Questions

1 The equation for a reversible reaction used in industry to convert methane to hydrogen is shown below.

$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$
$\Delta H^{\ominus} = +210$ kJ

Which statement is always correct about this reaction when equilibrium has been reached?

A. The concentrations of methane and carbon monoxide are equal.

B. The rate of the forward reaction is greater than the rate of the reverse reaction.

C. The amount of hydrogen is three times the amount of methane.

D. The value of $\Delta H^{\ominus}$ for the reverse reaction is -210 kJ. [1]

IB, May 2006

2 Sulfur dioxide and oxygen react to form sulfur trioxide according to the equilibrium:

$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

How are the amount of SO_2 and the value of the equilibrium constant for the reaction affected by an increase in pressure?

A. The amount of SO_3 and the value of the equilibrium constant both increase.

B. The amount of SO_3 and the value of the equilibrium constant both decrease.

C. The amount of SO_3 increases but the value of the equilibrium constant decreases.

D. The amount of SO_3 increases but the value of the equilibrium constant does not change. [1]

IB, November 2007

3 What will happen to the position of equilibrium and the value of the equilibrium constant when the temperature is increased in the following reaction? [1]

$Br_2(g) + Cl_2(g) \rightleftharpoons 2BrCl(g) \qquad \Delta H = +14$ kJ

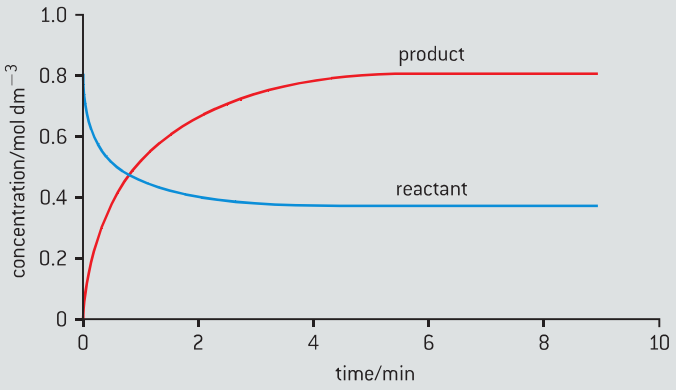
	Position of equilibrium	Value of equilibrium constant
A.	shifts towards the reactants	decreases
B.	shifts towards the reactants	increases
C.	shifts towards the products	decreases
D.	shifts towards the products	increases

IB, November 2003

4 The equation for one reversible reaction involving oxides of nitrogen is shown below:

$N_2O_4(g) \rightleftharpoons 2NO_2(g) \qquad \Delta H^{\ominus} = +58$ kJ

Experimental data for this reaction can be represented on the following graph (figure 8).



▲ Figure 8

a) Write an expression for the equilibrium constant, K_c, for the reaction. Explain the significance of the horizontal parts of the lines on the graph. State what can be deduced about the magnitude of K_c for the reaction, giving a reason. [4]

b) Use Le Châtelier's principle to predict and explain the effect of increasing the temperature on the position of equilibrium. [2]

c) Use Le Châtelier's principle to predict and explain the effect of increasing the pressure on the position of equilibrium. [2]

d) State and explain the effects of a catalyst on the forward and reverse reactions, on the position of equilibrium, and on the value of K_c. [6]

IB, November 2005

Topic 7 - Equilibrium

Quick questions

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C

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a) $K_c = \dfrac{[NH_3]}{[N_2]^{1/2}[H_2]^{3/2}}$

b) $K_c = \dfrac{[NO_2][ClNO]}{[ClNO_2][NO]}$

c) $K_c = \dfrac{[NO]^4[H_2O]^6}{[O_2]^5[NH_3]^4}$

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1. $\dfrac{1}{K_c} = 4.2 \times 10^{-34}$

2. $\sqrt{K_c} = 0.028$

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a) the reaction is endothermic; an increase in the temperature of the system will shift the equilibrium, favoring the forward reaction, increasing the volume of PCl_3 and Cl_2;

b) as chlorine gas is a product, an increase in the volume of chlorine will shift the equilibrium, favoring the reverse reaction;

c) in this system, there is 1 mol of gas on the reactant side and 2 mol of gas on the product side; an increase in pressure will shift the equilibrium to favor the side with the least number of moles of gas, the reactant side;

d) the addition of a catalyst increases the rate of the forward and reverse reactions equally; there is no shift in the equilibrium position;

End of topic questions (page 190)

1. D

2. D

3. D

4. a) $K_c = \dfrac{[NO_2]^2}{[N_2O_4]}$;

horizontal line: concentration of reactant and product remains constant/equilibrium reached; magnitude of K_c greater than 1; product concentration greater than reactant concentration;

b) increased temperature shifts equilibrium position to right; (forward) reaction is endothermic/absorbs heat;

c) increased pressure shifts equilibrium to left; fewer (gas) moles/molecules on left;

d) both/forward and reverse rates increased/increase in forward reverse rates are equal; activation energy reduced; position of equilibrium unchanged; concentration/amount of reactants and products remain constant; value of K_c unchanged; K_c only affected by changes in temperature;

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