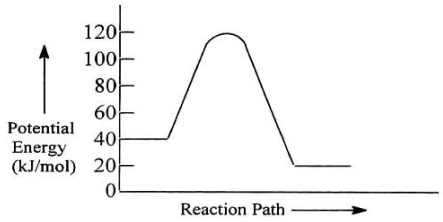
Equilibrium and Reaction Rate

Multiple Choice Questions - **Answers**

__D_ 1. Activation energy could be considered as the minimum energy required to do which of these?

A. change the orientation of the reactant molecules
B. increase the vibrational energy of the reactant molecules
C. make the reactant molecules collide
D. transform the reactants into an activated complex

__B_ 2. What activation energy is required for the forward reaction shown on the diagram?



A. 40 kJ/mol B. 80 kJ/mol C. 100 kJ/mol D. 120 kJ/mol

__B_ 3. Which factor causes an increase in the rate of most reactions when the temperature is increased?

A. The reaction mechanism is changed.
B. The reactant particles have more energy.
C. The reactant particles collide less efficiently.
D. The reactant particles collide less frequently.

__A_ 4. In general, what is the function of a catalyst?

A. to alter the activation energy and the reaction rate
B. to alter the heat content of the reactants
C. to oxidize unwanted waste products
D. to permit the reaction products to be filtered easily

__A_ 5. Which statement is true when this closed system reaches equilibrium?

$$2N_2(g) + O_2(g) \leftrightarrows 2N_2O(g)$$

A. Pressure changes no longer occur.
B. The forward reaction no longer occurs.
C. The $N_2(g)$ has all been consumed.
D. The $O_2(g)$ has all been consumed.

__D_ 6. The following chemical equation represents a reaction that occurs when soft drinks are carbonated:

$$CO_2(g) + H_2O(l) \leftrightarrows H_2CO_3(aq)$$

What occurs when this reaction is at equilibrium in a closed system?

A. The decomposition of $H_2CO_3(aq)$ begins.
B. The formation of $H_2CO_3(aq)$ stops.
C. The formation of $H_2CO_3(aq)$ stops, and the decomposition of $H_2CO_3(aq)$ begins.
D. The rates of formation and decomposition of $H_2CO_3(aq)$ are equal.

__B_ 7. What is the result of an increase in the temperature of a system at equilibrium?

A. The endothermic reaction is favoured, and the reaction rate decreases.
B. The endothermic reaction is favoured, and the reaction rate increases.
C. The exothermic reaction is favoured, and the reaction rate decreases.
D. The exothermic reaction is favoured, and the reaction rate increases.

__C_ 8. According to Le Châtelier's principle, which chemical system shifts to the right when pressure is increased?

A. $CO_2(g) + H_2(g) \leftrightarrows CO(g) + H_2O(g)$
B. $H_2(g) + I_2(g) \leftrightarrows 2HI(g)$
C. $N_2(g) + 3H_2(g) \leftrightarrows 2NH_3(g)$
D. $PCl_5(g) \leftrightarrows PCl_3(g) + Cl_2(g)$

__A_ 9. Which equation has this equilibrium constant expression?

$$K = \frac{[Ni^{2+}]}{[Co^{2+}]}$$

A. $Ni(s) + Co^{2+}(aq) \leftrightarrows Ni^{2+}(aq) + Co(s)$
B. $Ni^{2+}(aq) + Co(s) \leftrightarrows Ni(s) + Co^{2+}(aq)$
C. $Ni^{2+}(aq) + Co^{2+}(aq) \leftrightarrows NiCo^{4+}(aq)$
D. $Ni^{2+}(aq) + Co^{2+}(aq) \leftrightarrows NiCo^{4+}(s)$

__C_ 10. What is the numerical value of the equilibrium constant for the system:

$$CO(g) + Br_2(g) \leftrightarrows COBr_2(g)$$

If the equilibrium concentrations are $[CO] = 1.0$, $[Br_2] = 1.0$, and $[COBr_2] = 2.0$?
A. 0.50 B. 1.0 C. 2.0 D. 4.0

__A_ 11. For the reaction, $2NO_2(g) \leftrightarrows N_2O_4(g)$, which value of the equilibrium constant indicates the largest concentration of NO_2?
A. 1.8×10^{-2} B. 1.5×10^{-1} C. 0.41 D. 0.87

__B_ 12. The activation energy for the decomposition of nitrosyl chloride is 100 kJ.

$$NOCl(g) \rightarrow NO(g) + \tfrac{1}{2}Cl_2(g) \qquad \Delta H = 38 \text{ kJ}$$

What is the activation energy for the reverse reaction?
A. 38 kJ B. 62 kJ C. 100 kJ D. 138 kJ

__A_ 13. Which phrase could be a definition of the activation energy of a reaction?
A. the energy gained by reactant molecules to undergo a reaction
B. the energy supplied by the attractive forces between molecules
C. the energy supplied by a catalyst
D. the heat content of the products minus that of the reactants

__D_ 14. Which factors affect the initial rate of a reaction?
1. the nature of the reactants
2. the concentration of the reactants
3. the size of solid reactant particles

A. 1 and 2 only B. 1 and 3 only C. 2 and 3 only D. 1, 2, and 3

__B_ 15. What is the detailed sequence of steps that leads to the net overall reaction called?
A. reaction coordinate
B. reaction mechanism
C. reaction potential
D. reaction rate law

__B_ 16. Which examples illustrate a state of dynamic equilibrium at constant temperature?
1. a stoppered flask half full of water
2. an open pan of boiling water
3. a stoppered flask of a saturated sodium carbonate solution

A. 1 and 2 only B. 1 and 3 only C. 2 and 3 only D. 1, 2, and 3

__B_ 17. Which change would favour the net reverse reaction for the system,

$$N_2(g) + 3H_2(g) \leftrightarrows 2NH_3(g) + \text{heat}$$

A. a decrease in the concentration of ammonia
B. a decrease in the concentration of nitrogen
C. a decrease in the temperature
D. a decrease in the volume

__C_ 18. Consider he equilibrium: $SO_2Cl_2(g) \leftrightarrows SO_2(g) + Cl_2(g) \qquad \Delta H = +67$ kJ
How could the amount of SO_2 be increased?
A. adding Cl_2 to the system
B. decreasing the volume of the reaction vessel
C. increasing the temperature
D. removing SO_2Cl_2

__B__ 19. Which change will increase the amount of SO_3?

$$2SO_2(g) + O_2(g) \leftrightarrows 2SO_3(g) + \text{heat}$$

A. Decrease the concentration of $O_2(g)$.
B. Increase the pressure on the system.
C. Increase the temperature of the system.
D. Introduce a catalyst.

__D__ 20. When a catalyst is used in a chemical reaction that reaches equilibrium, what does it change?

A. the amount of products obtained at equilibrium
B. the concentration of the products at equilibrium
C. the equilibrium constant at a given temperature
D. the rate of attaining equilibrium

__D__ 21. What affects the numerical value of the equilibrium constant for a reversible reaction at equilibrium?

A. adding a catalyst
B. changing reactant concentrations
C. changing the pressure
D. changing the temperature

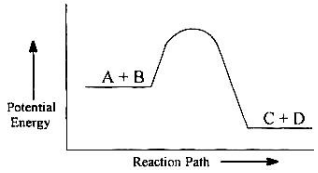
__C__ 22. What is the numerical value of the equilibrium constant for the system:

$$2CO(g) + O_2(g) \leftrightarrows 2CO_2(g)$$

if the equilibrium concentrations are $[CO] = 2.0$, $[O_2] = 1.0$, and $[CO_2] = 16$?

A. 8.0 B. 32 C. 64 D. 128

__A__ 23. For the system described by the potential energy diagram, which statement is correct?



A. A and B are less stable than C and D.
B. Activation energy for the forward reaction is greater than for the reverse reaction.
C. The effect of a temperature change is greater for the forward reaction than for the reverse reaction.
D. The forward reaction is endothermic.

__C__ 24. What is the main reason for the increase in reaction rate with increasing temperature?

A. Activation energy increases rapidly with temperature.
B. Heat acts as a catalyst.
C. The fraction of high energy molecules increases exponentially.
D. There is a dramatic increase in the number of collisions.

__A__ 26. What is usually true concerning the activation energy of a reaction?

A. It is decreased by the addition of a catalyst.
B. It is decreased by increasing the temperature of the system.
C. It is equal to the ΔH of the reaction.
D. It is equal to the sum of the energies of the reactants and products.

__A__ 27. In which reaction does a decrease in the volume of the reaction vessel at constant temperature favour formation of the products?

A. $2H_2(g) + O_2(g) \leftrightarrows 2H_2O(g)$
B. $MgCO_3(s) \leftrightarrows MgO(s) + CO_2(g)$
C. $NO_2(g) + CO(g) \leftrightarrows NO(g) + CO_2(g)$
D. $2O_3(g) \leftrightarrows 3O_2(g)$

__C__ 28. Which of the following equilibria would be affected by pressure changes at constant temperature?

1. $FeO(s) + CO(g) \leftrightarrows Fe(s) + CO_2(g)$
2. $CaCO_3(s) \leftrightarrows CaO(s) + CO_2(g)$
3. $2Mg(s) + CO_2(g) \leftrightarrows 2MgO(s) + C(s)$

A. 1 and 2 only B. 1 and 3 only C. 2 and 3 only D. 1, 2, and 3

__B_ 29. Consider the reaction: $S_2Cl_2(l) + CCl_4(l) \leftrightarrows CS_2(g) + 3Cl_2(g)$ $\Delta H = 84.3$ kJ
If the reactants and products are at equilibrium in a closed vessel, how can the number of moles of CS_2 be decreased?
A. adding some S_2Cl_2 to the system
B. decreasing the size of the reaction vessel
C. increasing the temperature of the reaction system
D. removing some Cl_2 from the system

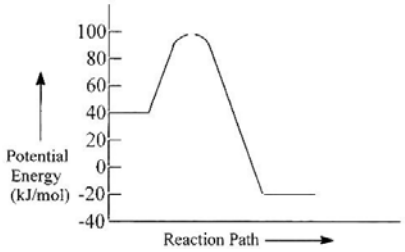
__C_ 30. For the equilibrium, $2NO(g) + 2CO(g) \leftrightarrows N_2(g) + 2CO_2(g)$ + heat,
what conditions favour maximum conversion of the reactants to products?
A. high temperature and high pressure
B. high temperature and low pressure
C. low temperature and high pressure
D. low temperature and low pressure\

__D_ 31. In a chemical reaction at constant temperature, what does the addition of a catalyst do?
A. affects the equilibrium constant
B. decreases the energy released in the chemical reaction
C. increases the concentration of the products at equilibrium
D. provides an alternate reaction pathway with a different activation energy

__B_ 32. The equilibrium constant at 1300 K for the reaction $H_2(g) + Br_2(g) \leftrightarrows 2HBr(g)$ is 1.6×10^5. What is the value of K for the reverse reaction?
A. -1.6×10^5 B. 6.3×10^{-6} C. 1.6×10^{-5} D. 6.3×10^{-5}

__A_ 33. Analysis of a sample of HCl gas showed that when equilibrium was reached at a certain temperature, one half of the HCl molecules had dissociated into H_2 and Cl_2 molecules:
$$2HCl(g) \leftrightarrows H_2(g) + Cl_2(g)$$
What is numerical value of the equilibrium constant at this temperature?
A. 0.25 B. 0.50 C. 1.0 D. 2.0

__B_ 34. What activation energy is required for the forward reaction shown on the diagram?



A. 40 kJ/mol B. 60 kJ/mol C. 100 kJ/mol D. 120 kJ/mol

__D_ 35. Why does increasing the concentrations of the reactants in a chemical reaction increase the rate of the reaction?
A. The activation energy of the reaction decreases.
B. The average kinetic energy of the reactants increases.
C. The collisions become more effective.
D. The frequency of collisions increases.

__C_ 36. How does a catalyst speed up a chemical reaction?
A. decreases the heat of reaction
B. increases the heat of reaction
C. lowers the activation energy
D. raises the activation energy

__B_ 37. A student prepares a sodium chloride solution by placing 100 g of solid sodium chloride in a flask, adding 200 mL of distilled water, placing a stopper in the flask and then shaking the flask vigorously. Which is an observable property that indicates the system is at equilibrium?

A. The amount of undissolved sodium chloride gradually decreases.
B. The amount of undissolved sodium chloride remains constant.
C. The rate of dissolving equals the rate of crystallizing.
D. The rate of precipitation equals the rate of crystallizing.

__C_ 38. "If a system is subjected to stress, the system acts to relieve the effects of the stress" Who proposed this idea?

A. Arrhenius B. Brønsted and Lowry C. Le Châtelier D. Lewis

__B_ 39. Which change will increase the equilibrium concentration of SO_3?

$$2SO_2(g) + O_2(g) \leftrightarrows 2SO_3(g) + \text{heat}$$

A. Decrease the concentration of $O_2(g)$.
B. Increase the pressure on the system.
C. Increase the temperature of the system.
D. Introduce a catalyst.

__D_ 40. What is the result of increasing the concentration of CH_3COOH in this equilibrium system?

$$CH_3COOC_2H_5(aq) + H_2O(l) \leftrightarrows C_2H_5OH(aq) + CH_3COOH(aq)$$

A. a change in the equilibrium constant
B. a decreased concentration of $CH_3COOC_2H_5$
C. a decreased concentration of H_2O
D. a decreased concentration of C_2H_5OH

__D_ 41. Which expression represents the equilibrium constant for this equation?

$$2NO(g) + O_2(g) \leftrightarrows 2NO_2(g)$$

A. $\dfrac{[NO][O_2]}{[NO_2]}$ B. $\dfrac{[NO]^2 + [O_2]}{[NO_2]^2}$ C. $\dfrac{[NO_2]}{[NO][O_2]}$ D. $\dfrac{[NO_2]^2}{[NO]^2[O_2]}$

__A_ 42. A mixture of gases is placed in a one litre container, and the gases react according to the equation:

$$4A(g) + 3B(g) \leftrightarrows 2C(g)$$

At equilibrium, 2.0 mol of A, 3.0 mol of B, and 4.0 mol of C are present in the container. What is the value of the equilibrium constant?

A. 0.037 B. 0.37 C. 0.67 D. 0.80

__C_ 43. At a certain temperature, the equilibrium constant of this reaction equals 8.81:

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

If the concentration of NO_2 is 0.200 mol/L, what is the concentration of N_2O_4?

A. 1.76×10^{-1} mol/L B. 2.27×10^{-2} mol/L C. 3.52×10^{-1} mol/L D. 4.53×10^{-3} mol/L

__D_ 44. For the reaction, $2NO_2(g) \leftrightarrows N_2O_4(g)$, which value of the equilibrium constant indicates the greatest conversion to products?

A. 1.5×10^{-1} B. 1.8×10^{-2} C. 4.1×10^{-1} D. 8.7×10^{-1}

__C_ 45. What happens as the temperature of a gas increases?

A. Every gas molecule now moves faster than any molecule did before.
B. None of the gas molecules experiences a change in velocity.
C. The average molecular velocity increases.
D. When gas molecules collide, they lose energy.

__C_ 46. If the activation energy for an exothermic reaction is 50 kJ/mol, what is the activation energy for the reverse reaction?

A. < 50 kJ/mol B. 50 kJ/mol C. > 50 kJ/mol D. 100 kJ/mol

__A_ 47. Which conditions will cause a reaction to occur at the fastest rate?

A. high concentration of reactants and high temperature
B. high concentration of reactants and low temperature
C. low concentration of reactants and high temperature
D. low concentration of reactants and low temperature

__B_ 48. What is true about a chemical system at equilibrium?

A. complete conversion of reactants into products
B. constant quantities of reactants and products
C. equal quantities of reactants and products
D. only reactants present

__D_ 49. Which system would most likely be at equilibrium?

A. beaker of alcohol sitting on a counter at room temperature
B. kettle of water boiling at a constant rate
C. natural gas burning in a home furnace
D. unopened can of soda pop sitting on a grocery shelf

__D_ 50. Ammonia reacts with aqueous silver ions to form a complex ion.

$$Ag^+(aq) + 2NH_3(aq) \leftrightarrows Ag(NH_3)_2^+(aq) \qquad K = 1.7 \times 10^7 \text{ at } 25°C$$

What will be the final result of adding more ammonia to this system without changing the temperature?

A. The concentration of $Ag^+(aq)$ will increase.
B. The concentration of $Ag(NH_3)_2^+(aq)$ will decrease.
C. The concentration of $NH_3(aq)$ will decrease.
D. The equilibrium constant will remain the same.

__D_ 51. Which would increase the equilibrium concentration of $Cl_2O(g)$?

$$2Cl_2(g) + O_2(g) \leftrightarrows 2Cl_2O(g) \qquad \Delta H = +103 \text{ kJ}$$

A. adding a suitable catalyst
B. decreasing the concentration of $Cl_2(g)$
C. decreasing the temperature
D. increasing the concentration of $O_2(g)$

__D_ 52. What is the equilibrium constant expression for this equation?

$$CO_2(g) + C(s) \leftrightarrows 2CO(g)$$

A. $\dfrac{[CO_2][C]}{[CO]^2}$ B. $\dfrac{[CO]^2}{[CO_2][C]}$ C. $\dfrac{[CO_2]}{[CO]^2}$ D. $\dfrac{[CO]^2}{[CO_2]}$

__C_ 53. At equilibrium in this gaseous system $2A + B \leftrightarrows 2C + D$
[A] = 2.00, [B] = 1.20, [C] = 3.00, and [D] = 0.600. What is the numerical value of the equilibrium constant?

A. 4.32 B. 1.33 C. 1.13 D. 0.889

__A_ 54. At a certain temperature, the equilibrium constant of this reaction equals 0.018:

$$2HI(g) \leftrightarrows H_2(g) + I_2(g)$$

If the concentration of HI is 1.6 x 10–2 mol/L and the concentration of H_2 is 2.9×10^{-3} mol/L, what is the concentration of I_2?

A. 1.6×10^{-3} mol/L B. 1.8×10^{-2} mol/L C. 9.9×10^{-2} mol/L D. 1.0×10^{1} mol/L

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_A_ 55. For the reaction, $2NO_2(g) \leftrightarrows N_2O_4(g)$, which value of the equilibrium constant indicates the largest concentration of N_2O_4?

A. 0.87 B. 0.41 C. 0.15 D. 0.018