Question number	Answer	Notes	Marks
1 (a)	**M1** (Curve) A **M2** faster reaction (at higher temperature) **M3** therefore curve is steeper / curve levels off sooner	 **M2** and **M3** dep on correct or missing **M1** accept 'reaction takes less time'	3
(b)	**M1** (Curve) C **M2** only half the mass/amount of zinc used **M3** therefore only half the volume / 20 cm^3 of hydrogen produced	 **M2** and **M3** dep on correct or missing **M1** accept 'less zinc used, so less hydrogen produced' for **1** mark, if **M2** and **M3** not scored	3

Question number	Answer	Notes	Marks
2 (a) (i)	**M1** 0.53 ÷ 106 **M2** 0.005(0) (mol)	 correct answer scores (2)	2
(ii)	**M1** $n(CO_2)$ = 0.005 mol / answer to (a)(i) **M2** vol(CO_2) = (110 ÷ 0.005) = 22 000 (cm^3) OR 110 ÷ **M1** correctly evaluated	 correct answer scores (2)	2
(b)	any two from: **M1** the bung was not replaced quickly after the acid was added (so some carbon dioxide/gas escaped) **M2** (some) carbon dioxide/gas dissolved in the water (in the trough or in the acid) **M3** sodium carbonate is not pure	 allow 'the bung was not on tightly/there was a leak around the bung (so some carbon dioxide/gas escaped)' allow 'reacted with the water'	2

Question number	Answer	Accept	Reject	Marks
3 (a)	**A** - (tap) funnel	burette		1
	B - (conical) flask			1
	C - (gas) jar	measuring cylinder		1
(b)	**M1** (limewater) goes milky/chalky/cloudy OR (white) precipitate/solid/suspension (formed)	ppt	colours other than white	1
	M2 (mixture) goes clear OWTTE (eg cloudiness disappears) **IGNORE** bubbles	solid dissolves OWTTE colourless solution (formed)		1
(c)	more dense than air/oxygen	poor conductor of electricity	just heavier than air	1
(d)	**C** weakly acidic			1
			Total	**7**

Question number	Answer	Accept	Reject	Marks
4 (a) (i)	**M1**  **M2** 0.004(0)			1 1
(ii)	**M1**  **M2** 0.01(00)	an answer of 10(.0) for 1 mark (i.e. failing to divide by 1000)		
(b)	**M1** 0.004 mol of Mg react with 0.008 mol of HCl **OR** 0.01 is greater than 0.008 / M2 from (a)(ii) is greater than 2 x **M2** from (a)(i) **M2** HCl is in excess **M2** dep on **M1** Mark csq on answers in (a)(i) and (a)(ii)	Mg and HCl react in a 1:2 ratio (by moles)		1 1
			Total	**6**

Question number	Answer	Notes	Marks
5 a i	M1 $n(Na_2S_2O_3) = \frac{0.300 \times 20}{1000}$ OR 0.006(0) mol (= $n(SO_2)$)		3
	M2 *M*r of SO_2 = 32 + (2 x16) OR 64		
	M3 mass of SO_2 = (0.006 × 64) = 0.38 (g)	Mark CQ throughout Accept any number of sig fig Correct final answer with or without marking scores 3 marks	
ii	M1 mass of SO_2 in 1 dm^3 = $\frac{0.38(4) \times 1000}{50}$	M1 CQ on M3 in ai	
	= 7.6(8) (g)	Accept any number of sig fig	
	M2 this is less than 100 so no SO_2 will escape	If candidate value for M1 is greater than 100, award M2 for opposite argument If no answer to M1 then M2 cannot be awarded	
	OR		
	M1 volume of solvent is 50cm^3 which would dissolve (100/20) = 5(g) M2 0.384(g) is less than 5(g) so no SO_2 would escape	If answers based on volume of solvent = 20cm^3 eg 20cm^3 which would dissolve (100/50) = 2(g) 0.384(g) is less than 2(g) so no SO_2 would escape worth 1 mark	

b	as the (hydrochloric) acid/HCl is added	Allow (immediately) after (all) the acid/HCl added Ignore when the solutions are mixed	1
c i	timer started too late / stopped too early OR thermometer (scale) read incorrectly / timer read incorrectly	 Allow misread/incorrectly recorded the temperature/time	1
ii	19.5 (s)	Accept range 19-20	1

Question number	Answer	Notes	Marks
5 d i	M1 times are (very) short	Accept reaction happens too/very/so quickly (so hard to time accurately/precisely) Ignore reaction is quicker Ignore hard(er) to measure rate Allow human reaction time becomes significant Allow references to shorter times producing greater percentage (measurement) uncertainties/errors	2
	M2 heat loss greater	Accept heat loss occurs more quickly Accept difficult to maintain a higher temperature/keep temperature constant Ignore references to evaporation occurring	
ii	M1 more collisions/particles have energy equal to/greater than the activation energy	Ignore particles have more (kinetic) energy Ignore harder/more vigorous collisions Ignore references to speed of particles	2
	M2 (therefore there are) more successful collisions (per second)	if state activation energy is lowered scores 0/2 references to concentration scores 0/2	

e	Any three from M1 concentration of the (hydrochloric/nitric) acid M2 volume of the (hydrochloric/nitric) acid M3 volume of sodium thiosulfate M4 temperature	Allow amount for volume If neither M2 or M3 scored allow 1 mark for total volume of the mixture OR depth of liquid in the flask Ignore reference to volume of water Ignore references to size of flask/same apparatus Ignore references to distance of eye from flask/ the X/references to timing	3