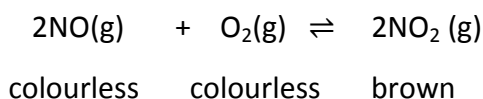


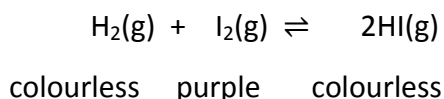
QUESTION (2009:3)

- (a) Nitrogen monoxide gas reacts with oxygen gas to form nitrogen dioxide gas. The equilibrium reaction can be represented by:



At 230°C the equilibrium constant for this reaction has a value of 6.44×10^5 .

- (i) Complete the equilibrium constant expression for this reaction. $K_c =$
- (ii) State which gas will be in the highest concentration at 230°C.
- (b) The following equilibrium system is formed when hydrogen gas is mixed with iodine gas.



The reaction has a negative value for $\Delta_r H$.

For each of the following changes applied to this system:

- (i) describe the expected observation
- (ii) use equilibrium principles to discuss the reason for this observation.

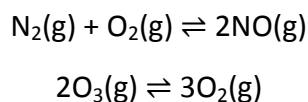
HI(g) is added.

The reaction mixture is cooled

The pressure is increased.

QUESTION (2008:2)

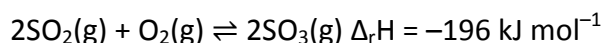
Complete the equilibrium constant expressions for the following equations.



QUESTION (2008:6)

One step in the production of sulfuric acid involves forming sulfur trioxide from sulfur dioxide.

The equilibrium reaction can be represented by



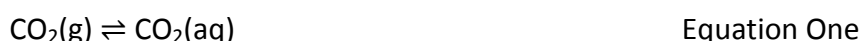
- (a) (i) Explain why a low temperature favours the formation of $\text{SO}_3(\text{g})$.

(ii) The temperature that is actually used is approximately 450°C. However, this is not considered to be a low temperature. Discuss why this temperature is used.

- (b) (i) Describe another way of increasing the amount of $\text{SO}_3(\text{g})$ present at equilibrium without adding any more reactants.
- (ii) Explain why this will increase the amount of $\text{SO}_3(\text{g})$ present at equilibrium.

QUESTION (2008:7)

Carbon dioxide is added to drinks to make them fizzy. The following equilibria are involved:



The drink is fizzy when there is dissolved carbon dioxide, $\text{CO}_2(\text{aq})$. The drink stops being fizzy when the carbon dioxide escapes from the drink as a gas.

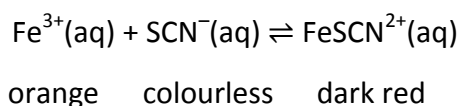
Using equilibrium principles, discuss the changes that occur as a bottle containing fizzy drink is opened.

Your answer must include reference to:

- equilibrium shift in Equation One and Equation Two
- changes in the fizziness of the drink
- any change in pH.

QUESTION (2007:5)

The following equilibrium system is formed when potassium thiocyanate solution is added to a solution of iron(III) nitrate.

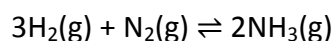


The reaction has a positive value for $\Delta_r H$. For each of the following changes applied to this system:

- (i) describe the expected observation
- (ii) use equilibrium principles to discuss the reason for this observation.
- (a) The reaction mixture is cooled.
- (b) Solid sodium fluoride is added to the reaction mixture. The fluoride ions react with Fe^{3+} ions.
- (c) Solid iron(III) chloride is added to the reaction mixture.

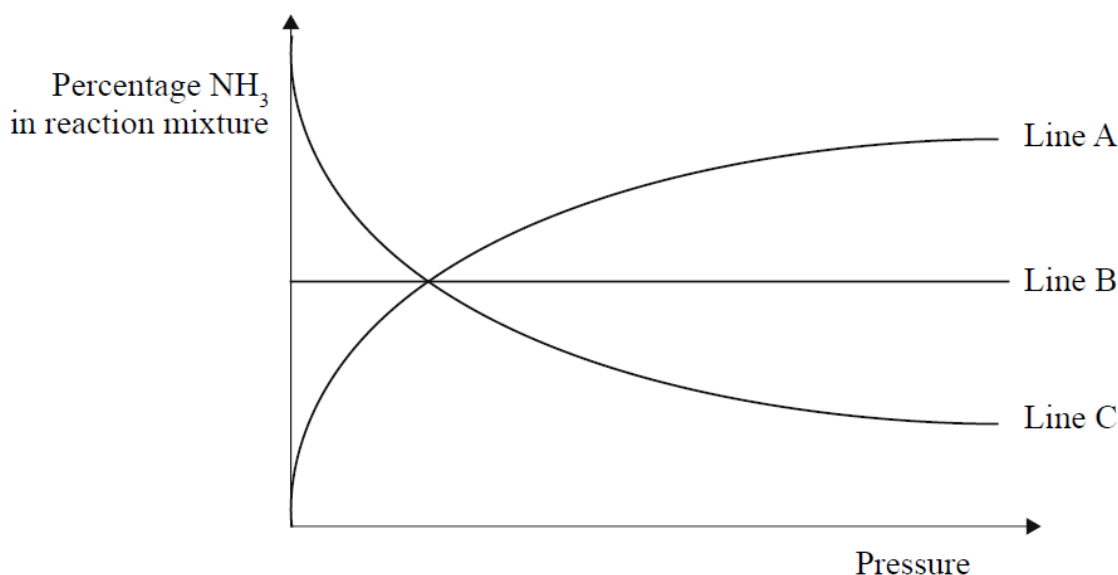
QUESTION (2006:5)

An equilibrium system is shown below.



- (a) Complete the equilibrium constant expression for this reaction. $K_c =$

The pressure of the system is increased, while maintaining a constant temperature. The percentage of NH_3 in the reaction mixture is recorded and graphed.



- (b) On the above graph, identify the line that shows the correct relationship between the percentage of NH_3 in the reaction mixture, and increasing pressure.

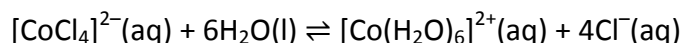
Circle the correct answer below.

Line A Line B Line C

Explain your answer by applying knowledge of equilibrium principles.

QUESTION (2006:6)

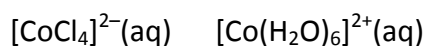
An equilibrium system involving different species of cobalt(II) is shown in the equation below.



$[\text{CoCl}_4]^{2-}(\text{aq})$ is blue and $[\text{Co}(\text{H}_2\text{O})_6]^{2+}(\text{aq})$ is pink.

At room temperature (25°C) the equilibrium mixture is pink.

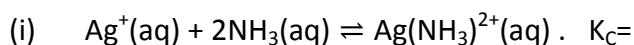
- (a) Describe the expected observation when solid sodium chloride (NaCl) is added to the equilibrium mixture. Explain your answer.
- (b) The enthalpy change ($\Delta_r H$) for this reaction as written above, has a negative value. Circle the ion that would be present in the higher concentration when the equilibrium mixture is heated.



Explain your answer.

QUESTION (2005:2)

(a) Complete the equilibrium constant expression for the following reaction.

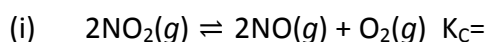


(ii) At 25°C the value of K_c is 1.70×10^7 . Circle the species that would be present in the higher concentration in the equilibrium mixture at this temperature.

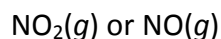


Justify your choice.

(b) Complete the equilibrium constant expression for the following reaction.



(ii) At 200°C the value of K_c is 1.10×10^{-5} . Circle the species that would be present in the higher concentration in the equilibrium mixture at this temperature.



Justify your choice.

QUESTION (2005:4)

The following reaction is exothermic: $2\text{N}_2\text{O}_5(\text{g}) \rightleftharpoons 4\text{NO}_2(\text{g}) + \text{O}_2(\text{g})$ Both N_2O_5 and O_2 are colourless gases and NO_2 is a brown gas. A mixture of these gases exists at equilibrium and is observed as a brown colour.

(a) Complete the equilibrium constant expression for the reaction. $K_c =$

(b) For each of the following changes applied to the equilibrium system, describe the expected observation and explain why this occurs.

(i) The mixture of gases is heated (at constant pressure).

Expected observation:.

Explanation:

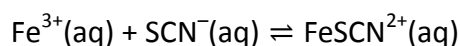
(ii) The pressure is increased, by decreasing the volume of the container.

Expected observation:

Explanation:

QUESTION (2004:4)

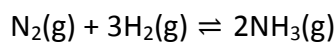
(a) The following equilibrium system is established when thiocyanate ions (SCN^-) are added to iron (III) ions (Fe^{3+}). The resulting aqueous solution is a dark red colour. The equation representing the equilibrium system and the colours of each species involved are given below.



pale orange colourless dark red

- (i) Complete the equilibrium constant expression for the above reaction. $K_C =$
- (ii) When iron (III) ions (Fe^{3+}) are removed from the equilibrium mixture (by adding sodium fluoride), a colour change is observed. Describe the colour change you would expect to see and explain why it occurs.

(b) Ammonia is produced industrially according to the Haber Process as shown below:



- (i) Complete the equilibrium constant expression for the above reaction. $K_c =$
- (ii) The pressure of the system at equilibrium is increased (by decreasing the total volume of the system). Describe the effect of this change on the amount of NH_3 in the system. Explain your answer.
- (iii) The percentage of NH_3 present in equilibrium mixtures at different temperatures and at constant pressure is shown in the table below.

| Temperature ($^{\circ}\text{C}$) | Percentage NH_3 present in equilibrium mixture |
|------------------------------------|---|
| 200 | 63.6 |
| 300 | 27.4 |
| 400 | 8.7 |
| 500 | 2.9 |

Justify whether the reaction in which NH_3 is formed, is endothermic or exothermic.