eqquiz Name

1.

$$2\ BaO_2(s) \rightleftarrows 2\ BaO(s) + O_2(g)$$

$$\Delta H^\circ = 162\ kJ/mol_{rxn}$$

A sealed rigid vessel contains $BaO_2(s)$ in equilibrium with $BaO(s)$ and $O_2(g)$ as represented by the equation above. Which of the following changes will increase the amount of $BaO_2(s)$ in the vessel?

(A) Removing a small amount of $O_2(g)$

(B) Removing a small amount of $BaO(s)$

(C) Adding He gas to the vessel

(D) Lowering the temperature

2.

$$2\ H_2S(g) + CH_4(g) \rightleftarrows CS_2(g) + 4\ H_2(g) \qquad K_c = 3.4 \times 10^{-4}$$

A 0.10 mol sample of each of the four species in the reaction represented above is injected into a rigid, previously evacuated 1.0 L container. Which of the following species will have the highest concentration when the system reaches equilibrium?

(A) $H_2S(g)$

(B) $CH_4(g)$

(C) $CS_2(g)$

(D) $H_2(g)$

---

eqquiz

3.

$$2\ S(s) + 2\ O_2(g) \rightleftarrows 2\ SO_2(g) \quad K_1 = 2 \times 10^{105}$$

$$2\ SO_2(g) + O_2(g) \rightleftarrows 2\ SO_3(g) \quad K_2 = 7 \times 10^{24}$$

Given the value of the equilibrium constants K_1 and K_2 for the reactions represented above, what is the value of the equilibrium constant, K_3, for the following reaction?

$$2\ S(s) + 3\ O_2(g) \rightleftarrows 2\ SO_3(g) \quad K_3 = ?$$

(A) 1×10^{130}

(B) 3×10^{80}

(C) 1×10^{65}

(D) 2×10^{40}

(E) 7×10^{24}

4.

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

After the equilibrium represented above is established, some pure $O_2(g)$ is injected into the reaction vessel at constant temperature. After equilibrium is reestablished, which of the following has a lower value compared to its value at the original equilibrium?

eqquiz

(A) K_{eq} for the reaction

(B) The total pressure in the reaction vessel

(C) The amount of $SO_3(g)$ in the reaction vessel

(D) The amount of $O_2(g)$ in the reaction vessel

(E) The amount of $SO_2(g)$ in the reaction vessel

---

5. $2\ XY(g) \rightleftarrows X_2(g) + Y_2(g)$ $K_p = 230$

A certain gas, XY(g), decomposes as represented by the equation above. A sample of each of the three gases is put in a previously evacuated container. The initial partial pressures of the gases are shown in the table below.

Gas	Initial Partial Pressure (atm)
XY	0.010
X_2	0.20
Y_2	2.0

The temperature of the reaction mixture is held constant. In which direction will the reaction proceed?

eqquiz

(A) The reaction will form more products.

(B) The reaction will form more reactant.

(C) The mixture is at equilibrium, so there will be no change.

(D) It cannot be determined unless the volume of the container is known.

---

6. $2X(g) + Y(g) \rightleftarrows 3Z(g)$

The reaction mixture represented above is at equilibrium at 298 K, and the molar concentrations are [X] = 2.0 *M*, [Y] = 0.5 *M*, and [Z] = 4.0 *M*. What is the value of the equilibrium constant for the reaction at 298 K ?

(A) 0.50

(B) 2.0

(C) 4.0

(D) 16

(E) 32

---

7. $3\ O_{2(}g) \rightleftarrows 2O_3(g)$ $K_c = 1.8 \times 10^{-56}$ at 570 K

For the system represented above, $[O_2]$ and $[O_3]$ initially are 0.150 mol/L and 2.5 mol/L respectively. Which of the following best predicts what will occur as the system approaches equilibrium at 570 K?

eqquiz

(A) The amount of $O_3(g)$ will increase, because $Q < K_c$.

(B) The amount of $O_3(g)$ will decrease, because $Q < K_c$.

(C) The amount of $O_3(g)$ will increase, because $Q > K_c$.

(D) The amount of $O_3(g)$ will decrease, because $Q > K_c$.

---

8. $4\ HCl(g) + O_2(g) \rightleftarrows 2\ Cl_2(g) + 2\ H_2O(g)$

Equal numbers of moles of HCl and O_2 in a closed system are allowed to reach equilibrium as represented by the equation above. Which of the following must be true at equilibrium?

I. [HCl] must be less than $[Cl_2]$.

II. $[O_2]$ must be greater than [HCl].

III. $[Cl_2]$ must equal $[H_2O]$.

(A) I only

(B) II only

(C) I and III only

(D) II and III only

(E) I, II, and III

Refer to the following.

$PCl_5(g) \rightleftarrows PCl_3(g) + Cl_2(g)$

$PCl_5(g)$ decomposes into $PCl_3(g)$ and $Cl_2(g)$ according to the equation above. A pure sample of $PCl_5(g)$ is placed in a rigid, evacuated 1.00 L container. The initial pressure of the $PCl_5(g)$ is 1.00 atm. The

temperature is held constant until the $PCl_5(g)$ reaches equilibrium with its decomposition products. The figures below show the initial and equilibrium conditions of the system.

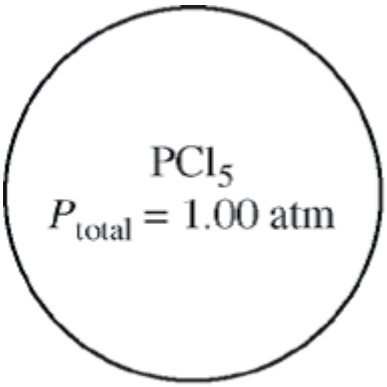


Figure 1: Initial

Figure 2: Equilibrium

9. As the reaction progresses toward equilibrium, the rate of the forward reaction

(A) increases until it becomes the same as the reverse reaction rate at equilibrium

(B) stays constant before and after equilibrium is reached

(C) decreases to become a constant nonzero rate at equilibrium

(D) decreases to become zero at equilibrium

10. Which of the following statements about K_p, the equilibrium constant for the reaction, is correct?

eqquiz

(A) $K_p > 1$

(B) $K_p < 1$

(C) $K_p = 1$

(D) It cannot be determined whether $K_p > 1$, $K_p < 1$, or $K_p = 1$ without additional information.

11.

$$CO(g) + H_2O(g) \rightleftarrows CO_2(g) + H_2(g) \qquad K_c = 1.5 \times 10^3$$

A 2.0 mol sample of CO(*g*) and a 2.0 mol sample of H_2O(g) are introduced into a previously evacuated 100. L rigid container, and the temperature is held constant as the reaction represented above reaches equilibrium. Which of the following is true at equilibrium?

(A) $[H_2O] > [CO]$ and $[CO_2] > [H_2]$

(B) $[H_2O] > [H_2]$

(C) $[CO_2] > [CO]$

(D) $[CO] = [H_2O] = [CO_2] = [H_2]$

12.

$$CaCO_3(s) \rightleftarrows CaO(s) + CO_2(g) \qquad \Delta H° = 178 \text{ kJ/mol}_{rxn}$$

The reaction system represented above is at equilibrium. Which of the following will decrease the amount of CaO(*s*) in the system?

eqquiz

(A) Increasing the volume of the reaction vessel at constant temperature

(B) Lowering the temperature of the system

(C) Removing some $CO_2(g)$ at constant temperature

(D) Removing some $CaCO_3(s)$ at constant temperature

13.

Reaction 1:	$\mathrm{CO}(g) + 3\,\mathrm{H_2}(g) \rightleftarrows \mathrm{CH_4}(g) + \mathrm{H_2O}(g)$	$K_1 = \frac{[\mathrm{CH_4}][\mathrm{H_2O}]}{[\mathrm{CO}][\mathrm{H_2}]^3}$
Reaction 2:	$\mathrm{CO_2}(g) + \mathrm{H_2}(g) \rightleftarrows \mathrm{CO}(g) + \mathrm{H_2O}(g)$	$K_2 = \frac{[\mathrm{CO}][\mathrm{H_2O}]}{[\mathrm{CO_2}][\mathrm{H_2}]}$
Reaction 3:	$\mathrm{CH_4}(g) + 2\,\mathrm{H_2O}(g) \rightleftarrows \mathrm{CO_2}(g) + 4\,\mathrm{H_2}(g)$	$K_3 = ?$

The chemical equations and equilibrium expressions for two reactions at the same temperature are given above. Based on the information, which of the following expressions can be used to calculate the value of K_3 for reaction 3 at the same temperature?

(A) $K_3 = (-K_1) + (-K_2)$

(B) $K_3 = (-K_1) - (-K_2)$

(C) $K_3 = K_1 \times K_2$

(D) $K_3 = \frac{1}{K_1} \times \frac{1}{K_2}$

---

eqquiz

14.

Time (minutes)	$[\mathrm{X}]$	$[\mathrm{XY}]$
0	5.0×10^{-2}	0.0
5	4.1×10^{-2}	9.0×10^{-3}
15	2.9×10^{-2}	2.1×10^{-2}
35	1.0×10^{-2}	4.0×10^{-2}
75	8.0×10^{-3}	4.2×10^{-2}
155	7.0×10^{-3}	4.3×10^{-2}
315	7.0×10^{-3}	4.3×10^{-2}
500	7.0×10^{-3}	4.3×10^{-2}

$\mathrm{X}(g) + \mathrm{Y}(g) \rightleftarrows \mathrm{XY}(g)$In an experiment, $\mathrm{X}(g)$ and $\mathrm{Y}(g)$ were combined in a rigid container at constant temperature and allowed to react as shown in the equation above. The table provides the data collected during the experiment. Based on the data, which of the following claims is most likely correct?

(A) The reaction was about to reach equilibrium 15 minutes after the reactants were combined because the concentrations of X and XY were almost the same.

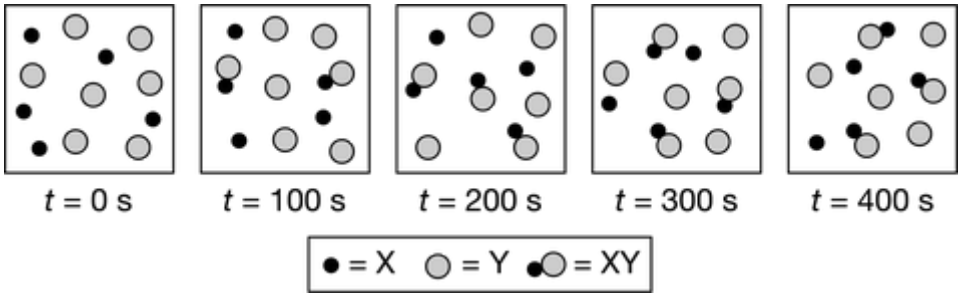
(B) The reaction reached equilibrium between 75 minutes and 155 minutes after the reactants were combined because the concentrations of X and XY remained constant.

(C) The reaction did not reach equilibrium because only 86% of the initial concentration of X was consumed.

(D) The reaction did not reach equilibrium because initially there was no XY inside the container.

eqquiz

15.



$\mathbf{X}(g) + \mathbf{Y}(g) \rightleftarrows \mathbf{XY}(g)$The particle diagram above illustrates the changes that take place when $\mathbf{X}(g)$ and $\mathbf{Y}(g)$ are placed inside a rigid container at constant temperature. Which of the following is a characteristic of a system at equilibrium that is best represented by the particle diagram?

(A) The particle diagram shows that initially the reaction proceeds to the right to form products, which is a characteristic of a system at equilibrium.

(B) The particle diagram shows that after $\mathbf{200\ s}$ the rate of the reverse reaction is slower than the rate of the forward reaction, which is a characteristic of a system at equilibrium.

(C) The particle diagram shows that after $\mathbf{200\ s}$ there are no observable changes in the amounts of reactants and products, which is a characteristic of a system at equilibrium.

(D) The particle diagram shows that between $\mathbf{0\ s}$ and $\mathbf{200\ s}$ the rates of the forward and reverse reactions are the same, which is a characteristic of a system at equilibrium.

16.

$$CO(g) + 2\ H_2(g) \rightleftarrows CH_3OH(g) \qquad \Delta H < 0$$

The synthesis of $CH_3OH(g)$ from $CO(g)$ and $H_2(g)$ is represented by the equation above. The value of K_c for the reaction at 483 K is 14.5.

Which of the following explains the effect on the equilibrium constant, K_c, when the temperature of the reaction system is increased to 650 K?

eqquiz

(A) K_c will increase because the activation energy of the forward reaction increases more than that of the reverse reaction.

(B) K_c will increase because there are more reactant molecules than product molecules.

(C) K_c will decrease because the reaction is exothermic.

(D) K_c is constant and will not change.

---

17. $$CO(g) + 2\ H_2(g) \rightleftarrows CH_3OH(g) \qquad \Delta H < 0$$

The synthesis of $CH_3OH(g)$ from $CO(g)$ and $H_2(g)$ is represented by the equation above. The value of K_c for the reaction at 483 K is 14.5.

A mixture of $CO(g)$ and $H_2(g)$ is pumped into a previously evacuated 2.0 L reaction vessel. The total pressure of the reaction system is 1.2 atm at equilibrium. What will be the total equilibrium pressure of the system if the volume of the reaction vessel is reduced to 1.0 L at constant temperature?

(A) Less than 1.2 atm

(B) Greater than 1.2 atm but less than 2.4 atm

(C) 2.4 atm

(D) Greater than 2.4 atm

---

18. $COCl_2(g) \rightleftarrows CO(g) + Cl_2(g)$

$COCl_2(g)$ decomposes according to the equation above. When pure $COCl_2(g)$ is injected into a rigid, previously evacuated flask at 690 K, the pressure in the flask is initially 1.0 atm. After the reaction reaches equilibrium at 690 K, the total pressure in the flask is 1.2 atm. What is the value of K_p for the reaction at 690 K?

eqquiz

A 0.040

B 0.050

C 0.80

D 1.0

19.

Reaction	Equilibrium Reactions at $298\ \mathrm{K}$	K_{eq}
1	$\mathrm{Br_2}(g) + \mathrm{Cl_2}(g) \rightleftarrows 2\ \mathrm{BrCl}(g)$	10.
2	$\mathrm{N_2}(g) + \mathrm{O_2}(g) \rightleftarrows 2\ \mathrm{NO}(g)$	4.2×10^{-31}

The table above shows data for two reactions carried out in two separate evacuated 1.0-liter rigid containers at constant temperature of $298\ \mathrm{K}$. To each container $0.50\ \mathrm{mol}$ of the appropriate reactants was added, and the reaction was allowed to reach equilibrium. Based on this information, which of the following correctly compares the relative concentrations of BrCl and NO present inside their respective containers at equilibrium?

A $[\mathrm{BrCl}]_{eq} = [\mathrm{NO}]_{eq}$ because equimolecular mixtures of the reactants were allowed to reach equilibrium at the same constant temperature.

B $[\mathrm{BrCl}]_{eq} > [\mathrm{NO}]_{eq}$ because $\mathrm{Br_2}$ and $\mathrm{Cl_2}$ are larger molecules that can collide more frequently to form products.

C $[\mathrm{BrCl}]_{eq} > [\mathrm{NO}]_{eq}$ because the much larger K_{eq} for reaction 1 means that a much higher concentration of products will be present at equilibrium for reaction 1 compared with reaction 2.

D $[\mathrm{BrCl}]_{eq} < [\mathrm{NO}]_{eq}$ because the much larger K_{eq} for reaction 1 means that hardly any products will be present at equilibrium compared with reaction 2.

eqquiz

20. $\mathrm{Fe^{3+}}(aq) + \mathrm{SCN^-}(aq) \rightleftarrows \mathrm{FeSCN^{2+}}(aq)$

Colorless Colorless Red

When colorless solutions containing $\mathrm{Fe^{3+}}(aq)$ ions and $\mathrm{SCN^-}(aq)$ ions are combined, a deep-red complex ion, $\mathrm{FeSCN^{2+}}(aq)$ quickly forms, as shown in the net ionic equation above. Which of the following explains the observation that adding a few additional crystals of $\mathrm{KSCN}(s)$ results in the red color of the solution becoming deeper?

(A) The added $\mathrm{KSCN}(s)$ dissolves, disturbing the charge balance in the solution, causing $\mathrm{Fe(SCN)_3}$ to precipitate as a red solid.

(B) The added $\mathrm{KSCN}(s)$ dissolves, causing the solution to become saturated in $\mathrm{SCN^-}$ ions, which appear red at high concentrations.

(C) The added $\mathrm{KSCN}(s)$ dissolves, causing the reaction system to respond by producing more product to partially consume $\mathrm{SCN^-}(aq)$ and reduce its concentration.

(D) The added $\mathrm{KSCN}(s)$ dissolves, causing the reaction system to respond by forming more $\mathrm{Fe^{3+}}$ ions, which have a deep orange color at high concentrations.

---

21. $\mathrm{Cl_2}(aq) + 2\,\mathrm{H_2O}(l) \rightleftarrows \mathrm{H_3O^+}(aq) + \mathrm{Cl^-}(aq) + \mathrm{HOCl}(aq)$

$K_c = \frac{[\mathrm{H_3O^+}][\mathrm{Cl^-}][\mathrm{HOCl}]}{[\mathrm{Cl_2}]} = 4.8 \times 10^{-4}$

The equilibrium reaction between $\mathrm{Cl_2}(aq)$ and $\mathrm{H_2O}(l)$ at $25^\circ\mathrm{C}$ is represented by the chemical equation shown above. If a solution at equilibrium at $25^\circ\mathrm{C}$ is diluted with distilled water to twice its original volume, which of the following gives the value for Q_c and predicts the response by the system immediately after dilution?

(A) $Q_c = 4K_c$, and the rate of the reverse reaction will be greater than the rate of the forward reaction.

(B) $Q_c = 4K_c$, and the rate of the forward reaction will be greater than the rate of the reverse reaction.

(C) $Q_c = \frac{K_c}{4}$, and the rate of the reverse reaction will be greater than the rate of the forward reaction.

(D) $Q_c = \frac{K_c}{4}$, and the rate of the forward reaction will be greater than the rate of the reverse reaction.

---

eqquiz

22. $2\,NO(g) + Cl_2(g) \rightleftarrows 2\,NOCl(g)\ K_c = 2000$

A mixture of $NO(g)$ and $Cl_2(g)$ is placed in a previously evacuated container and allowed to reach equilibrium according to the chemical equation shown above. When the system reaches equilibrium, the reactants and products have the concentrations listed in the following table.

Species	Concentration (M)
$NO(g)$	0.050
$Cl_2(g)$	0.050
$NOCl(g)$	0.50

Which of the following is true if the volume of the container is decreased by one half?

(A) $Q = 100$, and the reaction will proceed toward reactants.

(B) $Q = 100$, and the reaction will proceed toward products.

(C) $Q = 1000$, and the reaction will proceed toward reactants.

(D) $Q = 1000$, and the reaction will proceed toward products.

23.

$$Ag^+(aq) + NH_3(aq) \rightleftarrows Ag(NH_3)^+(aq) \qquad K_{eq_1} = 2.0 \times 10^3$$

$$Ag(NH_3)^+(aq) + NH_3(aq) \rightleftarrows Ag(NH_3)_2{}^+(aq) \qquad K_{eq_2} = 8.0 \times 10^3$$

Equal volumes of 0.1 *M* $AgNO_3(aq)$ and 2.0 *M* $NH_3(aq)$ are mixed and the reactions represented above occur. Which Ag species will have the highest concentration in the equilibrium system shown below, and why?

$$Ag^+(aq) + 2\,NH_3(aq) \rightleftarrows Ag(NH_3)_2{}^+(aq) \qquad K_{eq_3} = ?$$

eqquiz

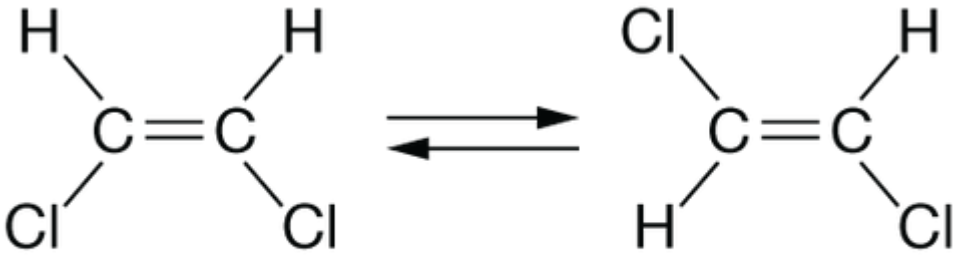
(A) $Ag^+(aq)$, because $K_{eq3} = 4$

(B) $Ag^+(aq)$, because $K_{eq1} < K_{eq2}$

(C) $Ag(NH_3)_2^+(aq)$, because $K_{eq3} = 1.6 \times 10^7$

(D) $Ag(NH_3)_2^+(aq)$, because $K_{eq1} < K_{eq2}$

24.



Y Z

Substance	Y	Z
Initial concentration (M)	2.0	0.0
Equilibrium concentration (M)	1.2	0.80

The diagram above represents the equilibrium between the two isomers of $C_2H_2Cl_2$, and the table provides the data collected in an experiment to determine its equilibrium constant, K_c, at $490\ K$. In a second experiment done at the same temperature, $[Z]_{eq} \approx 1.0\ M$. Which of the following is the approximate equilibrium concentration of Y in the second experiment, and why?

eqquiz

(A) $[\mathrm{Y}]_{eq} \approx 1.4\,M$ because $[\mathrm{Y}]_{eq} - [\mathrm{Z}]_{eq}$ should be the same for the same reaction.

(B) $[\mathrm{Y}]_{eq} \approx 1.5\,M$ because the ratio $\frac{[\mathrm{Z}]_{eq}}{[\mathrm{Y}]_{eq}}$ should remain constant when the reaction is done at the same temperature.

(C) $[\mathrm{Y}]_{eq} \approx 1.6\,M$ because the ratio $\frac{[\mathrm{Y}]_{initial}}{[\mathrm{Y}]_{eq}}$ should remain constant when the reaction is done at the same temperature.

(D) $[\mathrm{Y}]_{eq} \approx 2.0\,M$ because $\left([\mathrm{Y}]_{initial} - [\mathrm{Y}]_{eq}\right) = \left([\mathrm{Z}]_{initial} - [\mathrm{Z}]_{eq}\right)$ should be the same for the same reaction.

---

25. $2\,\mathrm{A}(g) + \mathrm{B}(g) \rightleftarrows 2\,\mathrm{C}(g)$

$\mathrm{A}(g)$ and $\mathrm{B}(g)$ react to form $\mathrm{C}(g)$, according to the balanced equation above. In an experiment, a previously evacuated rigid vessel is charged with $\mathrm{A}(g)$, $\mathrm{B}(g)$, and $\mathrm{C}(g)$, each with a concentration of $0.0100\,M$. The following table shows the concentrations of the gases at equilibrium at a particular temperature.

$[\mathrm{A}]_{eq}$	$[\mathrm{B}]_{eq}$	$[\mathrm{C}]_{eq}$
0.0180	0.0140	0.0020

If the experiment is repeated at a higher temperature at which K_c is larger, which of the following best describes the effect of the temperature change on the concentrations of the gases at equilibrium?

(A) $[\mathrm{A}]_{eq}$, $[\mathrm{B}]_{eq}$, and $[\mathrm{C}]_{eq}$ will all increase because K_c increased.

(B) $[\mathrm{A}]_{eq}$ and $[\mathrm{B}]_{eq}$ will remain constant, but $[\mathrm{C}]_{eq}$ will increase because K_c increased.

(C) There will be a decrease in $[\mathrm{A}]_{eq}$ that will be two times the decrease in $[\mathrm{B}]_{eq}$ because A and B react in a 2-to-1 ratio.

(D) There will be an increase in $[\mathrm{A}]_{eq}$ that will be two times the increase in $[\mathrm{B}]_{eq}$ because A and B react in a 2-to-1 ratio.

---

eqquiz

26. $2\,\mathrm{NO}(g) + \mathrm{Br_2}(g) \rightleftarrows 2\,\mathrm{NOBr}(g) \qquad K_p = \dfrac{(P_{\mathrm{NOBr}})^2}{(P_{\mathrm{NO}})^2\left(P_{\mathrm{Br_2}}\right)} = 28$

Substance	Initial Partial Pressure (torr)
NO	10.
$\mathrm{Br_2}$	2.0
NOBr	80.

The system represented by the equation above is allowed to establish equilibrium. The initial pressures of the substances are given in the table. Which of the following explains what the system will do as it approaches equilibrium?

(A) $Q = \dfrac{(80.)^2}{(10.)(2.0)} > K_p$ and equilibrium will be approached by producing NOBr because the forward reaction is faster than the reverse reaction.

(B) $Q = \dfrac{(80.)}{(10.)(2.0)} < K_p$ and equilibrium will be approached by producing NOBr because the forward reaction is faster than the reverse reaction.

(C) $Q = \dfrac{(80.)^2}{(10.)^2(2.0)} < K_p$ and equilibrium will be approached by consuming NOBr because the reverse reaction is faster than the forward reaction.

(D) $Q = \dfrac{(80.)^2}{(10.)^2(2.0)} > K_p$ and equilibrium will be approached by consuming NOBr because the reverse reaction is faster than the forward reaction.

---

27. $2\,\mathrm{HI}(g) \rightleftarrows \mathrm{H_2}(g) + \mathrm{I_2}(g) \qquad K_p = \dfrac{P_{\mathrm{H_2}} P_{\mathrm{I_2}}}{P_{\mathrm{HI}}^2} = 0.0016$

The decomposition of $\mathrm{HI}(g)$ at $298\ \mathrm{K}$ is represented by the equilibrium equation above. When $100.\ \mathrm{torr}$ of $\mathrm{HI}(g)$ is added to a previously evacuated, rigid container and allowed to reach equilibrium, the partial pressure of $\mathrm{I_2}(g)$ is approximately $3.7\ \mathrm{torr}$. If the initial pressure of $\mathrm{HI}(g)$ is increased to $200.\ \mathrm{torr}$ and the process is repeated at the same temperature, which of the following correctly predicts the equilibrium partial pressure of $\mathrm{I_2}(g)$, and why?

eqquiz

(A) $P_{I_2} \approx 14\,\text{torr}$, because it is directly proportional to the square of the initial pressure of $\mathbf{HI}$.

(B) $P_{I_2} \approx 0.073\,\text{torr}$, because it is inversely proportional to the square of the initial pressure of $\mathbf{HI}$.

(C) $P_{I_2} \approx 7.4\,\text{torr}$, because it is directly proportional to the initial pressure of $\mathbf{HI}$.

(D) $P_{I_2} \approx 1.9\,\text{torr}$, because it is inversely proportional to the initial pressure of $\mathbf{HI}$.

---

28. For which of the equilibrium systems represented below will the amount of product(s) at equilibrium increase if the volume of the reaction vessel is increased at a constant temperature?

(A) $PCl_5(g) \rightleftarrows PCl_3(g) + Cl_2(g)$

(B) $2\ NO(g) + O_2(g) \rightleftarrows 2\ NO_2(g)$

(C) $N_2(g) + O_2(g) \rightleftarrows 2\ NO(g)$

(D) $2\ CO(g) \rightleftarrows C(s) + CO_2(g)$

$$\underset{\text{colorless}}{N_2O_4(g)} \rightleftarrows \underset{\text{brown}}{2\ NO_2(g)} \qquad K_p = 3.0 \text{ at } 70^\circ C$$

A mixture of $NO_2(g)$ and $N_2O_4(g)$ is placed in a glass tube and allowed to reach equilibrium at 70°C, as represented above.

eqquiz

29. If

$$P_{N_2O_4}$$

is 1.33 atm when the system is at equilibrium at 70°C, what is

$$P_{NO_2}$$

?

(A) 0.44 atm

(B) 2.0 atm

(C) 2.3 atm

(D) 4.0 atm

30. Which of the following best predicts how the partial pressures of the reacting species will be affected if a small amount of Ar(*g*) is added to the equilibrium mixture at constant volume?

(A) P_{NO_2} will decrease and $P_{N_2O_4}$ will increase.

(B) P_{NO_2} will increase and $P_{N_2O_4}$ will decrease.

(C) Both P_{NO_2} and $P_{N_2O_4}$ will decrease.

(D) No change will take place.

31. Which of the following statements best helps to explain why the contents of the tube containing the equilibrium mixture turned a lighter color when the tube was placed into an ice bath?

eqquiz

A The forward reaction is exothermic.

B The forward reaction is endothermic.

C The ice bath lowered the activation energy.

D The ice bath raised the activation energy.

32.

$\mathrm{H_2CO_3}(aq) + \mathrm{H_2O}(l) \rightleftarrows \mathrm{HCO_3^-}(aq) + \mathrm{H_3O^+}(aq)$	K_1
$\mathrm{HCO_3^-}(aq) + \mathrm{H_2O}(l) \rightleftarrows \mathrm{CO_3^{2-}}(aq) + \mathrm{H_3O^+}(aq)$	K_2
$\mathrm{NH_3}(aq) + \mathrm{H_2O}(l) \rightleftarrows \mathrm{NH_4^+}(aq) + \mathrm{OH^-}(aq)$	K_3
$2\,\mathrm{H_2O}(l) \rightleftarrows \mathrm{H_3O^+}(aq) + \mathrm{OH^-}(aq)$	K_4

$\mathrm{H_2CO_3}(aq) + \mathrm{NH_3}(aq) \rightleftarrows \mathrm{NH_4^+}(aq) + \mathrm{HCO_3^-}(aq)\ K_5 = ?$

The table above lists some equilibrium systems and their equilibrium constants. Which of the following identifies the correct mathematical relationship that uses the information to calculate K_5?

A $K_5 = \frac{K_1 \times K_3}{K_4}$

B $K_5 = \frac{K_4}{K_1 \times K_3}$

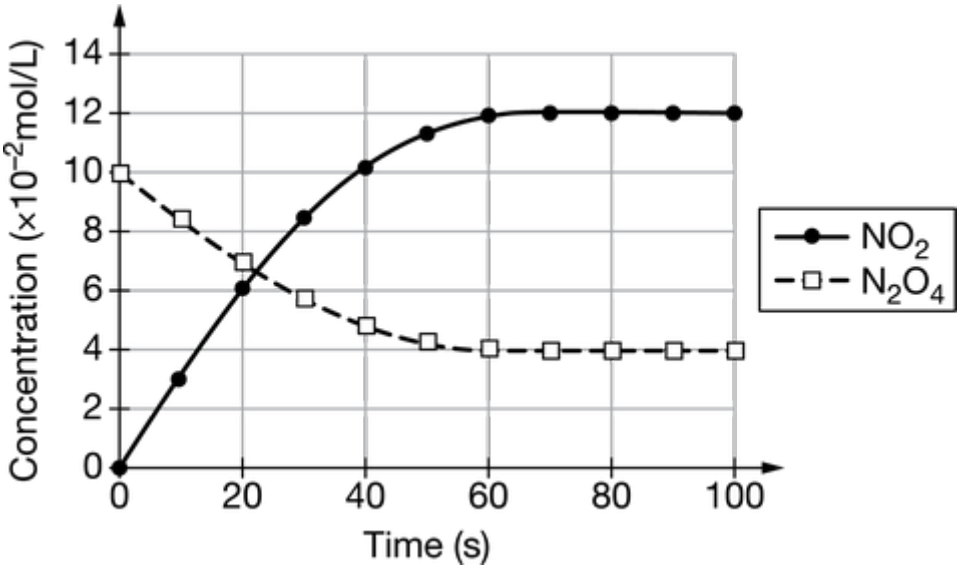
C $K_5 = K_1 \times K_3 \times K_4$

D $K_5 = \frac{K_1 \times K_3}{K_2}$

---

eqquiz

33.



A sample of $\mathrm{N_2O_4}(g)$ is placed into an evacuated container at $373\ \mathrm{K}$ and allowed to undergo the reversible reaction $\mathrm{N_2O_4}(g) \rightleftarrows 2\ \mathrm{NO_2}(g)$. The concentration of each species is measured over time, and the data are used to make the graph shown above. Which of the following identifies when equilibrium is first reached and provides a correct explanation?

(A) At 14 seconds, because $[\mathrm{N_2O_4}]$ is twice $[\mathrm{NO_2}]$, which implies that the forward and reverse reaction rates are equal.

(B) At 23 seconds, because $[\mathrm{NO_2}]$ equals $[\mathrm{N_2O_4}]$, which shows that equal concentrations are present at equilibrium.

(C) At 40 seconds, because $[\mathrm{NO_2}]$ is twice $[\mathrm{N_2O_4}]$, which matches the stoichiometry of the balanced chemical equation.

(D) At 60 seconds, because $[\mathrm{NO_2}]$ and $[\mathrm{N_2O_4}]$ remain constant, indicating that the forward and reverse reaction rates are equal.

34.

$$PCl_3(g) + Cl_2(g) \rightleftarrows PCl_5(g) \qquad K_c = 6.5$$

At a certain point in time, a 1.00 L rigid reaction vessel contains 1.5 mol of $PCl_3(g)$, 1.0 mol of $Cl_2(g)$, and 2.5 mol of $PCl_5(g)$. Which of the following describes how the measured pressure in the reaction vessel will change and why it will change that way as the reaction system approaches equilibrium at constant temperature?

eqquiz

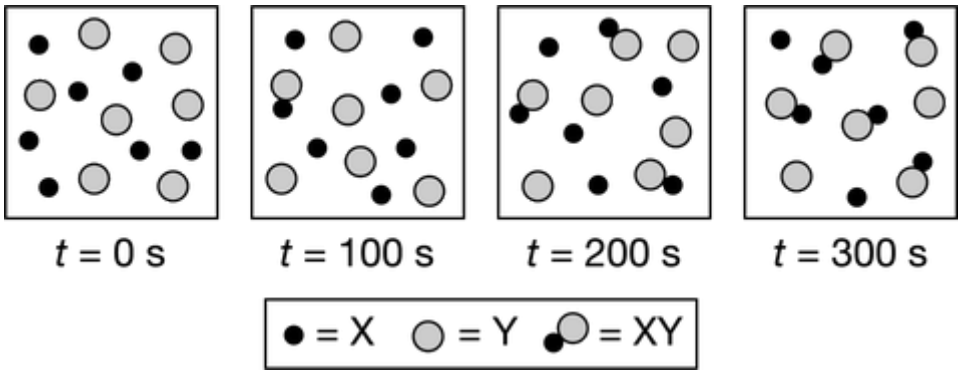
(A) The pressure will increase because $Q < Kc$.

(B) The pressure will increase because $Q > Kc$.

(C) The pressure will decrease because $Q < Kc$.

(D) The pressure will decrease because $Q > Kc$.

35.



An equimolar mixture of $\mathrm{X}(g)$ and $\mathrm{Y}(g)$ is placed inside a rigid container at constant temperature. The particle diagram above represents the changes that occur over time. Based on the particle diagram, which of the following best predicts whether or not the system has reached equilibrium by $300\ \mathrm{s}$?

(A) It is not possible to determine that the system has reached equilibrium by $300\ \mathrm{s}$ because the stoichiometry of the reaction is not known.

(B) It is not possible to determine that the system has reached equilibrium by $300\ \mathrm{s}$ because the amounts of X, Y, and XY have continued to change.

(C) The system has reached equilibrium by $300\ \mathrm{s}$ because the rate of formation of XY is constant.

(D) The system has reached equilibrium by $300\ \mathrm{s}$ because the rates of consumption of X and Y are equal.

---

eqquiz

36. Reaction A: $4\ HCl(g) + O_2(g) \rightleftarrows 2\ Cl_2(g) + 2\ H_2O(g)$

Reaction B: $N_2O_4(g) \rightleftarrows 2\ NO_2(g)$

Reaction C: $H_2(g) + I_2(g) \rightleftarrows 2\ HI(g)$

Reaction D: $2\ NH_3(g) \rightleftarrows N_2(g) + 3\ H_2(g)$

The reactions represented above are carried out in sealed, rigid containers and allowed to reach equilibrium. If the volume of each container is reduced from 1.0 L to 0.5 L at constant temperature, for which of the reactions will the amount of product(s) be increased?

(A) Reaction A

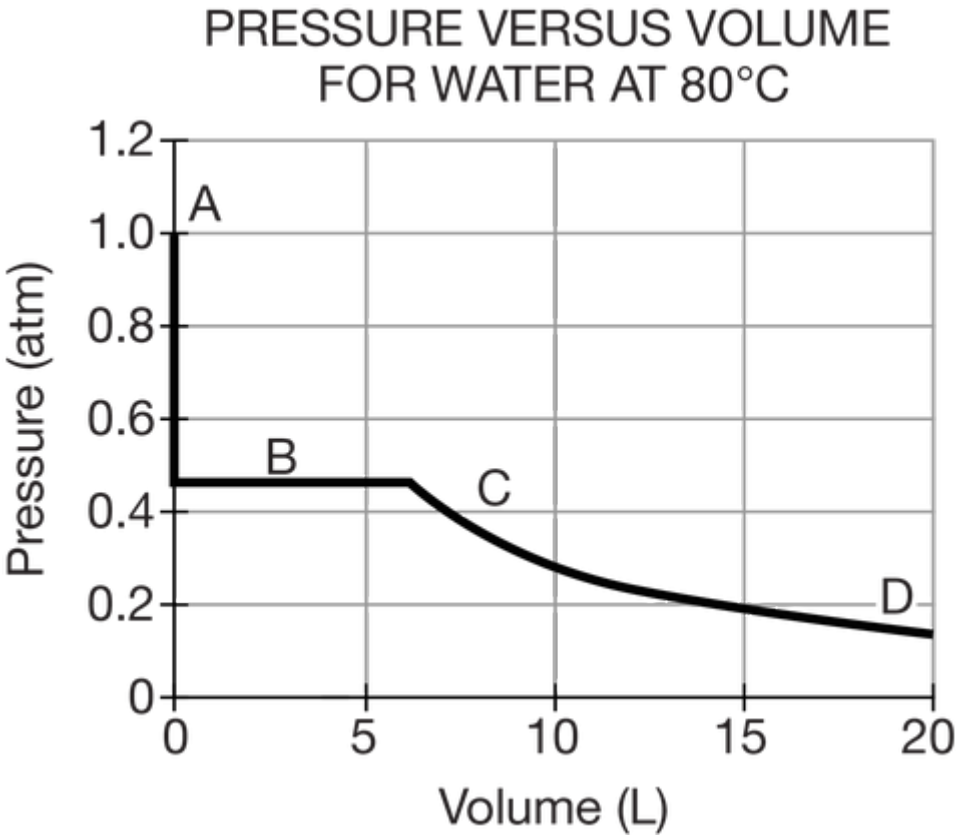
(B) Reaction B

(C) Reaction C

(D) Reaction D

eqquiz

37.



A cylinder with a moveable piston is completely filled with a small amount (100 millimoles) of liquid water at a pressure of $1.0\ \text{atm}$ and a temperature of 80°C. All the air in the cylinder is excluded. The cylinder is placed in a water bath held at 80°C. The piston is slowly moved out to expand the volume of the cylinder to $20\ \text{L}$ as the pressure inside the cylinder is monitored. A plot of the pressure versus volume for the system is shown in the figure above. Which of the following statements most closely indicates, with justification, the region of the curve where the equilibrium represented below occurs?

$\text{H}_2\text{O}(l) \rightleftarrows \text{H}_2\text{O}(g)$

(A) Region A, because the initial pressure inside the cylinder is equal to the pressure outside the cylinder, so there is no net force on the piston.

(B) Region B, because the pressure inside the cylinder is equal to the vapor pressure of water at 80°C when both liquid and gas phases are present.

(C) Region C, because the water vapor is behaving according to the ideal gas law as expansion occurs.

(D) Region D, because the pressure inside the cylinder has leveled off.

eqquiz

38.

$$X(g) + 2\,Q(g) \rightleftarrows R(g) + Z(g) \quad K_c = 1.3 \times 10^5 \text{ at } 50°C$$

A 1.0 mol sample of X(*g*) and a 1.0 mol sample of Q(*g*) are introduced into an evacuated, rigid 10.0 L container and allowed to reach equilibrium at 50°C according to the equation above. At equilibrium, which of the following is true about the concentrations of the gases?

(A) [R] = 1/2[Q]

(B) [Q] = 1/2[X]

(C) [R] = [Z] > [Q]

(D) [x] = [Q] = [R] = [Z]