

Question number	Answer	Notes	Marks
1 a	Any two of: <ul style="list-style-type: none"> • (same) volume of acid • (same) concentration of acid • (same) concentration of alkali • (same) rate of stirring / stir for the same time • (same) starting temperature / temperature of acid/alkali/solutions/room 	Reject volume(s) of solutions Accept amount of acid as alternative to either of first two bullet points	2
b	M1 correct reference to accuracy / temperature rise M2 correct reference to insulation / heat loss	eg accuracy improved or increased / temperature rise greater or more accurate or closer to correct value(s) / final temperatures higher Accept temperatures more accurate Ignore just higher temperatures Ignore results more reliable / valid eg polystyrene is a (better) insulator / poorer conductor (than glass) / reduces heat loss / more heat trapped Ignore <u>no</u> heat loss Accept reverse argument for glass	2

Question number	Answer	Notes	Marks
1 c i	M1 (final) 39(.0) M2 (initial) 17(.0) M3(change) (+)22(.0)	Both values correct but in wrong order scores 1 mark (of M1 and M2) M3 CQ on final and initial values	3
ii	<u>exothermic</u> AND temperature has increased / temperature change is positive / final temperature higher than initial temperature	Accept heat / thermal energy given out or transferred to the surroundings Reject just energy has been given out	1

Question number	Answer	Notes	Marks
1 d	<p>Any two of:</p> <ul style="list-style-type: none"> • correct statement about first part of graph, identified as positive gradient / positive correlation / temperature increase / temperatures up to 30 or 32.5 °C / volumes up to 20 or 22 cm³ / experiments 1-4 • correct statement about top of graph, identified as where lines cross / intersection / peak / maximum • correct statement about second part of graph, identified as negative gradient / negative correlation / temperature decrease / temperatures after 30 or 32.5 °C / volumes after 20 or 22 cm³ or up to 40 cm³ / experiments 5-8 	<p>eg reaction continuing or acid being neutralised or some acid still unreacted or heat being produced</p> <p>eg reaction complete or all acid neutralised or neutralisation point reached or shows volume of alkali needed to neutralise acid</p> <p>eg further alkali causes cooling or sodium hydroxide absorbs heat or no reaction occurs or no acid left or alkali in excess Reject reaction becomes endothermic</p> <p>Ignore references to direct proportion / particle collisions / limiting reagents / rate of reaction</p>	2
		Total 10 marks	

Question number		Answer	Notes	Marks
2	a	sulfur/precipitate forms	Accept usual precipitate alternatives Ignore precipitate colour Accept cloudy / opaque Reject wrongly identified <u>precipitate</u> (eg sodium chloride)	1
	b	to keep the depth/height/shallowness of liquid (in the conical flask) the same / OWTTE OR the same mass of sulfur (needed to obscure the cross)	Accept reverse argument Reject to keep the concentration the same	1
	c	reaction would start before the correct depth /concentration of liquid was obtained OR the reaction starts when the acid is added / straight away/ before the water is added	Ignore references to keeping the total volume constant Ignore references to fair test / accuracy / safety	1

Question number		Answer	Notes	Marks
2	d	fume cupboard / well-ventilated room /open windows / extractor fan OR wear eye protection / safety goggles / OWTTE OR (gas) mask / respirator		1
		(SO ₂ /it is) poisonous/toxic OR reference to specific harmful effect on humans (eg affects breathing/respiratory irritant /eye irritant/triggers asthma attack/makes bronchitis or emphysema worse) OR to prevent gas reaching eyes/lungs/OWTTE	Ignore references to pollution / acid rain / greenhouse effect Ignore just harmful Mark independently To score M1 and M2, explanation must match precaution: <ul style="list-style-type: none"> • fume cupboard etc can link with all explanations • eye protection etc. can link with all explanations except those involving breathing etc. • mask etc. can link with all explanations except those involving eyes etc. 	1

Question number		Answer	Notes	Marks
3	a	brown precipitate	Accept usual alternatives for precipitate Ignore qualifiers such as dark / light Ignore red(dish) / orange / rust(y) Reject other colours Ignore all names and formulae	1
	b	i	ammonium / NH_4^+ gas given off is ammonia / NH_3	1 1
		ii	sulfate / SO_4^{2-}	1
	c	Zn / zinc (atom) (it) loses (2) electrons / gives electron(s) to Fe^{3+} /zinc is oxidised / zinc increases its oxidation number	Accept Fe^{3+} gains electron(s)/is reduced/oxidation number decreases Ignore Fe^{3+} converted to Fe^{2+} / Zn converted to Zn^{2+} Reject iron/Fe gains electrons M2 DEP on M1	1 1

(Total for Question 3 = 6 marks)

Question number	Answer	Notes	Marks
4 (a)	hydrogen / H ₂ burns with a pop/squeak OR use burning/lit splint/flame to see if pop/squeak	Ignore H Must be reference to test and result Reference to splint/match with no indication of flame is not enough Reject reference to glowing splint Ignore flame extinguished 'Squeaky pop test' on its own is not sufficient	1 1
(b) i	AgCl (dilute) nitric acid / HNO ₃	Ignore names even if wrong Accept sulfuric acid / H ₂ SO ₄ Reject hydrochloric acid / HCl Ignore concentrated acid Ignore acidified without a named acid Reject other named acids	1 1
ii	iron nitrate	Accept ferrous nitrate and ferric nitrate Ignore oxidation states (II) and (III) Reject other oxidation states	1

Question number	Answer	Notes	Marks
4 (c)	<p>(add) sodium hydroxide (solution) / NaOH</p> <p>green precipitate</p> <p>brown precipitate</p>	<p>Any group I hydroxide / ammonium hydroxide / barium or calcium hydroxide / ammonia solution (names or formulae) If reagent incorrect, then 0/3 If reagent missing, then M2 and M3 can be awarded If near miss (eg ammonia hydroxide) then M2 and M3 can be awarded</p> <p>Ignore qualifiers such as light / pale / dark Accept solid / suspension / ppt(e) in place of precipitate Reject all other colours Ignore names and formulae even if incorrect</p> <p>Ignore qualifiers such as light / pale / dark / rusty / foxy / orange Accept red-brown Accept solid / suspension / ppt(e) in place of precipitate Reject all other colours Ignore names and formulae even if incorrect</p> <p>If both colours correct, penalise missing precipitate once only Do not award M2 or M3 for two correct observations in the wrong order Ignore references to bubbles etc</p>	<p>1</p> <p>1</p> <p>1</p>
Total			8

Question number	Answer	Accept	Reject	Marks
5 (a)	M1 - bubbles (of gas) / fizzing / effervescence	gas/carbon dioxide given off		1
	M2 - <u>lump/calcium carbonate/solid</u> disappears/gets smaller	dissolves forms a colourless solution		1
(b)	M1 - (bubble through) limewater/calcium hydroxide solution			1
	M2 - (goes) milky/cloudy/chalky M2 dependent on M1 or near miss, e.g. Ca(OH) ₂ (s) IGNORE references to lighted spill goes out	white precipitate/ suspension/solid (formed)		1
(c)	time increases , mass decreases IGNORE references to mass eventually stops decreasing	reverse statement mass decreases with time (they have a) negative correlation 3 min 18s to 3 min 30s	mass goes down with no reference to time	1
(d) (i)	3.3 to 3.5			1
	(ii) lump/calcium carbonate/solid <u>completely</u> reacted	used up/has gone	has dissolved (both) reactants used up	1

Question Number	Answer	A	Reject	Marks
5 (e)	(i) calcium chloride AND hydrochloric acid IGNORE carbon dioxide / carbonic acid / calcium carbonate	hydrogen chloride for hydrochloric acid correct formulae		1
	(ii) calcium chloride AND hydrochloric acid IGNORE carbon dioxide / carbonic acid	hydrogen chloride for hydrochloric acid correct formula	calcium carbonate	1
(f)	M1 - steeper curve to left of original starting at, or close to (100,0) M2 - levels at 98.4 g			1
			curves that 'dip' below 98.4 by more than ½ small square	1
			Total	11

Question number	Answer	Accept	Reject	Marks
6 (a)	Cu ²⁺ penalise incorrect use of cases and subscript ignore names	Formula showing correct charges on the ions		1
(b)	to remove carbonate (ions) / to avoid precipitating any other (named) insoluble (barium) compounds / to remove ions that would form (white) precipitates	to remove compounds that would form (white) precipitates		1
(c)	CuSO ₄ .5H ₂ O / CuSO ₄ 5H ₂ O (i.e. no dot)	formula showing correct charges on the ions		1
(d)	(use a clean) wire / glass rod / silica rod ignore references to hydrochloric acid (to put) solid in <u>non-luminous / Bunsen</u> flame No marks if solid is in container eg test tube / tray / crucible	any method of introducing the solid / solution into the flame. e.g. (wet) wooden spill / tip or sprinkle in Bunsen/non-luminous anywhere in answer Burner in place of flame Blue for non-luminous	copper rod / any metal that will burn or melt in a flame (eg magnesium, aluminium)	1 1
			Total	5

Question number	Answer	Accept	Reject	Marks
7(a)(i)	fermentation			1
(ii)	(to provide the) catalyst/enzyme/zymase	to increase the rate of the reaction		1
(b)(i)	M1 (test) – flame test	suitable description of flame test		2
	M2 (observation) – brick red / orange-red	red		
(ii)	copper(II) ions:	accept other suitable alkalis		5
	M1 (test) – (aqueous) sodium hydroxide / NaOH	suitable alternatives to precipitate	all other colours	
	M2 (observation) – blue precipitate ignore shades of blue			
	M2 dep on M1 or near miss of formula, eg Na(OH) ₂			
	sulfate ions:	(dilute) nitric acid / HNO ₃		
	M1 (test) – (dilute) hydrochloric acid / HCl	(aqueous) barium nitrate / Ba(NO ₃) ₂	Reject sulfuric acid for M1 only	
	M2 (test) - (aqueous) barium chloride / BaCl ₂			
	M3 (observation) – white precipitate			
	M3 dep on M2 or near miss			

Question number	Answer	Accept	Reject	Marks
7 (c)	<p>M1 (pressure) – 60-70 atm</p> <p>M2 (catalyst) – phosphoric acid / H_3PO_4 ignore references to concentration</p>	<p>any pressure or range within this range</p> <p>phosphoric(V) acid</p>	any other oxidation state	2
(d)	<p>M1 (Σ bonds broken) $348 + 412 + 360 (= 1120)$</p> <p>M2 (Σ bonds made) $612 + 463 (= 1075)$</p> <p>M3 $\text{M1} - \text{M2} / \Sigma$ bonds broken – Σ bonds made</p> <p>M4 (+)45 (kJ/mol)</p> <p>Correct answer with no working scores 4</p> <p>– 5 (kJ/mol) scores 3</p>	<p>3231</p> <p>3186</p>		4

Total 15 marks