Question Number	Answers	Acceptable Answers	Mark
1(a)(i)	A displacement		**(1)**

Question Number	Answers	Acceptable Answers	Mark
1(a)(ii)	orange	Any colour or combination of colours from brown, red, orange and yellow Ignore shade of colours Reject other colours combined with these e.g. yellow-green	**(1)**

Question Number	Answers	Acceptable Answers	Mark
1(b)	**C**		**(1)**

Question Number	Answer	Acceptable answers	Mark
1(c)	(H_2 + Br_2 →) 2HBr • correct formula for HBr **(1)** • balancing of correct formulae **(1)**	Ignore state symbols Allow BrH **(1)**	**(2)**

Question Number	Answer	Acceptable answers	Mark
1(d)	[24 + 2x35.5] **(1)** (= 95)	95 with no working [24 + 2x35.5] with no answer or an incorrect answer scores **(1)**	**(1)**

Question Number	Answers	Acceptable Answers	Mark
1(e)	• relative formula mass =[23 + 19] **(1)** (= 42) • [(19/their relative formula mass) x100] **(1)** (=45.2(%)) **consequential** on their relative formula mass	(19/42) x 100 **(2)** (= 45.2 (%)) (19/[19+23]) x 100 **(2)** (= 45.2 (%)) 45/45.2 (%) with no working **(2)** Ignore additional significant figures Allow 42 seen in working **(1)** Allow (19/23) x 100 = {82.6% / 83%} **(1)**	**(2)**

Question Number	Answer	Acceptable answers	Mark
2(a)(i)	C cations in a sea of electrons		**(1)**

Question Number	Answer	Acceptable answers	Mark
2(a)(ii)	(metals have) high melting point	a lot of energy needed to break/overcome (metallic) bonds energy needed to break/overcome strong (metallic) bonds Ignore references to boiling point Reject reference to intermolecular forces/covalent (bonds) /attraction between ions/breaking ionic bonds/ breaking covalent bonds	**(1)**

Question Number	Answer	Acceptable answers	Mark
2(a)(iii)	An explanation including two of the following points • argon is inert/does not react/is unreactive (1) • because it has 8 electrons in its outer shell (1) • metals would react in/with air/oxygen (1) • argon will exclude air from welding point (1)	Ignore argon is in group 0/8 argon is a noble gas Ignore argon does not burn does not {gain/lose/share} electrons has a full outer shell (of electrons) has a stable electron configuration form (metal) oxide prevents oxidation	**(2)**

Question Number	Answer	Acceptable answers	Mark
2(b)	$2\ Fe + 3\ Br_2 \rightarrow 2\ FeBr_3$ M1 Correct symbol/formulae (1) M2 balancing of correct symbol/formulae (1)	Reject incorrect use of upper/lower case / subscripts for M1 but allow ECF for M2	**(2)**

Question Number	Answer	Acceptable answers	Mark
2(c)	C – grey solid		**(1)**

Question Number	Answer	Acceptable answers	Mark
2(d)	A explanation including M1 order of reactivity chlorine > bromine > iodine (1) and M2 one of the following points • chlorine displaces bromine (from bromide) AND chlorine displaces iodine (from iodide) (1) • bromine displaces iodine (from iodide) AND bromine does not displace chlorine (from chloride) (1) • iodine does not displace chlorine(from chloride) AND iodine does not displace bromine (from bromide) (1)	For M1 reject reference to reactivity of halide ions eg chlorine more reactive than bromide halogens/they decrease in reactivity down the group/table chlorine is most reactive <u>and</u> iodine is least reactive Ignore reference to displacement of halide ions eg chlorine displaces bromide Ignore “replaces” chlorine reacts with bromide AND iodide chlorine takes part in two (displacement) reactions bromine reacts with iodide AND does not react with chloride bromine takes part in one (displacement) reactions iodine does not react with chloride or bromide iodine does not take part in any (displacement) reactions	**(2)**

Question number	Answer	Mark
3(a)	Candidates relate information given to order of elements in the periodic table to predict: dark grey/black **and** solid/crystals	(1)

Question number	Indicative content	Mark
*3(b)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **AO1 (6 marks)** • order of reactivity: chlorine > bromine > iodine The order of reactivity supported by suitable experiments from: • add (aqueous) chlorine to a solution of potassium bromide • the solution turns orange/yellow • bromine is produced / $Cl_2 + 2KBr \rightarrow Br_2 + 2KCl$ / $Cl_2 + 2Br^- \rightarrow Br_2 + 2Cl^-$ • (so) chlorine is more reactive than/displaces bromine /oxidises bromide ions • add (aqueous) bromine to a solution of potassium iodide • the solution turns yellow/red/ brown • iodine is produced / $Br_2 + 2KI \rightarrow I_2 + 2KBr$ / $Br_2 + 2I^- \rightarrow I_2 + 2Br^-$ • (so) bromine is more reactive than/displaces iodine/ oxidises iodide ions • add (aqueous) chlorine to a solution of potassium iodide • the solution turns yellow/red/ brown • iodine is produced / $Cl_2 + 2KI \rightarrow I_2 + 2KCl$ / $Cl_2 + 2I^- \rightarrow I_2 + 2Cl^-$ • (so) chlorine is more reactive than/displaces iodine/oxidises iodide ions Allow use of suggested reactions which do not produce a displacement reaction, e.g. add (aqueous) bromine to a solution of a potassium chloride with suitable conclusion/explanation	(6)

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	• Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific ideas, enquiry, techniques and procedures lacks detail. (AO1) • Presents an explanation with some structure and coherence. (AO1)
Level 2	3–4	• Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas, enquiry, techniques and procedures is not fully detailed and/or developed. (AO1) • Presents an explanation that has a structure, which is mostly clear, coherent and logical. (AO1)
Level 3	5–6	• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas, enquiry, techniques and procedures is detailed and fully developed. (AO1) • Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)

Question number	Answer	Additional guidance	Mark
3(c)(i)	• calculates mol of Fe (1) • calculates mol of Br^2 (1) • determines simplest ratio/LHS of equation (1) • deduces formula of iron bromide produced/RHS of equation (1) OR • divides mass by relative atomic mass (1) • simplest ratio (1) • empirical formula (1) • deduces LHS to obtain balanced equation (1)	<u>Example of calculation</u> mol Fe = $\frac{5.6}{56}$ = 0.1 mol Br_2 = $\frac{24}{(2\times80)}$ = 0.15 ratio Fe:Br_2 = 2 : 3/ 2Fe + 3Br_2 2$FeBr_3$/Fe_2Br_6 Fe : Br $\frac{5.6}{56}$: $\frac{24}{80}$ 0.1 : 0.3 1 : 3 $FeBr_3$ 2Fe + 3Br_2 → 2$FeBr_3$	**(4)**

Question number	Answer	Mark
3(c)(ii)	An explanation that combines identification – application of knowledge (1 mark) and reasoning/justification – application of understanding (1 mark): • bromine atoms are reduced (1) • because electrons are gained to form bromide ions (1)	**(2)**

Question Number	Answer	Acceptable answers	Mark
4(a)	Fe Cl 2.8/56 3.55/35.5 (1) 0.05 0.1 or 1 2 (1) $FeCl_2$ (1)	Cl_2Fe $FeCl_2$ with no working (3) Consequential errors: if "upside down" ie 56 / 2.8 and 35.5 / 3.55 ratio 20 : 10 or 2 : 1 (1) empirical formula Fe_2Cl (1) allow 3 marks for 2.8 / 56 and 3.55 / 71 ratio 0.05: 0.05 or 1 : 1 empirical formula $FeCl_2$ allow 2 marks for 2.8 / 56 and 3.55 / 71 ratio 0.05: 0.05 or 1 : 1 empirical formula FeCl allow 2 marks for Fe Cl 2.8/56 3.55/35.5 (1) 0.5 0.1 (0) Fe_5Cl (1) - ECF	**(3)**

Question Number	Answer	Acceptable answers	Mark
4(b)	**EITHER** 2x23 (1) g Na makes 2x58.5 (1) g NaCl 9.2 g Na makes $\frac{(2\times58.5)\times9.2}{46}$ g NaCl (1) (= 23.4 g) **OR** 23 g Na makes 58.5 (1) g NaCl 9.2 g Na makes $\frac{(58.5)\times9.2}{23}$(1) g NaCl (1) (= 23.4 g) mark consequentially eg 46 (1) g Na makes (2x23+35.5) (0) g NaCl 9.2 g Na makes $\frac{(2\times23+35.5)\times9.2}{46}$ (1) g NaCl (= 16.3 g)	23.4 g with no working (3) 23.4 g from any method (3) do not accept 23(.0) mol Na used = 9.2/23 (1) (= 0.4) mol NaCl = 0.4 (1) mass NaCl = 0.4 x 58.5 (1) (= 23.4 g) Ignore units throughout unless incorrect mark consequentially awarding 2 marks for 46.8 g,11.7 g and 16.3 g (see last example opposite).	**(3)**

Question Number		Indicative Content	Mark
	***4(c)**	A description, comparison and explanation including some of the following points Order of reactivity: chlorine > bromine > iodine Experiment • add (aqueous) chlorine to a solution of potassium bromide • the solution turns orange/yellow • bromine is produced Conclusion/Explanation and equation: (so) chlorine is more reactive than / displaces bromine $Cl_2 + 2KBr \rightarrow Br_2 + 2KCl$ / $Cl_2 + 2Br^- \rightarrow Br_2 + 2Cl^-$ Experiment • add (aqueous) bromine to a solution of potassium iodide • the solution turns brown • iodine is produced Conclusion/Explanation and equation: (so) bromine is more reactive than / displaces iodine $Br_2 + 2KI \rightarrow I_2 + 2KBr$ / $Br_2 + 2I^- \rightarrow I_2 + 2Br^-$ Experiment • add (aqueous) chlorine to a solution of potassium iodide • the solution turns brown • iodine is produced Conclusion/Explanation and equation: (so) chlorine is more reactive than / displaces iodine $Cl_2 + 2KI \rightarrow I_2 + 2KCl$ / $Cl_2 + 2I^- \rightarrow I_2 + 2Cl^-$ ▪ Allow use of organic solvents to identify halogens ▪ Allow use of suggested reactions which do not produce a displacement reaction eg add (aqueous) bromine to a solution of a potassium chloride with suitable conclusion/explanation ▪ Allow use of table of suggested experiments	**(6)**

Level		No rewardable content
1	**1 - 2**	• a limited description of at least one experiment in which any halogen solution is added to any halide solution (not of the same halogen) **OR** describes order of reactivity as Cl > Br > I • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy
2	**3 - 4**	• a simple description of at least two displacement experiments AND • EITHER at least one correct explanation/conclusion OR • at least one correct observation of a displacement reaction that works/balanced equation. • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy
3	**5 - 6**	• a detailed description of at least two displacement experiments **AND** • (a total of) at least two correct explanations/conclusions **AND** • at least one correct observation of a displacement reaction that works/ balanced equation • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors

Question Number	Answer	Acceptable answers	Mark
5(a)(i)	toxic / poisonous (gas)	Ignore other words such as harmful / dangerous / smelly / corrosive	**(1)**

Question Number	Answer	Acceptable answers	Mark
5(a)(ii)	A description including the following points • (damp blue) litmus (paper) (1) • (turns red then) white / bleaches (1)	Allow use of any suitable named indicator with correct result eg • (damp) universal indicator paper (1) • (turns red then) white (1) OR • (damp) starch iodide paper (1) • (turns) dark blue / black (1)	**(2)**

Question Number	Answer	Acceptable answers	Mark
5(a)(iii)	making {poly(chloroethene / PVC / solvents / medicines / agrochemicals / disinfectants} bleach / sterilising water / killing bacteria	**ignore** water purification / "swimming pools" micro-organisms	**(1)**

Question Number	Answer	Acceptable answers	Mark
5(a)(iv)	$2NaCl + 2H_2O \rightarrow 2NaOH + H_2 + C_2$ correct products (1) balancing of correct formulae (1)	$NaCl + H_2O \rightarrow NaOH + ½ H_2 + ½ Cl_2$	**(2)**

Question Number		Indicative Content	Mark
QWC	***5(b)**	A comparison including some of the following points **Comparing volumes of hydrogen and oxygen** • (in each experiment) volume of hydrogen is twice volume of oxygen • because water molecules contain twice as many hydrogen atoms as oxygen atoms / is H_2O • overall $2H_2O \rightarrow 2H_2 + O_2$ **Relating volumes of gases to current and time** • (from experiments 1 and 2) time doubles • (from experiments 1 and 2) volumes of gases double • Volumes of gases are directly proportional to the time for electrolysis / passage of current • (from experiments 1 and 3) as current x 1.5 • (from experiments 1 and 3) volumes of gases x 1.5 • volumes of gases are directly proportional to the current	**(6)**
Level	**0**	No rewardable content	
1	**1 - 2**	• a limited description of one trend e.g. increased time gives an increased gas volume • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy	
2	**3 - 4**	• a simple description e.g. if the time is doubled, the volume of gas is doubled and if the current is increased the volume of gas increases • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy	
3	**5 - 6**	• a detailed description e.g. volume of hydrogen is twice volume of oxygen and as time doubles, volume of gas doubles or as current x 1.5, volume of gas x 1.5 • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors	