Revision 2

- Equilibrium and rate of reaction.

a) - $N_2O_4(g) \rightleftarrows 2NO_2(g)$ $K_c = 3.6 \times 10^{-3}$ M

b) - $N_2(g) + 2O_2(g) \rightleftarrows 2NO_2(g)$ $K_c = 3.1 \times 10^{-9}$ M^{-}

1) Use the information above to obtain the value of the Kc for the reaction shown below.
$N_2O_4(g) \rightleftarrows N_2(g) + 2O_2(g)$
Step 1 Flip equation b) to get c) *$2NO_2(g) \rightleftarrows N_2(g) + 2O_2(g)$ $K_c = 3.23 \times 10^8$*
Step 2 Add equations a) and c) to get *$N_2O_4(g) \rightleftarrows N_2(g) + 2O_2(g)$ K =* (3.6×10^{-3}) *(3.23×10^8)*
⇨ *$N_2O_4(g) \rightleftarrows N_2(g) + 2O_2(g)$ K =* (3.6×10^{-3}) *$(3.23 \times 10^8) = 1.16 \times 10^6\ M^2$*

2) At a given temperature 3.00 mol of A_2 gas and 4.00 mol of B_2 gas were mixed in a 4.00 litre sealed vessel and allowed to react according to the equation below
$A_2(g) + B_2(g) \rightleftarrows 2AB(g)$
After a while equilibrium was reached, at which point the gas mixture in the sealed container was analysed and found to contain 2.00 mol of AB gas.
    a) What is the theoretical yield of AB?
    Step 1 Identify the limiting reactant
    => A_2 gas
    Step 2 Using the limiting reactant find the
    mol AB produced
    => 6.00 mol of AB
    b) Percentage yield is given by the formula below

$$\frac{\text{actual yield}}{\text{theoretical yield}} \times 100$$

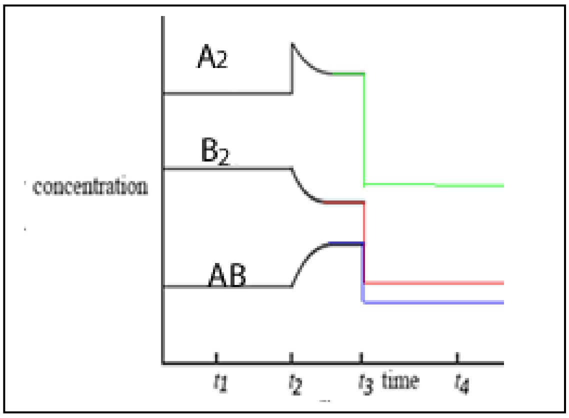
    Calculate the percentage yield for this system.

    (2.00 / 6.00) X 100 = 33.3%

.

    c) Calculate the value of the K_c for the reaction .
    If
    If 2.00 of AB is formed then 1.00 mol of A_2 has reacted and 1.00 mol of B_2 has also reacted. This leaves 2.00 mol of A_2 and 3.00 mol of B_2 at equilibrium.
    $[A_2]$ = 2.00/4.00 =0.50 M
    $[B_2]$ = 3.00/4.00 =0.7500 M
    [AB] = 2.00/4.00 =0.500 M
    => $[AB]^2/([A_2]\ [B_2])$ = 0.667 (no units)

3) The same system as in Q2 above was subjected to a number of changes. A graph of the change in concentrations of each species is shown on the right



a) What change was made to the system at t_2? Explain how the system responded.

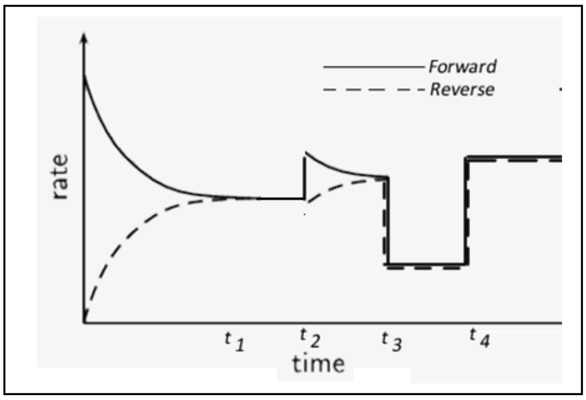
A_2 gas was injected into the reaction vessel.
The system responded to partially undo the change by moving in a net forward reaction.

b) At t_3 the volume of the vessel was doubled. Draw, on the graph above, how the concentration of each species changes over time before equilibrium is reached once more just before t_4.

Since the same number of particles exist on both sides of the equation then the system can not respond.

a) At t_4 a catalyst was added. Draw, on the graph above, how the system responded.

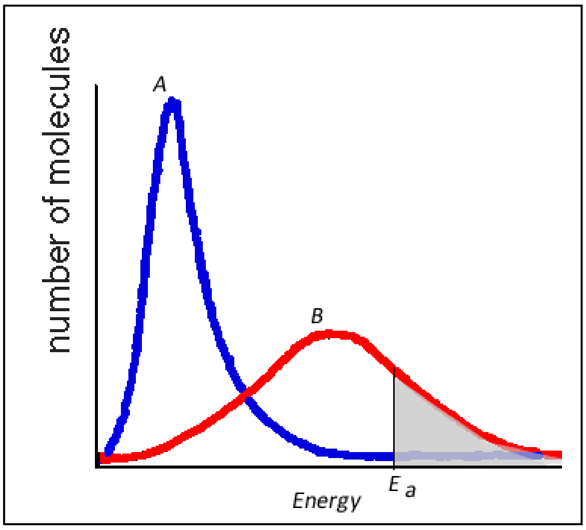
b) Indicate how the rates of the forward and reverse reactions change as the changes at t_2, t_3 and t_4 take place.



c) The following reaction takes place at a given temperature.

$2HCl(aq) + BaO(s) \rightarrow BaCl_2(aq) + H_2O(l)$

The graph on the right shows the kinetic energy of molecules at two different temperatures A and B. E_a represents the activation energy for the reaction.



a) Write a balanced ionic equation for the above reaction.

Step 1 Write the equation out again but this time separating the (aq) species, as shown below.

$2H^+(aq) + 2Cl^-(aq) + BaO(s) \rightarrow Ba^{2+}(aq) + 2Cl^-(aq) + H_2O(l)$

Step 2 Cancel out any species that appear on both sides

$2H^+(aq) + \cancel{2Cl^-(aq)} + BaO(s) \rightarrow Ba^{2+}(aq) + \cancel{2Cl^-(aq)} + H_2O(l)$

=> $2H^+(aq) + BaO(s) \rightarrow Ba^{2+}(aq) + H_2O(l)$

b) Which graph represents the hottest temperature? *B*

c) Which statements below are true?

i. The kinetic energy of all molecules increases at higher temperature.
False

ii. The average kinetic energy of the particles decreases at lower temperatures.
True

iii. All particles have a lower kinetic energy at lower temperatures.
False

d) At which temperature A or B will the fastest rate of reaction take place? Explain.
At temperature B as more particles have the activation energy .

e) What does the shaded area represent?

The number of particles with energy greater than the activation energy.

f) Two students were arguing as to how the rate of a reaction can be increased. Darren suggested that a catalyst will definitely speed up the reaction. Jason also suggested that increasing temperature will also increase the rate of the reaction. On the graphs shown on the right, draw how a catalyst or an increase in temperature changes the distribution of energy amongst the particles and hence causes an increase in the rate of a reaction.
Explain how each increases the rate of the reaction.