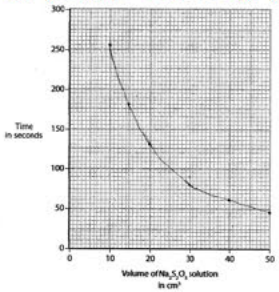
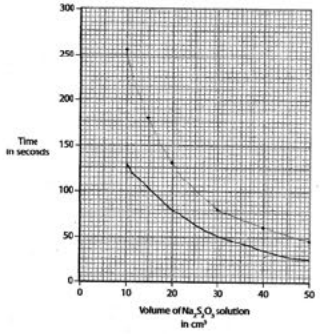
Question number	Answer	Notes	Marks
1 a	Any two of: • (same) volume of acid • (same) concentration of acid • (same) concentration of alkali • (same) rate of stirring / stir for the same time • (same) starting temperature / temperature of acid/alkali/solutions/room	Reject volume(s) of solutions Accept amount of acid as alternative to either of first two bullet points	2
b	M1 correct reference to accuracy / temperature rise	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	2
	M2 correct reference to insulation / heat loss	eg polystyrene is a (better) insulator / poorer conductor (than glass) / reduces heat loss / more heat trapped Ignore no heat loss Accept reverse argument for glass	

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	Any two of: • 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 cm^3 / 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 cm^3 or up to 40 cm^3 / experiments 5-8	eg reaction continuing or acid being neutralised or some acid still unreacted or heat being produced eg reaction complete or all acid neutralised or neutralisation point reached or shows volume of alkali needed to neutralise acid 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 Ignore references to direct proportion / particle collisions / limiting reagents / rate of reaction	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: • 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
2	e	i	all points correctly plotted to nearest gridline  	Deduct 1 mark for each incorrect plot	2
			suitable curve of best fit based on plotted points	Do not penalise continuation of line above 255 s unless incorrect (eg straight line to 300 s)	1
		ii	curve completely below original curve	Do not award mark if curve starts from (10,255)	1
			starts at vol = 10 cm^3, finishes at vol = 50 cm^3  	DEP on point plotted for experiment 1	1

(Total for Question 2 = 10 marks)

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^+	If name and formula given, both must be correct	1
			gas given off is ammonia / NH_3	Accept gas given off is alkaline If name and formula given, both must be correct M2 DEP on M1 or near miss	1
		ii	sulfate / SO_4^{2-}	If name and formula given, both must be correct	1
	c		Zn / zinc (atom)		1
			(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

(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 sufuric acid / H_2SO_4 Reject hydrochloric acid / HCl Ignore conc(entrated) acid Ignore acid(ified) 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)	(add) sodium hydroxide (solution) / NaOH	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 then M2 and M3 can be awarded If near miss (eg ammonia hydroxide) then M2 and M3 can be awarded	1
	green precipitate	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	1
	brown precipitate	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	1
		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	
		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	mass goes down with no reference to time	1
(d) (i)	3.3 to 3.5	3 min 18s to 3 min 30s		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		 curves that 'dip' below 98.4 by more than ½ small square	1 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)	$CuSO_4.5H_2O$ / $CuSO_4$ $5H_2O$ (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	any method of introducing the solid / solution into the flame. e.g. (wet) wooden spill / tip or sprinkle in	copper rod / any metal that will burn or melt in a flame (eg magnesium, aluminium)	1
	(to put) solid in <u>non-luminous / Bunsen</u> flame No marks if solid is in container eg test tube / tray / crucible	Bunsen/non-luminous anywhere in answer Burner in place of flame Blue for non-luminous		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	Reject sulfuric acid for **M1** only	
	M1 (test) – (dilute) hydrochloric acid / HCl	(aqueous) barium nitrate / $Ba(NO_3)_2$		
	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)	**M1** (pressure) – 60-70 atm **M2** (catalyst) – phosphoric acid / H_3PO_4 ignore references to concentration	any pressure or range within this range phosphoric(V) acid	 any other oxidation state	2
(d)	**M1** (Σ bonds broken) 348 + 412 + 360 (= 1120) **M2** (Σ bonds made) 612 + 463 (= 1075) **M3** **M1** – **M2** / **Σ** bonds broken – Σ bonds made **M4** (+)45 (kJ/mol) Correct answer with no working scores 4 **– 5 (kJ/mol) scores 3**	3231 3186		4

Total 15 marks