Unit 8 · Chemical Equilibrium

WORKSHEET

Full marks 33

Name _____ Class _____ Roll no. _____ Date _____ Marks _____ / 33

1 Key words [4]

Write True or False after each sentence. Correct the false ones. Each carries 0.5 mark.

i. At equilibrium the forward and backward reactions still go on, at equal rates. ☐

ii. At equilibrium the concentrations of the reactants and the products are equal. ☐

iii. A catalyst shifts the position of equilibrium towards the products. ☐

iv. The equilibrium constant of a reaction changes when its temperature changes. ☐

v. A large equilibrium constant means that the reaction is fast. ☐

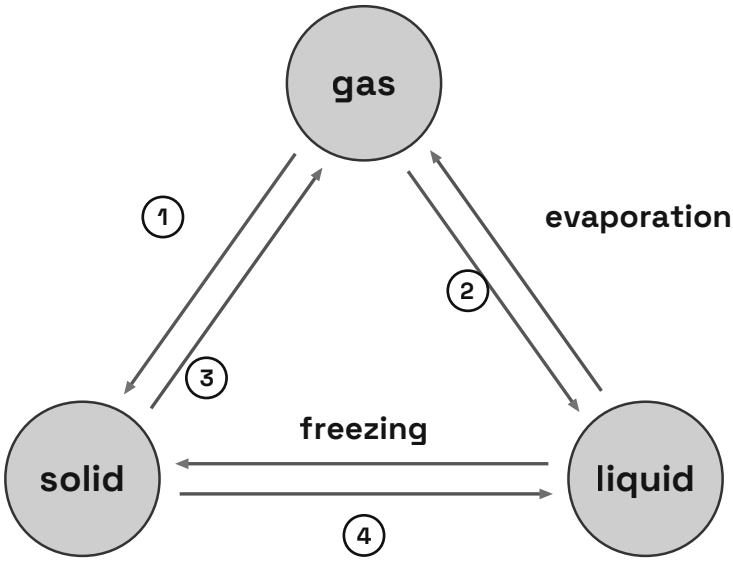
vi. Chemical equilibrium can be reached only in a closed system. ☐

vii. The concentration of a pure solid appears in the expression for K_c. ☐

viii. The equilibrium constant of the backward reaction is the reciprocal of that of the forward reaction. ☐

2 Label the diagram [2]

The diagram shows the changes between the three states of matter. Write the names of the changes marked 1 to 4. Each carries 0.5 mark.



1. _____ 2. _____

3. _____ 4. _____

3 Multiple choice [5]

Choose the correct option for each of the following questions.

i. Which of these is a physical equilibrium? [1]

a. $I_2(s) \rightleftharpoons I_2(g)$
b. $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$
c. $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$
d. $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

ii. What does adding a catalyst to a reaction mixture at equilibrium do? [1]

a. shifts the equilibrium to the right
b. shifts the equilibrium to the left
c. increases the equilibrium constant
d. nothing to the amounts at equilibrium

iii. For $2NO_2(g) \rightleftharpoons N_2O_4(g)$, $K_c = K$. What is K_c for $N_2O_4(g) \rightleftharpoons 2NO_2(g)$ at the same temperature? [1]

a. K
b. $-K$
c. $1/K$
d. K^2

iv. What is the unit of K_c for $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$? [1]

a. mol L^{-1}
b. L mol^{-1}
c. mol^2 L^{-2}
d. it has no unit

v. How does increasing the pressure affect the equilibrium $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$? [1]

a. more HI forms
b. HI breaks up into H_2 and I_2
c. the position doesn't change
d. the equilibrium constant increases

4 Short answers [7]

Write short answers to the following questions.

a. Heated in a closed vessel, limestone reaches the equilibrium $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$. In an open lime kiln, it turns completely into lime. Why? [2]

b. Write K_p for $2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$. At 500 K, is K_p greater or less than K_c? (R = 0.0821 L atm/(mol K)) [2]

c. Consider $H_2(g) + CO_2(g) \rightleftharpoons H_2O(g) + CO(g)$, $\Delta H = +41$ kJ. What happens to the amount of carbon monoxide at equilibrium when a. the temperature is raised, b. the pressure is raised, c. water vapor is removed? [3]

5 Long answer [4]

Write a long answer to the following question.

State the law of mass action. Write K_c for $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$. What does a very large and a very small value of K_c tell you? How does K_c change if the equation is written as $SO_2(g) + 1/2\,O_2(g) \rightleftharpoons SO_3(g)$?

6 Numerical problems [8]

Solve the following problems. Show your working. Take R = 0.0821 L atm/(mol K).

a. 2.0 mol of PCl_5 is heated in a closed 2.0 L flask at 250 °C. At equilibrium, 40% of it has dissociated: $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$. [4]

i. Find the equilibrium concentration of each gas.

ii. Find K_c.

iii. Find K_p at this temperature.

Answer:

b. At a certain temperature $K_c = 64$ for $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$. 1.0 mol of H_2 and 1.0 mol of I_2 are put into a 1.0 L flask at that temperature. [4]

i. Find the concentration of each gas at equilibrium.

ii. Find K_c for $2HI(g) \rightleftharpoons H_2(g) + I_2(g)$ at the same temperature.

Answer:

7 Think [3]

Heating speeds up both the forward and the backward reaction. Nabin says, "So heating can't change where an equilibrium lies." Use $N_2O_4(g) \rightleftharpoons 2\,NO_2(g)$, whose forward reaction is endothermic, to show that he is wrong.

8 Activity: Equilibrium with two glasses (not marked)

Fill one glass with water (glass A) and leave another empty (glass B). With two straws of different widths, one in each glass, move water back and forth: each turn, Sagar lifts a strawful from A into B while Aayusha lifts a strawful from B into A. Keep going for 20 turns, noting the water level in each glass every 4 turns.

Turns	Level in glass A (cm)	Level in glass B (cm)
0		
4		
8		
12		
16		
20		

Do the levels ever stop changing? Is water still being moved when they do? How is this like a chemical equilibrium?