Chemical Equations: Reacting Masses

Mark Scheme

Level	International A Level
Subject	Chemistry
Exam Board	Edexcel
Topic	Chemistry Lab Skills 1
Sub Topic	Chemical Equations: Reacting Masses
Booklet	Mark Scheme

Time Allowed: **74 minutes**

Score: **/61**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

Question Number	Acceptable Answers	Reject	Mark
1(a)	To avoid (loss of solid due to) 'spitting' ALLOW To prevent loss of solid/reactant IGNORE reference to water vapour	Spillage Removal of impurities	1

Question Number	Acceptable Answers	Reject	Mark
1(b)	Heat to constant mass/weight IGNORE Keep heating until .... no more steam/misty fumes are given off OR there is no further reaction OR the crystals turn to powder		1

Question Number	Acceptable Answers	Reject	Mark
1(c)	Anhydrous (sodium carbonate)	Dry/Dehydrated	1

Question Number	Acceptable Answers	Reject	Mark
1(d)(i)	**Additional Comments** **Throughout 3d,** **correct answers score full marks** **and** **ignore SF (including 1SF)** **and** **penalise incorrect units once only** (M_r Na_2CO_3=) 2x23 + 12 + 3x16 / 106 ($g\ mol^{-1}$) **(1)** (1.06 ÷ 106 =) 0.01/ 1.0 x 10^{-2} (mol) **(1)** TE for incorrect M_r		2

Question Number	Acceptable Answers	Reject	Mark
1(d)(ii)	(m= 2.50 – 1.06 = 1.44(g) n = 1.44 ÷18=) 0.08 (mol)		1

Question Number	Acceptable Answers	Reject	Mark
1(d)(iii)	(0.08 ÷ 0.01 =) 8 TE from (d)(i) and (d)(ii)		1

Question Number	Acceptable Answers	Reject	Mark
1(e)	Washings/Rinsing (from the beaker) should have been transferred to the volumetric flask		1

Question Number	Acceptable Answers	Reject	Mark
1(f)	Titration 1 is not concordant/a range finder/ an overshot/ an outlier/a trial /only a 'rough'/ more than 0.2 cm^3 from the other 2 titres IGNORE Inaccurate OR (Titrations 2 and 3) are within 0.1/0.2 cm^3/concordant IGNORE More accurate		1

Question Number	Acceptable Answers	Reject	Mark
1(g)(i)	**Throughout 3g ignore SF except 1SF** (Mean titre = 16.5 cm^3/ 0.0165 dm^3) n=(0.10 x 0.0165=) 1.65 x 10^{-3}/0.00165 (mol) Correct answer with no working scores (1) No TE on incorrect mean		1

Question Number	Acceptable Answers	Reject	Mark
1(g)(ii)	n=(1.65 x 10^{-3} ÷ 2=) 8.25 x 10^{-4}/0.000825 (mol) TE Ans to (g) ÷ 2		1

Question Number	Acceptable Answers	Reject	Mark
1(g)(iii)	n(8.25 x 10^{-4} x 10=) 8.25 x 10^{-3}/0.00825 (mol) TE Ans to (g)(ii) x 10		1

Question Number	Acceptable Answers	Reject	Mark
1(g)(iv)	M_r=(2.50 ÷ 8.25 x 10^{-3} =) 303.03 **(1)** (303.03 -106 = 197.03 then 197.03 ÷ 18=) (x =) 10.946/10.95/10.9/11 **(1)** Alternative Methods M_r = 106 + 18x Mass = (8.25 x 10^{-3}) x M_r = 0.8745 + 0.1485x **(1)** 2.50 = 0.8745 + 0.1485x X=(2.50-0.8745) ÷ 0.1485 = 10.946 **(1)** OR Mass Na_2CO_3 = 8.25x10^{-3} x106 = 0.8745(g) Mass H_2O = 2.5 – 0.8745 = 1.6255 **(1)** Mol H_2O = 1,6255÷18 = 0.0903 X = 0.0903÷ 8.25x10^{-3} = 10.946 **(1)** TE from previous answers Correct final answer with/without working scores (2)		2

Question Number	Acceptable Answers	Reject	Mark
1(h)	**Marking point 1** The number of moles of sodium carbonate would be too large **OR** the molar mass of hydrated salt would be too small **(1)** **Marking point 2** Hence the value of x would be too small/low **(1)** MP2 is **not** standalone and may be awarded only if one or other of the statements for the first mark is given No TE on incorrect MP1		2

(TOTAL FOR QUESTION 1 = 16 MARKS)

Question Number	Acceptable Answers	Reject	Mark
2(a)	(Bubble into) lime water / calcium hydroxide (solution) / $Ca(OH)_2$((aq)) **and** Goes cloudy / white precipitate forms / turns milky / turns chalky IGNORE extinguishes a lighted splint	 Goes muddy Turns misty	1

Question Number	Acceptable Answers	Reject	Mark
2(b)	Flask stoppered with connection to apparatus in which gas can be collected. ALLOW Either bung in neck or side arm sealed IGNORE Small gaps between bung and mouth of flask Heater under flask **(1)** Syringe OR inverted burette/ inverted measuring cylinder in trough of water ALLOW Tubes without graduation marks shown if labelled as burette, syringe or measuring cylinder **(1)**	Large gaps in connection to flask / unstoppered flask Delivery tube through wall of trough Burette or measuring cylinder without water (Test) tube without graduation marks	2

Question Number	Acceptable Answers	Reject	Mark
2(c)	(Mol gas = 41/24000 =) 1.7083×10^{-3} / 0.0017083 (mol) Ignore sf except 1sf Ignore lack of units	 Incorrect units	1

Question Number	Acceptable Answers	Reject	Mark
2(d)	Correct answer of **87.8** without working scores 2 Mol XCO_3 = 1.7083 x 10^{-3} **(1)** Mass of 1 mol = (0.15/1.7083 x 10^{-3}) = 87.8 (Use of 1.7 gives mass 88.2 use of 1.71 gives 87.7) Ignore sf except 1 sf **(1)** TE from 2c Ignore lack of units	Incorrect units but do not penalise if already penalised in (c).	2

Question Number	Acceptable Answers	Reject	Mark
2(e)	Relative atomic mass X = (87.8-(12+48)) = 27.8 X = Mg ALLOW Mg^{2+} No mark for identification of Mg **without** relative atomic mass or some working. ALLOW Calculation of atomic mass shown in (d) TE from 2d	Element with no justification. Identification as Sr because 2(d) gives 88	1

Question Number	Acceptable Answers	Reject	Mark
2(f)	(Some) carbon dioxide dissolved in the dilute hydrochloric acid / water ALLOW CO_2 reacts with water Ignore references to standard conditions and faulty apparatus	CO_2 reacts with hydrochloric acid. Impure carbonate Impure acid Incomplete reaction Side reactions	1

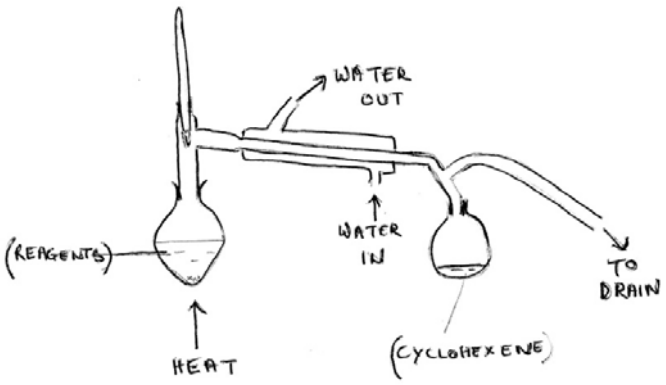
Question Number	Acceptable Answers	Reject	Mark
2(g)	No colour/ no change (to flame) ALLOW Colourless flame TE from incorrect Group 2 metal in 2(e): Ca (brick) red/ yellow-red Sr crimson/ (dark) red Ba green	White/ bright light Answers about Mg metal No flame More than one colour given	1

Question Number	Acceptable Answers	Reject	Mark
2(h)	Some sulfates are insoluble/ $BaSO_4$ is insoluble/ Sulfates become less soluble going down group ALLOW A precipitate of the **sulfate** would form IGNORE All group II sulfates are insoluble **(1)** Reaction with acid will be incomplete **(1)** Mark independently.	Carbonates become less soluble going down group Element is insoluble in sulfuric acid. Gases other than carbon dioxide form e.g SO_2. Just "**it** would form a precipitate"	2

Total for Question 2 = 11 marks

Question Number	Acceptable Answers	Reject	Mark
3(a)	Two different hazards must be given to score 2 marks. Phosphoric acid corrosive ALLOW burns skin/ damages skin (1) Cyclohexanol / cyclohexene (in)flammable ALLOW Irritant (1) IGNORE Comments on glass wool, calcium chloride Cyclohexene / cyclohexanol is volatile	Additional hazards e.g. irritant harms skin carcinogenic Additional hazards e.g. explosive carcinogenic	2

Question Number	Acceptable Answers	Reject	Mark
3(b)	**Correct final answer scores (2)** Mass of 12 cm^3 $C_6H_{11}OH$ = 12 x 0.962 (1) = 11.544 / 11.54 / 11.5 (g) Number of moles = (11.544 / 100 = 0.11544) = 0.115 / 0.12 (mol) ALLOW TE from incorrect mass (1) Ignore sf except 1 sf	0.11	2

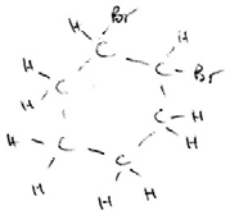
Question Number	Acceptable Answers	Reject	Mark
3(c)	Flask with heat source AND stillhead AND a closed system to the left hand side of the outlet to the condenser. Heat source can be electrical heater, water bath ALLOW bunsen or just arrow ALLOW appropriate tubing or flask with long neck as alternative to stillhead (1) Bulb of thermometer opposite opening to condenser (1) Water condenser sloping downwards AND direction of water (1) Connected to receiver with a vent OR delivery tube to an open **narrow** necked flask (1) Ignore fractionating column if included. Drawing showing reflux distillation scores max 1 for water direction in condenser.  	Conical flask Sealed receiver, beaker	4

Question Number	Acceptable Answers	Reject	Mark
3(d)	**D rating agent** removes water in a (chemical) reaction OR causes two H and one O atoms to be lost (in a reaction) OR removes the elements of water (from reactant molecules) OR removes water from molecules of a compound ALLOW answers indicating a reaction occurs eg H^+ protonates OH in alcohol forming water removes water causing bonds to break reference to elimination reactions (1) **Drying agent** removes water mixed with other materials OR removes water from a mixture OR removes water in a physical change ALLOW Absorbs water (1) "A dehydrating agent removes water in a reaction but there is no reaction when a drying agent removes water" scores 1	Reference to removal of solvents other than water	2

Question Number	Acceptable Answers	Reject	Mark
3(e)	Glass wool less absorbent OR No cyclohexene left on wool OR filtration is faster through glass wool OR filter paper absorbs liquids/ product/ mixture IGNORE yield is higher with glass wool/ lower with filter paper more efficient filtration		1

Question Number	Acceptable Answers	Reject	Mark
3(f)	**Look at final answer. If correct award 3 marks.** There are several correct methods. All involve calculating a number of moles of cyclohexene, a mass of cyclohexanol and the use of the 75% but these stages can be done in different orders. EITHER Need theoretical yield of (10.0 x 100/75) = 13.3333 / 13.33 / 13.3 g (1) 13.3333g= (13.3333/82) = 0.1626 / 0.163 mol cyclohexene (1) 0.1626 mol cyclohexanol = **16.26 / 16.3 / 16 g** (1) OR Mol of cyclohexene = (10/82) = 0.12195 (1) Mol of cyclohexanol = (0.12195 x 100/75) = 0.1626 (1) Mass of cyclohexanol = (0.1626 x 100) = **16.26 / 16.3 / 16 g** (1) OR Mol of cyclohexene = (10/82) = 0.12195 (1) Theoretical mass of cyclohexanol = (0.12195 x 100) = 12.195/12.2g (1) Mass of cyclohexanol = (12.2 x 100/75) = **16.26 / 16.3 / 16 g** (1) ALLOW **16.2** (g) in all methods from rounding **9.146** (g) from incorrect use of 75% scores **(2)** Ignore SF in final answer except 1 SF	Theoretical yield = (10.0 x 75/100) = 7.5g (0.12195 x 75/100) = 0.09146	3

Question Number	Acceptable Answers	Reject	Mark
3(g)(i)	Brown / red-brown / orange / yellow/ yellow-brown to colourless ALLOW Brown / red-brown / orange / yellow is decolorised. IGNORE Clear for colourless	Red to colourless	1

Question Number	Acceptable Answers	Reject	Mark
3(g)(ii)	 ALLOW Rings with CH_2 and/or CHBr IGNORE Angles in ring Placing of H and Br inside or outside ring	Benzene ring Just skeletal formula/ molecular formula Bromoalcohols Non-adjacent Br atoms	1

Total for Question 3 = 16 marks

Question Number	Acceptable Answers	Reject	Mark
4(a)	Bromine / Br_2 **(1)** Redox/ oxidation **(1)** OR sulfur dioxide / SO_2 **(1)** Redox/ reduction **(1)** ALLOW Redox but no product given scores 1 mark Butanal/ butanoic acid and redox / oxidation scores 1 mark	HBr and redox scores 0. Oxidation/ reduction if no product given	2

Question Number	Acceptable Answers	Reject	Mark
4(b)(i)	To ensure condenser is full of water / to prevent an airlock forming/ to stop air bubbles forming / to stop hot spots forming ALLOW To ensure that all of the condenser surface is covered with cold water/ So that (hot) vapour is next to the coolest water first / So the lower region (of the condenser) is colder / Makes cooling more efficient	To prevent back flow of water Just “So that nothing escapes” Just explanation that condensation occurs Makes cooling faster	1

Question Number	Acceptable Answers	Reject	Mark
4(b)(ii)	There would be **escape** of flammable liquid / corrosive spray / corrosive acid (spray) /poisonous gas/ toxic gas/ harmful gas IGNORE Prevents boiling over Very exothermic Any **named** toxic gas is only allowed if it would condense.	Named substance e.g. Br_2 / sulfuric acid without reference to hazard Eg bromine could escape Escape of HBr /SO_2 which are toxic (because they do not condense) Risk of explosion Just "escape of product"	1

Question Number	Acceptable Answers	Reject	Mark
4(c)(i)	(teat) pipette/ syringe (to remove upper aqueous layer) ALLOW decant / description of decanting	To remove lower aqueous layer Add drying agent Add dehydrating agent Just "Use separating funnel" Use a siphon	1

Question Number	Acceptable Answers	Reject	Mark
4(c)(ii)	Separating funnel / tap funnel **(1)** Run off lower layer **(1)** ALLOW pipette off upper layer	 Run off lower **aqueous** layer BUT do not penalise if mark in (c)(i) lost for wrong layers. Answers showing candidate is unaware that lower layer is the product	2

Question Number	Acceptable Answers	Reject	Mark
4(d)	To remove / neutralize (excess) acid OR to neutralize unreacted acid OR to remove / neutralize HCl ALLOW To neutralise the solution To remove all the HCl To wash out unreacted acid IGNORE To remove impurities	To **eliminate** HCl Just "to react with acid" To remove/ neutralise H_2SO_4 (and HCl) To remove HBr	1

Question Number	Acceptable Answers	Reject	Mark
4(e)	**S 8** Dry/ remove water from the bromobutane **(1)** With (anhydrous) calcium chloride / (anhydrous) magnesium sulfate / sodium sulfate/ silica gel ALLOW $CaCl_2$ / $MgSO_4$ / Na_2SO_4 If name and formula are given both must be correct **(1)** **Step 9** (Filter / decant and then) redistil / distil **(1)** If only one step is given accept the answer in **Step 8** or **Step 9** ALLOW Description of drying carried out **after** redistillation max (2)	Dry in an oven/ evaporate to half volume scores 0 for this step. Copper sulfate Concentrated sulphuric acid Calcium hydroxide Metal carbonates Calcium sulfate recondense	3

Question Number	Acceptable Answers	Reject	Mark
4(f)(i)	(7.5 x 0.81) = 6.075 / 6.08 (g) Ignore sf except 1sf	6.07 Wrong units	1

Question Number	Acceptable Answers	Reject	Mark
4(f)(ii)	**Look at final answer.** **67% scores 3 marks; answers with 3sf rounding to 67 score 2 marks.** If this is incorrect follow this scheme: **METHOD 1** Mol butan-1-ol = (6.075/74) = 0.0820945 **(1)** maximum mass 1-bromobutane = (0.0820945 x 137) = 11.246959 g **(1)** % yield = ((7.5/11.24659)x100 = 66.85) =67% to 2 sf **(1)** **OR METHOD 2** 7.5/137 = 0.0547445 mol (bromobutane) **(1)** 6.075/74 = 0.0820945 mol butan-1-ol **(1)** % yield = ((0.05474455)x100/0.0820945) = 66.85) =67% to 2 sf **(1)** Also TE from one step of the calculation to the next and TE on 4f(i) unless yield > 100%. Use of 6.08 gives 0.082161 mol, 11.256216 g bromobutane, final answer 67% 11.3g bromobutane gives 66%.	Percentages calculated from volumes with no conversion to mol or mass. 6.075/7.5 x 100 =81% scores 0 67.0 (This is 3sf)	3

Total for Question 4 = 15 marks

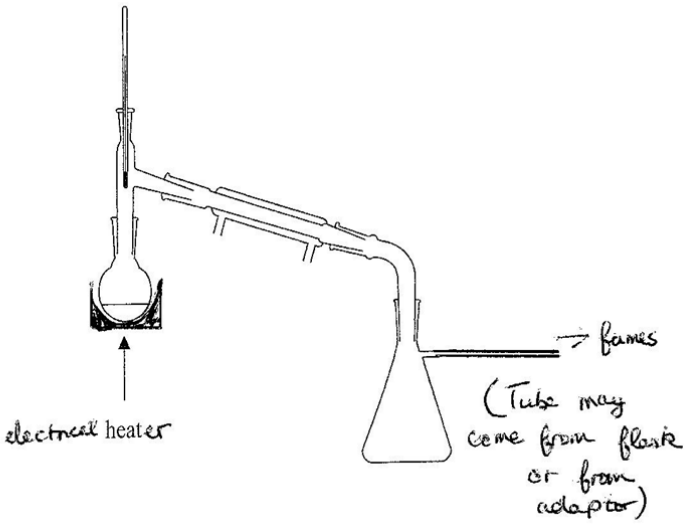
Question Number	Acceptable Answers	Reject	Mark
5(a)	Orange to green / blue / brown ALLOW Orange to blue-green Orange to dark green		**1**

Question Number	Acceptable Answers	Reject	Mark
5(b)	To prevent solvent boiling / vaporising / escaping (from mouth of flask) ALLOW **Solvent** may ignite / is flammable Reactant / product / butan-2-ol / butanone are prevented from boiling / vaporising / escaping (from mouth of flask) IGNORE Comments on sulfuric acid spray being corrosive Butan-2-ol / solvent / butanone is volatile or has a low boiling temperature		**1**

Question Number	Acceptable Answers	Reject	Mark
5(c)	(Purpose:) removes / neutralizes (excess) acid **(1)** (Method:) Put in a (stoppered) **separating funnel / tap funnel** with sodium hydrogencarbonate (and shake the mixture) **(1)** Open the tap at intervals / remove stopper at intervals / release pressure at intervals ALLOW Pressure builds up because carbon dioxide forms **(1)** Final mark can be awarded if washing is carried out in a **stoppered** flask IGNORE comments on separating organic product after washing	Removes impurities	**3**

Question Number	Acceptable Answers	Reject	Mark
5(d)	Drying agent / removes water / removes moisture ALLOW Absorbs water	Dehydrating agent Reacts with water Removes impurities	**1**

Question Number	Acceptable Answer	Reject	Mark
5(e)	**Fi mark**: Suitable flask (round bottom or pear shaped) fitted with stillhead, **and** with thermometer in correct position with bulb opposite opening to condenser ALLOW Flask with long neck and delivery tube in place of flask & stillhead IGNORE Fractionating column **(1)** **Second mark:** Condenser angled downwards with correctly drawn inner tube and (water cooled) outer tube IGNORE (Direction of) water flow in condenser **(1)** **Third mark**: Collecting flask with vent in flask or in connection to it ALLOW Open necked flask / beaker **(1)** **Fourth mark**: Electrical heater ALLOW Water bath heated by electrical heater / Bunsen / heat arrow If heat source is shown as "Heat" or with an arrow then ALLOW either of these precautions: Tube between condenser and collecting flask to lead fumes away to drain or fume cupboard OR Cool collecting flask in ice **(1)** Labels only needed for items which cannot be identified in diagram eg electric heater	Conical flask Still head open Air condenser (ie no water jacket) Sealed system Use of Bunsen but no water bath	**4**



Question Number	Acceptable Answers	Reject	Mark
5(f)(i)	(5.0 / 0.805) = 6.2112 / 6.211 / 6.21 / 6.2 (cm^3) ALLOW comma for decimal point	6 (cm^3)	**1**

Question Number	Acceptable Answers	Reject	Mark
5(f)(ii)	There are many possible correct methods for this calculation. Two of these methods are shown below: **Look at final answer:** **4.8(2) (g) scores 3 marks,** **1.97 (g) OR 3.08 (g) scores 2 marks** For other answers, look at working; do not penalise intermediate rounding. 0.042 moles butanone gives final answer of 4.9 (g) **First mark:** 3.0 g butanone = 0.041609 mol **(1)** **THEN Route 1:** **Second mark** Need to make $\frac{(0.0416 \times 100)}{64}$ = 0.065 mol **(1)** **Third mark** Mass butanol = (0.065 x 74.1) = 4.8175 / 4.8(2) (g) **(1)** **OR Route 2:** **Second mark** Mass of 0.041609 mol butanol = 0.041609 x 74.1 = 3.082 (g) (Use of 0.042 mol gives 3.11 (g)) **(1)** **Third mark** **M**ass butanol needed = (3.082 x 100/ 64) = 4.8175 / 4.8(2) (g) **(1)** IGNORE sf except 1 sf at all stages Rounding may be done at different stages of calculation and intermediate values may not be shown		**3**

Total for Question 5 = 14 marks