Kinetics & Chemical Equilibria Test Answers
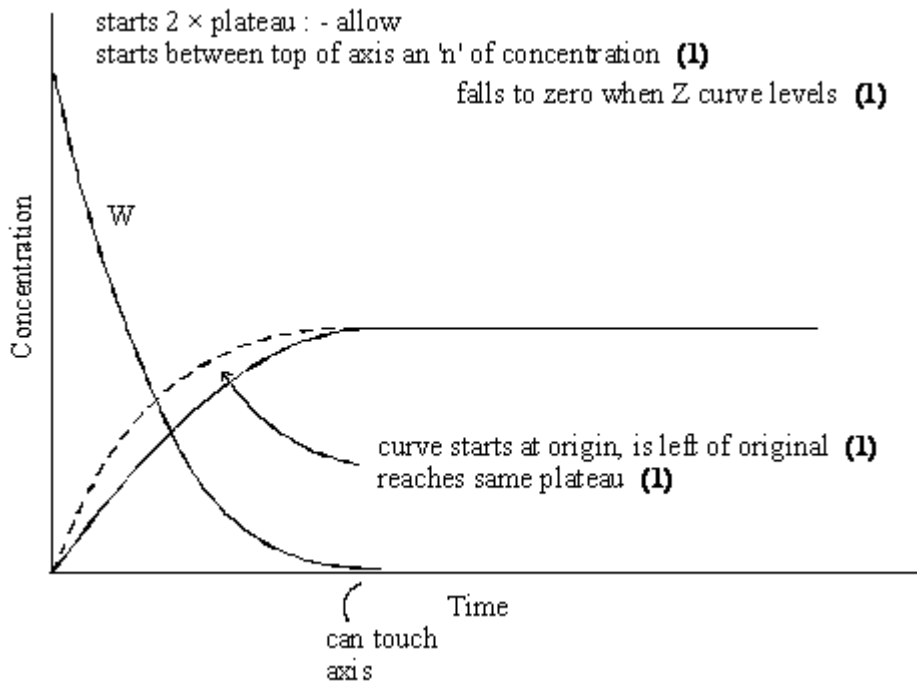
1.   (a)   Activation energy;-
              The minimum energy needed for a reaction to occur / start **(1)**

                                                                                          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)**
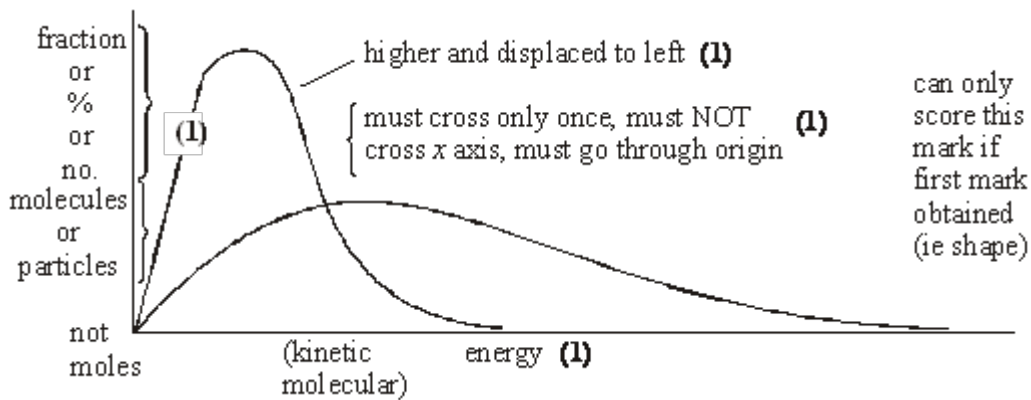   without being (chemically) changed **(used up) (1)**

                                                                                          2

(c)   (i)

(ii)

starts 2 × plateau : - allow
starts between top of axis an 'n' of concentration **(1)**
falls to zero when Z curve levels **(1)**

W

Concentration

curve starts at origin, is left of original **(1)**
reaches same plateau **(1)**

Time

can touch
axis

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

6

[10]

3.   (a)

fraction
or
%
or
no.
molecules
or
particles

(1)

not
moles

higher and displaced to left **(1)**

must cross only once, must NOT **(1)**
cross *x* axis, must go through origin

can only
score this
mark if
first mark
obtained
(ie shape)

(kinetic   energy **(1)**
molecular)

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 ⟶ 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 = $\dfrac{(NO_2)^2}{(N_2O_4)}$

1

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

1

= 0.067

1

(iv)   move to NO_2/ to right / forwards

1

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) $K_c = \dfrac{[H_2][I_2]}{[HI]^2}$

> *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) $K_c = \dfrac{(0.023)^2}{(0.172)^2}$

> *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]