

## Mark schemes

## Q1.

- (a) (Random) movement of electrons in one molecule (creates a dipole) / a (temporary) dipole is formed in one molecule / an imbalance in electron density in one molecule 1

Induces a dipole in a neighbouring molecule. 1

(These) temporary dipoles attract / temporary attraction between  $\delta+$  and  $\delta-$  1

- (b)  $\text{Cl}_2 + \text{H}_2\text{O} \rightleftharpoons \text{HCl} + \text{HClO}$  /  $2 \text{Cl}_2 + 2 \text{H}_2\text{O} \rightarrow 4 \text{HCl} + \text{O}_2$  1

Kills bacteria / kills microorganisms / kills microbes / kills pathogens  
*Allow sterilise water / disinfect water* 1

- (c)  $\text{Cl}_2 + 2 \text{NaOH} \rightarrow \text{NaCl} + \text{NaClO} + \text{H}_2\text{O}$  1

[6]

## Q2.

D

$\text{NaI}(\text{aq}) + \text{Br}_2(\text{aq})$  [1]

## Q3.

A

$\text{NaCl}$  [1]

## Q4.

- (a) **M1**  $2\text{H}_2\text{SO}_4 + 2\text{NaBr} \rightarrow \text{Na}_2\text{SO}_4 + \text{SO}_2 + \text{Br}_2 + 2\text{H}_2\text{O}$   
**allow** ionic and equation forming  $\text{NaHSO}_4$   
 $3\text{H}_2\text{SO}_4 + 2\text{NaBr} \rightarrow 2\text{NaHSO}_4 + \text{SO}_2 + \text{Br}_2 + 2\text{H}_2\text{O}$   
 $2\text{H}^+ + 2\text{Br}^- + \text{H}_2\text{SO}_4 \rightarrow \text{SO}_2 + \text{Br}_2 + 2\text{H}_2\text{O}$   
**not** equation from  $\text{HBr}$  unless formation of  $\text{HBr}$  shown in separate equation 1

**M2** orange/brown fumes/solution  
**not** liquid / yellow solid / bad eggs smell / white ppt  
**ignore** choking gas/fumes / steamy/white fumes 1

- (b) HNO<sub>3</sub> removes (hydroxide/carbonate) ions that may give other ppts with AgNO<sub>3</sub> 1

AgNO<sub>3</sub> produces ppts with chloride/iodide/halide  
*not* chlorine/iodine/halogen 1

Ag<sup>+</sup>(aq) + Cl<sup>-</sup>(aq) → AgCl(s) **OR**  
Ag<sup>+</sup>(aq) + I<sup>-</sup>(aq) → AgI(s)  
**allow** Ag<sup>+</sup>(aq) + X<sup>-</sup>(aq) → AgX(s)  
state symbols not required but **not** if wrong 1

NH<sub>3</sub> dissolves AgCl (leaving yellow AgI)  
**allow** chloride/iodide salt/ppt 1

AgCl(s) + 2NH<sub>3</sub>(aq) → Ag(NH<sub>3</sub>)<sub>2</sub><sup>+</sup>(aq) + Cl<sup>-</sup>(aq)  
**allow** with Ag<sup>+</sup>(aq) 1

[7]

**Q5.**

- (a) Reason: sterilise water / disinfect water / kill bacteria / kill microorganisms / kill microbes 1

Explanation: health benefit outweighs risk / only used in small quantities/low concentrations 1

Equation:  
Cl<sub>2</sub> + H<sub>2</sub>O ⇌ HCl + HClO  
2 Cl<sub>2</sub> + 2 H<sub>2</sub>O → 4 HCl + O<sub>2</sub> 1

- (b) 2I<sup>-</sup> → I<sub>2</sub> + 2e<sup>-</sup> 1

H<sub>2</sub>SO<sub>4</sub> + 6H<sup>+</sup> + 6e<sup>-</sup> → S + 4H<sub>2</sub>O  
*Allow* S<sub>8</sub> 1

6H<sup>+</sup> + 6I<sup>-</sup> + H<sub>2</sub>SO<sub>4</sub> → 3I<sub>2</sub> + S + 4H<sub>2</sub>O  
*Allow correct equations using 8H<sup>+</sup> + SO<sub>4</sub><sup>2-</sup>* 1

SO<sub>2</sub> or H<sub>2</sub>S  
*Mark independently* 1

- (c) To ensure that all the halide ions (chloride and iodide) are removed from the solution / to ensure that all the halide ions precipitate out of solution

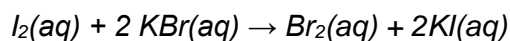
*Must refer either to both halide ions, or to all halide ions.*

- 1
- (d)  $n(\text{AgI}) = 0.315/234.8 = 1.34 \times 10^{-3}$  moles  
1
- (e)  $n(\text{NaI}) = 1.34 \times 10^{-3}$   
mass of NaI =  $1.34 \times 10^{-3} \times 149.9 = 0.201\text{g}$   
*Ans part (d) x 149.9*  
1
- (f) mass of NaCl =  $600 - 201 = 399\text{mg}$   
 $600 - (\text{Ans part (e)} \times 1000)$   
1
- $\% \text{NaCl} = 399/600 \times 100 = 66.5\%$   
(66.5 – 68.3)  
**M1**/600 x 100  
OR  
(Ans part (e) x 1000) / 600 x 100  
100 – **M1**  
1  
[12]

**Q6.****B**

*boiling point*

[1]

**Q7.****D**

[1]

**Q8.**

- (a) Colourless (solution)  
*Allow no (visible) change, no reaction or no ppt (formed)*  
*Ignore none or nothing*  
1
- (b) **M1** Misty or steamy or white fumes/gas  
1
- M2**  $\text{NaCl} + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{HCl}$  OR  $2\text{NaCl} + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + 2\text{HCl}$   
*Accept multiples*  
1

	<b>M3</b> Base OR proton acceptor	1
(c)	<b>M1</b> $2\text{NaBr} + 2\text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + \text{Br}_2 + \text{SO}_2 + 2\text{H}_2\text{O}$ OR $2\text{Br}^- + 2\text{H}^+ + \text{H}_2\text{SO}_4 \rightarrow \text{SO}_2 + \text{Br}_2 + 2\text{H}_2\text{O}$ <b>M1</b> Allow ionic equations $2\text{Br}^- + 2\text{H}_2\text{SO}_4 \rightarrow \text{Br}_2 + \text{SO}_4^{2-} + \text{SO}_2 + 2\text{H}_2\text{O}$ OR $2\text{Br}^- + 4\text{H}^+ + \text{SO}_4^{2-} \rightarrow \text{Br}_2 + \text{SO}_2 + 2\text{H}_2\text{O}$	1
	Br changes oxidation state from <u>-1 to 0</u> and is <u>oxidised</u>	1
	S changes oxidation state from <u>+6 to +4</u> and is <u>reduced</u>	1
(d)	<b>M1</b> Yellow or orange <u>solution</u> <b>M1</b> Do not accept brown solution	1
	<b>M2</b> $\text{Cl}_2 + 2\text{Br}^- \rightarrow 2\text{Cl}^- + \text{Br}_2$ <b>M2</b> Accept multiples	1
		[9]
<b>Q9.</b>		
C		[1]
<b>Q10.</b>		
A		[1]
<b>Q11.</b>		
C		[1]
<b>Q12.</b>		
A		[1]
<b>Q13.</b>		
(a)	$\text{NaCl} + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{HCl}$ Allow $2\text{NaCl} + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + 2\text{HCl}$	1
	Proton donor Allow (Bronsted-Lowry) acid	

- 1
- (b)  $2 \text{NaBr} + 2 \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + \text{SO}_2 + \text{Br}_2 + 2 \text{H}_2\text{O}$   
 Or  
 $2 \text{NaBr} + 3 \text{H}_2\text{SO}_4 \rightarrow 2 \text{NaHSO}_4 + \text{SO}_2 + \text{Br}_2 + 2 \text{H}_2\text{O}$   
 Or  
 $2 \text{H}^+ + 2 \text{Br}^- + \text{H}_2\text{SO}_4 \rightarrow \text{SO}_2 + \text{Br}_2 + 2 \text{H}_2\text{O}$   
 Or  
 $4 \text{H}^+ + 2 \text{Br}^- + \text{SO}_4^{2-} \rightarrow \text{SO}_2 + \text{Br}_2 + 2 \text{H}_2\text{O}$   
*Ignore  $2 \text{NaBr} + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + 2 \text{HBr}$*   
*Ignore  $\text{NaBr} + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{HBr}$*
- 1
- brown gas or brown fumes or orange gas or orange fumes  
*Do not accept yellow solid*  
*Ignore fizzing and misty fumes*
- 1
- Oxidising agent  
*Allow electron acceptor*  
*Ignore acid / proton donor*
- 1
- (c) (+)5 and -1
- 1
- (d) Is oxidised and reduced  
*Allow undergoes disproportionation*  
*Allows gains and loses electrons*
- 1
- (e) D AgBr  
*Ignore state symbols*
- 1
- E Ag<sub>2</sub>CO<sub>3</sub>
- 1
- F CO<sub>2</sub>
- 1
- $2 \text{Ag}^+ + \text{CO}_3^{2-} \rightarrow \text{Ag}_2\text{CO}_3$
- 1
- $\text{AgBr} + 2 \text{NH}_3 \rightarrow \text{Ag}(\text{NH}_3)_2^+ + \text{Br}^-$   
 Or  $\rightarrow \text{Ag}(\text{NH}_3)_2\text{Br}$   
*One mark for  $\text{Ag}(\text{NH}_3)_2^+$  and 1 mark for equation*  
*If D = AgCl, then allow 2 marks for*  
 $\text{AgCl} + 2 \text{NH}_3 \rightarrow \text{Ag}(\text{NH}_3)_2^+ + \text{Cl}^-$
- 2

[13]

Q14.

<p>Marks awarded for this answer will be determined by the quality of written communication as well as the standard of the scientific response. Examiners should apply a 'best-fit' approach to the marking.</p> <p><b>Additional tests limits to lower mark within a level.</b> This would include, for example, adding silver nitrate to the already identified sodium carbonate.</p> <p>Use of hydrochloric acid with silver nitrate also limits to lower mark within a level as this would not be a logical sequence/method that would work.</p>	
<p>Level 3 5-6 marks</p>	<p>All stages are covered and each stage is generally correct and virtually complete.</p> <p>Answer is communicated coherently and shows a logical progression from Stage 1 to Stages 2 and 3 to identify all three compounds in a logical sequence with results and equations for all compounds stated.</p> <p><b>Covers 2 tests with matching observations, conclusions and equations</b></p>
<p>Level 2 3-4 marks</p>	<p>All stages are covered but stage(s) may be incomplete or may contain inaccuracies</p> <p>OR two stages are covered and are generally correct and virtually complete.</p> <p>Answer is communicated mainly coherently and shows a logical progression from Stage 1 to Stages 2 and 3.</p> <p><b>Covers 2 compounds</b></p> <p>Isolated tests on named compounds – max LEVEL 2</p>
<p>Level 1 1-2 marks</p>	<p>Two stages are covered but stage(s) may be incomplete or may contain inaccuracies OR only one stage is covered but is generally correct and virtually complete.</p> <p>Answer includes isolated statements but these are not presented in a logical order.</p>

### Indicative Chemistry Content

#### Stage 1 Suggested tests

1a Add named acid to all 3

1b Add water / make into a solution

1c Add  $\text{AgNO}_3$

Ignore addition of  $\text{NH}_3$  / Ignore additional test for  $\text{CO}_2$  produced

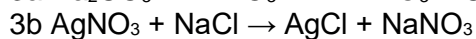
#### Stage 2 Expected observations - conclusions

2a  $\text{Na}_2\text{CO}_3$  will fizz with acid

2b  $\text{NaCl}$  gives white ppt with  $\text{AgNO}_3$

2c  $\text{NaF}$  shows no (visible) change / no ppt

Additional incorrect observations loses point

**Stage 3 Equations – state symbols must match method**

... or ionic

3c correct state symbols

[6]

**Q15.**

C

[1]

**Q16.**

C

[1]

**Q17.**

C

[1]

**Q18.**

A

[1]

**Q19.**

This question is marked using levels of response. Refer to the Mark Scheme Instructions for Examiners for guidance on how to mark this question.

**Level 3**

All stages are covered and the explanation of each stage is generally correct and virtually complete.

Stage 2 is supported by correct equations.

Answer communicates the whole process coherently and shows a logical progression from stage 1 to stage 2 and then stage 3. The steps in stage 3 are in a logical order.

5-6 marks

**Level 2**

All stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies **OR** two stages are covered and the explanations are generally correct and virtually complete.

Answer is mainly coherent and shows a progression through the stages. Some steps in each stage may be out of order and incomplete.

3-4 marks

**Level 1**

Two stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies, **OR** only one stage is covered but the explanation is generally correct and virtually complete.

Answer includes some isolated statements, but these are not presented in a logical order or show confused reasoning.

1-2 marks

**Level 0**

Insufficient correct chemistry to warrant a mark.

0 marks

**Indicative Chemistry content****Stage 1 Apparatus**

- *Boiling tube likely to be too small for 50.0 g solid plus acid*
- *Use a (large / medium / 250 ml) beaker instead*

**Stage 2 AgCl Prep**

- *HNO<sub>3</sub> will form soluble AgNO<sub>3</sub> so max AgCl not obtained*
- *Use HCl instead*
- *Method doesn't say how much acid should be used*  
*Or*  
*Use excess acid / Add acid until no more bubbles evolved*

**Stage 3 Making pure dry solid**

- *Decanting means solid wet / contaminated with HNO<sub>3</sub> / acid or decanting means some solid lost*
- *Instead use filter and then wash with distilled water*  
*(and then dry)*

**[6]****Q20.**(a) SrCl<sub>2</sub> > ICl > Br<sub>2</sub>*If wrong can award 1 for one in the correct 'position'*

2

SrCl<sub>2</sub> strong ionic bonds / (strong electrostatic attraction between opposite ions)

1

Lattice so many strong bonds to overcome

1

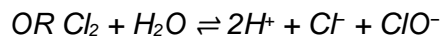
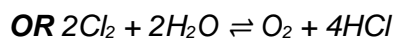
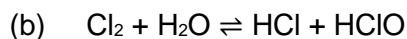
ICl has dipole-dipole between molecules – weaker than ionic bonds

1



Br<sub>2</sub> has van der Waals forces between molecules – much weaker  
*Accept London / dispersion / induced dipole forces*

1



1

Kills bacteria

1

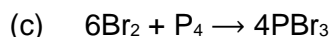
Wasteful as most potable water not used for drinking - used in washing clothes etc

**OR** Some people suffer eye irritation / Some people find the taste unpleasant

**OR** can react with organic compounds to produce harmful substances

*Allow 'it is potentially toxic as it can be if over concentrated'*

1



*Accept 4P for P<sub>4</sub>*

1

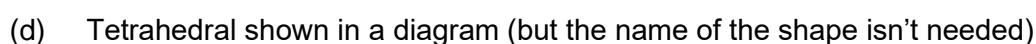
Pyramidal shown in a diagram (but the name of the shape isn't needed)

1

100–108°

*Actual value is 101° (hence larger range of values allowed)*

1



1

109.5°

*Accept 109° or 109°28'*

1

[14]

**Q21.**

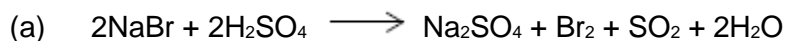
A

[1]

**Q22.**

A

[1]

**Q23.**

*Allow ionic equation*



1

$\text{Br}^-$  ions are bigger than  $\text{Cl}^-$  ions

1

Therefore  $\text{Br}^-$  ions more easily oxidised / lose an electron more easily (than  $\text{Cl}^-$  ions)

1

- (b) This question is marked using levels of response. Refer to the Mark Scheme Instructions for Examiners for guidance on how to mark this question.

**Level 3**

All stages are covered and the explanation of each stage is generally correct and virtually complete. Stages 1 and 2 are supported by correct equations.

Answer communicates the whole process coherently and shows a logical progression from stage 1 to stage 2 and then stage 3. The steps in stage 3 are in a logical order.

5–6 marks

**Level 2**

All stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies OR two stages are covered and the explanations are generally correct and virtually complete.

Answer is mainly coherent and shows a progression through the stages. Some steps in each stage may be out of order and incomplete.

3–4 marks

**Level 1**

Two stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies, OR only one stage is covered but the explanation is generally correct and virtually complete.

Answer includes some isolated statements, but these are not presented in a logical order or show confused reasoning.

1–2 marks

**Level 0**

Insufficient correct chemistry to warrant a mark.

0 marks

***Indicative chemistry content***

**Stage 1: formation of precipitates**

- Add silver nitrate
- to form precipitates of AgCl and AgBr
- $\text{AgNO}_3 + \text{NaCl} \rightarrow \text{AgCl} + \text{NaNO}_3$
- $\text{AgNO}_3 + \text{NaBr} \rightarrow \text{AgBr} + \text{NaNO}_3$

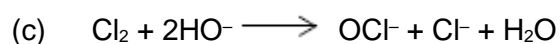
**Stage 2: selective dissolving of AgCl**

- Add excess of dilute ammonia to the mixture of precipitates
- the silver chloride precipitate dissolves
- $\text{AgCl} + 2\text{NH}_3 \rightarrow \text{Ag}(\text{NH}_3)_2^+ + \text{Cl}^-$

**Stage 3: separation and purification of AgBr**

- Filter off the remaining silver bromide precipitate
- Wash to remove soluble compounds
- Dry to remove water

6



1

OCl<sup>-</sup> is +1

Cl<sup>-</sup> is -1

*Both required for the mark*

1

**[11]**