



AS Level Chemistry

ELECTROCHEMISTRY

9701 - PAPER 2 THEORY



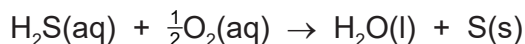
2026 EDITION

Q1 - Easy

9701/21/O/N/21/Q1(c)(iii)

2 marks

- (iii) $\text{H}_2\text{S}(\text{aq})$ reacts slowly with oxygen dissolved in water. The reaction is represented by the following equation.



Explain, with reference to oxidation numbers, why this reaction is a redox reaction.

.....

.....

.....

..... [2]

Also appears as: 9701/23/O/N/21/Q1(c)(iii)

Q2 - Easy

9701/22/M/J/22/Q1(b)(i)-(ii)

2 marks

- (b) When magnesium is heated in air, magnesium oxide, MgO , is the major product. Smaller amounts of magnesium nitride, Mg_3N_2 , are also made.
- (i) Calculate the oxidation number for magnesium and for the nitrogen species in Mg_3N_2 to complete Table 1.1.

Table 1.1

species	magnesium in Mg_3N_2	nitrogen in Mg_3N_2
oxidation number		

[1]

- (ii) Identify the type of reaction which takes place between magnesium and nitrogen. Explain your answer.

.....

..... [1]

Q3 - Easy

9701/22/F/M/21/Q2(c)(ii)

1 mark

The halide ions react easily with concentrated H_2SO_4 .

The main sulfur-containing product of each reaction is shown in the table.

halide ion	Cl^-	Br^-	I^-
main sulfur-containing product of reaction with concentrated H_2SO_4	HSO_4^-	SO_2	H_2S
oxidation number of sulfur			

- (ii) Complete the table to show the oxidation number of sulfur in each of the sulfur-containing products. [1]

Q4 - Easy

9701/22/F/M/22/Q2(c)(ii)

1 mark

- (c) P_4O_6 is a white solid that has a melting point of 24°C . Solid P_4O_6 reacts with water to form H_3PO_3 .

- (ii) Determine the oxidation number of P in H_3PO_3 .

..... [1]

Q5 - Easy

9701/22/M/J/23/Q2(a)(i)-(ii)

2 marks

2 Chlorine is a reactive element. It forms many compounds.

- (a) (i) Complete Table 2.1 to show the maximum oxidation number of the elements Na to P in their chlorides.

Table 2.1

element	Na	Mg	Al	Si	P
maximum oxidation number					

[1]

- (ii) State what determines the maximum oxidation number of elements in Period 3.

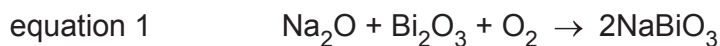
.....
 [1]

Q6 - Easy

9701/22/F/M/24/Q1(c)(i)-(ii)

2 marks

- (c) Bi_2O_3 can be used to form NaBiO_3 , as shown in equation 1.



- (i) Deduce the oxidation number of Bi in Bi_2O_3 and in NaBiO_3 .

oxidation number of Bi:

in Bi_2O_3 in NaBiO_3 [1]

- (ii) Identify the reducing agent in equation 1.

..... [1]

Q7 - Easy

9701/22/F/M/25/Q1(a)(i)

2 marks

1 Phosphorus and chlorine are elements in Period 3 of the Periodic Table.

(a) Chlorine forms three different compounds with phosphorus.

The most common compounds are PCl_3 and PCl_5 .

(i) Complete Table 1.1.

Table 1.1

compound	oxidation number of P	oxidation number of Cl
PCl_3		
PCl_5		

[2]

Q8 - Easy

9701/21/M/J/25/Q1(c)

2 marks

(c) State the oxidation number of the Period 3 elements bonded to Cl in NaCl and PCl_5 .
Explain the difference in the oxidation number.

.....

.....

..... [2]

Q9 - Hard

9701/23/M/J/23/Q1(d)(i)-(ii)

2 marks

- (d) When KI(aq) is added to $\text{CuSO}_4(\text{aq})$ the blue-coloured solution turns brown and a white precipitate of $\text{CuI}(\text{s})$ is seen.

The reaction between copper ions and iodide forms only two products.

- (i) Complete the equation for this reaction.



[1]

- (ii) Identify the oxidising agent in this reaction. Explain your answer in terms of electron transfer.

.....
..... [1]

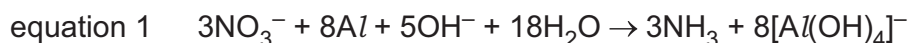
Q10 - Hard

9701/22/O/N/24/Q3(b)(i)-(ii)

2 marks

..... [1]

- (b) A common test for nitrates is the reaction with NaOH and Al. Equation 1 shows the reaction.



- (i) Deduce the oxidation state of nitrogen in NO_3^{-} .

..... [1]

- (ii) Identify the species that is oxidised in equation 1.

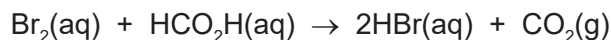
..... [1]

Q11 - Easy

9701/21/M/J/21/Q4(a)

1 mark

- 4 Aqueous bromine reacts with methanoic acid to form hydrogen bromide and carbon dioxide gas.



The table shows the oxidation numbers of bromine and carbon in the species involved in this reaction.

	Br in Br ₂	C in HCO ₂ H	Br in HBr	C in CO ₂
oxidation number	0	+2	-1	+4

- (a) Identify the oxidising agent in this reaction. Explain your reasoning with reference to oxidation numbers.

.....
 [1]

Q12 - Easy

9701/22/F/M/22/Q2(a)(i)

1 mark

- 2 Some oxides of elements in Period 3 are shown.



- (a) Na reacts with O₂ to form Na₂O. Na is the reducing agent in this reaction.

- (i) Define reducing agent.

.....
 [1]

Q13 - Easy

9701/21/O/N/23/Q3(a)

1 mark

- 3 Potassium chlorate, KClO₃, is widely used as an oxidising agent and to make O₂(g).

- (a) Define oxidising agent.

.....
 [1]

Also appears as: 9701/23/O/N/23/Q3(a)

Q14 - Easy

9701/24/O/N/25/Q1(a)(i)-(ii)

2 marks

1 The Group 17 elements are oxidising agents.

(a) (i) Explain how the Group 17 elements act as oxidising agents.

.....
..... [1]

(ii) Write an equation to show the reaction in which Cl_2 oxidises aluminium metal.

..... [1]



Q15 - Hard

9701/23/M/J/21/Q1(f)

2 marks

- (f) Sodium chlorate(I), NaClO , oxidises dilute hydrochloric acid to form three products. The products which contain chlorine have chlorine species with oxidation number -1 or 0 .

No other species changes its oxidation number during the reaction.

Use this information to complete the ionic equation.

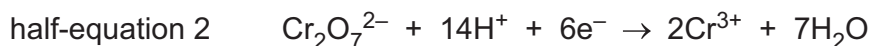
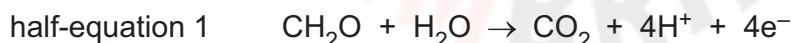


Q16 - Hard

9701/21/O/N/25/Q1(c)(i)-(ii)

2 marks

- (c) Acidified dichromate(VI) ions will convert methanal, CH_2O , to carbon dioxide. The movement of electrons to or from relevant species is shown in the following half-equations.



- (i) Identify the species that is reduced in half-equation 2. Explain your answer.

..... [1]

- (ii) The oxidation state of the carbon atom in methanal is 0 .

Calculate the oxidation state of carbon in carbon dioxide.

..... [1]

Also appears as: 9701/23/O/N/25/Q1(c)(i)-(ii)

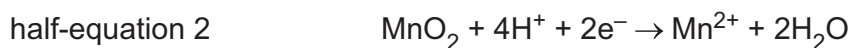
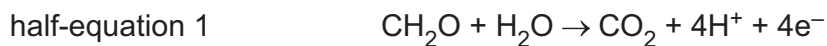
Q17 - Hard

9701/22/O/N/25/Q1(c)(i)-(ii)

2 marks

.....

- (c) Manganese(IV) oxide reacts with methanal, CH_2O , in acidic conditions to produce carbon dioxide. The movement of electrons to or from relevant species is shown in the following half-equations.



- (i) Identify the species that is reduced in half-equation 2. Explain your answer.

.....
..... [1]

- (ii) The oxidation state of carbon in methanal is 0.

Calculate the oxidation state of carbon in carbon dioxide.

..... [1]

Q18 - Easy

9701/22/F/M/21/Q2(d)(i)-(ii)

2 marks

(d) Cl_2 reacts with aqueous sodium hydroxide in a disproportionation reaction.

(i) State what is meant by *disproportionation*.

.....
..... [1]

(ii) Write an equation for the reaction of Cl_2 with cold aqueous sodium hydroxide.

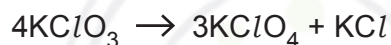
..... [1]

Q19 - Easy

9701/21/O/N/23/Q3(c)

1 mark

(c) When KClO_3 is heated without a catalyst, KClO_4 and KCl form.



Explain why this reaction is described as a disproportionation reaction.

.....
..... [1]

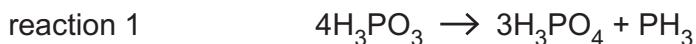
Also appears as: 9701/23/O/N/23/Q3(c)

Q20 - Hard

9701/22/O/N/23/Q3(b)(iii)

2 marks

(b) H_3PO_4 is also formed in the process shown in reaction 1.



(iii) Explain why reaction 1 is a disproportionation reaction.

Explain your reasoning with reference to relevant oxidation numbers.

.....
.....
..... [2]

Q21 - Easy

9701/22/F/M/24/Q2(b)(i)-(iii)

3 marks

(b) When Cl_2 reacts with **cold** NaOH(aq) , Cl_2 is both oxidised and reduced. The products are NaCl , water and **G**.

(i) State the type of redox reaction in which the same species is both oxidised and reduced.
 [1]

(ii) Identify **G**.
 [1]

(iii) Write an equation for the reaction between Cl_2 and **hot** NaOH(aq) .
 [1]

Q22 - Easy

9701/21/O/N/24/Q2(c)(ii)

1 mark

NaClO is made from chlorine in a disproportionation reaction.

(ii) Define disproportionation.

 [1]

Also appears as: 9701/23/O/N/24/Q2(c)(ii)

Q23 - Easy

9701/24/M/J/25/Q2(b)(ii)

2 marks

(b) SCl_2 is a red liquid that reacts with water.



(ii) When SCl_2 reacts with water, the SCl_2 is broken down and a disproportionation reaction occurs.

State the oxidation numbers of sulfur in SCl_2 and H_2SO_3 .

oxidation number of S in SCl_2

oxidation number of S in H_2SO_3

[2]

Q1 - Official MS
9701/21/O/N/21/Q1(c)(iii)

2 marks

1(c)(iii)	M1 S (increases) oxidation number $-2 \rightarrow 0$ so oxidation / or is oxidised M2 O (decreases) O.N. $0 \rightarrow -2$ so reduction / is reduced	2
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Q2 - Official MS
9701/22/M/J/22/Q1(b)(i)-(ii)

2 marks

1(b)(i)	<table border="1"> <tr> <td>species</td><td>magnesium in Mg_3N_2</td><td>nitrogen in Mg_3N_2</td></tr> <tr> <td>oxidation number</td><td>2(+)/(+)II</td><td>3-/-III</td></tr> </table>	species	magnesium in Mg_3N_2	nitrogen in Mg_3N_2	oxidation number	2(+)/(+)II	3-/-III	1
species	magnesium in Mg_3N_2	nitrogen in Mg_3N_2						
oxidation number	2(+)/(+)II	3-/-III						
1(b)(ii)	- redox - Mg loses electrons / Mg increases ox no / Mg is oxidised - N gains electrons / N reduces ox no / N is reduced	1						

Q3 - Official MS
9701/22/F/M/21/Q2(c)(ii)

1 mark

2(c)(ii)	(+)6, (+)4, -2	1
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Q4 - Official MS
9701/22/F/M/22/Q2(c)(ii)

1 mark

2(c)(ii)	(+)3 / III	1
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Q5 - Official MS
9701/22/M/J/23/Q2(a)(i)-(ii)

2 marks

2(a)(i)		<table><tr><td>element</td><td>Na</td><td>Mg</td><td>Al</td><td>Si</td><td>P</td></tr><tr><td>maximum oxidation number of elements in chlorides</td><td>(+)1</td><td>(+)2</td><td>(+)3</td><td>(+)4</td><td>(+)5</td></tr></table>					element	Na	Mg	Al	Si	P	maximum oxidation number of elements in chlorides	(+)1	(+)2	(+)3	(+)4	(+)5	1
	element	Na	Mg	Al	Si	P													
	maximum oxidation number of elements in chlorides	(+)1	(+)2	(+)3	(+)4	(+)5													
All correct for one mark																			
2(a)(ii)	number of outer/valence electrons																		
						1													

Q6 - Official MS
9701/22/F/M/24/Q1(c)(i)-(ii)

2 marks

1(c)(i)	Bi_2O_3 (+)3 / III AND NaBiO_3 (+)5 / V	1
1(c)(ii)	Bi_2O_3	1

Q7 - Official MS

9701/22/F/M/25/Q1(a)(i)

2 marks

1(a)(i)	• (+)3 / III • (+)5 / V • -1 / I • -1 / I	2
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Q8 - Official MS

9701/21/M/J/25/Q1(c)

2 marks

1(c)	M1 $\text{NaCl} + 1$ AND $\text{PCl}_5 + 5$ M2 Na has only 1 valence (shell) electrons AND P has 5	2
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Q9 - Official MS

9701/23/M/J/23/Q1(d)(i)-(ii)

2 marks

1(d)(i)	$2\text{Cu}^{2+} + 4\text{I}^- \rightarrow 2\text{CuI} + \text{I}_2$	1
1(d)(ii)	Cu^{2+} OR CuSO_4 AND copper (species / ion) has gained / taken electron(s) from iodide (ion)	1

Q10 - Official MS

9701/22/O/N/24/Q3(b)(i)-(ii)

2 marks

3(b)(i)	(+)5 / V	1
3(b)(ii)	aluminium / Al	1

Q11 - Official MS

9701/21/M/J/21/Q4(a)

1 mark

4(a)	Br / bromine as the oxidation number of Br decreases / goes from 0 $\rightarrow$ -1 OR bromine as it causes oxidation number of C (in methanoic acid) to increase / go from (+)2 $\rightarrow$ (+)4	1
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Q12 - Official MS

9701/22/F/M/22/Q2(a)(i)

1 mark

2(a)(i)	species that donates electrons	1
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Q13 - Official MS

9701/21/O/N/23/Q3(a)

1 mark

3(a)	compound / molecule / substance that oxidises another / is reduced	1
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Q14 - Official MS

9701/24/O/N/25/Q1(a)(i)-(ii)

2 marks

1(a)(i)	(halogens can) remove electron(s) (from a reactant)	1
1(a)(ii)	$2Al + 3Cl_2 \rightarrow 2AlCl_3$	1

Q15 - Official MS

9701/23/M/J/21/Q1(f)

2 marks

1(f)	M1 products contain Cl^- AND Cl_2	1
	M2 correct balanced equation $ClO^- + 2HCl \rightarrow Cl^- + H_2O + Cl_2$	1

Q16 - Official MS

9701/21/O/N/25/Q1(c)(i)-(ii)

2 marks

1(c)(i)	Cr / $Cr_2O_7^{2-}$ AND it gains electrons	1
1(c)(ii)	(+)4	1

Q17 - Official MS

9701/22/O/N/25/Q1(c)(i)-(ii)

2 marks

1(c)(i)	Mn / MnO_2 AND it gains electrons	1
1(c)(ii)	(+)4	1

Q18 - Official MS

9701/22/F/M/21/Q2(d)(i)-(ii)

2 marks

2(d)(i)	when a species is both oxidised and reduced	1
2(d)(ii)	$Cl_2 + 2NaOH \rightarrow NaCl + NaClO + H_2O$	1

Q19 - Official MS

9701/21/O/N/23/Q3(c)

1 mark

3(c)	Cl/ chlorine is both oxidised and reduced	1
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Q20 - Official MS

9701/22/O/N/23/Q3(b)(iii)

2 marks

3(b)(iii)	P (in H_3PO_3) is (both) oxidised and reduced (simultaneously)	1
	P (is oxidised) from (+)3 / (+)III $\rightarrow$ (+)5 / (+)V AND (reduced to) -3 / -III	1

Q21 - Official MS

9701/22/F/M/24/Q2(b)(i)-(iii)

3 marks

2(b)(i)	disproportionation	1
2(b)(ii)	NaClO / sodium chlorate(I)	1
2(b)(iii)	$3\text{Cl}_2 + 6\text{NaOH} \rightarrow \text{NaClO}_3 + 5\text{NaCl} + 3\text{H}_2\text{O}$	1

Q22 - Official MS

9701/21/O/N/24/Q2(c)(ii)

1 mark

2(c)(ii)	a reaction where a species / same species is both oxidised and reduced simultaneously / in the same reaction	1
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Q23 - Official MS

9701/24/M/J/25/Q2(b)(ii)

2 marks

2(b)(ii)	oxidation number of S in $\text{SCl}_2 = (+) 2 / (+) \text{II}$ oxidation number of S in $\text{H}_2\text{SO}_3 = (+) 4 / (+) \text{IV}$	2
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