

1. (a) (i) **M1** The peak of the new curve is displaced to the right.

M2 All of the following are required

- The new curve starts at the origin
 - The peak of the new curve is lower than the original
 - and the new curve only crosses the original curve once
 - and an attempt has been made to draw the new curve correctly towards the energy axis but not to touch the original curve
 - the new curve must not start to diverge from the original curve
- M1 is low demand*
M2 is higher demand.

2

(ii) **M1** Increase in the number/proportion of molecules with $E \geq E_a$

OR more molecules have $E \geq E_a$

OR more molecules have sufficient energy to react

M2 More effective/productive/successful collisions

Ignore "molecules have more energy"

Ignore "more energetic collisions"

Ignore "molecules gain activation energy"

Ignore "more collisions"

Accept "particles" for "molecules" but NOT "atoms"

Ignore "chance of collision"; this alone does not gain M2

2

(b) (i) Iron **OR** Fe

1

(ii) **M1** Catalysts provide an alternative route/pathway/mechanism

OR

(in this case) surface adsorption/surface reaction occurs.

For M1, not simply "provides a surface" alone

M2 that has a lower activation energy

OR

lowers the activation energy

For M2, the candidate may use a definition of activation energy without referring to the term

2

[7]

2.	(a)	Gradient (or slope) (or draw a tangent)	1
	(b)	(i) Curve X is lower and starts at origin	1
		And levels out at same volume as original curve	1
		(ii) Curve Y is steeper than original and starts at origin	1
		Then levels out at half the volume of the original	1
	(c)	(i) $2\text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{O}_2$	1
		(ii) Speeds up (alters the rate of) a chemical reaction	1
		Remains unchanged (or not used up)	1
		(iii) Remains unchanged (or not used up or not in the overall reaction equation)	1
		Offers alternative reaction route (or acts as an intermediate)	1
			[10]
3.	(a)	(i) acid 0.46	1
		alcohol 1.46	1
		water 5.54	1
	(ii)	$K_c = \frac{[\text{CH}_3\text{CH}_2\text{COOCH}_2\text{CH}_3][\text{H}_2\text{O}]}{[\text{CH}_3\text{CH}_2\text{COOH}][\text{CH}_3\text{CH}_2\text{OH}]} = \frac{[\text{ester}][\text{water}]}{[\text{acid}][\text{alcohol}]}$ <p><i>penalise ()</i> <i>allow molecular formulae or minor slip in formulae</i></p>	1

$$(iii) \quad \frac{(0.54/V)(5.54/V)}{(0.46/V)(1.46/V)}$$

Allow without V

Conseq on values in (a)(i)

If values used wrongly

or wrong values inserted

or wrong K_c no marks for calc

1

4.45 or 4.5

Part (a)(iii) for info $0.46 \times 1.46 = 0.6716$

1

cancel (as equal no of moles on each side of equation)

1

Possible wrong answers

acid	0.46	✓	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> Gives $K_c = 3.59$ ✓✓ </div>
alcohol	1.46	✓	
water	4.46	✗	

acid	0.46	✓	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> Gives $K_c = 0.434$ ✓✓ </div>
alcohol	1.46	✓	
water	0.54	✗	

(b) (i) decrease or be reduced or fewer

1

(ii) decrease or be reduced or less time or faster or quicker

1

(iii) decrease or be reduced

1

[10]

4.	no change	1	[6]
	equal number of gaseous moles on either side	1	
	both sides affected equally	1	
	increases	1	
	equilibrium moves to lower the temperature/oppose the change	1	
	endothermic reaction favoured /forward reaction is endothermic	1	
5.	(a) T_2		[5]
	<i>(Must be correct to score any marks in this section)</i>	1	
	<u>Exothermic</u>	1	
	Reduce T to shift equilibrium to the right or forward reaction favoured by low T or K_p increases for low T or low T favours exothermic reaction	1	
(b)	Increase	1	[5]
	None	1	
6.	high pressure expensive (due to energy or plant costs)	1	[2]
	(Rate is) slow (at lower temperatures)	1	

7.	D	
8.	D	[1]
9.	A	[1]
10.	C	[1]
11.	D	[1]
12.	A	[1]
13.	C	[1]
14.	D	[1]
15.	A	[1]
16.	C	[1]