

Name _____ KEY _____ Period _____

Chemical Equilibria
Review Worksheet

1. What does "K" stand for in a mathematical expression for chemical equilibrium?

K represents a constant. The position of the equilibrium may change, but the value for K will not change as long as temp. is constant.

2. What states of matter would not be included in a mathematical expression for equilibrium? Why?

SOLID & LIQUID - THE CONCENTRATIONS DO NOT VARY.

3. Compare the rate of the forward and reverse reactions once an equilibrium has been established.

THEY ARE THE SAME.

4. At equilibrium are the concentrations of reactants and products equal? Explain.

NOT USUALLY! THE RATE AT WHICH PRODUCTS AND REACTANTS FORM IS THE SAME.

5. Distinguish between the terms equilibrium constant and equilibrium position.

EQ. CONSTANT: DOES NOT CHANGE FOR A GIVEN RXN AT A GIVEN TEMP.

EQ. POSITION: REFERS TO THE SPECIFIC CONCENTRATIONS OF REACTANTS AND PRODUCTS FOR A GIVEN EQUILIBRIUM

6. At a particular temperature, a 3.0L flask contains 3.5mol HI, 4.1 mol H₂, and 0.3 mol I₂ in equilibrium. Calculate K at this temperature for the reaction:



$$\frac{3.5 \text{ mol HI}}{3.0 \text{ L}} = 1.17 \text{ M HI}$$

$$\frac{4.1 \text{ mol H}_2}{3.0 \text{ L}} = 1.37 \text{ M H}_2$$

$$\frac{0.3 \text{ mol I}_2}{3.0 \text{ L}} = 0.10 \text{ M I}_2$$

$$K = \frac{[\text{HI}]^2}{[\text{H}_2][\text{I}_2]}$$

$$K = \frac{(1.17)^2}{(1.37)(0.10)} = 10$$

7. Changing the pressure in a reaction vessel by changing the volume may shift the position of equilibrium, whereas changing the pressure by adding an inert gas will not. Why?

INERT MEANS THE GAS WILL NOT REACT. THEREFORE NONE OF THE COLLISIONS WITH THE INERT GAS WILL BE EFFECTIVE SO EQUILIBRIUM WILL NOT BE DISTURBED.

8. In a reaction the equilibrium constant is found to be 55.0. During one experiment, the equilibrium concentrations of hydrogen and chlorine were measured to be 4.8×10^{-3} and 2.1×10^{-3} respectively. What was the concentration of the hydrogen chloride at this point? The equation for the reaction is below.



$$K = \frac{[\text{HCl}]^2}{[\text{H}_2][\text{Cl}_2]}$$

$$55.0 = \frac{x^2}{(4.8 \times 10^{-3})(2.1 \times 10^{-3})} = \frac{x^2}{1.0 \times 10^{-5}}$$

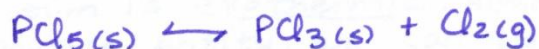
$$x = [\text{HCl}]$$
$$x = 0.024 \text{ M}$$

9. In a system at equilibrium, which of the following is **not** always true?

- A) There are both reactants and products present.
- B) The forward and reverse reactions occur at the same rate.
- C) The concentrations of reactants and products are equal.**
- D) The concentrations of reactants and products remain constant.

10. When solid phosphorus(V) chloride is heated it decomposes to solid phosphorus(III)chloride and chlorine gas. Conversely when phosphorus(III) chloride is shaken in an atmosphere of chlorine, it forms phosphorus (V) chloride.

a) Write a balanced equation for this reversible reaction, with phosphorus(V) chloride on the left hand side.



b) Consider warming some phosphorus(V) chloride in an empty, sealed flask:

i) What will happen to the phosphorus(V) chloride?

It will start to decompose (dissociate).

ii) As time passes what will happen to the rate at which this occurs? Why?

The rate will decrease because as PCl_5 is consumed.

iii) Initially, what is the rate of reaction between phosphorus(III) chloride and chlorine? Why?

Zero - Neither of the reactants are present to react.

iv) As time passes what will happen to the rate at which this occurs? Why?

The rate will increase as the amount PCl_3 and Cl_2 increase.

v) Eventually what will happen to the rates of these two processes?

Eventually they will become equal.

vi) What name is given to this state?

EQUILIBRIUM

vii) At this point what species will be present in the flask?

ALL 3 WILL BE PRESENT.

c) Would the same thing occur if the phosphorus(V) chloride was heated in an open beaker? If not explain why and predict what would in fact happen.

NO - A state of equilibrium will never be reached because the $\text{Cl}_2(\text{g})$ will escape and the reverse reaction will never reach a rate equal to the forward reaction.

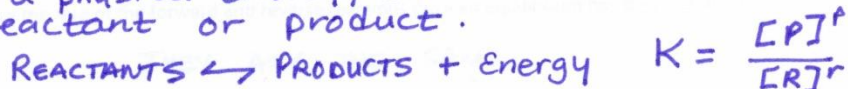
The solution is saturated and
addition of a solid will not
affect the equilibrium

11. When dealing with a gaseous system, we can use either pressure or concentration in the equilibrium expression. Use the equation $PV=nRT$ to show how pressure and concentration are related.

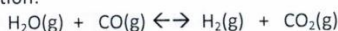
$PV = nRT$ and concentration (in terms of molarity) is moles per liter (which could be represented as n/V). Thus, $P = (n/V)RT$ or $P = MRT$

12. If the value of K for a reaction decreases as the temperature is increased, is the reaction exothermic or endothermic? Explain.

The reaction is exothermic. Although heat is not a physical entity, we can think of it as a reactant or product.



13. Consider an equilibrium mixture consisting of $H_2O(g)$, $CO(g)$, $H_2(g)$ and $CO_2(g)$ reacting in a closed vessel according to the equation:



- a) You add more H_2O to the flask. How does the concentration of each chemical after equilibrium is reestablished compare to its original concentration? Justify your answer.

$[H_2]$ & $[CO_2]$ are higher because eq. shifted right.
 $[CO]$ lower for the same reason.

$[H_2O]$ is lower than when H_2O was first added, but higher than the original concentration

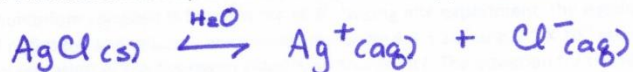
- b) You add more H_2 to the flask. How does the concentration of each chemical after equilibrium is reestablished compare to its original concentration? Justify your answer.

$[H_2O]$ & $[CO]$ higher - shift left.

$[CO_2]$ lower - shift left.

$[H_2]$ lower than when H_2 was added, but higher than the original concentration.

14. You have a solution of $AgCl$ and there is undissolved silver chloride on the bottom of the beaker. What happens to the ion concentration if you add more silver chloride (s) to the beaker? Why?



The solution is saturated (at equilibrium).
 Addition of a solid will not affect the equilibrium.