Question number	Answer	Notes	Marks
1 (a) (i)	**M1** & **M2** – any two from: • does not melt/high melting point • does not colour the flame • inert/unreactive / does not burn/react with oxygen/air	Ignore general physical properties of metals, eg boiling point	2
(ii)	to remove any substance that may affect the colour	ignore references to removing impurities Allow result/flame for colour	1
(iii)	difficult to see the colour produced by the substance (under test)	Accept flame not hot enough (to vaporise the sample) Accept the temperature is not high enough (to vaporise the sample) Allow flame is (already) coloured	1
(b) (i)	(X) **M1** – sodium **M2** – chloride (Y) **M3** – lithium **M4** – sulfate	Accept symbol in any formula accept Li symbol and SO_4 in any formula accept strontium for **M3**	1 1 1 1
(ii)	iron(II) / Fe^{2+} / Fe^{+2} / Fe^{++}	accept ferrous ignore iron ion if both name and formula given both must be correct	1

(c)	M1 – add (dilute) acid M2 – test gas/bubbles/carbon dioxide with limewater M3 – limewater turns milky	 If incorrect gas mentioned, only M1 can be awarded M3 DEP on mention of gas	1 1 1

Question number	Answer	Accept	Reject	Marks
2 (a)	magnesium chloride/$MgCl_2$ oxygen/O_2 sulfuric (acid)/H_2SO_4 IGNORE hydrogen sulfate If name and formula given, both must be correct	 carbon dioxide/CO_2		1 1 1
(b)	$Mg + H_2O \rightarrow MgO + H_2$ IGNORE state symbols even if incorrect Penalise incorrect symbols and failure to use subscripts			1

(Total marks for Question 2 = 4 marks)

Question number	Answer	Accept	Reject	Marks
3 (a) (i)	Impurities/chemicals/substances may affect the colour/flame **IGNORE** affect the result/test			1
(ii)	colour can (easily) be seen (in a non-luminous flame) **IGNORE** references to temperature	a luminous flame may mask the colour		1
(iii)	yellow/orange/gold(en)	any combination of the acceptable colours, e.g. golden-yellow		1
(b) (i)	Li^+ and Ca^{2+}	lithium and calcium/Li and Ca	Ca^+ etc	1
(ii)	**M1** – ammonia/NH_3			1
	M2 – (water is needed) to form hydroxide ions/OH^-	to form an alkali/an alkaline solution/ammonium hydroxide		1
(iii)	**M1** – iron(III)/Fe^{3+}	to dissolve the ammonia ammonia needs to be aqueous	any other oxidation states/ferrous	1
	M2 – ammonium/NH_4^+ If both names and formulae given both must be correct	ferric	ammonia	1
			Total	**8**

Question number	Answer	Notes	Marks
4 (a) (i)	) hydroxide sodium sulfate	Accept ferrous in place of iron(II) Accept in either order Ignore formulae even if wrong Max 1 if extra product added Ignore oxidation state of sulfate	1 1
(ii)	green precipitate	Ignore qualifiers such as pale / dark / dirty Accept solid / suspension / ppt(e) in place of precipitate Ignore grey Reject all other colours Reject bubbles or equivalent Ignore refs to turning brown Ignore refs to reaction type (eg displacement / oxidation) Ignore refs to solution turning colourless / clear Ignore refs to reactants Do not penalise wrong identity or formula of precipitate	1

4 (b) (i)	ba ium sulfate / $BaSO_4$		1
(ii)	(dilute) hydrochloric acid / HCl	Accept other suitable acids (name or formula) such as HNO_3 / CH_3COOH Ignore hydrogen chloride Reject sulfuric acid Reject 'acid' alone Reject extra incorrect reagents	1
	fizzing / bubbles / effervescence	Allow gas Ignore carbon dioxide Ignore gas tests Ignore wrongly named gas Reject wrong observation (eg precipitate) M2 dep on M1 given Allow M2 if sulfuric acid or just 'acid' given in M1	1

4 (c)	M1	ad sodium hydroxide (solution) (and warm)	Accept any named Group 1 or Group 2 hydroxide Addition of any other incorrect reagent means 0/3 If no reagent added, max 1 for correct test and result	1
	M2	test (gas/ammonia) with (damp red) litmus (paper) OR test with hydrogen chloride / conc. hydrochloric acid	Accept use of universal indicator paper Reject blue litmus for M2 and M3 Ignore 'ammonium' Accept HCl Reject dilute hydrochloric acid	1
	M3	turns blue OR <u>white</u> smoke / solid / powder	Do not award M3 if clear statement that litmus is dipped into solution Accept <u>white</u> fumes	1

Total 9 marks

Question number	Answer	Notes	Marks
5 a	burns with a pop/squeak OR use burning/lit splint/flame to see if pop/squeak	Must be reference to test and result Reference to splint/match with no indication of flame is not enough Ignore flame extinguished Reject reference to glowing splint Squeaky pop test on its own is not enough	1
b i	anhydrous/white copper sulfate turns blue OR anhydrous/blue cobalt chloride turns pink	Ignore colourless Accept correct formula Incorrect formula (eg CuSO) counts as near miss Accept correct formula Incorrect formula (eg CoCl) counts as near miss M2 DEP on M1 or near miss	2
ii	measure boiling point / freezing point	Accept boil it / freeze it Ignore heat	2
	100 (°C) / 0 (°C)	Value must match property Ignore units	
		Answers such as boils/distils at 100 °C / freezes at 0 °C score M2 only	

Question number	Answer	Notes	Marks
5 b iii	cross by carbon dioxide from the air reacts to cause the cloudiness cross by the cloudiness is caused by the formation of a white precipitate ☐ carbon dioxide forms when the hydrogen burns ☒ carbon dioxide from the air reacts to cause the cloudiness ☐ the cloudiness is caused by the formation of calcium hydroxide ☒ the cloudiness is caused by the formation of a white precipitate ☐ the reaction in the limewater is an example of oxidation	If 3 boxes crossed then max 1 If 4 or more boxes crossed then 0	2
			Total 7 marks

Question number				Answer	Notes	Marks
6	a	i	M1	bubbles / fizzing / effervescence	Accept gas formed /given off	1
					Ignore any name or formula	
			M2	iron/solid disappears OR green/colourless solution (forms)	Accept iron/solid gets smaller / dissolves	1
					Ignore references to heat change / change in pH	
		ii		iron sulfate AND hydrogen (in either order)	Penalise oxidation states other than (II)	1
					Accept ferrous sulfate	
					Reject ferric sulfate	
	b			2 (1) 2	Accept multiples and fractions	1
	c	i	M1 M2	white blue	Ignore colourless Ignore all qualifiers such as pale / dark	1 1
		ii		D		1
		iii	M1 M2	boiling point / melting/freezing point 100 ºC / 0 ºC	 Accept just º or C but not just number Value must match property Accept correct values in K Ignore other physical properties such as pH / density	1 1

Question number				Answer	Notes	Marks
6	d	i		low density / less dense than air	Accept lighter than air / the lightest gas but not just light / lightweight	1
		ii		non-flammable OR does not burn / explode (when ignited)	Ignore unreactive Accept does not react with oxygen/air	1
	e			$H_2(g) \rightarrow H_2(l)$	Ignore "+ heat/energy" on RHS Penalise indication of endothermic process	1
					Total	**12**

Question number				Answer	Notes	Marks
7	a		M1	NH_4^+	Award 1 if wrong way around	1
			M2	Cl^-	Penalise missing charges both times	1
	b	i	M1	(add) sodium hydroxide/NaOH (solution) (and warm)	Accept any identified Group 1 or Group 2 hydroxide If no reagent added, max 1 mark for correct test AND result even if dipped into solution If just hydroxide or OH^- ions, do not award M1 but continue marking If any other incorrect reagent added, then 0/3	1
			M2	test (gas / ammonia) with (damp red) litmus (paper) OR test with hydrogen chloride / conc HCl	Accept use of universal indicator Accept holding litmus above tube etc Reject blue litmus for M2 and M3 Do not penalise ammonium instead of ammonia in M2 Do not allow (dilute) hydrochloric acid	1
			M3	(litmus paper) turns blue OR <u>white</u> smoke/solid/powder	Do not award M3 if litmus dipped into solution (even if only implied)	1
		ii	M1	(add) silver nitrate/$AgNO_3$ (solution)	If missing or incorrect reagent, 0/3	1
			M2	(dilute) nitric acid	Do not accept any other acid or just acidified If acid missing or wrong, M3 can still be awarded	1
			M3	white precipitate / solid / suspension	If bleaching litmus paper mentioned, only M1 can be awarded	1

Question number				Answer	Notes	Marks
7	c		M1	reversible / goes both ways	Ignore equilibrium	1
	d	i	M1	ammonium chloride / NH_4Cl	Do not accept ammonia chloride If name and formula given, both must be correct	1
		ii	M1	ammonia / NH_3 / molecules / they / it are / move / diffuse /travel faster / quicker	Ignore descriptions such as lighter / smaller / denser Accept phonetic spellings including amonia / ammonium Do not accept hydrogen chloride / hydrochloric acid / HCl / ammonium chloride / NH_4Cl in place of ammonia Accept all other words with same meaning as faster - eg speedier Do not accept react faster or travel further Accept reverse statements such as hydrogen chloride slower	1
	e		M1 M2	Corrosive / burns / damages skin or eyes Wear eye protection eg goggles or mask / gloves / place bung in the end of the tube / use of fume cupboard	Ignore harmful / irritant / toxic / poisonous Allow tongs / tweezers if reference to cotton wool Ignore lab coats M1 and M2 are independent	**1** **1**

Total 13 marks