

**Question 1**

1(c)(i)	gas syringe drawn / measuring cylinder (or burette) dipping into water drawn (1) apparatus closed, i.e. no air gaps (1)	2
1(c)(ii)	increases / goes faster	1
1(c)(iii)	increases / goes faster	1

**Question 2**

2(a)(i)	27 (cm <sup>3</sup> )	1
2(a)(ii)	steeper initial gradient starting at 0-0 (1) line levels off at 44 cm <sup>3</sup> (1)	2
2(b)(i)	(rate) decreases / reaction slows down	1
2(b)(ii)	(rate) decreases / reaction slows down	1

**Question 3**

3(a)(i)	1.0 (mol / dm <sup>3</sup> ) 2.0 (mol / dm <sup>3</sup> ) 1.5 (mol / dm <sup>3</sup> )	1
3(a)(ii)	takes longer time / time increases	1
3(a)(iii)	takes shorter time / time decreases	1

**Question 4**

4(a)(i)	29 cm <sup>3</sup>	1
4(a)(ii)	steeper initial gradient starting at 0-0 (1) line levels off above 42 cm <sup>3</sup> (1)	2
4(b)(i)	rate faster / rate increases / reaction speeds up	1
4(b)(ii)	rate slower / rate decreases	1
4(c)	iron(II) chloride / iron chloride (1) hydrogen (1)	2
4(d)	substance that increases the rate of reaction (1) and is unchanged (at the end of the reaction) (1)	2

**Question 5**

5(a)(i)	reaction complete / reaction finished / no more sulfuric acid left	1
5(a)(ii)	3 min / 180 s (unit needed)	1
5(a)(iii)	line with steeper gradient and starting at (0,0)	1
	line ends at same volume and before the line already drawn	1
5(b)	faster reaction / rate increases / reaction speeds up	1
	(zinc) powder has a larger surface area <b>ORA</b>	1

**Question 6**

6(c)	large pieces: (rate) decreases / (reaction gets) slower (1) catalyst: (rate) increases / (reaction gets) faster (1) lower concentration: (rate) decreases / (reaction gets) slower (1)	3
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## Question 7

7(a)	180.42	1
7(b)	initial gradient steeper and line starts at 181.00 (1) line is curved and ends at same final volume (1)	2
7(c)	catalyst: rate increases / reaction faster / rate higher / reaction speeds up (1) concentration: rate decreases / reaction slower / rate lower / reaction slows down (1)	2
7(d)	95 (cm <sup>3</sup> )	1

## Question 8

8(b)(i)	1.0 2.0 0.5	1
8(b)(ii)	takes longer / time increases	1

## Question 9

9(b)(v)	<b>M1</b> kinetic energy of particles increases (1) <b>M2</b> frequency of collisions between particles increases (1) <b>M3</b> higher percentage / proportion / fraction of collisions / particles have energy greater than / equal to activation energy (1) or more of the collisions / particles have energy greater than / equal to activation energy	3
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## Question 10

10(a)	<b>M1</b> increases the rate of reaction / speeds up a reaction(1) <b>M2</b> unchanged at the end of the reaction(1)	2
10(b)(i)	oxygen escapes from the flask or apparatus	1
10(b)(ii)	<b>concentration</b> of hydrogen peroxide is highest at the start / <b>particles</b> of hydrogen peroxide are closest together at the start OR <b>collision</b> frequency is highest at the start	1
10(b)(iii)	the <b>hydrogen peroxide</b> is used up / <b>ALL</b> the <b>hydrogen peroxide</b> has reacted or decomposed	1

10(c)	<b>M1</b> kinetic energy of particles increases(1) <b>M2</b> frequency of collisions between particles increases(1) <b>M3</b> more or higher percentage or higher proportion or higher fraction of <b>particles</b> have energy greater than / equal to activation energy OR more of the collisions or higher percentage or higher fraction of <b>collisions</b> have energy greater than or equal to activation energy(1)	3
10(d)	<b>M1</b> (50.0 × 0.200 ÷ 1000 =) 0.01(1) <b>M2</b> 0.005(1) <b>M3</b> 0.16(0)(1)	3
10(e)	no effect	1

10(f)	2HgO → 2Hg + O <sub>2</sub> <b>M1</b> all formulae correct(1) <b>M2</b> equation correct(1)	2
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## Question 11

11(a)	test: relights <b>AND</b> observations: a glowing splint	1
11(b)(i)	lower gradient (at t <sub>2</sub> )	1
11(b)(ii)	<b>M1</b> concentration (of H <sub>2</sub> O <sub>2</sub> particles) decreases (1) <b>M2</b> frequency of collisions between particles decreases (1)	2
11(b)(iii)	<b>M1</b> steeper curve which does not cross original curve and levels off before the original curve (1) <b>M2</b> finishes at same volume (1)	2

## Question 12

12(a)(i)	gradient decreases	1
12(a)(ii)	concentration of HCl is decreasing <b>OR</b> answers in terms of numbers of reactant molecules decreasing	1
12(a)(iii)	200 seconds	1
12(b)	new line steeper than printed line, starts at origin and levels before 200 seconds	1
	new line reaches same final volume as printed line	1
12(c)(i)	minimum energy that colliding particles	1
	must have to react	1
12(c)(ii)	(particles) have more energy and so move faster	1
	more frequent collisions between particles	1
	a greater percentage of collisions / particles have energy greater than the activation energy, $E_a$	1

## Question 13

13(d)(i)	gradient (of line) decreases	1
13(d)(ii)	concentration of particles (of acid) decreases lower rate of collisions of particles	2
13(d)(iii)	a new line steeper than printed line and starts at origin and levels off earlier than printed line levels off at the same volume	2

## Question 14

14(g)	<b>M1</b> rate decreases <b>and</b> particles have less energy (1) <b>M2</b> less collisions (between particles) occur per second / per unit time (1) <b>M3</b> less of the particles/collisions have energy equal to or above the activation energy (1)  or less of the particles / collisions have sufficient energy to react  or a lower percentage / proportion / fraction of collisions (of particles) • are successful or • have energy equal to or above activation energy	3
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