Exercise 6.22 – The equilibrium law
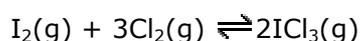
Q622-01 For a gaseous reaction the equilibrium constant expression is:

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

Which equation corresponds to this equilibrium expression?
A. $4NH_3 + 5O_2 \rightleftharpoons 4NO + 6H_2O$
B. $4NO + 6H_2O \rightleftharpoons 4NH_3 + 5O_2$
C. $8NH_3 + 10O_2 \rightleftharpoons 8NO + 12H_2O$
D. $2NO + 3H_2O \rightleftharpoons 2NH_3 + 5/2O_2$

Q622-02 Which of the following is the equilibrium expression for the reaction below?

$$I_2(g) + 3Cl_2(g) \rightleftharpoons 2ICl_3(g)$$

A. $Kc = \dfrac{[ICl_3]}{[I_2][Cl_2]}$

B. $Kc = \dfrac{2[ICl_3]}{3[I_2][Cl_2]}$

C. $Kc = \dfrac{2[ICl_3]}{[I_2]+3[Cl_2]}$

D. $Kc = \dfrac{[ICl_3]^2}{[I_2][Cl_2]^3}$

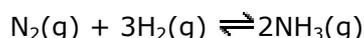**Q622-03** The reaction between methane and hydrogen sulphide is represented by the equation below:

$$CH_4(g) + 2H_2S(g) \rightleftharpoons CS_2(g) + 4H_2(g)$$
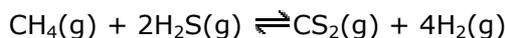
What is the equilibrium expression for the reaction:

A. $[CS_2][H_2] / [CH_4][H_2S]$
B. $4[CS_2][H_2] / 2[CH_4][H_2S]$
C. $[CS_2]+4[H_2] / [CH_4]+2[H_2S]$
D. $[CS_2][H_2]^4 / [CH_4][H_2S]^2$

Q622-04 What is the equilibrium expression for the following reaction:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

A. $Kc = $ $\dfrac{[NH_3]}{[N_2][H_2]}$

B. $Kc = $ $\dfrac{2[NH_3]}{[N_2][H_2]}$

C. $Kc = $ $\dfrac{2[NH_3]}{3[N_2][H_2]}$

D. $Kc = $ $\dfrac{[NH_3]^2}{[N_2][H_2]^3}$

Q622-05 In the reaction of iron III oxide with hydrogen at 500ºC the following equilibrium is established:

$$Fe_2O_3(s) + 3H_2(g) \rightleftharpoons 2Fe(s) + 3H_2O(g)$$
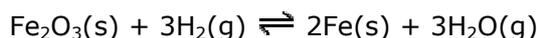
Write the equilibrium expression for this reaction.

Q622-06 The equilibrium between nitrogen dioxide (dark brown) and dinitrogen tetroxide (colourless) is represented by the reaction:

$$2NO_2(g) \rightleftharpoons N_2O_4(g) \qquad ΔH = -57.2 \text{ kJmol-1; Kc = 1 at 328K.}$$
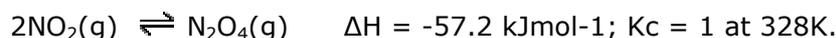
If 4 moles of $N_2O_4(g)$ are present in a $1dm^3$ flask at equilibrium, calculate the concentration of the $NO_2(g)$.

Q622-07 When 1 mole of hydrogen iodide is allowed to dissociate into its elements at 440ºC in a $1dm^3$ vessel, only 0.78 moles of hydrogen iodide are present at equilibrium. Calculate the value of the equilibrium constant at this temperature.

Q622-08 The expression for the equilibrium constant for a reaction is:

$$K_c = \frac{[B][C]}{[A]^2}$$

At a certain temperature the values of [A], [B] and [C] are all 0.2 mol dm^{-3}. What happens to the value of Kc when all three values are doubled to 0.4 mol dm^{-3}?

Exercise 6.22 – The equilibrium law

Q622-09 In the equilibrium:

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

The 1 mol of $N_2O_4(g)$ in a $1dm^3$ flask at 25ºC became 0.8 mol of $N_2O_4(g)$ when equilibrium had been established.
Calculate: The number of moles of $NO_2(g)$ present at equilibrium and the numerical value of Kc with units.

Q622-10 Methanol is an important industrial solvent and fuel. It can be produced from carbon monoxide and hydrogen according to the equation:

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g) \quad \Delta H = -91 \text{ kJmol}^{-1}$$

Calculate a value for the equilibrium constant, Kc, if the maximum yield of methanol is 85%.