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 δ+ and δ–

1

(b) $Cl_2 + H_2O \rightleftharpoons HCl + HClO$ / $2\ Cl_2 + 2\ H_2O \rightarrow 4\ HCl + O_2$

1

Kills bacteria / kills microorganisms / kills microbes / kills pathogens

Allow sterilise water / disinfect water

1

(c) $Cl_2 + 2\ NaOH \rightarrow NaCl + NaClO + H_2O$

1

[6]

Q2.

D

NaI(aq) + Br_2(aq)

[1]

Q3.

A

NaCl

[1]

Q4.

(a) **M1** $2H_2SO_4 + 2NaBr \rightarrow Na_2SO_4 + SO_2 + Br_2 + 2H_2O$

allow *ionic and equation forming $NaHSO_4$*

$3H_2SO_4$ + $2NaBr \rightarrow 2NaHSO_4 + SO_2 + Br_2 + 2H_2O$

$2H^+ + 2Br^- + H_2SO_4 \rightarrow SO_2 + Br_2 + 2H_2O$

not *equation from HBr unless formation of 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_3 removes (hydroxide/carbonate) ions that may give other ppts with $AgNO_3$

1

$AgNO_3$ produces ppts with chloride/iodide/halide

***not** chlorine/iodine/halogen*

1

$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$ **OR**
$Ag^+(aq) + I^-(aq) \rightarrow AgI(s)$

***allow** $Ag^+(aq) + X^-(aq) \rightarrow AgX(s)$*

*state symbols not required but **not** if wrong*

1

NH_3 dissolves AgCl (leaving yellow AgI)

***allow** chloride/iodide salt/ppt*

1

$AgCl(s) + 2NH_3(aq) \rightarrow Ag(NH_3)_2^+(aq) + Cl^-(aq)$

***allow** with $Ag^+(aq)$*

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:
$Cl_2 + H_2O \rightleftharpoons HCl + HClO$

$2\ Cl_2 + 2\ H_2O \rightarrow 4\ HCl + O_2$

1

(b) $2I^- \rightarrow I_2 + 2e^-$

1

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

Allow S_8

1

$6H^+ + 6I^- + H_2SO_4 \rightarrow 3I_2 + S + 4H_2O$

Allow correct equations using $8H^+ + SO_4^{2-}$

1

SO_2 or H_2S

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(AgI) = 0.315/234.8 = 1.34 x 10^{-3} moles

1

(e) n(NaI) = 1.34 x 10^{-3}
mass of NaI = 1.34 x 10^{-3} x 149.9 = 0.201g

Ans part (d) x 149.9

1

(f) mass of NaCl = 600 – 201 = 399mg

600 – (Ans part (e) x 1000)

1

%NaCl = 399/600 x 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

$I_2(aq) + 2\ KBr(aq) \rightarrow Br_2(aq) + 2KI(aq)$

[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 $NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl$ OR $2NaCl + H_2SO_4 \rightarrow Na_2SO_4 + 2HCl$

Accept multiples

1

M3 Base OR proton acceptor

1

(c) **M1** $2NaBr + 2H_2SO_4 \rightarrow Na_2SO_4 + Br_2 + SO_2 + 2\ H_2O$ OR
$2Br^- + 2H^+ + H_2SO_4 \rightarrow SO_2 + Br_2 + 2H_2O$

M1 *Allow ionic equations*

$2Br^- + 2H_2SO_4 \rightarrow Br_2 + SO_4^{2-} + SO_2 + 2H_2O$ *OR*

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

1

Br changes oxidation state from −1 to 0 and is oxidised

1

S changes oxidation state from +6 to +4 and is reduced

1

(d) **M1** Yellow or orange solution

M1 *Do not accept brown solution*

1

M2 $Cl_2 + 2\ Br^- \rightarrow 2\ Cl^- + Br_2$

M2 *Accept multiples*

1

[9]

Q9.

C

[1]

Q10.

A

[1]

Q11.

C

[1]

Q12.

A

[1]

Q13.

(a) $NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl$

Allow $2\ NaCl + H_2SO_4 \rightarrow Na_2SO_4 + 2\ HCl$

1

Proton donor

Allow (Bronsted-Lowry) acid

1

(b) $2\ NaBr + 2\ H_2SO_4 \rightarrow Na_2SO_4 + SO_2 + Br_2 + 2\ H_2O$
Or
$2\ NaBr + 3\ H_2SO_4 \rightarrow 2\ NaHSO_4 + SO_2 + Br_2 + 2\ H_2O$
Or
$2\ H^+ + 2\ Br^- + H_2SO_4 \rightarrow SO_2 + Br_2 + 2\ H_2O$
Or
$4\ H^+ + 2\ Br^- + SO_4^{2-} \rightarrow SO_2 + Br_2 + 2\ H_2O$
Ignore 2 NaBr + H_2SO_4 → Na_2SO_4 + 2 HBr
Ignore NaBr + H_2SO_4 → $NaHSO_4$ + 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_2CO_3

1

F CO_2

1

$2\ Ag^+ + CO_3^{2-} \rightarrow Ag_2CO_3$

1

$AgBr + 2\ NH_3 \rightarrow Ag(NH_3)_2^+ + Br^-$
Or → $Ag(NH_3)_2Br$
One mark for $Ag(NH_3)_2^+$ and 1 mark for equation
If D = AgCl, then allow 2 marks for
$AgCl + 2\ NH_3 \rightarrow Ag(NH_3)_2^+ + Cl^-$

2

[13]

Q14.

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. **Additional tests limits to lower mark within a level.** This would include, for example, adding silver nitrate to the already identified sodium carbonate. 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.	
Level 3 5-6 marks	All stages are covered and each stage is generally correct and virtually complete. 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. **Covers 2 tests with matching observations, conclusions and equations**
Level 2 3-4 marks	All stages are covered but stage(s) may be incomplete or may contain inaccuracies OR two stages are covered and are generally correct and virtually complete. Answer is communicated mainly coherently and shows a logical progression from Stage 1 to Stages 2 and 3. **Covers 2 compounds** Isolated tests on named compounds – max LEVEL 2
Level 1 1-2 marks	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. Answer includes isolated statements but these are not presented in a logical order.

Indicative Chemistry Content

Stage 1 Suggested tests
1a Add named acid to all 3
1b Add water / make into a solution
1c Add $AgNO_3$
Ignore addition of NH_3 / Ignore additional test for CO_2 produced

Stage 2 Expected observations - conclusions
2a Na_2CO_3 will fizz with acid
2b NaCl gives white ppt with $AgNO_3$
2c NaF shows no (visible) change / no ppt
Additional incorrect observations loses point

Stage 3 Equations – state symbols must match method
3a $Na_2CO_3 + 2HNO_3 \rightarrow 2NaNO_3 + CO_2 + H_2O$ … or ionic
3b $AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$
… 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_3 will form soluble $AgNO_3$ 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_3 / acid or decanting means some solid lost*
- *Instead use filter and then wash with distilled water*
  (and then dry)

[6]

Q20.

(a) $SrCl_2$> ICl > Br>

If wrong can award 1 for one in the correct 'position'

2

$SrCl_2$ <u>strong ionic</u> bonds / (<u>strong</u> electrostatic attraction between opposite ions)

1

Lattice so <u>many</u> strong bonds to overcome

1

ICl has <u>dipole-dipole</u> between molecules – weaker than ionic bonds

1

Br_2 has van der Waals forces between molecules – much weaker

Accept London / dispersion / induced dipole forces

1

(b) $Cl_2 + H_2O \rightleftharpoons HCl + HClO$

OR *$2Cl_2 + 2H_2O \rightleftharpoons O_2 + 4HCl$*

OR $Cl_2 + H_2O \rightleftharpoons 2H^+ + Cl^- + ClO^-$

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

(c) $6Br_2 + P_4 \longrightarrow 4PBr_3$

Accept 4P for P_4

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

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

1

109.5°

Accept 109° or 109°28'

1

[14]

Q21.

A

[1]

Q22.

A

[1]

Q23.

(a) $2NaBr + 2H_2SO_4 \longrightarrow Na_2SO_4 + Br_2 + SO_2 + 2H_2O$

Allow ionic equation

$2Br^- + 2H_2SO_4 \longrightarrow Br_2 + SO_4^{2-} + SO_2 + 2H_2O$

1

Br^- ions are bigger than Cl^- ions

1

Therefore Br^- ions more easily oxidised / lose an electron more easily (than 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*
- $AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$
- $AgNO_3 + NaBr \rightarrow AgBr + NaNO_3$

***Stage 2**: selective dissolving of AgCl*

- *Add excess of dilute ammonia to the mixture of precipitates*
- *the silver chloride precipitate dissolves*
- $AgCl + 2NH_3 \rightarrow Ag(NH_3)_2^+ + Cl^-$

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

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

6

(c) $Cl_2 + 2HO^- \longrightarrow OCl^- + Cl^- + H_2O$

1

OCl^- is +1

Cl^- is –1

Both required for the mark

1

[11]