

Past-paper walk-through

The reactions of chlorine ■ 11.4

eXercise

Questions in this set

- 9701/12 N25 Q21 ■ 1 mark
- 9701/14 N25 Q22 ■ 1 mark
- 9701/24 N25 Q1 ■ 22 marks

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- **//** separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = “or words to that effect” – the wording need not match.

Question 21

9701/12 N25 ■ Q21 ■ 1 mark

21 In an experiment, 0.600 mol of chlorine gas, Cl_2 , is reacted with an excess of hot aqueous sodium hydroxide. One of the products is NaClO_3 .

Which mass of NaClO_3 is formed?

A 21.3 g

B 44.7 g

C 63.9 g

D 128 g

Solution 21

Answer: **A**

Why

- Hot concentrated alkali disproportionates chlorine: $3\text{Cl}_2 + 6\text{NaOH} \rightarrow 5\text{NaCl} + \text{NaClO}_3 + 3\text{H}_2\text{O}$.
- So three moles of chlorine give just one of NaClO_3 : $0.600/3 = 0.200$ mol.
- $M_r = 106.5$, so the mass is $0.200 \times 106.5 = 21.3$ g.

Question 22

9701/14 N25 ■ Q22 ■ 1 mark

22 An excess of chlorine gas is bubbled into hot potassium hydroxide solution.

Which chlorine-containing species are present in the final solution?

- A** Cl^- and ClO^-
- B** Cl^- and ClO_3^-
- C** ClO^- and ClO_3^-
- D** ClO_3^- only

Solution 22

Answer: **B**

Why

- In *hot* alkali chlorine disproportionates all the way to chloride and chlorate(V).
- $3\text{Cl}_2 + 6\text{OH}^- \rightarrow 5\text{Cl}^- + \text{ClO}_3^- + 3\text{H}_2\text{O}$.
- ClO^- is the *cold*-alkali product, so it is not present here.

Question 1

9701/24 N25 ■ Q1 ■ 22 marks

1 The Group 17 elements are oxidising agents.

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

Question 1

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

Question 1

- (iii) A student heats equal amounts of $\text{I}_2(\text{g})$ and $\text{H}_2(\text{g})$ in a sealed flask. The student leaves the contents to cool.

State what you would observe during the reaction.

Question 1

- (b)** Cl_2 and Br_2 can each react with NH_3 to give N_2 and a hydrogen halide, HX .



The relative bond strengths of X-X and H-X determine the difference in enthalpy change of the two reactions.

- (i)** Describe and explain the difference in the X-X bond strengths of Cl_2 and Br_2 .

Question 1

- (ii) Describe the relative thermal stabilities of HCl and HBr .

Question 1

- (iii) Define enthalpy change of formation, ΔH_f .

Question 1

(iv) Table 1.1 gives data relevant to the reaction of $\text{Cl}_2(\text{g})$ with $\text{NH}_3(\text{g})$.

Table 1.1

compound	enthalpy change of formation, $\Delta H_f^\circ / \text{kJ mol}^{-1}$
$\text{NH}_3(\text{g})$	-46
$\text{HCl}(\text{g})$	-92

Use the data in Table 1.1 to calculate the enthalpy change of the reaction of $\text{Cl}_2(\text{g})$ with $\text{NH}_3(\text{g})$.

Question 1

Question 1

(v) I_2 reacts with NH_3 to form NI_3 .

Predict the shape of a molecule of NI_3 . Explain your answer.

Question 1

Question 1

Question 1

[2]

(c) Table 1.2 shows some information about reactions of NaCl, NaBr and NaI.

Table 1.2

	NaCl	NaBr	NaI
observation with $\text{Ag}^+(\text{aq})$	white precipitate		
type of reaction with concentrated H_2SO_4	acid–base	acid–base, then redox	acid–base, then redox
observations with concentrated H_2SO_4			• black solid • yellow solid • effervescence

(i) Complete Table 1.2.

[4]

Question 1

Question 1

- (ii) Suggest an identity for the species that produces each observation in the reaction of NaI with concentrated H_2SO_4 .

Question 1

Question 1

Question 1

[2]

(d) Table 1.3 gives some information about MgCl_2 and SiCl_4 .

Table 1.3

	MgCl_2	SiCl_4
electrical conductivity when liquid	conducts	does not conduct
observation when added to water	dissolves	vigorous reaction

- (i) Explain the difference between the electrical conductivity of liquid MgCl_2 and of liquid SiCl_4 . Refer to bonding and relevant particles in your answer.

Question 1

- (ii) Suggest the pH of the solutions that form when each chloride is added to water.

Question 1

[2]

Total: 221 -

Solution 1

(a)(i)

Mark scheme

- (halogens can) remove electron(s) (from a reactant)
- 1

(a)(ii)

Mark scheme

- $2\text{Al} + 3\text{Cl}_2 \rightarrow 2\text{AlCl}_3$ /1

Solution 1

(a)(iii)

Mark scheme

- purple (gas) disappears
- 1

Solution 1

(b)(i)

Mark scheme

- M1 Br—Br is weaker (than Cl—Cl) AND Br atoms are larger (M2)
- less (significant) overlap of orbitals (in Br-Br)
- 2

Solution 1

(b)(ii)

Mark scheme

- HCl is more thermally stable
- 1

Solution 1

(b)(iii)

Mark scheme

- M1 (enthalpy change / energy change) when one mole of a compound / substance is formed **M2**
- from its (constituent) elements in their standard state(s)
- 2

Solution 1

(b)(iv)

Mark scheme

- M1 $(6 \times -92) - (2 \times -46) =$ M2
- $-460 \text{ (kJ mol}^{-1}\text{)}$
- 2

Solution 1

(b)(v)

Mark scheme

- M1 (trigonal) pyramidal **M2**
- three bonding pairs AND one lone pair (of electrons)
- 2

Solution 1

(c)(i) Mark scheme

- NaCl
- NaBr
- NaI
- with $\text{Ag}^+(\text{aq})$
- white precipitate (M1)
- cream / off-white
- ppt (M2)
- yellow ppt

Solution 1

- with conc.
- H_2SO_4
- acid – base
- acid – base,
- then redox
- acid – base,
- then redox
- observations
- with conc.
- H_2SO_4 M3

Solution 1

- steamy fumes
- OR
- fizzing M4
- brown liquid
- OR
- fizzing
- ■
- black solid
- ■
- yellow solid

Solution 1

- ■
- effervescence
- 4
- 9701/24
- October/November 2025

Solution 1

(c)(ii)

Mark scheme

- M1 black solid = iodine / I_2 AND yellow solid = sulfur / $S(8)$ **M2**
- effervescence = hydrogen sulfide / $H_2S(g)$
- 2

Solution 1

(d)(i)

Mark scheme

- M1 MgCl_2 (is ionic and) has mobile ions (M2)
- SiCl_4 is covalent AND no charge carriers
- OR (no ions and) no delocalised electrons
- OR no mobile / moving ions
- 2

Solution 1

(d)(ii)

Mark scheme

- M1 MgCl_2 pH = 7 (M2)
- SiCl_4 pH 0 – 4/2 9701/24
- October/November 2025