

Question 1

1(e)(vi)	\rightleftharpoons	1
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Question 2

2(b)(i)	reversible reaction	1
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Question 3

3(d)(i)	reversible reaction	1
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Question 4

4(c)(i)	nothing can enter or leave	1
4(c)(ii)	M1 the rate of forward reaction equals (the rate of the) reverse reaction M2 concentrations of reactants and products are constant	2

4(c)(iii)	M1 increases M2 decreases M3 decreases M4 no effect	4
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Question 5

5(a)	nitrogen: air (1) hydrogen: methane (1)	2						
5(b)(i)	enthalpy change	1						
5(b)(ii)	(the value of) ΔH is negative	1						
5(b)(iii)	M1 450 (1) M2 20 000 (1) M3 iron (1)	3						
5(b)(iv)	one mark for each of <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td></td> <td>decreases</td> </tr> <tr> <td>decreases</td> <td>decreases</td> </tr> <tr> <td></td> <td>no change</td> </tr> </table>		decreases	decreases	decreases		no change	4
	decreases							
decreases	decreases							
	no change							
5(b)(v)	M1 kinetic energy of particles increases (1) M2 frequency of collisions between particles increases (1) M3 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						

Question 6

6(a)(i)	$4\text{FeS}_2 + 11\text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3 + 8\text{SO}_2$	1
6(a)(ii)	iron(III) oxide	1
6(b)(i)	yield of SO_3 is less	1
6(b)(ii)	yield of SO_3 is less OR rate is less	1

Question 7

7(a)(i)	$S + O_2 \rightarrow SO_2$	1
7(a)(ii)	(temperature) 450 °C (1) (pressure) 1–2 atmosphere(s) (1) vanadium(V) oxide catalyst (1) $2SO_2 + O_2 \rightleftharpoons 2SO_3$ (1)	4
7(a)(iii)	$SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$	1
7(a)(iv)	water	1

Question 8

8(a)	the rate of forward reaction equals the rate of the reverse reaction (1) concentrations of reactants and products are constant (1)	2				
8(b)	reaction too slow (1) yield of ethanoic acid too low (1)	2				
8(c)	<table border="1" style="display: inline-table; vertical-align: middle;"> <tr> <td>increases (1)</td> <td></td> </tr> <tr> <td>decreases (1)</td> <td>decreases (1)</td> </tr> </table>	increases (1)		decreases (1)	decreases (1)	3
increases (1)						
decreases (1)	decreases (1)					
8(d)	cobalt (1) transition element (1)	2				

Question 9

9(a)	Haber (process)	1
9(b)	air	1
9(c)	reversible	1
9(d)	450 (1) 200 (1)	2
9(e)	Iron / Fe	1
9(f)	reduced temperature: M1 (position of) equilibrium moves to right-hand side (1) M2 reaction is exothermic (1) reduced pressure: M3 (position of) equilibrium moves to left-hand side (1) M4 more (gaseous) moles on left hand side (1)	4
9(g)	M1 rate decreases and particles have less energy (1) M2 less collisions (between particles) occur per second / per unit time (1) M3 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
9(h)	$(NH_4)_2SO_4$	1

Question 10

10(d)(i)	water(s) of crystallisation	1
10(d)(ii)	blue	1
10(d)(iii)	CuSO ₄ ·5H ₂ O M1 CuSO ₄ (1) M2 ·5H ₂ O (1)	2