Reaction Rate and Equilibrium Revision Questions

1. For the following situations, draw graphs of concentration against time to show the change and the reaction that occurs. Your initial values can be whatever you like, but should be well above zero.

   (a) $H_{2\,(g)} + I_{2\,(g)} \rightleftharpoons 2HI_{(g)}$ is at equilibrium and then the concentration of I_2 is increased.

   (b) $2NO_{2\,(g)} \rightleftharpoons N_2O_{4\,(g)}$ is at equilibrium and then the pressure is doubled.

   (c) $2NO_{2\,(g)} \rightleftharpoons N_2O_{4\,(g)}$ $\Delta H = -ve$ is at equilibrium and then the temperature is increased.

2.

   (a) Draw an energy profile diagram for an *exothermic* reaction. Label ΔH and whether it is +ve or -ve.

   (b) Draw an energy profile diagram for an *endothermic* reaction which has the same activation energy.

   (c) Draw an energy profile diagram for the same reaction as (a) if a catalyst is present.

3. Consider a closed system with starting concentrations of:

   $[SO_2] = 2.0$ mol L^{-1}, $[O_2] = 1.0$ mol L^{-1}, and $[SO_3] = 0.0$ mol L^{-1}.

   $$2SO_{2\,(g)} + O_{2\,(g)} \rightleftharpoons 2SO_{3\,(g)} \quad \text{at } 100°C$$

   (a) When equilibrium is reached, the concentration of SO_2 is 0.6 mol L^{-1}.
   Determine the final concentrations of O_2 and SO_3.

   (b) Calculate K_C for this reaction at this temperature.

   (c) If the temperature of this reaction is increased, K_C decreases to 0.0036.

      (i) State whether the reaction above is exothermic or endothermic.

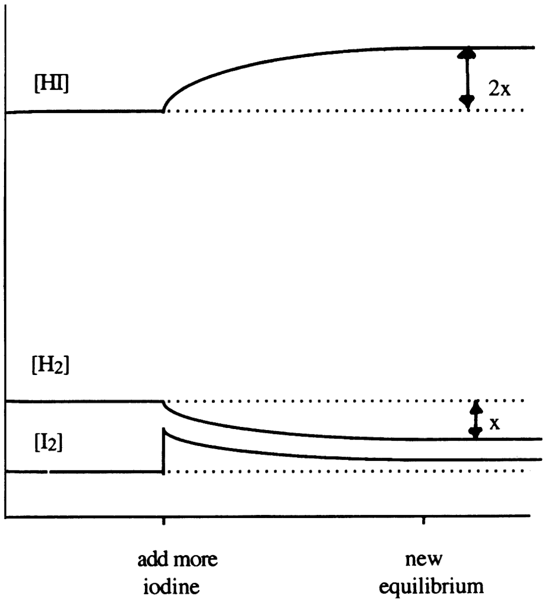
      (ii) At this temperature, the final concentration of SO_2 is 1.9 mol L^{-1} and the final concentration of SO_3 is 0.11 mol L^{-1}.
      Use the K_C expression to determine the final concentration of O_2.

   (d) If the concentration of SO_2 is increased, explain using K_C whether the forward or backward reaction would be favoured.

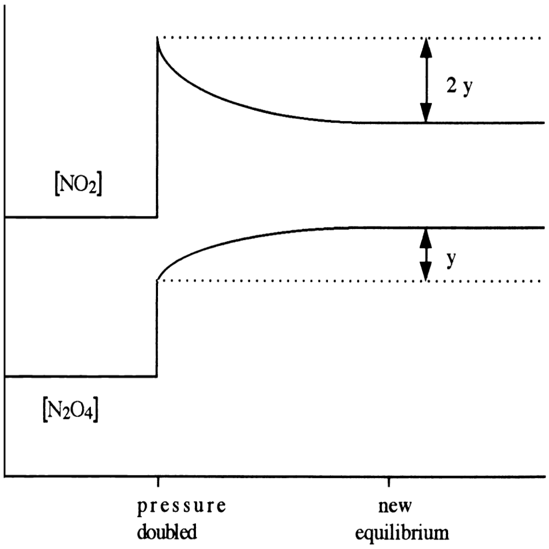
Reaction Rate and Equilibrium Revision Answers

1. *These are suggested answers; the positioning of the lines could be quite different.*

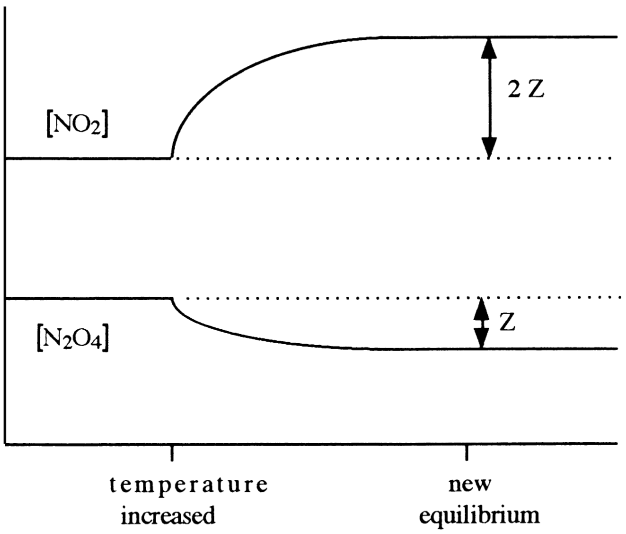
(a)



(b)

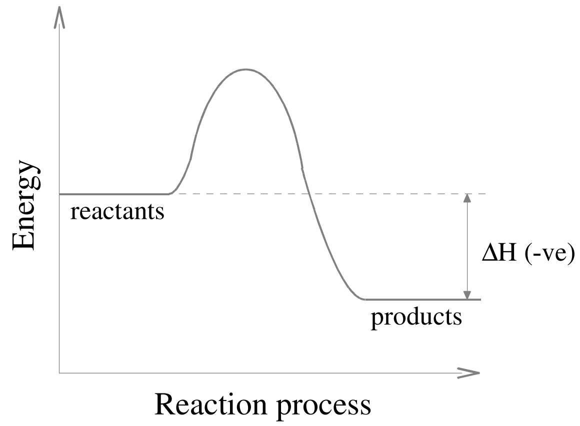


(c)

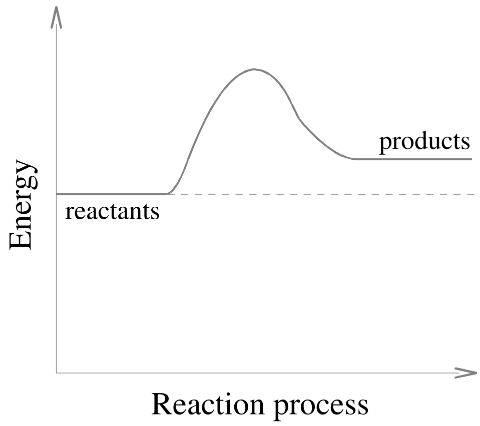


2.

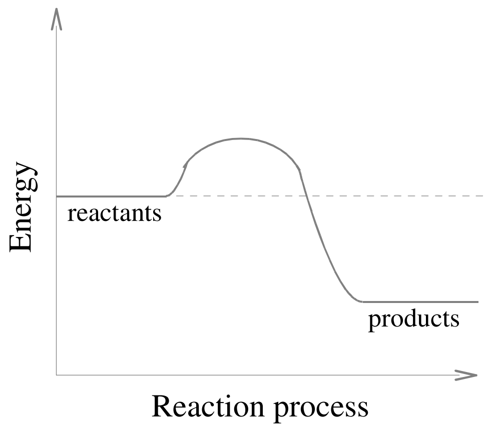
(a)


Energy
reactants
ΔH (-ve)
products
Reaction process

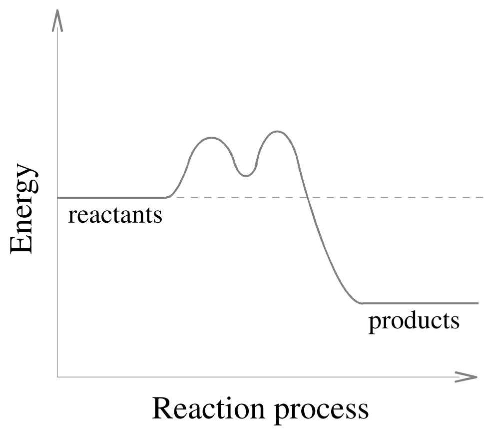
(b)


Energy
products
reactants
Reaction process

(c)


Energy
reactants
products
Reaction process

or


Energy
reactants
products
Reaction process

3.

(a)

	SO_2	O_2	SO_3
Initial	2.0	1.0	0.0
Change	**-1.4**	**-0.7**	**+1.4**
Final	0.6	**0.3**	**1.4**

(b) $$K_C = \frac{[SO_3]^2}{[SO_2]^2[O_2]} = \frac{1.4^2}{0.6^2 \times 0.3} = 18$$

(c)

(i) Exothermic

(ii) $$K_C = \frac{[SO_3]^2}{[SO_2]^2[O_2]}$$

$$\therefore [O_2] = \frac{[SO_3]^2}{[SO_2]^2 K_C} = \frac{0.11^2}{1.9^2 \times 0.0036} = 0.93 \text{ mol L}^{-1}$$

(d) SO_2 is in the denominator (underneath) of the fraction, so increasing [SO_2] will make the total value of the fraction *smaller*. This means the net reaction needs to *increase the value of the fraction* to restore it to be equal to K_C again. This means the *forward* reaction will be favoured.