Past-paper walk-through

The chemical properties of the halogen elements and the hydrogen halides ▪ 11.2

eXercise

Questions in this set

- 9701/11 N25 Q22 ▪ 1 mark
- 9701/11 N25 Q23 ▪ 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 22

9701/11 N25 ▪ Q22 ▪ 1 mark

22 What happens when iodine solution is added to a solution of sodium bromide?

A A reaction occurs without changes in oxidation state.

B Bromide ions are oxidised; iodine atoms are reduced.

C Bromide ions are reduced; iodine atoms are oxidised.

D No reaction occurs.

Solution 22

Answer: **D**

Why

- A halogen displaces only the halide ions *below* it in the group.
- Iodine sits below bromine, so it is the weaker oxidising agent.
- It cannot oxidise bromide ions, so nothing happens.

Question 23

9701/11 N25 ▪ Q23 ▪ 1 mark

23 Which statement is correct?

A Nitrogen is unreactive due to the absence of lone pairs in the molecule.

B Aqueous ammonia contains both $NH_3(aq)$ and $NH_4^+(aq)$. The $NH_4^+(aq)$ ion is a Brønsted–Lowry acid.

C High temperatures are needed to supply the energy to break the strong double bonds in nitrogen molecules when they react.

D Atmospheric SO_2 reacts with unburnt hydrocarbons to form a component of photochemical smog.

Solution 23

Answer: **B**

Why

- Ammonia is a weak base, so its solution holds both NH_3 and the NH_4^+ formed from it.
- NH_4^+ can donate a proton, which is the Br\o{}nsted–Lowry definition of an acid.
- Nitrogen is unreactive because of a strong *triple* bond, and it does have a lone pair – so A and C fail.

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 $I_2(g)$ and $H_2(g)$ 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.

$$3X_2 + 2NH_3 \rightarrow N_2 + 6HX \qquad X = Cl \text{ or } Br$$

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 HC*l* 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 $Cl_2(g)$ with $NH_3(g)$.

Table 1.1

compound	enthalpy change of formation, ΔH_f / kJ mol^{-1}
$NH_3(g)$	–46
$HCl(g)$	–92

Use the data in Table 1.1 to calculate the enthalpy change of the reaction of $Cl_2(g)$ with $NH_3(g)$.

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

[2]

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

Table 1.2

	NaC*l*	**NaBr**	**NaI**
observation with $Ag^+(aq)$	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: 22]

Solution 1

(a)(i)

Mark scheme

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

(a)(ii)

Mark scheme

- $2Al + 3Cl2 \rightarrow 2AlCl3/1$

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 (kJ mol−1)
- 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 Ag+(aq)
- white precipitate **M1**
- cream / off-white
- ppt **M2**
- yellow ppt

Solution 1

- with conc.
- H2SO4
- acid – base
- acid – base,
- then redox
- acid – base,
- then redox
- observations
- with conc.
- H2SO4 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 / I2 AND yellow solid = sulfur / S(8) M2
- effervescence = hydrogen sulfide / H2S(g)
- 2

Solution 1

(d)(i)

Mark scheme

- M1 MgCl2 (is ionic and) has mobile ions M2
- SiCl4 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 MgCl2 pH = 7 M2
- SiCl4 pH 0 – 4/2 9701/24
- October/November 2025