised once in any paper).

Question	Expected response	Max mark	Additional guidance
8.	Award 1 mark where the candidate has demonstrated, at an appropriate level, a limited understanding of the chemistry involved. They have made some statement(s) which are relevant to the situation, showing that they have understood at least a little of the chemistry within the problem.	3	
	Award 2 marks where the candidate has demonstrated, at an appropriate level, a reasonable understanding of the chemistry involved. They make some statement(s) which are relevant to the situation, showing that they have understood the problem.		
	Award 3 marks where the candidate has demonstrated, at an appropriate level, a good understanding of the chemistry involved. They show a good comprehension of the chemistry of the situation and provide a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the problem. The answer does not need to be 'excellent' or 'complete' for the candidate to gain full marks.		
	Award 0 marks where the candidate has not demonstrated, at an appropriate level, an understanding of the chemistry involved. There is no evidence that they have recognised the area of chemistry involved, or they have not given any statement of a relevant chemistry principle. Award this mark also if the candidate merely restates the chemistry given in the question.		

Q	uestic	on	Expected response	Max mark	Additional guidance
9.	(a)	(i)	The more carbons/longer carbon chain the higher the boiling point. (1 mark)	2	
			The further down group 7/the halogen is the higher the boiling point. (1 mark)		Reference to group 7 molecule is cancelling.
		(ii)	Permanent dipole- Permanent dipole interactions.	1	Allow permanent dipole-dipole interaction. Accept pd-pd i's.
	(b)	(i)	The halogen/bromine (atom) is attached to a carbon that is attached to two other carbons. OR The halogen/bromine (atom) is attached to a carbon that has only	1	
			one hydrogen attached.		
		(ii)	H Br H HCCH H CH ₃ H	1	Accept shortened structural formula
	(c)	(i)	Ultraviolet/UV (radiation/light)	1	
		(ii)	1 mark for one of the following • $CH_3 + Br \bullet \rightarrow CH_3Br$ • $CH_3 + \bullet CH_3 \rightarrow CH_3CH_3$ $Br \bullet + Br \bullet \rightarrow Br_2$	1	
	(d)		H Br H H H—C—C—C—C—H H H H H	1	Accept shortened structural formula
	(e)		2-bromo-3-chloro-1,1,1- trifluoropentane	1	Apply general marking principle (o)

Q	uestic	on	Expected response	Max mark	Additional guidance
10.	(a)		Tare the balance with the crucible. (1 mark)	2	Accept use of a filter paper/paper towel/watch glass or other
			Transfer 1·5 g (into the crucible). (1 mark)		weighing boat.
			OR		
			Tare a weighing boat, transfer the 1.5 g onto the weighing boat. Record mass. Transfer into the crucible. (1 mark)		
			Reweigh the weighing boat and record the mass/calculate the difference. (1 mark)		
			OR		
			Weigh mixture and weighing boat, record the mass. Transfer mixture into the crucible. (1 mark)		
			Reweigh the weighing boat and record the mass/calculate the difference. (1 mark)		
			Weigh the crucible (empty) and then with (1.5 g of) mixture. (1 mark)		
			Subtract the mass of crucible from mass of crucible and mixture. (1 mark)		
	(b)	(i)	Allow CO ₂ /gas to escape.	1	
		(ii)	Reactants/products/mixture are not flammable.	1	

Question			Expected response	Max mark	Additional guidance
10.	(c)		0.582, 0.58 (g) (2 marks)	2	
			Partial marking		
			Calculating number of moles of CO ₂ (0.0069). (1 mark)		
			Calculating mass of MgCO ₃ from incorrectly calculated number of moles of CO ₂ . (1 mark)		
	(d)	(i)	Diagram shows a workable method of generating gas with mixture in contact with acid. Labels required for mixture/powder/magnesium oxide + magnesium carbonate and (excess) acid.	1	
		(ii)	Carbon dioxide is (relatively) insoluble/has very low solubility (in water).	1	

[END OF MARKING INSTRUCTIONS]