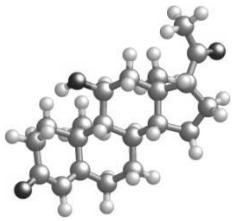


Chem!stry

Name: …… **( )**

Class: ……

Date: …… **/** …… **/** ……

Multiple-Choice Questions on Dynamic Equilibrium

1. In the Contact process for making sulfuric acid, one step involves the oxidation of sulfur dioxide to sulfur trioxide.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

The forward reaction is exothermic. Which change would increase the amount of sulfur trioxide produced at equilibrium?

A Adding a catalyst.

B Decreasing the pressure.

C Decreasing the temperature.

D Increasing the temperature.

2. When bismuth(III) chloride, $BiCl_3$, is added to water, a white precipitate of BiOCl is formed.

$$BiCl_3(aq) + H_2O(l) \rightleftharpoons BiOCl(s) + 2HCl(aq)$$

If this reversible reaction is at equilibrium and hydrochloric acid is added, what will happen?

A The position of equilibrium moves to the left and more white precipitate is formed.

B The position of equilibrium moves to the left and the white precipitate disappears.

C The position of equilibrium moves to the right and more white precipitate is formed.

D The position of equilibrium moves to the right and the white precipitate disappears.

3. The equation shows the reaction for the formation of sulfur trioxide using a catalyst.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H = -197 \text{ kJ/mol}$$

Which change in reaction conditions would produce more sulfur trioxide?

A Adding more catalyst.

B Decreasing the pressure.

C Increasing the temperature.

D Removing some sulfur trioxide.

4. The equation shows the decomposition of ammonia into nitrogen and hydrogen.

$$2NH_3(g) \rightleftharpoons N_2(g) + 3H_2(g) \quad \Delta H = +46.0 \text{ kJ/mol}$$

The reaction was allowed to reach equilibrium.

Which change would cause the equilibrium position to shift towards the right-hand-side?

1 Adding a catalyst.

2 Increasing the temperature.

3 Increasing the volume of the reaction vessel.

4 Removing some ammonia from the reaction vessel.

A 1 and 3 only **B** 2 and 3 only

C 2 and 4 only **D** 3 and 4 only

5. Methanol is made in industry by a reaction between carbon monoxide and hydrogen.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g) \quad \Delta H = -90 \text{ kJ/mol}$$

The process is usually carried out at a temperature of 400°C.

Which row correctly shows the effect on both the position of the equilibrium and on the rate of the reaction of increasing the temperature to above 400°C?

	position of equilibrium	rate of reaction
A	moves to the left	decreases
B	moves to the left	increases
C	moves to the right	decreases
D	moves to the right	increases

6. The equilibrium between chromate(VI), CrO_4^{2-}, and dichromate(VI), $Cr_2O_7^{2-}$, is shown below.

$$2CrO_4^{2-}(aq) + 2H^+(aq) \rightleftharpoons Cr_2O_7^{2-}(aq) + H_2O(l)$$

yellow orange

The reaction was allowed to reach equilibrium.

Which change will cause the equilibrium position to move towards the left-hand-side?

A Adding dilute aqueous hydrochloric acid to the reaction.

B Adding dilute aqueous sodium hydroxide to the reaction.

C Increasing the pressure inside the reaction vessel.

D Removing dichromate(VI) ions from the reaction.

7. The equilibrium between dinitrogen tetroxide, N_2O_4, and nitrogen dioxide, NO_2, is shown below.

$$N_2O_4(g) \rightleftharpoons 2NO_2 \qquad \Delta H = +58 \text{ kJ/mol}$$

colourless brown

The reaction is allowed to reach equilibrium.

Which one of the following changes will happen when the flask containing the equilibrium mixture is placed in a beaker of iced-water?

	colour of equilibrium mixture	pressure inside the flask
A	becomes darker	decreases
B	becomes darker	increases
C	becomes lighter	decreases
D	becomes lighter	increases

8. When bismuth(III) chloride, $BiCl_3$ is added to water, a reaction occurs and a white precipitate of BiOCl is formed.

$$BiCl_3(aq) + H_2O(l) \rightleftharpoons BiOCl(s) + 2HCl(aq)$$

Which changes increase the mass of white precipitate formed?

1 Adding more water.

2 Adding aqueous sodium hydroxide.

3 Adding dilute hydrochloric acid.

A 1 and 2 **B** 1 and 3 **C** 1 only **D** 2 and 3

9. Sulfuric acid is manufactured using the contact process. The equations for the reactions in the process are shown.

Reaction 1 $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H = -198 \text{ kJ/mol}$

Reaction 2 $SO_3(g) + H_2O(l) \rightarrow H_2SO_4(aq)$

Which statements are correct?

1 Reaction 1 is reversible.

2 Reaction 1 is exothermic.

3 In reaction 2, sulfur dioxide reacts with water to form sulfuric acid.

A 1 and 2 only **B** 1 and 3 only

C 2 and 3 only **D** 1, 2 and 3

10. Elements X and Y react together in a reversible reaction to form XY_2.

$$X + 2Y \rightleftharpoons XY_2$$

1.0 mol of X is mixed with 1.0 mol of Y and the mixture is left to react until an equilibrium position is reached.

Which statements about this reaction are correct?

1 After the equilibrium position has been reached, the reaction stops.

2 At equilibrium there is more than 0.5 mol of X present.

3 At equilibrium there is less than 0.5 mol of XY_2 present.

A 1, 2 and 3 **B** 2 only

C 3 only **D** 2 and 3 only

11. The equation shows a reversible reaction.

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

The forward reaction is endothermic.

Which of these changes will increase the yield of NO_2?

	pressure	temperature
A	decreased	decreased
B	decreased	increased
C	increased	decreased
D	increased	increased

12. When a solution containing silver ions is added to a solution containing iron(II) ions, an equilibrium is set up.

$$Ag^+(aq) + Fe^{2+}(aq) \rightleftharpoons Ag(s) + Fe^{3+}(aq)$$

The addition of which substance would **not** affect the amount of silver precipitated?

A $Ag^+(aq)$ **B** $Fe^{2+}(aq)$ **C** $Fe^{3+}(aq)$ **D** $H_2O(l)$

13. Which statement about catalysts is correct for a typical equilibrium reaction?

A A catalyst can be either an inorganic or an organic species.

B A catalyst does not take part in the reaction.

C A catalyst only speeds up the forward reaction.

D A catalyst provides the energy required to start a reaction.

14. Solid ammonium chloride is heated. The gases ammonia and hydrogen chloride are formed.

This is reaction 1.

Ammonia gas is mixed with hydrogen chloride gas. Solid ammonium chloride is formed.

This is reaction 2.

Which statement is correct?

A Both reaction 1 and reaction 2 are exothermic.

B Reaction 2 is reversible.

C The equation for reaction 1 is $NH_5Cl \rightarrow NH_4 + HCl$.

D The three substances involved in each reaction all have a simple molecular structure.

15. When water is liquid, it ionises slightly.

$$H_2O(l) \rightleftharpoons H^+(aq) + OH^-(aq)$$

The forward reaction is endothermic.

When the temperature of water is increased, which changes take place?

1 The water becomes acidic.

2 The water becomes alkaline.

3 More water molecules form ions.

A 1 and 3 **B** 1 only **C** 2 and 3 **D** 3 only

16. Chlorine can be manufactured by the following reaction.

$$4HCl(g) + O_2(g) \rightleftharpoons 2H_2O(g) + 2Cl_2(g) \quad \Delta H \text{ is negative}$$

A mixture in dynamic equilibrium is formed.

Which change to the mixture will increase the amount of chlorine at equilibrium?

A Adding a catalyst

B Adding more $HCl(g)$

C Decreasing the pressure

D Increasing the temperature

17. Ammonia is made by a reversible reaction between nitrogen and hydrogen.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \quad \Delta H = -92 \text{ kJ/mol}$$

What is the effect of increasing the pressure in this process?

A Less heat is produced.

B More ammonia is formed.

C More nitrogen is present at equilibrium.

D The reaction slows down.

18. In which of these equilibria is the forward reaction favoured by an increase in pressure?

A $2HI(g) \rightleftharpoons H_2(g) + I_2(g)$

B $N_2O_4(g) \rightleftharpoons 2NO_2(g)$

C $2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$

D $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

19. The equation shows the formation of sulfur trioxide in the contact process.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \quad \Delta H = -196 \text{ kJ/mol}$$

What would **decrease** the yield of sulfur trioxide?

A Addition of more oxygen.

B An increase in pressure.

C An increase in temperature.

D Removal of sulfur trioxide from the reaction chamber.

20. Nitrogen reacts with oxygen in an equilibrium reaction.

$$N_2(g) + O_2(g) \rightleftharpoons 2NO(g) \quad \Delta H = +170 \text{ kJ/mol}$$

When the reaction is at equilibrium, which statement is correct?

A The concentration of nitrogen present will change with time.

B The forward and backward reactions are taking place at the same rate.

C The forward reaction releases heat energy.

D There are more molecules on the left hand side of the equation than on the right.

21. In a closed flask, gases Q and R reach a dynamic equilibrium.

$$Q(g) \rightleftharpoons 2R(g) \quad \Delta H \text{ is positive}$$

Which change will move equilibrium to the right?

A Adding a catalyst.

B Decreasing the temperature.

C Increasing the pressure.

D Increasing the volume of the reaction flask.

22. The equations show four reversible reactions.

For which reaction would the equilibrium move to the right for both an increase in pressure and an increase in temperature?

	reaction	enthalpy change
A	$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$	exothermic
B	$4NO(g) + 6H_2O(g) \rightleftharpoons 4NH_3(g) + 5O_2(g)$	endothermic
C	$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$	endothermic
D	$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$	exothermic

23. Ammonia is manufactured by the Haber process.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \quad \Delta H = -92 \text{ kJ/mol}$$

For this reaction, which rows gives a true statement together with a correct reason?

	statement	reason
1	Nitrogen and hydrogen are mixed in the ratio 1:3 by volume.	The formula of ammonia is NH_3.
2	The pressure used is approximately 200 atmospheres.	A high pressure is needed to produce a good yield of ammonia at equilibrium.
3	The temperature used is approximately 450 °C.	A high temperature is needed to produce a good yield of ammonia at equilibrium.
4	Vanadium(V) oxide is used as a catalyst.	A catalyst speeds up the rate of the reaction.

A 1 and 2 only **B** 2 and 3 only **C** 3 and 4 only **D** 1, 2 and 3 only

24. Ammonia is manufactured by the Haber process.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

The forward reaction is exothermic.

Which statement about the Haber process is correct?

A A low pressure is used to shift the position of the equilibrium to the right.

B A high temperature is used to shift the position of the equilibrium to the right.

C An iron catalyst is used to shift the position of the equilibrium to the right.

D The nitrogen used is obtained from the air.

25. The Haber process is used to make ammonia at a temperature of 400 °C and a pressure of 20 000 kPa. The temperature is changed to 500 °C but the pressure is kept the same.

What will be the effects of this change on the production of ammonia?

A It is made at an increased rate and the position of the equilibrium moves to the left.

B It is made at an increased rate and the position of the equilibrium moves to the right.

C It is made at a decreased rate and the position of the equilibrium moves to the left.

D It is made at a decreased rate and the position of the equilibrium moves to the right.

26. Esters are sweet and fruity smelling chemicals that are used in the food and perfume industries. The balanced chemical equation for the formation of the ester *ethyl ethanoate* is given below.

$$\text{ethanoic acid} + \text{ethanol} \rightleftharpoons \text{ethyl ethanoate} + \text{water}$$

$$CH_3COOH(l) + C_2H_5OH(l) \rightleftharpoons CH_3COOC_2H_5(l) + H_2O(l)$$

This exothermic reaction is catalysed by adding a few drops on concentrate sulfuric acid to the mixture. What would cause the equilibrium position to shift towards the right-hand-side?

A Addition of more concentrated sulfuric acid.

B An increase in pressure.

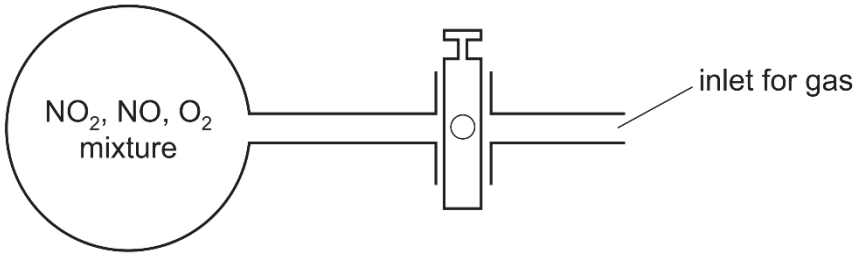
C An increase in temperature.

D Removal of water.

27. Nitrogen dioxide, NO_2, is a dark brown gas that decomposes as shown in the equation.

$$\underset{\text{dark brown}}{2NO_2(g)} \rightleftharpoons \underset{\text{colourless}}{2NO(g) + O_2(g)}$$

The diagram shows a glass flask containing a mixture of the three gases. The mixture is pale brown.



More oxygen is forced into the flask. Which colour change is seen in the mixture?

A It becomes a darker brown.

B It becomes a paler brown.

C It turns colourless.

D There is no change.

28. Study the equilibrium system given below.

$$\underset{\text{yellow chromate(VI)}}{2CrO_4^{2-}(aq)} + 2H^+(aq) \rightleftharpoons \underset{\text{orange dichromate(VI)}}{Cr_2O_7^{2-}(aq)} + H_2O(l)$$

Which statements about this equilibrium system are correct?

1 Adding a catalyst will make the mixture turn yellow.

2 Adding sodium hydroxide will make the mixture turn yellow.

3 Adding a dehydrating agent will make the mixture turn orange.

4 Increasing the pressure will make the mixture turn orange.

A 1 and 2 only **B** 1 and 3 only **C** 2 and 3 only **D** 3 and 4 only.

29. The Haber process converts nitrogen and hydrogen into ammonia.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

Which row is correct?

	change in condition	position of equilibrium
A	pressure is increased	moves to the left
B	pressure is reduced	no change
C	catalyst is present	moves to the right
D	catalyst is present	no change

30. A reversible reaction involves a solid reacting with hydrogen.

Which of the metals, aluminium and iron, would catalyse the reaction and what is their effect on the position of equilibrium?

	act as a catalyst	position of equilibrium
A	both aluminium and iron	moves to the right
B	both aluminium and iron	no change
C	iron only	moves to the right
D	iron only	no change

- Scan the QR Code below to view the answers to this assignment.

http://www.chemist.sg/ammonia_equilibrium/equilibrium_mcq_ans.pdf