EXAM PAPERS PRACTICE

Boost your performance and confidence with these topic-based exam questions

Practice questions created by actual examiners and assessment experts

Detailed mark scheme

Suitable for all boards

Designed to test your ability and thoroughly prepare you

Halogen 2

CHEMISTRY

Mark Scheme

AQA

AS & A LEVEL

Inorganic Chemistry

Mark schemes

1

(a) Hydrochloric acid contains chloride ions / Cl^-
OR
Chloride ions / Cl^- (in the acid) would react
OR
Chloride ions / Cl^- would interfere with the test
OR
Would form a (white) precipitate
OR
Would form insoluble AgCl

QoL
If a precipitate colour is given it must be white

1

(b) **M1** No precipitate
OR
Colourless solution
OR
No change.

1

Ignore "nothing"

M2 Silver fluoride / AgF is soluble (in water)
Do not penalise the spelling "flouride"

1

(c) **M1** Yellow precipitate
OR
Yellow solid

Both words needed for M1
Ignore "pale" as a prefix before "yellow"

1

M2 $Ag^+ + I^- \rightarrow AgI$

Ignore state symbols
Allow crossed out nitrate ions, but penalise if not crossed out

1

[5]

2

(a) sulfuric acid / H_2SO_4

1

(b) hydriodic acid / HI **OR** hydrobromic acid / HBr

1

(c) add **dilute** ammonia solution

Notes
* *do not allow 'concentrated ammonia' or 'ammonia '*

1

precipitate / ppt disappears / dissolves **OR** colourless solution forms

1

(d) would react with the acid / no gas evolved in tests

1

[5]

3

Mark Range	The marking scheme for this part of the question includes an overall assessment for the Quality of Written Communication (QWC). There are no discrete marks for the assessment of QWC but the candidates' QWC in this answer will be one of the criteria used to assign a level and award the marks for this part of the question **Descriptor** an answer will be expected to meet most of the criteria in the level descriptor
4-5	– claims supported by an appropriate range of evidence – good use of information or ideas about chemistry, going beyond those given in the question – argument well structured with minimal repetition or irrelevant points – accurate and clear expression of ideas with only minor errors of grammar, punctuation and spelling
2-3	– claims partially supported by evidence – good use of information or ideas about chemistry given in the question but limited beyond this – the argument shows some attempt at structure – the ideas are expressed with reasonable clarity but with a few errors of grammar, punctuation and spelling
0-1	– valid points but not clearly linked to an argument structure – limited use of information or ideas about chemistry – unstructured – errors in spelling, punctuation and grammar or lack of fluency

(a) Kills bacteria / prevents bacterial diseases QWC

1

Chlorine is a toxic substance

1

$Cl_2 + H_2O \rightarrow HCl + HClO$

1

(b) $Cl_2(aq)$ to $Br^-(aq)$; yellow-orange or yellow-red or QWC
yellow-brown solution

1

$2Br^- + Cl_2 \rightarrow 2Cl^- + Br_2$
or molecular equation

1

$Cl_2(aq)$ to $I^-(aq)$; brown/black solution formed or QWC
black/brown/grey ppt/solid

1

$2I^- + Cl_2 \rightarrow 2Cl^- + I_2$
or molecular equation

1

(c) Bromide: Brown/orange fumes

1

Bromine produced

1

Sulphur dioxide produced

1

Iodide: Purple fumes or black/brown/grey solid QWC or smell of bad eggs

1

Iodine produced

1

SO_2, S, H_2S produced (one mark each)

3

Half-equations $2Br^- \rightarrow Br_2 + 2e^-1$

OR $2I^- \rightarrow I_2 + 2e^-$

1

$H_2SO_4 + 2e^- + 2H^+ \rightarrow SO_2 + 4H_2O$

OR $H_2SO_4 + 6e^- + 6H^+ \rightarrow S + 4H_2O$

OR $H_2SO_4 + 8e^- + 8H^+ \rightarrow H_2S + 4H_2O$

1

Overall equation Any correct equation based on half-equations QWC

1

[18]

4 (a) Reduction involves gain of electrons (1)

A reducing agent loses (donates) electrons (1)

2

(b) (i) Sulphur dioxide (1)

oxidation state +4 (1)

Sulphur (1)

oxidation state 0 (1)

Hydrogen sulphide (1)

oxidation state – 2 (1)

6

(ii) Sulphur dioxide is a choking gas or has a pungent odour (1)

Sulphur is a yellow solid (1)

Hydrogen sulphide has a smell of bad eggs (1)

Any 2 marks

2

(iii) $SO_4^{2-} + 4H^+ + 2e^- \rightarrow SO_2 + 2H_2O$ (1)

$SO_4^{2-} + 8H^+ + 6e^- \rightarrow S + 4H_2O$ (1)

$SO_4^{2-} + 10H^+ + 8e^- \rightarrow H_2S + 4H_2O$ (1)

Any 2 marks

(Allow equations with H_2SO_4)

2

(c) $Cl_2 + H_2O \rightarrow H^+ + Cl^- + HOCl$

or $Cl_2 + H_2O \rightarrow 2H^+ + Cl^- + OCl^-$

or $Cl_2 + H_2O \rightarrow HCl + HOCl$ (1)

Water is not oxidised (1)

The oxidation states of O (–2) and H (+1) remain unchanged (1)

3

[15]

5 D

[1]

6 (a) decreases

1

number of shells increases/ shielding increases /atomic size increases

weaker attraction (by nucleus) on bonding electrons / weaker attraction (by nucleus)

1

on electron pair in a covalent bond

1

(b) (i) increases

1

(ii) concentrated sulphuric acid

1

(c) white ppt

1

soluble in ammonia

1

cream ppt

1

partially soluble /insoluble in ammonia

1

(d) $Cl_2 + 2NaOH \rightarrow NaCl + NaOCl + H_2O$

1

bleach

1

disinfectant /steriliser/kills bacteria

1

[12]

7 (a) decreases;

1

increase in shielding ;

1

(or atomic radius)
less attraction for bonding *(or shared)* electrons;

1

(b) brown solution;

1

(or black solid)
$Cl_2 + 2KI \rightarrow 2KCl + I_2$;

(or ionic equation)

1

(c) SO_2;

1

$SO_4^{2-} + 4H^+ 2e^- \rightarrow SO_2 + 2H_2O$;

1

S (also H_2S);

1

$SO_4^{2-} + 8H^+ 6e^- \rightarrow S + 4H_2O$ (or $SO_4^{2-} + 10H^+ + 6e^- \rightarrow H_2S + 4H_2O$)

1

(d) $Cl_2 + 2NaOH \rightarrow NaCl + NaOCl + H_2O$;

1

sodium chloride;

1

–1;

1

sodium chlorate(I) (or bleach etc);

1

+1;

1

[14]

8 (a) (i)

	The addition of $AgNO_3$	followed by concentrated	the addition of $NH_3(aq)$
Observation with NaBr(aq)	Cream or off white precipitate or solid (1)	Precipitate dissolves (1)	
Observation with NaI(aq)	Yellow precipitate or solid (1)	Precipitate insoluble or no change (1)	

(ii) Ag F is soluble;

5

(b) (i) identity: $[Ag(S_2O_3)_2]^{3-}$;

1

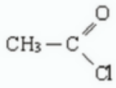
(ii) equation: $AgI + 2S_2O_3^{2-} \rightarrow [Ag(S_2O_3)_2]^{3-} + I^-$

1

(iii) use: in photography or as a fixer;

1

(c) (i) Structure

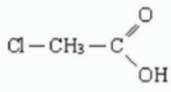


1

Observation: Vigorous or violent or exothermic reaction
or fumes or white precipitate formed immediately

1

(ii) Structure:



1

Observation: No immediate precipiate or reaction

OR

white precipitate formed very slowly;

1

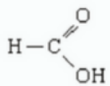
(d) (i) Silver-containing complex: $[Ag(NH_3)_2]^+$;

1

Shape: Linear;

1

(ii) Structure



1

Explanation: Methanoic acid contains an aldehyde group;

1

(iii) H_2CO_3 or CO_2 or $OC(OH)NH_2$ or $(NH_2)_2CO$ or $(NH_4)_2CO_3$

OR

$HCOONH_4$;

1

[17]

[1]

10 A [1]

11 A [1]

12 B [1]

13 D [1]

14 D [1]

15 A [1]

16 B [1]

17 C [1]

18 D [1]

19 D [1]

20 C [1]

21 (a) (i) Halides:- Fluoride
Chloride **(1)**

Equation:- $H^+ + F^- \rightarrow HF$ *(or molecular / for a correct halide)* **(1)**

(ii) Halides:- Bromide and iodide **(1)**

Equation:- H_2SO_4 *(or* $2H^+ + SO_4^{2-}$*)* $+ 2H^+ + 2e^- \rightarrow SO_2 + 2H_2O$ **(1)**

$2Br^- \rightarrow Br_2 + 2e^-$ **(1)**

$H_2SO_4 + 2H^+ + 2Br^-$ (or 2HBr) $\rightarrow Br_2 + SO_2 + 2H_2O$ **(1)**

Q of L penalise wrong symbol for fluoride or bromide once
Ignore state symbols in equations

(iii) Products Sulphur (or S_8 not S_4) **(1)**
Hydrogen sulphide **(1)**

Equation:- H_2SO_4 *(or* $2H^+ + SO_4^{2-}$*)* $+ 6H^+ + 6e^- \rightarrow S + 4H_2O$ **(1)**
OR
H_2SO_4 *(or* $2H^+ + SO_4^{2-}$*)* $+ 8H^+ + 8e^- \rightarrow H_2S + 4H_2O$

9

Ignore halide if given even if incorrect
Do not allow elements, molecules or atoms in part (a)

(b) Addition of silver nitrate

Chloride gives white precipitate / solid **(1)**
Bromide gives cream precipitate / solid **(1)**
Iodide gives yellow precipitate / solid **(1)**

Addition of ammonia

Chloride precipitate soluble in dilute **(1)**
Bromide precipitate soluble in concentrated **(1)**
Iodide precipitate insoluble **(1)**

Do not allow halogen or sodium halide

6

[15]

22 A

[1]

23 D

[1]

24 (a) Increase

1

Van der Waal's forces between molecules

1

Increase with size (or M_r or surface area etc)

1

More energy needed to break (overcome) these forces

(Note max 2 from last three marks if no mention of molecules or 'molecular')

1

(b) (i) Brown solution (or yellow or orange)

1

$Cl_2 + 2Br \rightarrow 2C1^- + Br_2$

1

(ii) cream precipitate

1

$Br^- + Ag^+ \rightarrow AgBr$

1

Precipitate dissolves

1

(iii) orange (brown) fumes (gas), White fumes (or misty fumes), choking gas (any 2)

2

(c) $2H^+ + H_2SO_4 + 2Br^- \rightarrow SO_2 + Br_2 + 2H_2O$ (SO_2 and Br_2 (1), equation (1))

2

[13]

25 D

[1]

26 C

[1]

27 (a) Gains electrons (or removes electrons)

1

(b) (i) +4

1

+6

1

(ii) $Br_2 + 2e^- \rightarrow 2Br^-$

1

(iii) $SO_2 + 2H_2O \rightarrow 4H^+ + SO_4^{2-} + 2e^-$

1

(iv) $Br_2 + SO_2 + 2H_2O \rightarrow 2Br^- + 4H^+ + SO_4^{2-}$

1

(c) $Cl_2 + H_2O \rightarrow H^+ + Cl^- + HOCl$

1

Chloride: –1

1

Chlorate(I): +1

1

(d) Chloride ions cannot reduce sulphuric acid

(Or chloride ions are weak reducing agents

Or sulphuric acid is not a strong enough oxidising agent

Or sulphuric acid is a weaker oxidising agent than chlorine)

1

(e) $KCl + H_2SO_4 \rightarrow HCl + KHSO_4$

(Allow $2KCl + H_2SO_4 \rightarrow 2HCl + K_2SO_4$)

1

(f) (i) Bromine

1

(ii) Sulphur dioxide

1

[13]

28

(a) (i) HNO_3 or CH_3COOH **(1)**

CE in (a) if incorrect acid given

(ii) $2HNO_3 + Na_2CO_3 \rightarrow 2NaNO_3 + CO_2 + H_2O$ **(1)**

OR $2H^+ + CO_3^{2-} \rightarrow H_2O + CO_2$

Not H_2CO_3

2

(b) (i) I^- or At^- not elements, atoms or molecules **(1)**

(ii) F^- not elements, atoms or molecules **(1)**

2

(c) (i) Cl^- **(1)**

Allow AgCl Not element, atoms or molecules

(ii) Br^- **(1)**

Allow AgBr Not element, atoms or molecules

2

[6]

29

(a) (i) –2 OR 2–

(ii) NaI or NaAt or I^- or iodide or At^-or Astatide **(1)**

Not atoms or molecules

(iii) Smell of bad eggs **(1)**

Allow $PbAc_2$ goes black and $K_2Cr_2O_7/H^+$ goes cloudy green

(iv) $8\ e^- + 8\ H^+ + H_2SO_4 \rightarrow H_2S + 4H_2O$ **(1)**

OR $10\ H^+ + SO_4^{2-}$

4

(b) (i) HF or HCl **(1)**

CE = 0 if redox answer given

If wrong halide given allow max one in b(iii)

If NaF or NaCl, or F^- or Cl^- given lose mark in (i)

Mark on if X is e.g. HF_2 or H_2F

(ii) NaF or NaCl or F^- or Cl^- **(1)**

(iii) A proton donor or an acid **(1)**

(iv) $H^+ + F^- \rightarrow HF$

OR $H_2SO_4 + NaF \rightarrow NaHSO_4 + HF$

OR $H_2SO_4 + 2\ NaF \rightarrow Na_2SO_4 + 2\ HF$

OR for chloride

4

[8]

30 (a) increases from fluorine to iodine **(1)**

sizes of molecules increase **(1)**
(or molecules have more electrons or mass of molecules increases)

QoL mark

Magnitude of intermolecular forces or vdW forces increase **(1)** (or more vdW forces)

More energy required to separate molecules (or particles) **(1)**
(or more energy to break intermolecular forces)
or intermolecular forces difficult to break

4

(b) with NaCl white ppt **(1)**
soluble in ammonia **(1)**

note, if ppt clearly refers to wrong substance
e.g. NaCl then C.E = 0

with NaBr cream (or off white or biege) ppt **(1)**
partially soluble (or insoluble) in ammonia **(1)**

ignore references to conc ammonia

if obviously added silver nitrate mixed with ammonia allow:
*NaCl: no change **(2)***
*NaBr: cream ppt **(2)***

4

(c) oxidising ability decreases from chlorine to iodine (or down the Group) **(1)**

$Cl_2 + 2Br^- \rightarrow 2Cl^- + Br_2$ **(1)**

allow use of NaBr, HBr etc

Br_2 red brown (or yellow or orange) liquid (or solution but not solid) **(1)**

$Cl_2 + 2I^- \rightarrow 2Cl^- + I_2$ **(1)**

allow use of NaBr etc, penalise HI once only

I_2 brown solution / black solid **(1)**

do not allow any reference to purple

$Br_2 + 2I^- \rightarrow 2Br^- + I_2$ **(1)**

Yellow/orange/red-brown/brown solution goes brown/darker brown solution/black solid **(1)**

7

[15]

31 (a) *Trend*: decrease **(1) C.E if wrong**
Explanation: number of shells increases (or atomic radius increases) **(1)**
increased nuclear shielding **(1)**
or less attraction for bond (pair electrons)

3

(b) (i) *Observation*: brown solution or black solid **(1)**

purple wrong

Equation: $Br_2 + 2I^- \rightarrow I_2 + 2Br^-$ **(1)**

Allow NaI, KI

(ii) Br_2 is a weaker oxidising agent than Cl_2 **(1) (or converse)**

3

OR Br_2 is less reactive than Cl_2

penalise Cl, Br, Cl^-, Br^- etc

(c) *Observation with KF (aq)*: no change **(1) (or colourless)**
Observation with KBr(aq): cream/off white ppt **(or solid) (1)**

2

(d) $KF + H_2SO_4 \rightarrow KHSO_4 + HF$ **(1)**

or $2\,KF + H_2SO_4 \rightarrow K_2HSO_4 + 2\,HF$

Allow ions

1

Balanced equation **(1)**

Allow $2\ H_2SO_4 + 2\ NaBr \rightarrow SO_2 + Br_2 + 2\ H_2O + Na_2SO_4$

$H_2SO_4 + 2\ HBr \rightarrow 2\ H_2O + Br_2 + SO_2$ *etc*

2

[11]