CHEMISTRY 12 – UNIT II – EQUILIBRIUM
D Learning Goals

1. Chemical equilibrium is said to by dynamic because
    a. The reaction proceeds quickly
    b. The mass of the reactants is decreasing
    c. The macroscopic properties are constant
    d. Both forward and reverse reactions are occurring

2. In an equilibrium system, continuing microscopic changes indicate that the equilibrium is
    a. Dynamic
    b. Complete
    c. Exothermic
    d. Spontaneous

3. In a certain reaction ΔH = - 136 kJ and Ea = 96 kJ. Which of the following is true of its reverse reaction?
    a. The reverse reaction is exothermic and Ea = -40 kJ
    b. The reverse reaction is exothermic and Ea = 40 kJ
    c. The reverse reaction is endothermic and Ea = 96 kJ
    d. The reverse reaction is endothermic and Ea = 232 kJ

4. Which of the following is true for an endothermic reaction?
    a. forward Ea > reverse Ea
    b. reverse Ea > forward Ea
    c. forward Ea = reverse Ea
    d. forward Ea + Reverse Ea = 0

5. All chemical equilibriums must have
    a. Keq = 1
    b. [reactants] = [products]
    c. Rate forward = Rate reverse
    d. Mass of reactants = mass products

6. Two experiments were performed involving the following equilibrium. The temperature was the same in both experiments.

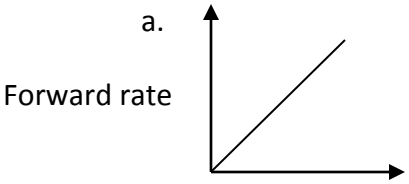
$$H_{2(g)} + I_{2(g)} \rightleftharpoons 2\,HI_{(g)}$$

In experiment A, 1.0 M H_2 and 1.0 M I_2 were initially added to a flask and equilibrium was established. In experiment B, 2.0 M HI was initially added to a second flask and equilibrium was established. Which of the following statements is always true about the equilibrium concentrations?

a. $[H_2]$ equals [HI] in experiment A.
b. [HI] equals $2[H_2]$ in experiment A
c. [HI] in experiment A equals [HI] in experiment B
d. [HI] in experiment A equals ½ $[I_2]$ in experiment B

7. At different conditions the relationship between the forward and reverse rates of reaction in an equilibrium system can be presented by

a.



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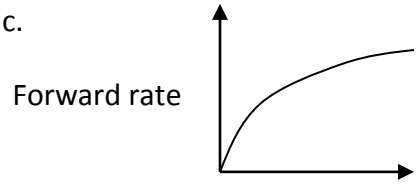

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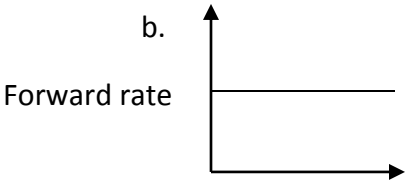

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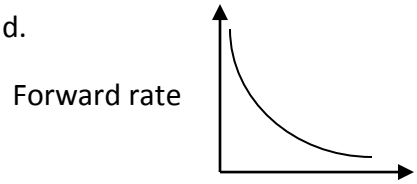


8. Two substances are mixed and no reaction occurs. With respect to enthalpy and entropy, which of the following could explain why no reaction occurs?

	Enthalpy	Entropy
a.	Increases	Increases
b.	Increases	Decreases
c.	Decreases	Increases
d.	Decreases	Decreases

9. In which of the following will entropy and enthalpy factors favour the establishment of an equilibrium?
   a. $CaCO_{3(s)} + 178\ kJ \rightarrow CaO_{(s)} + CO_{2(g)}$
   b. $Mg_{(s)} + 2\ HCl_{(aq)} \rightarrow MgCl_{2(aq)} + H_{2(g)} + 425\ kJ$
   c. $2C_{(s)} + 2H_{2(g)} \rightarrow C_2H_{4(g)} \qquad \Delta H = +\ 52.3\ kJ$
   d. $2\ C_2H_{6(g)} + 7\ O_{2(g)} \rightarrow 4\ CO_{2(g)} + 6\ H_2O_{(g)} \qquad \Delta H = -\ 1560\ kJ$

10. Consider the following equilibrium system: $2\ CO(g) + O_2(g) \rightleftharpoons 2\ CO_2(g)$
    A container is initially filled with CO and O_2 only. How will the [CO] and [CO_2] change as the system reaches equilibrium?

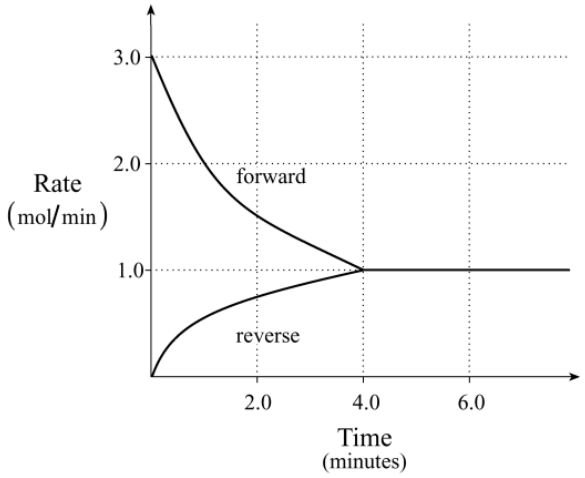
	[CO]	[CO_2]
a.	Increase	Decrease
b.	Increase	Increase
c.	Decrease	Decrease
d.	Decrease	increase

11. A saturated $NaCl_{(aq)}$ solution is an example of an equilibrium system because of the reversible nature of:
    a. Solidifying and melting
    b. Crystallizing and dissolving
    c. Evaporating and condensing
    d. Crystal structure and bond energy

12. Consider the following graph:

When equilibrium is reached,
the rate of the forward reaction is

a. 0.00 mol/min
b. 0.25 mol/min
c. 1.0 mol/min
d. 3.0 mol/min



13. Consider the following equilibrium: $N_{2(g)} + O_{2(g)} \rightleftharpoons 2\ NO_{(g)}$
Nitrogen gas and oxygen gas react when placed in a closed container. As the reaction proceeds towards equilibrium, the rate of the reverse reaction
    a. Increases as the concentration of products decreases
    b. Decreases as the concentration of products decreases
    c. Increases as the concentration of products increases
    d. Decreases as the concentration of products increases

14. Consider the following equilibrium: $H_2O_{(g)} + CO_{(g)} \rightleftharpoons H_{2(g)} + CO_{2(g)}$
At high temperature, H_2O and CO are placed in a closed container. As the system approaches equilibrium, the
    a. Rate of the forward and reverse reactions both increase
    b. Rate of the forward and reverse reaction both decrease
    c. Rate of the forward reaction decreases and the rate of the reverse reaction increases
    d. Rate of the forward reaction increases and the rate of the reverse reaction decreases

15. Consider the following equilibrium:

$SO_2Cl_{2(g)} \rightleftharpoons SO_{2(g)} + Cl_{2(g)}$

A 1.0 L container is initially filled with 2.0 mol of SO_2Cl_2. As the reaction proceeds towards equilibrium, the rate of the forward reaction

a. Increases and the $[SO_2]$ increases
b. Increases and the $[SO_2]$decreases
c. Decreases and the $[SO_2]$ increases
d. Decreases and the $[SO_2]$ decreases

16. Which of the following describes ALL chemical equilibrium systems?

a. The mass of the reactants equals the mass of the products
b. The species are present in the same ratio as in the balanced equation
c. The rate of the forward reaction equals the rate of the reverse reaction
d. The concentration of the reactants equals the concentration of the products

17. Which of the following apply to all equilibrium systems?

i. Forward and reverse rates are equal
ii. Macroscopic properties are constant
iii. Mass of reactants equals mass of products

a. i and ii only
b. i and iii only
c. ii and iii only
d. i, ii, and iii

18. Which of the following are true for all equilibrium systems?

i. Forward and reverse rates are equal
ii. Macroscopic properties are constant
iii. Can be achieved from either direction
iv. Concentrations of reactants and products are equal

a. i and ii only
b. i and iv only
c. i, ii, and iii only
d. ii, iii, and iv only

19. In ALL systems at equilibrium, the
    a. Concentration of reactants is less than the concentration of products
    b. Concentration of reactants and the concentration of products are equal
    c. Concentration of reactants is greater than the concentration of products
    d. Concentration of reactants and the concentration of products are constant

20. Consider the following equilibrium: $2\ SO_{3(g)} \rightleftharpoons 2\ SO_{2(g)} + O_{2(g)}$
    At equilibrium, the rate of decomposition of SO_3
    a. Equals the rate of formation of O_2
    b. equals the rate of formation of SO_3
    c. Is less than the rate of formation of O_2
    d. Is less than the rate of formation of SO_3

21. Which of the following is characteristic of ALL systems at equilibrium?
    a. Activation energy is not required
    b. Changes do not occur at the microscopic level
    c. Two opposing reactions occur at the same rate
    d. Temperature and pressure affect the equilibrium position equally

22. Which of the following does NOT apply to all chemical equilibrium systems?
    a. They are closed
    b. The macroscopic properties are constant
    c. Forward and reverse reaction rates are equal
    d. There are equal concentrations of reactants and products

23. Chemical equilibrium is said to be dynamic because
    a. The reaction proceeds quickly
    b. The mass of the reactants is decreasing
    c. The macroscopic properties are constant
    d. Both forward and reverse reactions are occurring

24. A chemical equilibrium is described as dynamic because
    a. Maximum randomness has been achieved
    b. The pressure and temperature do not change
    c. Both reactants and products continue to form
    d. The concentrations of chemical species remains constant

25. Consider the following reaction: $N_{2(g)} + 3\ H_{2(g)} \rightarrow 2\ NH_{3(g)}$ + energy
Which of the following describes the changes in enthalpy and entropy as the reaction proceeds?

	ENTHALPY	**ENTROPY**
a.	Increases	Decreases
b.	Increases	Increases
c.	Decreases	Decreases
d.	Decreases	Increases

26. In which reaction is entropy decreasing?
    a. $H_2O_{(l)} \rightarrow H_2O_{(g)}$
    b. $N_2O_{4(g)} \rightarrow 2\ NO_{2(g)}$
    c. $CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$
    d. $Fe^{3+}_{(aq)} + SCN^{-}_{(aq)} \rightarrow FeSCN^{2+}_{(aq)}$

27. Consider the following equilibrium: $N_{2(g)} + 3N_{2(g)} \rightleftharpoons 2\ NH_{3(g)}$ + 92 kJ
The forward reaction is
    a. Exothermic and entropy is increasing
    b. Exothermic and entropy is decreasing
    c. Endothermic and entropy is increasing
    d. Endothermic and entropy is decreasing

28. In which reaction is the enthalpy of the reactants greater than the enthalpy of the products?
    a. $H_2O_{(s)} \rightarrow H_2O_{(l)}$
    b. $H_2O_{(s)} \rightarrow H_2O_{(g)}$
    c. $H_2O_{(l)} \rightarrow H_2O_{(s)}$
    d. $H_2O_{(l)} \rightarrow H_2O_{(g)}$

29. Consider the following reaction:
$Na_2CO_{3(s)} + 2\ HCl_{(aq)} \rightarrow 2\ NaCl_{(aq)} + CO_{2(g)} + H_2O_{(l)}$ $\Delta H = -27.7$ kJ
In this reaction…
    a. Minimum enthalpy and maximum entropy both favour products
    b. Minimum enthalpy and maximum entropy both favour reactants
    c. Minimum enthalpy favours products and maximum entropy favours reactants
    d. Minimum enthalpy favours reactants and maximum entropy favours products

30. Consider the following possible reaction:

$N_2O_{(g)} + NO_{2(g)} \rightarrow 3\ NO_{(g)} \qquad \Delta H = +156\ kJ$

Which of the following statements is correct?

a. Minimum enthalpy and maximum entropy both favour the products
b. Minimum enthalpy and maximum entropy both favour the reactants
c. Minimum enthalpy favours reactants and maximum entropy favours products
d. Minimum enthalpy favours products and maximum entropy favours reactants

31. In which of the following systems will the factors of entropy and enthalpy both favour the reactants?

a. $3C_{(s)} + 3\ H_{2(g)} + \text{heat} \rightleftharpoons C_3H_{6(g)}$
b. $PCl_{5(g)} + \text{heat} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$
c. $NH_4Cl_{(s)} + \text{heat} \rightleftharpoons NH_4^+{}_{(aq)} + Cl^-{}_{(aq)}$
d. $Cl_{2(g)} + 2\ HI_{(g)} \rightleftharpoons I_{2(g)} + 2HCl_{(g)} + \text{heat}$

32. Which of the following reactions results in an entropy increase?

a. $2C_{(s)} + O_{2(g)} \rightarrow 2CO_{(g)}$
b. $N_{2(g)} + 2H_{2(g)} \rightarrow N_2H_{4(l)}$
c. $2\ SO_{2(g)} + O_{2(g)} \rightarrow 2\ SO_{3(g)}$
d. $Ag^+{}_{(aq)} + Cl^-{}_{(aq)} \rightarrow AgCl_{(s)}$

33. In an endothermic equilibrium system, the

a. Minimum enthalpy and the maximum entropy both favour the products
b. Minimum enthalpy and the maximum entropy both favour reactants
c. Minimum enthalpy favours products and the maximum entropy favours reactants
d. Minimum enthalpy favours reactants and the maximum entropy favours products

34. Chemical systems tend to move toward positions of

a. Minimum enthalpy and maximum entropy
b. Maximum enthalpy and minimum entropy
c. Minimum enthalpy and minimum entropy
d. Maximum enthalpy and maximum entropy

Answer Key

1. D
2. A
3. D
4. A
5. C
6. C
7. A
8. B
9. A
10. D
11. B
12. C
13. C
14. C
15. C
16. C
17. A
18. C
19. D
20. B
21. C
22. D
23. D
24. C
25. C
26. D
27. B
28. C
29. A
30. C
31. A
32. A
33. D
34. A