

Mark schemes

1	(a) (i) Z (1)	1
	(ii) Collisions (1)	
	Cause some molecules to slow down or lose energy (1)	2
	(b) Curve starts at origin and is displaced to the right (1)	
	Curve lower and does not touch energy axis (1)	2
	(c) (i) Only a small percentage/very few collisions have $E > E_a$ (1)	1
	(ii) Add a catalyst (1)	
	Lowers E_a (1)	
	More collisions/molecules have energy $> E_a$ (1)	3
		[9]
2	(a) minimum energy	1
	to start a reaction/ for a reaction to occur/ for a successful collision	1
	(b) activation energy is high / few molecules/particles have sufficient energy to react/few molecules/particles have the required activation energy	
	<i>(or breaking bonds needs much energy)</i>	1
	(c) molecules are closer together/ more particles in a given volume	1
	therefore collide more often	1
	(d) many	1
<u>more molecules have energy greater than activation energy (QoL)</u>	1	

- (e) speeds up a reaction but is chemically unchanged at the end 1
- (f) increases the surface area 1

[9]

3

- (a) the minimum energy; 1

Energy required for a reaction to occur;
(or to start a reaction or for successful collisions) 1

- (b) axes labelled:- y: number (or fraction or %) of molecules (or particles)
 x: energy (or KE); 1

curve starts at origin; 1

skewed to right; 1

approaches x axis as an asymptote;
(penalise a curve that levels off > 10% of max peak height or a curve that crosses the energy axis) 1

second curve displaced to the left (and does not cross T_1 curve for a second time) 1

and peak higher; 1

many fewer molecules; 1

fewer molecules have $E > E_a$;
(can score this mark from suitably marked curves) 1

- (c) molecules (*or particles or collisions*) do not have enough energy;
(or orientation may be wrong) 1
- increase the pressure; 1
- (or increase the concentration or reduce the volume)
 increases the collision frequency;
(or more collisions)
*(do not allow if stated to be due to increase in energy implied by
 temperature increase)* 1
- add a catalyst; 1
- lowers activation energy (or E_a) (*Q of L mark*); 1

[15]

4

- (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]

5

[1]

6

(a)	Graph starts at origin	1
	Graph skewed to left and has decreasing gradient to maximum	1
	Graph after maximum decreases in steepness, never touches x axis, levels out less than 5 mm from x axis.	1
(b)	Minimum energy	1
	To start a reaction (<i>or for a reaction to occur</i>)	1
(c)	Molecules gain energy (<i>or always some molecules have $E > E_a$</i>)	1
	Due to collisions	1

(d) Decreases

1

E_a lowered (1)

By alternative route (1)

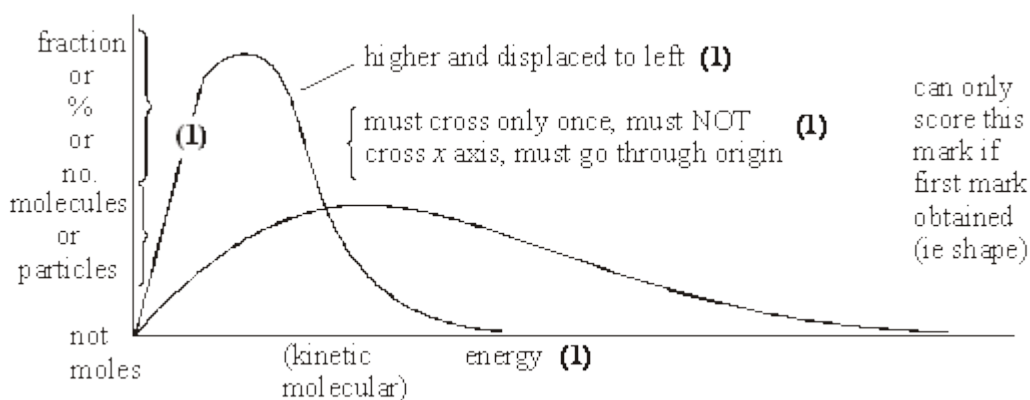
So more molecules have energy $> E_a$ (1)

max 2

[10]

7

(a)



2

(b) See above

2

(c) Energy $< E_a$ or must have enough energy (to react) (1)

1

(d) Increase concentration (or pressure) (1)

1

(e) Many (1) more molecules have $E > E_a$ / enough energy (1)

NOT KE increases with T

2

(f) Lowers E_a (1)
alternative route (1)

2

[10]

8

(a) minimum energy (1)
required before a reaction can occur or go or start (1)

2

- (b) speeds up (changes) reaction rate **(1)**
 without being (chemically) changed **(used up) (1)**

2

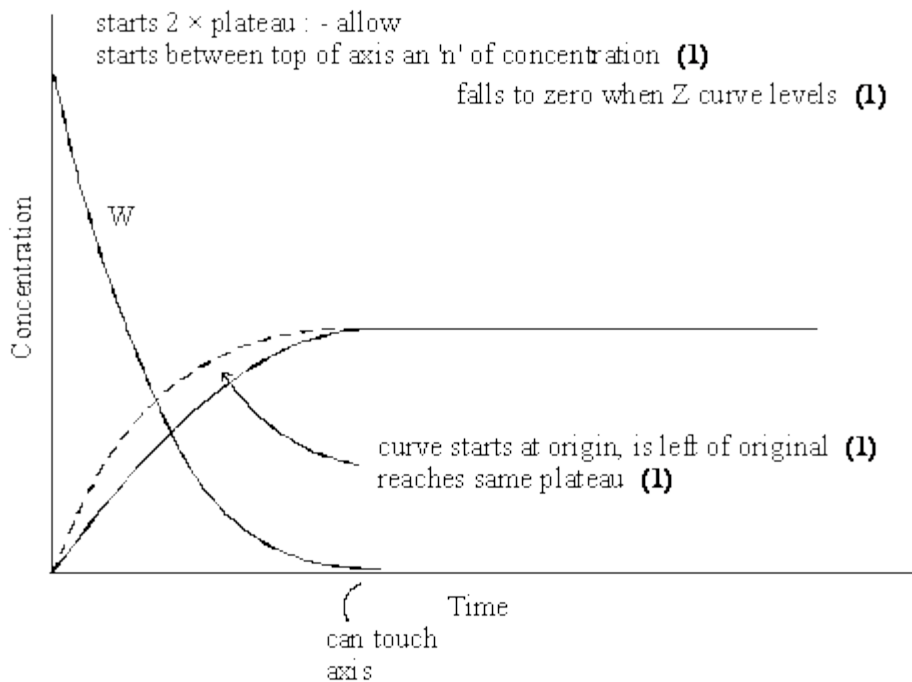
- (c) provides alternative reaction route **(1)**
 with a lower activation energy **(1)**

in (b) and (c) reward 4 marks for 4 points wherever found

2

- (d) (i)

- (ii)



- (iii) fewer collisions **(1)**
 W used up **(1)**
or reactants
or reagents
or fewer particles

6

[12]

9

(a) (i)



(ii) The total number of particles (or molecules) in the sample
OR the number of molecules present

(iii) No molecules have no energy
OR all molecules have some energy
Do not allow "if there are no molecules there is no energy"

4

(b) (i) The minimum energy required **(1)**

for a reaction to occur **(1)**

OR to start reaction or for a successful collision

(ii) Changes: Catalyst **(1)**

Explanation: Alternative route **(1)**, with a lower activation energy **(1)**

OR a lower activation energy (1)

so more molecules can react (1)/more molecules have this energy

If change incorrect CE = 0

Allow answers anywhere in b (ii)

5

[9]**10**

(a) **Increase in temperature:**

Yield is increased **(Allow if for H₂ (g) or products) (1)**

Reaction endothermic **(1)**

Equilibrium moves to the right **OR** forward, **OR** Equilibrium moves to oppose change **OR** to absorb heat **(1)**

If "Yield statement" incorrect allow max one if reaction stated to be endothermic

Increase in pressure:

Yield is decreased (**Allow if for H₂ (g) or products**) (1)

Increase in moles of gas **or** 2 moles increased to 4 moles **or** more moles on right (1)

Equilibrium moves to the left **OR** backwards, **OR** Equilibrium moves to oppose change **OR** to reduce pressure (1)

If "Yield statement" incorrect allow max one if number of moles change is correct.

6

(b) **Equilibrium yield:**

Unaffected **or** equilibrium unchanged (1)

Rate or speed increased (1)

Forward and backwards reactions equally or by the same amount (1)

Amount of hydrogen produced:

More hydrogen produced (1)

4

[10]

11

[1]

12

(a) Activation energy:-

The minimum energy needed for a reaction to occur / start (1)

1

(b) Catalyst effect:-

Alternative route (or more molecules have E_a) (1)

Lower activation energy (1)

2

- (c) Increase in moles of gas:-
Position of E_{mp} unchanged (1)
More molecules with E_{mp} (1)
Area under curve increases (1)
Molecules with $E \geq E_a$ increased (1)
- Temperature decreased:-
Position of E_{mp} moves to the left (1)
More molecules with E_{mp} (1)
Area under curve unchanged (1)
Molecules with $E \geq E_a$ decreased (1)
- Catalyst introduced:-
Position of E_{mp} unchanged (1)
Molecules with E_{mp} unchanged (1)
Area under curve unchanged (1)
Molecules with $E \geq E_a$ increased (1)

12

[15]

D
13

[1]

D
14

[1]