A-Level Chemistry

Inorganic Practical Questions

Mark Scheme

Time available: 76 minutes
Marks available: 61 marks

1. (a) Identity of gas: Carbon dioxide / CO_2

1

Test: When gas bubbled through limewater, a white ppt formed

When gas bubbled through limewater, it turns milky/cloudy

M2 dependent on M1

1

(b) Effervescence (with Na_2CO_3), so contains H^+ ions / Effervescence (with Na_2CO_3), so is acidic

The result from Test 1 shows the presence of H^+ / acidic

1

White ppt (with $AgNO_3$), so contains chloride ions

The result from Test 2 shows the presence of chloride ions.

1

Allow balanced equation for each test that links to each observation

(c) (Warm with some) NaOH,

1

Damp red litmus at the mouth of the tube turns blue

Do not allow red litmus dipped in solution

1

Add (acidified) $BaCl_2$ / $Ba(NO_3)_2$

If reagent incorrect, cannot score observation mark

1

White ppt formed

If reagent incomplete, mark on

1

Use of $Ba(OH)_2$ can score M1 and M3

(d) The second mass is smaller / the mass after step 4 is smaller than the mass after step 2

1

AgCl dissolves in dilute ammonia / some ppt dissolves as AgCl is soluble in dilute ammonia

The ppt formed by chloride ions dissolves in dilute ammonia.

1

[10]

2. 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 **5-6 marks**	All stages are covered and the explanation of each stage is correct and virtually complete Answer communicates the whole explanation, including equations, coherently and shows a logical progression through all three stages
Level 2 **3-4 marks**	All stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies **OR** two stages covered and the explanations are generally correct and virtually complete Answer is coherent and shows some progression through all three stages. Some steps in each stage may be incomplete
Level 1 **1-2 marks**	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 shows some progression between two stages
Level 0 **0 marks**	Insufficient correct Chemistry to warrant a mark

Indicative Chemistry content

Stage 1 Formula

1a) divides % masses by A_r for each element
(N = 0.221; H = 6.18; Al = 0.221; S = 0.441; O =4.41)
1b) divides throughout by smallest and confirms <u>formula</u> as $NH_{28}AlS_2O_{20}$
Correct formula ticks 1a and 1b irrespective of method
1c) x = 12

Stage 2 Ion ID

2a) addition of $NaOH/OH^-$ and warming gives gas that turns (damp) red litmus blue (= ammonia) showing NH_4^+ (water bath = warm)
2b) white ppt with acidified $BaCl_2/Ba^{2+}$ = SO_4^{2-}
2c) addition of $NaOH/OH^-$ until in excess gives white ppt that redissolves = Al^{3+} **OR** addition of carbonate giving white ppt and effervescence/fizzing/bubbles/gas formed

Stage 3 Equations (Ignore state symbols)

3a) $NH_4^+ + OH^- \longrightarrow NH_3 + H_2O$

3b) $Ba^{2+} + SO_4^{2-} \longrightarrow BaSO_4$

3c) $Al(H_2O)_6^{3+} + 3\ OH^- \longrightarrow Al(H_2O)_3(OH)_3 + 3\ H_2O$

Allow *$Al^{3+} + 3\ OH^- \longrightarrow Al(OH)_3$*

3d) $Al(H_2O)_3(OH)_3 + OH^- \longrightarrow Al(H_2O)_2(OH)_4^- + H_2O$

Allow *$Al(OH)_3 + OH^- \longrightarrow Al(OH)_4^-$ etc.*

OR *$2Al(H_2O)_6^{3+} + 3CO_3^{2-} \longrightarrow 2Al(H_2O)_3(OH)_3 + 3CO_2 + 3H_2O$*

Equation with CO_3^{2-} 'ticks' 3c AND 3d

[6]

3. (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]

4.

(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 + $H_2SO_4 \rightarrow Na_2SO_4$ + 2 HBr

Ignore NaBr + $H_2SO_4 \rightarrow NaHSO_4$ + 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 $\rightarrow Ag(NH_3)_2Br$

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]

5. (a) $Fe + H_2SO_4 \rightarrow FeSO_4 + H_2$

Allow $Fe + 2H^+ \rightarrow Fe^{2+} + H_2$

Allow $Fe + 2H^+ + SO_4^{2-} \rightarrow Fe^{2+} + SO_4^{2-} + H_2$

Allow $Fe + H_2SO_4 \rightarrow Fe^{2+} + SO_4^{2-} + H_2$

Allow $Fe + 2H^+ + SO_4^{2-} \rightarrow FeSO_4 + H_2$

Allow multiples

Ignore state symbols

1

(b) 22.65 (cm^3)

1

(c) $5\ Fe^{2+} + MnO_4^- + 8\ H^+ \rightarrow 5\ Fe^{3+} + Mn^{2+} + 4\ H_2O$

Allow multiples

Ignore state symbols

NOT if electrons shown

1

(d) colourless / (pale) green to (hint of) pink

NOT …. to purple

Allow …. to pale / hint of purple

1

(e) pipette

burette

both needed
Allow (graduated/volumetric) pipette
Allow (graduated/volumetric) burette
NOT dropping pipette

1

(f) 1.47(%)

Allow 1.5(%)

1

[6]

6. (a) **Q** is calcium or magnesium

1

bromide

1

R is aluminium

1

chloride

1

S is iron(III)

1

sulfate

1

Mark this question independently

(b) $Ba^{2+} + SO_4^{2-} \longrightarrow BaSO_4$

1

$[Fe(H_2O)_6]^{3+} + 3OH^- \longrightarrow Fe(H_2O)_3(OH)_3 + 3H_2O$

1

$2[Fe(H_2O)_6]^{3+} + 3CO_3^{2-} \longrightarrow 2Fe(H_2O)_3(OH)_3 + 3H_2O + 3CO_2$

1

$[Fe(H_2O)_6]^{3+} + 4Cl^- \longrightarrow [FeCl_4]^- + 6H_2O$

1

[10]

7. (a) $FeSO_4 + Na_2C_2O_4 \rightarrow FeC_2O_4 + Na_2SO_4$

Allow multiples, including fractions.
Allow $Fe^{2+} + C_2O_4^{2-} \rightarrow FeC_2O_4$
Allow correct equation which includes water of crystallisation.

1

(b) M_r $FeSO_4.7H_2O$ = 277.9

Allow if shown clearly in the calculation.

Allow 278

1

Moles = 6.95 / 277.9 = 2.5(0) × 10^{-2}

Do not penalise precision but must be to a minimum of two significant figures.

Allow correct calculation using incorrect M_r.

Correct answer without working scores this mark only.

1

(c) 3(.00) × 10^{-2}

1

(d) Theoretical mass = 2.50 × 10^{-2} × 179.8 = 4.50g

as long as 2.50 × 10^{-2} is the smaller of parts (b) and (c) **(M1)**

Allow consequential answer from parts (b) and (c).

Allow theoretical mass = (smaller of parts (b) and (c)) × 179.8

*If larger of parts (b) and (c) used, lose **M1** but can score **M2**.*

Allow answers based on moles of reactant and product.

1

Yield = 3.31 × 100 / 4.50 = 73.6% **(M2)**

Award this mark only if answer given to 3 significant figures.

Correct answer without working scores this mark only, provided answer given to 3 significant figures.

1

(e) Some left in solution / some lost during filtration

Do not allow 'incomplete reaction'.

Do not allow 'reaction is reversible'.

1

(f) MnO_4^- will oxidise the iron(II) ion and the ethanedioate ion

1

MnO_4^- does not oxidise the Cu^{2+} ion / larger volume needed for iron(II) ethanedioate

1

[9]