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<u>25</u> (tonnes) (1) 100	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$_2$Fe
		
		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$_2$Cl (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$_5$Cl (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 $\frac{(2 \times 58.5) \times 9.2}{46}$ g NaCl
	
	                            (1)
	               (= 23.4 g)
	
	OR
	23 g Na makes 58.5 (1) g NaCl
	
	9.2 g Na makes $\frac{(58.5) \times 9.2}{23}$ (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 $\frac{(2 \times 23 + 35.5) \times 9.2}{46}$ (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)**