

# Test Bank for General Organic and Biological Chemistry 5th Edition by Timberlake

## Sample

General, Organic & Biological Chemistry, 5e (Timberlake) **Chapter 10** Reaction Rates and Chemical Equilibrium

### 10.1 Multiple Choice Questions

1) A catalyst is

- A) a reactant in a chemical reaction.
- B) a product in a chemical reaction.
- C) a substance that speeds up a reaction without being consumed in the reaction.
- D) a substance that increases the energy of the products.
- E) a substance that decreases the energy of the products.

Answer: C

Objective: 10.1

Global Outcomes: GO2

2) The activation energy of a chemical reaction is the energy that

- A) must be removed from the mixture.
- B) must be released from the mixture.
- C) initiates the reaction.
- D) activates the catalyst.
- E) is the difference in the energies of the starting materials and products.

Answer: C      Objective: 10.1

Global Outcomes: GO2

3) In a catalyzed chemical reaction, one function of a catalyst is to

- A) increase the number of successful reactant collisions.
- B) decrease the concentration of reactants.
- C) change the equilibrium concentrations of the products and reactants.

D) increase the energy given off during the reaction.

E) increase the temperature at which the reaction is carried out.

Answer: A

Objective: 10.1

Global Outcomes: GO2

4) The rate of any chemical reaction can be determined by observing

A) the amount of product formed in a unit of time.

B) the ratio of product concentration to reactant concentration.

C) the percent composition of the final product.

D) the theoretical yield of the reaction.

E) the number of chemical bonds broken and remade.

Answer: A

Objective: 10.1

Global Outcomes: GO2

5) In any chemical reaction, the rate of the reaction can be increased by

A) decreasing the temperature.

B) changing the size of the container.

C) adding water to the reaction.

D) adding product molecules to the reaction mixture.

E) increasing the concentrations of the reactants.

Answer: E

Objective: 10.1

Global Outcomes: GO2

6) Refrigerating perishable foods affects biochemical reactions by

A) increasing concentrations of antioxidants.

B) removing bacteria.

C) decreasing the rate of reactions affecting spoilage.

D) catalyzing the removal of harmful chemicals from the foods.

E) improving the appearance of the foods.

Answer: C

Objective: 10.1

Global Outcomes: GO7

7) In a catalytic converter in an automobile, the reaction of carbon monoxide with oxygen produces

A) carbon dioxide.

B) carbon and more oxygen.

- C) water.
- D) methane.
- E) nitrogen oxide.

Answer: A

Objective: 10.1

Global Outcomes: GO7

8) One metal that is used as a catalyst in a catalytic converter in an automobile is

- A) carbon.
- B) iron.
- C) copper.
- D) platinum.
- E) plutonium.

Answer: D

Objective: 10.1

Global Outcomes: GO2

9) In the reaction of nitrogen and hydrogen to give ammonia, all the reactants and products are

- A) gases.
- B) liquids.
- C) solids.
- D) boiling.
- E) frozen.

Answer: A

Objective: 10.2

Global Outcomes: GO2

10) A reaction that can proceed in either the forward or the reverse direction as written is called a \_\_\_\_\_ reaction.

- A) reversible
- B) miniscule
- C) microscopic
- D) solid phase
- E) favored

Answer: A

Objective: 10.2

Global Outcomes: GO2

11) A chemical reaction has reached equilibrium when

- A) the concentrations of reactants and products are equal.

- B) all reactants have been converted to products.
- C) all products have been removed from the reaction mixture.
- D) the catalyst has been used up.
- E) the rate of the forward reaction equals the rate of the reverse reaction.

Answer: E

Objective: 10.2

Global Outcomes: GO2

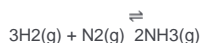
12) When a reaction is at equilibrium,

- A) all reaction stops.
- B) no more reactants are converted to products.
- C) the reaction is no longer reversible.
- D) the forward and reverse reactions occur at the same rate.
- E) the products and reactants have the same energy content.

Answer: D Objective: 10.2

Global Outcomes: GO2

13) The equation for the formation of ammonia from nitrogen and hydrogen is shown below. What is the form of the equilibrium constant?



- A)
- B)
- C)
- D)
- E)

Answer: A

Objective: 10.3

Global Outcomes: GO2

14) The reaction for the decomposition of  $\text{PCl}_5$  to chlorine and  $\text{PCl}_3$  is shown



If the equilibrium concentrations are  $[\text{PCl}_5] = 1.0 \text{ M}$ ,  $[\text{PCl}_3] = 0.10 \text{ M}$ ,  $[\text{Cl}_2] = 0.10 \text{ M}$ , what is the value of the equilibrium constant?

- A)  $1.0 \times 10^{-2}$
- B)  $1.0 \times 10^{-4}$
- C)  $10 \times 10^{-2}$
- D)  $1.0 \times 10^2$

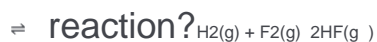
E)  $2.0 \times 10^{-2}$

Answer: A Objective: 10.3

Global Outcomes:

GO4

15) What is the correct form for the equilibrium constant expression for this



A)

B)

C)

D)

E)

Answer: B

Objective: 10.3

Global Outcomes: GO2

16) What is the correct form of the equilibrium constant for the reaction of hydrogen and oxygen to form water? The equation is:



A)  $K_c =$

B)  $K_c =$

C)  $K_c =$

D)  $K_c =$

E)  $K_c =$

Answer: A

Objective: 10.3

Global Outcomes: GO2

17) An equilibrium in which all the components are gases is a \_\_\_\_\_ equilibrium.

A) heterogeneous

B) liquid

C) catalytic

D) homogeneous

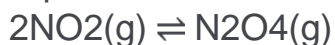
E) reversible

Answer: D Objective:

10.3 Global

Outcomes: GO2

18) For the following reaction, the equilibrium concentration of NO<sub>2</sub> is 0.38 M and equilibrium concentration of N<sub>2</sub>O<sub>4</sub> is 1.0M. What is the value of the equilibrium constant?



- A) 0.14
  - B) 2.6
  - C) 6.9
  - D) 0.38 E) 1.0
- Answer: C Objective:  
10.3

Global Outcomes: GO4

19) The equilibrium for the reaction for the decomposition of PCI<sub>5</sub> to chlorine and PCI<sub>3</sub> is 0.042.



If the equilibrium concentrations are [PCI<sub>3</sub>] = 0.010 M, [Cl<sub>2</sub>] = 0.10 M, what is the value of [PCI<sub>5</sub>]?

- A) 0.010 M
- B) 0.0020 M
- C) 0.042 M
- D) 0.024 M
- E) 0.0010 M

Answer: D

Objective: 10.2 Global

Outcomes: GO4

20) In the following gas phase reaction, K<sub>c</sub> is much less than 1. At equilibrium, which of the following statements is true?



- A) The concentration of reactant is much greater than the concentration of products.
- B) The concentration of products is much greater than the concentration of reactants.
- C) The concentrations of products and reactants are approximately equal.
- D) A catalyst will increase the concentration of products formed.

E) At equilibrium, the concentrations of reactants and products are equal.

Answer: A

Objective: 10.4

Global Outcomes: GO4

21) The equilibrium constant for the production of carbon dioxide from carbon monoxide and oxygen is

$K_c = 2 \times 10^{11}$ . This means that the reaction mixture at equilibrium is likely to consist of

- A) mostly starting materials.
- B) an equal mixture of products and reactants.
- C) twice as much starting material as product.
- D) twice as much product as starting material.
- E) mostly products.

Answer: E

Objective: 10.4

Global Outcomes: GO4

22) Which of the following equilibrium constants indicates the reaction that gives the smallest amount of product?

- A)  $K_c = 5 \times 10^{-10}$
- B)  $K_c = 5 \times 10^{-1}$
- C)  $K_c = 5 \times 100$
- D)  $K_c = 5 \times 10^1$
- E)  $K_c = 5 \times 10^{10}$

Answer: A Objective:

10.4 Global Outcomes: GO4

23) The value of the equilibrium constant for the combination of nitrogen and oxygen to make NO is  $2 \times 10^{-9}$ . What does this tell you about the concentrations of materials in the equilibrium mixture?

- A) The concentration of products exceeds the concentration of reactants.
- B) The concentrations of reactants and products are equal.
- C) The reactants are solids.
- D) The concentration of reactants exceeds the concentration of products.
- E) The products are solids.

Answer: D

Objective: 10.4

Global Outcomes: GO4

24) Carbon monoxide binds to hemoglobin 140 times more strongly than oxygen does. What does this tell you about the equilibrium constants for the two reactions of hemoglobin with carbon monoxide and oxygen?

- A) The equilibrium constant for the binding of CO is greater.
- B) The equilibrium constant for the binding of oxygen is greater.
- C) The concentration of carbon monoxide at equilibrium is twice that of oxygen.
- D) Oxygen and carbon monoxide have the same formula mass.
- E) Oxygen and carbon monoxide react with hemoglobin in different fashions.

Answer: A Objective: 10.4

Global Outcomes: GO4

25) For the following reaction, the equilibrium constant  $K_c$  is 2.0 at a certain temperature. If the concentration of both products is 0.10 M at equilibrium, what is the concentration of the starting material, NOBr?



- A)  $5 \times 10^{-4}$  M
- B)  $2.2 \times 10^{-4}$  M
- C)  $5 \times 10^{-2}$  M
- D)  $2.2 \times 10^{-2}$  M
- E) 2.2 M

Answer: D

Objective: 10.4 Global Outcomes:

GO4

26) For the following reaction, the equilibrium constant  $K_c$  is 0.60 at a certain temperature. If the concentration of NO(g) and NOBr(g) are both 0.50 M, at equilibrium, what is the concentration of Br<sub>2</sub>(g)?



- A) 1.7 M
- B) 0.60 M
- C) 0.36 M
- D) 2.8 M
- E) 1.0 M

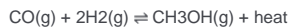
Answer: A

Objective: 10.4 Global Outcomes:

GO4



27) For the following equilibrium reaction, which cause and effect are correctly matched?

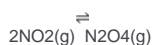


- A) add heat, shift right
- B) add CO, shift left
- C) remove CH<sub>3</sub>OH, shift left
- D) remove heat, no change
- E) remove H<sub>2</sub>, shift left

Answer: E Objective:

10.5 Global Outcomes: GO2

28) In the following gas phase reaction, what is the effect of adding more NO<sub>2</sub> to the starting reaction mixture?



- A) It would make the reaction more endothermic.
- B) It would make the reaction more exothermic.
- C) It would slow the reaction down.
- D) It would decrease the final quantity of products.
- E) It would increase the final quantity of products.

Answer: E

Objective: 10.5

Global Outcomes: GO2

29) The physiological equilibrium system that keeps the temperature of the body constant is called

- A) stimulation.
- B) regulation.
- C) metabolism.
- D) homeostasis.
- E) catalysis.

Answer: D

Objective: 10.5

Global Outcomes: GO7

30) When you open a bottle of a soft drink and leave it open, the drink eventually goes flat. This happens because the equilibrium between carbonic acid and carbon dioxide shifts to produce

- A) more carbonic acid.
- B) more water.
- C) more oxygen.
- D) more carbon dioxide.
- E) more hydrogen ions.

Answer: D

Objective: 10.5

Global Outcomes: GO7

31) Iron metal reacts with oxygen gas to produce iron(III) oxide. What will be the effect of increasing the pressure of oxygen gas in a closed reaction vessel?

- A) Less reaction will take place.
- B) More iron oxide will be produced.
- C) The reaction mixture will catch fire.
- D) There is no effect; a catalyst is needed.
- E) The rate of production of iron oxide will slow down.

Answer: B

Objective: 10.5

Global Outcomes: GO2

32) In the following gas phase reaction, what is the effect on the direction of the reaction if more SO<sub>3</sub> is added to the reaction mixture?



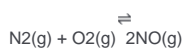
- A) The equilibrium shifts to produce more products.
- B) The position of the equilibrium remains unchanged.
- C) The rate of formation of products is increased.
- D) The equilibrium shifts to produce more reactants.
- E) The catalyst for the reaction is used up.

Answer: D

Objective: 10.5

Global Outcomes: GO2

33) In the reaction of nitrogen gas with oxygen gas to produce nitrogen oxide, what is the effect of adding more oxygen gas to the initial reaction mixture? The reaction is shown below.



- A) The equilibrium shifts to produce more N<sub>2</sub>.

- B) The equilibrium shifts to produce more NO.
- C) The equilibrium is not affected.
- D) Extra catalyst is required to reach equilibrium.
- E) The temperature of the reaction mixture is raised.

Answer: B

Objective: 10.5

Global Outcomes: GO2

34) The reaction of hemoglobin with oxygen can be written as follows.  $\text{Hb} + \text{O}_2 \rightleftharpoons \text{HbO}_2$

If the amount of oxygen available to the blood decreases significantly, what happens to the individual involved?

- A) Hypoxia results.
- B) Anemia results.
- C) Nitrogen narcosis results.
- D) Oxygen poisoning results.
- E) Acclimatization results.

Answer: A

Objective: 10.5

Global Outcomes: GO2

35)  $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{NO}(\text{g})$

For the reaction at equilibrium, if the volume of the container is decreased, the amount of NO present will

- A) decrease.
- B) increase.
- C) double.
- D) stay the same.
- E) triple.

Answer: D

Objective: 10.5 Global

Outcomes: GO2

36)  $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g})$

For the reaction at equilibrium, if O<sub>2</sub> is added, the amount of SO<sub>2</sub> present will

- A) decrease.
- B) increase.
- C) stay the same.

Answer: A Objective:

10.5 Global Outcomes:

GO2

37)  $\text{PCl}_5(\text{g}) \rightleftharpoons \text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g})$

For the reaction at equilibrium, if the volume of the container is increased, the amount of  $\text{PCl}_5$  present will

- A) decrease.
- B) increase.
- C) double.
- D) stay the same.
- E) triple.

Answer: A

Objective: 10.5 Global

Outcomes: GO2

38) Treatment of carbon monoxide poisoning can be accomplished by the use of pure oxygen for breathing. This is an example of the use of \_\_\_\_\_ in a clinical setting.

- A) the ideal gas law
- B) Le Châtelier's principle
- C) Henry's law
- D) conservation of mass
- E) a precipitation reaction

Answer: B

Objective: 10.5

Global Outcomes: GO2

39) In the reaction of carbon dioxide with water to give carbonic acid, the only gaseous component is the carbon dioxide. What will happen to the equilibrium concentration of carbonic acid if the pressure of carbon dioxide is increased in the container?

- A) The concentration of carbonic acid will increase.
- B) The carbonic acid concentration will decrease.
- C) The carbonic acid concentration will stay the same.
- D) There will be twice as much carbonic acid as carbon dioxide.
- E) There will be more water available for the reaction.

Answer: A

Objective: 10.5

Global Outcomes: GO2

40) In an exothermic reaction, heat can be considered a

- A) reactant.
- B) product.
- C) rate.
- D) catalyst.

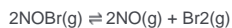
E) determinant.

Answer: B Objective:

10.5 Global Outcomes:

GO2

41) For the following reaction, the equilibrium constant  $K_c$  is 2.0 at a certain temperature. The reaction is endothermic. What do you expect to happen to the concentration of NO if the temperature is doubled?



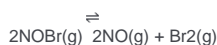
- A) The concentration of NO will increase.
- B) The concentration of NO will decrease.
- C) There will be no change in [NO].
- D) A catalyst will be needed to make a change in concentration.
- E) The change in concentration of [NO] will depend on the size of the vessel.

Answer: A

Objective: 10.5

Global Outcomes: GO2

42) For the following reaction, the equilibrium constant  $K_c$  is 2.0 at a certain temperature. Bromine can be liquefied easily and removed from the reaction vessel as it is formed. If this is done, how will it affect the equilibrium reaction?

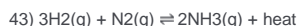


- A) More products will be made as  $\text{Br}_2$  is removed.
- B) There will be a larger proportion NOBr in the vessel when equilibrium is reached.
- C) Less NO will be made.
- D) The pressure in the vessel will increase.
- E) The equilibrium constant will change.

Answer: A

Objective: 10.5

Global Outcomes: GO2



For the reaction at equilibrium, if the temperature is raised, the amount of  $\text{N}_2$  will

- A) decrease.
- B) increase.
- C) stay the same.

Answer: B Objective:

10.5 Global Outcomes:

## GO2 10.2 Bimodal Questions

1) The \_\_\_\_\_ is the energy difference between reactants and products in a chemical reaction.

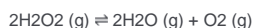
- A) transition energy
- B) activation energy
- C) product energy
- D) overall energy
- E) heat of reaction

Answer: E Objective:

10.1 Global Outcomes:

GO2

2) What is the correct form of the equilibrium constant for this reaction?



- A)
- B)
- C)
- D)

Answer: B

Objective: 10.3

Global Outcomes: GO2

3) For the following reaction, the equilibrium constant  $K_c$  is 2.0 at a certain temperature. Write the equilibrium constant expression of the equilibrium

constant,  $K_c$ .  $2\text{NOBr}(\text{g}) \rightleftharpoons 2\text{NO}(\text{g}) + \text{Br}_2(\text{g})$

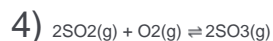
$\rightleftharpoons$

- A)
- B)
- C)
- D)
- E)

Answer: A

Objective: 10.3

Global Outcomes: GO2



For the reaction at equilibrium, if  $\text{O}_2$  is removed, the amount of  $\text{SO}_2$  present will

- A) decrease

- B) increase
- C) stay the same

Answer: B

Objective: 10.5

Global Outcomes: GO2

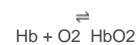
### 10.3 Short Answer Questions

1) Write the equilibrium constant expression for the reaction of nitrogen and hydrogen to give ammonia,  $\text{NH}_3$ .

Answer: Objective:

10.3 Global Outcomes: GO2

2) The equilibrium between hemoglobin and oxyhemoglobin in the blood can be represented by the following reaction. Write the form of the equilibrium constant expression.



Answer:  $K_c =$

Objective: 10.3

Global Outcomes: GO2

3) A mixture at equilibrium that contains less product than reactant has a  $K_c$  that is \_\_\_\_\_ than 1.

Answer: less

Objective: 10.4

Global Outcomes: GO2

4) An equilibrium constant with a value greater than 1 means the reaction favors the \_\_\_\_\_.

Answer: products

Objective: 10.4

Global Outcomes: GO2

5) The rule or principle that describes the effect of changing reaction conditions on an equilibrium is known as \_\_\_\_\_ principle. Answer: Le Châtelier's

Objective: 10.5

Global Outcomes: GO2

### 10.4 True/False Questions

1) A catalyst lowers the activation energy of a chemical reaction. Answer: TRUE

Objective: 10.1

Global Outcomes: GO2

2) Activation energy is always a large amount of energy. Answer: FALSE  
Objective: 10.1

Global Outcomes: GO2

3) The rate of a chemical reaction depends on temperature.

Answer: TRUE

Objective: 10.1

Global Outcomes: GO2

4) The rate of a chemical reaction is not affected by the concentration of reactants.

Answer: FALSE

Objective: 10.1

Global Outcomes: GO2

5) A catalyst for a chemical reaction affects the magnitude of the equilibrium constant.

Answer: FALSE

Objective: 10.1

Global Outcomes: GO2

6) One of the substances acted upon by a catalytic converter in an automobile is carbon dioxide.

Answer: FALSE

Objective: 10.1

Global Outcomes: GO2

7) At equilibrium, the concentrations of the reactants and products are always equal. Answer: FALSE

Objective: 10.2

Global Outcomes: GO2

8) The equilibrium constant is the ratio of the concentrations of the reactants over the concentrations of the products.

Answer: FALSE

Objective: 10.3

Global Outcomes: GO2



9) The equilibrium constant for the reaction of H<sub>2</sub> and F<sub>2</sub> to form HF, the concentration of HF is raised to the second power.

Answer: TRUE

Objective: 10.3

Global Outcomes: GO2

10) An equilibrium constant  $K_c = 1 \times 10^7$  for a reaction indicates that the reaction favors product formation.

Answer: TRUE

Objective: 10.4

Global Outcomes: GO4

11) An equilibrium constant greater than 1 for a reaction indicates that the reaction favors formation of the products.

Answer: TRUE

Objective: 10.4

Global Outcomes: GO4

12) An equilibrium constant  $K_c = 1 \times 10^{-3}$  for a reaction indicates that the reaction favors product formation.

Answer: FALSE

Objective: 10.4

Global Outcomes: GO4

13) If the equilibrium constant for a reaction is  $1 \times 10^{-5}$ , this means that the equilibrium mixture contains mostly reactants.

Answer: TRUE

Objective: 10.4

Global Outcomes: GO4

14) The equilibrium constant for a reaction does not change with temperature.

Answer: FALSE

Objective: 10.5

Global Outcomes: GO2

15) An example of a stress on an equilibrium is the increase of pressure in a closed system when the pressure of a reactant gas is increased from 1.0 atm to 2.0 atm.

Answer: TRUE

Objective: 10.5

Global Outcomes: GO2

### 10.5 Matching Questions

Indicate the effect of each change upon the rate of a reaction.

A) decreases

B) increases

1) adding a catalyst

Objective: 2.1 Global

Outcomes: GO2

2) removing some reactant

Objective: 2.1

Global Outcomes: GO2

3) The temperature is doubled.

Objective: 2.1

Global Outcomes: GO2

4) The concentration of a reactant is decreased.

Objective: 2.1

Global Outcomes: GO2

5) More collisions between molecules occur.

Objective: 2.1

Global Outcomes: GO2

Answers: 1) B 2) A 3) B 4) A 5) B