Question Number	Answer	Acceptable answers	Mark
1(a)(i)	12 + 16 +16 (= 44)	44 with no working	**(1)**

Question Number	Answer	Acceptable answers	Mark
1(a)(ii)	40+12+(3x16)/($CaCO_3$)100 (1) gives 40+16 /(CaO) 56 (1) 25 (tonnes) gives 56x$\frac{25}{100}$ (tonnes) (1)	 allow ecf 14 (tonnes) correct answer no working (3)	**(3)**

Question Number	Answer	Acceptable answers	Mark
1(b(i)	theoretical yield is calculated yield/ value calculated from balanced equation/maximum yield possible/maximum amount of product when reactants have fully reacted.		**(1)**

Question Number	Answer	Acceptable answers	Mark
1(b)(ii)	An explanation linking two of the following • reaction may be incomplete • product/reactant lost • other (side-)reactions may occur	 impure reactants unwanted reactions	**(2)**

Question Number	Answer	Acceptable answers	Mark
1(c)	A suggestion including two of the following • save money/improve profit/disposal of waste costs money (1) • waste product may be harmful to the environment/cause pollution/damage the environment (1)	 any specific examples ignore references to landfill	**(2)**

Question Number	Answer	Acceptable answers	Mark
2(a)	to allow air/oxygen in	to ensure magnesium reacts/burns / combusts	**(1)**

Question Number	Answer	Acceptable answers	Mark
2(b)(i)	all points correctly plotted to half a small square (2) line of best fit (1)	Allow one mark for four or five correctly plotted points ecf their points	**(3)**

Question Number	Answer	Acceptable answers	Mark
2(b)(ii)	Any one from not all magnesium {burned / reacted} / some left / incomplete reaction not enough air/oxygen some magnesium oxide / smoke lost	 lid not lifted / not enough times lid left off too long (so loses MgO)	**(1)**

Question Number	Answer	Acceptable answers	Mark
2(c)	$2Mg + O_2 \rightarrow 2MgO$ left hand formulae (1) right hand formula (1) balancing correct formulae (1)	correct multiples	**(3)**

Question Number	Answer	Acceptable answers	Mark
2(d)	0.414 / 207 or 0.064 / 16 (1) 0.002 : 0.004 or 1 : 2 (1) empirical formula PbO_2 (1)	if 207 / 0.414 and 16 / 0.064 ratio 500 : 250 or 2 : 1 (1) empirical formula Pb_2O (1) allow 3 marks for 0.414 / 207 or 0.064 / 32 ratio 1 : 1 empirical formula PbO_2 allow 2 marks for if 0.414 / 207 and 0.064 / 32 ratio 1 : 1 empirical formula PbO	**(3)**

Question Number	Answer	Acceptable answers	Mark
3(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
3(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
	***3(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
4(a)	A description including: • add (dilute) (hydrochloric) acid (1) • gas/carbon dioxide (passed into/tested) with limewater (1) • limewater goes milky / cloudy / white ppt (1)	correct formulae heat/thermally decompose bubbled through limewater dependent on use of limewater	**(3)**

Question Number	Answer	Acceptable answers	Mark
4(b)	40 +[2 x 35.5] (=111)	111 alone	**(1)**

Question Number	Answer	Acceptable answers	Mark
4(c)	• 100 (kg) (calcium carbonate) → 106 (kg) (sodium carbonate) (1) • $\frac{106 \times 40}{100}$ (1) (=42.4)	OR alternative 106÷100 40000÷100 /40÷100 (moles approach) Only 42.4 with no working worth 2 marks 42400**g** worth 2 marks	**(2)**

Question Number	Answer	Acceptable answers	Mark
4(d)(i)	• 10.4/15.0 **(1)** • (10.4/15.0) x100 **(1)** (= 69.3)	69.3 alone worth 2 marks If no/incomplete working shown answer to 2 or more sf scores 2 marks Ignore any units	**(2)**

Question Number	Answer	Acceptable answers	Mark
4(d)(ii)	Two suggestions from • reaction incomplete (1) • impure reactants (1) • other unwanted/side reaction(s) occur (1) • product lost during experiment/practical (1)	 reversible ignore by-products form could be an example eg some products left in apparatus ignore generic experimental errors eg measuring/weighing errors/human error/spillage	**(2)**