InkChemistry

ANSWER BOOK

Halide ions, the silver nitrate test, concentrated sulfuric acid, and chlorine in water

Group 2 and Group 7 · Unit C13

AQA 3.2.3.1, 3.2.3.2 · OCR A 3.1.3, 3.1.4

21 questions · 73 marks

NAVY EDITION

Every question in this book has a code beside its number.
Type inklearning.co.uk/q/ followed by the code to open that question online.
© 2026 Ink Learning Ltd. All rights reserved.
inklearning.co.uk/chemistry/

SECTION A · Short, 1 to 2 marks

A1 HI-Q23

B1 the H–F bond is much stronger than the H–Cl bond, because the small fluorine atom holds the shared pair close to its nucleus. **B1** so hydrogen fluoride gives its proton to water less readily and ionises only partly, while hydrogen chloride ionises completely. [2]

SECTION B · Standard, 3 to 5 marks

B1 HI-Q2

B1 reducing ability increases from fluoride to iodide. **B1** an iodide ion is larger, so its outer electrons are further from the nucleus. **B1** its outer electrons are more shielded by inner shells. **B1** they are less strongly attracted, so an iodide ion loses an electron more easily; reject 'iodine loses electrons'. [4]

B2 HI-Q4

B1 misty white fumes, due to hydrogen bromide. **B1** a brown gas (orange-brown fumes), due to bromine. **B1** a colourless, choking gas, sulfur dioxide, is also formed; ignore 'steamy fumes' for SO_2. **B1** $2HBr + H_2SO_4 \rightarrow Br_2 + SO_2 + 2H_2O$; allow the ionic form $2Br^- + H_2SO_4 + 2H^+ \rightarrow Br_2 + SO_2 + 2H_2O$. [4]

B3 HI-Q13

B1 chlorine (as HClO and ClO^-) disinfects the water so bacteria cannot survive, preventing the spread of diseases such as cholera and typhoid. **B1** some chlorine remains in the water, so it continues to disinfect it in the pipes. **B1** chlorine is toxic, and it can react with organic matter to form chlorinated hydrocarbons that may cause cancer. **B1** a conclusion: the benefit to public health outweighs the risk at the low concentrations used; a conclusion with no reason is not credited. [4]

B4 HI-Q19

B1 ammonium ions react with hydroxide ions to give ammonia gas: $NH_4^+(aq) + OH^-(aq) \rightarrow NH_3(g) + H_2O(l)$. **B1** ammonia is an alkaline gas and turns damp red litmus paper blue; it is the only common alkaline gas. **B1** ammonia must dissolve in water on the paper to form hydroxide ions before the litmus can change colour. **B1** sodium hydroxide on the glass is itself alkaline, so touching it would turn the paper blue even without ammonia. [4]

B5 HI-Q20

B1 misty fumes form, because hydrogen bromide is very soluble and dissolves in water vapour to form droplets of acid. **B1** $HBr(g) + H_2O(l) \rightarrow H_3O^+(aq) + Br^-(aq)$. **B1** dense white smoke forms, which is solid ammonium bromide, made as ammonia takes the proton from the hydrogen bromide. **B1** $NH_3(g) + HBr(g) \rightarrow NH_4Br(s)$. [4]

B6 HI-Q5

B1 +6 in sulfuric acid, H_2SO_4. **B1** +4 in sulfur dioxide, SO_2, and 0 in sulfur, S. **B1** −2 in hydrogen sulfide, H_2S. [3]

© 2026 Ink Learning Ltd. All rights reserved.

B7 HI-Q6

B1 $NaCl(s) + H_2SO_4(l) \rightarrow NaHSO_4(s) + HCl(g)$; allow $2NaCl + H_2SO_4 \rightarrow Na_2SO_4 + 2HCl$. **B1** no element changes oxidation state: chlorine stays -1 and sulfur stays +6. **B1** chloride ions are too weak a reducing agent to reduce the sulfuric acid, so it acts only as an acid. [3]

B8 HI-Q7

B1 add dilute nitric acid and then silver nitrate solution. **B1** a cream precipitate of silver bromide forms. **B1** the precipitate does not dissolve in dilute ammonia but dissolves in concentrated ammonia. [3]

B9 HI-Q8

B1 the acid removes carbonate (and hydroxide) ions. **B1** these would otherwise react with silver ions to form precipitates and give a false positive. **B1** hydrochloric acid adds chloride ions, which would give a white precipitate of silver chloride whatever the sample contained. [3]

B10 HI-Q9

B1 add dilute nitric acid and silver nitrate: a pale yellow mixture of silver chloride and silver iodide precipitates. **B1** add dilute ammonia: silver chloride dissolves while silver iodide remains, and filter. **B1** acidify the filtrate with dilute nitric acid; a white precipitate of silver chloride reappears, showing chloride. [3]

B11 HI-Q10

B1 astatine, At_2, and hydrogen sulfide (with sulfur and sulfur dioxide) would form. **B1** astatide is an even stronger reducing agent than iodide, so it reduces sulfur all the way to -2. **B1** $8HAt + H_2SO_4 \rightarrow 4At_2 + H_2S + 4H_2O$; allow the ionic form with $8At^-$ and $8H^+$. [3]

B12 HI-Q11

B1 $Cl_2(aq) + 2NaOH(aq) \rightarrow NaCl(aq) + NaClO(aq) + H_2O(l)$. **B1** sodium chlorate(I), NaClO, is the bleach; allow sodium hypochlorite. **B1** chlorine is +1 in NaClO, since oxygen is -2 and the ClO^- ion carries a 1- charge. [3]

B13 HI-Q12

B1 $Cl_2(g) + H_2O(l) \rightleftharpoons HCl(aq) + HClO(aq)$. **B1** chlorine goes from 0 in Cl_2 to -1 in HCl, so it is reduced, and from 0 to +1 in HClO, so it is oxidised. **B1** the same element is oxidised and reduced in the same reaction, which is disproportionation. [3]

B14 HI-Q14

M1 amount of $Cl_2 = 6.00 \div 24.0 = 0.250$ mol. **M1** $Cl_2(aq) + 2NaOH(aq) \rightarrow NaCl(aq) + NaClO(aq) + H_2O(l)$ gives 1 mol NaClO per mol Cl_2, and $Mr(NaClO) = 74.5$. **A1** mass $= 0.250 \times 74.5 = 18.6$ g, to three significant figures. [3]

B15 HI-Q15

M1 amount of $Cl^- = 30.0 \div 1000 \times 0.120 = 3.60 \times 10^{-3}$ mol. **M1** $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$ is 1 : 1, and $Mr(AgCl) = 143.4$. **A1** mass $= 3.60 \times 10^{-3} \times 143.4 = 0.516$ g, to three significant figures. [3]

© 2026 Ink Learning Ltd. All rights reserved.

B16 HI-Q16 [3]

B1 both give misty white fumes of hydrogen halide, though far less with sodium iodide. **B1** sodium iodide also gives purple vapour or a black solid (iodine) and a yellow solid (sulfur). **B1** sodium iodide gives a smell of bad eggs (hydrogen sulfide); sodium chloride gives nothing further, because chloride does not reduce the acid.

B17 HI-Q22 [3]

M1 amount of NaX = amount of AgX, so $0.250 \div (23.0 + x) = 0.613 \div (107.9 + x)$. **M1** $0.250 \times (107.9 + x) = 0.613 \times (23.0 + x)$, so $26.98 - 14.10 = 0.363x$. **A1** $x = 35.5$ to three significant figures (Ar has no unit), so X is chlorine and the salt is sodium chloride.

B18 HI-Q25 [3]

B1 chlorine is 0 in Cl_2 and −1 in NaCl. **B1** chlorine is +5 in $NaClO_3$, since three oxygens at −2 and the 1− charge of ClO_3^- leave +5. **B1** chlorine is both reduced, from 0 to −1, and oxidised, from 0 to +5, in the same reaction, so it disproportionates.

SECTION C · Long, 6 marks or more

C1 HI-Q17 [6]

Indicative content

B1 test for carbonate first by adding dilute nitric acid: effervescence, and the gas turns limewater milky. **B1** test a fresh portion for sulfate by adding dilute hydrochloric acid, then barium chloride solution: a white precipitate. **B1** test a fresh portion for chloride by adding dilute nitric acid, then silver nitrate solution: a white precipitate. **B1** the chloride is confirmed when the white precipitate dissolves in dilute ammonia, which neither bromide nor iodide precipitates do. **B1** carbonate is tested first because carbonate ions give white precipitates with both barium and silver ions. **B1** sulfate is tested before chloride because silver sulfate can precipitate, and the acids are chosen so as not to add the ion being tested for.

Levels

Level 3 (5–6 marks) all three tests are given in the right order with the reagents, the acids and the observations, the ammonia confirmation for chloride is included, and both reasons for the order are explained, carbonate interfering with both later tests and silver sulfate interfering with the chloride test; the answer explains why each acid is chosen.

Level 2 (3–4 marks) the three tests have the right reagents and observations; the order is only partly justified, the ammonia confirmation is left out, or an acid is chosen that adds the ion under test.

Level 1 (1–2 marks) one or two tests are described; the usual slip is to acidify the barium chloride test with sulfuric acid or the silver nitrate test with hydrochloric acid.

© 2026 Ink Learning Ltd. All rights reserved.

C2 HI-Q24

Indicative content [6]

B1 with sodium chloride, misty white fumes of hydrogen chloride form, $NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl$, an acid–base reaction that is not redox. **B1** with sodium bromide, misty fumes of hydrogen bromide form first, and then brown fumes of bromine and colourless, choking sulfur dioxide. **B1** $2HBr + H_2SO_4 \rightarrow Br_2 + SO_2 + 2H_2O$, in which sulfur is reduced from +6 to +4 and bromide is oxidised to bromine. **B1** with sodium iodide there are few misty fumes, but purple vapour or a black solid of iodine, a yellow solid of sulfur and a bad-egg smell of hydrogen sulfide. **B1** iodide reduces sulfur to +4 in SO_2, 0 in S and -2 in H_2S, for example $8HI + H_2SO_4 \rightarrow 4I_2 + H_2S + 4H_2O$. **B1** reducing ability increases from chloride to iodide because the larger ion's outer electrons are further from the nucleus and more shielded, so lost more easily.

Levels

Level 3 (5–6 marks) the observations for all three halides are given and matched to the products, the chloride reaction is identified as acid–base only, the bromide and iodide reactions are shown with equations and the oxidation states of sulfur in each product, and the trend in reducing power is explained through the size and shielding of the halide ion.

Level 2 (3–4 marks) the observations for the three halides are mostly right and one equation carries oxidation states; the chloride reaction is not called acid–base, the sulfur products from iodide are incomplete, or the trend is unexplained.

Level 1 (1–2 marks) misty or brown fumes are mentioned; the chloride is often said to reduce the acid to sulfur dioxide, and no oxidation states are given.

© 2026 Ink Learning Ltd. All rights reserved.

THIS BOOK ONLINE

Scan the code, or type the address, to open the questions in this book online:

inklearning.co.uk/chemistry/practise/questions/halide-ions-and-chlorine/

© 2026 Ink Learning Ltd. All rights reserved.