1. (a) Activation energy;-
The minimum energy needed for a reaction to occur / start **(1)**

1

(b) Catalyst effect:-
Alternative route (or more molecules have Ea) **(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]

2. (a) <u>minimum</u> energy **(1)**
required before a reaction can occur or go or start **(1)**

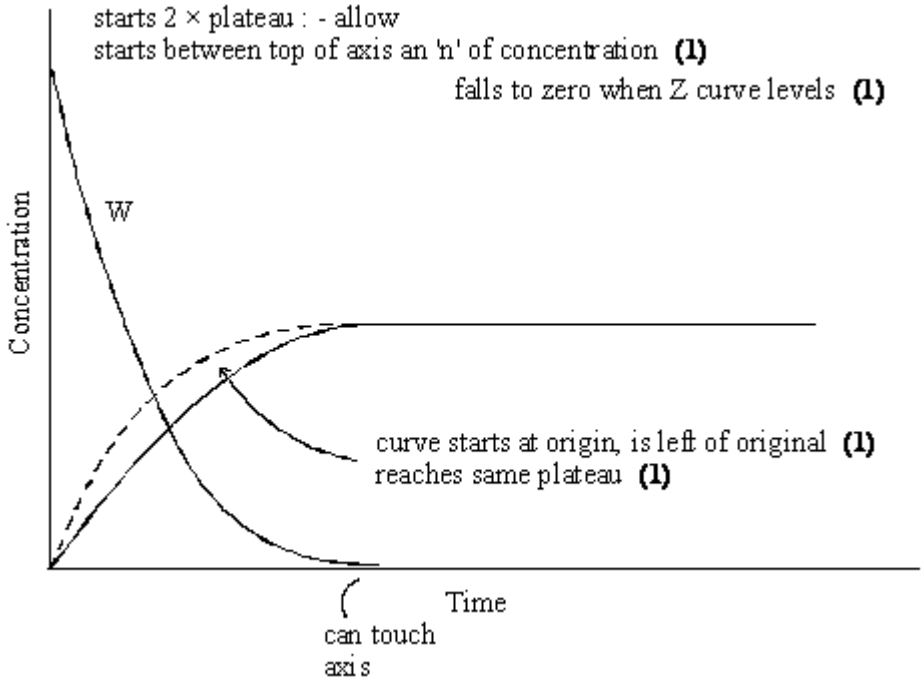
2

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

2

(c) (i)

(ii)

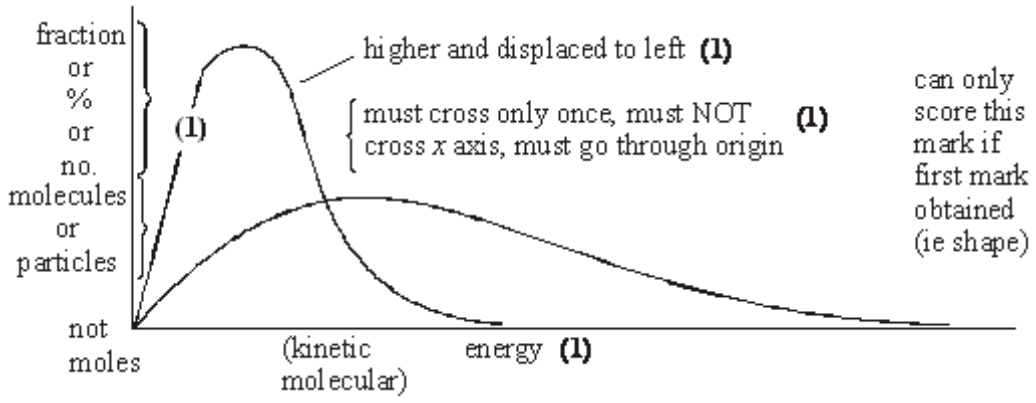


(iii) fewer collisions **(1)**
W used up **(1)**
or reactants
or reagents
or fewer particles

6

[10]

3. (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

[10]

4. (a) Stoppered flask or similar with side arm

Allow gas outlet through stopper.

1

Calibrated container for collection eg gas syringe

Allow collection over water, but must use calibrated vessel for collection.

Lose 1 mark if apparatus is not gas tight.

1

(b) Plot a graph of 'volume (of gas)' against 'time'

1

Determine the <u>slope (gradient) at the beginning</u>

1

(c) Repeat with same volume **or** concentration of hydrogen peroxide <u>and</u> at the same temperature

Ignore references to results.

Do not allow 'keep everything the same' or words to that effect. Must mention volume or concentration and temperature.

1

Add cobalt(II) chloride to one experiment

1

[6]

5. (a) (i) $C + 3D \longrightarrow 2A + B$

1

(ii) $mol^{-1}\ dm^3$

1

(iii) (forward reaction is) exothermic or more products formed

1

(b) (i) for N_2O_4 M_r = 92.0

1

Mol = $\frac{36.8}{92.0} = 0.400$

1

(ii) mol N_2O_4 reacted = 0.400 – 0.180 = 0.220

1

mol NO_2 formed = 0.440

1

(iii) $K_c = \frac{(NO_2)^2}{(N_2O_4)}$

1

$= \frac{(0.44/16)^2}{(0.18/16)}$

1

= 0.067

1

(iv) move to NO_2/ to right / forwards

1

none

1

[12]

6. (a) (i) Increase (if wrong no further marks in part (i)

1

higher *P* gives lower yield or moves to left

1

Eqm shifts to reduce *P* or eqm favours side with fewer moles

1

(ii) Endothermic if wrong no further marks in part (ii)

1

increase *T* increases yield or moves to right

1

Eqm shifts to reduce *T* or eqm favours endothermic direction

1

(b) (i) Moles of iodine = 0.023

If wrong no marks in (i)

1

Moles of HI = 0.172

1

If × 2 missed, max 1 in part (iv)

(ii) $K_c = \frac{[H_2][I_2]}{[HI]^2}$

must be square brackets (penalise once in paper) – if round, penalise but mark on in (iv)

if K_c wrong, no marks in (iv) either but mark on from a minor slip in formula

1

(iii) V cancels in K_c expression

or no moles same on top and bottom of expression

or total moles reactants = moles products, i.e. total no of moles does not change

1

(iv) $K_c = \frac{(0.023)^2}{(0.172)^2}$

Conseq on (i)

1

= 0.0179 or 1.79×10^{-2}

Allow 0.018 or 1.8×10^{-2}

1

(v) K_c = 55.9 or 56

Conseq i.e. (answer to (iv))$^{-1}$

1

[13]

7. (a) Rate forward reaction = rate backward reaction (1)

Concentrations of reactants and products are constant (1)

2

(b) System opposes change (1)

Moves to the side with fewer moles (1)

In this case NH_3 (2 moles) on right side < N_2 + H_2 together (4 moles) on left side of equation (1)

3

(c) Too expensive to generate etc (1)

1

(d) (i) Yield of ammonia increases (1)

Exothermic reaction favoured (1)

System moves to raise temp / or oppose decrease in temp (1)

3

(ii) Faster reaction (1)

1

(iii) Balance between rate and yield (1)

1

[11]

8. C

[1]

9. B

[1]

10. B

[1]

11. D

[1]

12. A

[1]