1. All chemical equilibriums have:

I.	rates that are continuing to change
II.	an equilibrium constant expression
III.	equal concentrations of products and reactants

A. II only
B. III only
C. I and II only
D. I and III only

2. From the following, select the situation where both enthalpy and entropy favour the reaction toward products:

	Enthalpy	Entropy
A.	increasing	increasing
B.	increasing	decreasing
C.	decreasing	decreasing
D.	decreasing	increasing

3. Consider the following equilibrium:

$$2NO_{(g)} + Br_{2(g)} \rightleftarrows 2NOBr_{(g)} + \text{energy}$$

The equilibrium will shift to the left as a result of

A. adding a catalyst.
B. adding some $NO_{(g)}$.
C. increasing the volume.
D. decreasing the temperature.

4. Consider the following equilibrium: **(2**

$$PCl_{3(g)} + 3NH_{3(g)} \rightleftarrows P(NH_2)_{3(g)} + 3HCl_{(g)}$$

The volume of the equilibrium system is increased and a new equilibrium is established. How have the rates been affected?

	Rate (forward)	Rate (reverse)
A.	increased	decreased
B.	decreased	increased
C.	decreased	decreased
D.	did not change	did not change

5. Starting with equal moles of reactants, which of the following equilibrium systems most favours the reactants?

A. $SO_{2(g)} + NO_{2(g)} \rightleftarrows SO_{3(g)} + NO_{(g)}$ $K_{eq} = 3.4$

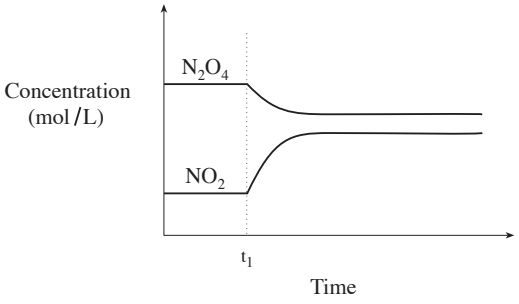
B. $CO_{(g)} + H_2O_{(g)} \rightleftarrows CO_{2(g)} + H_{2(g)}$ $K_{eq} = 31.4$

C. $H_{2(g)} + I_{2(g)} \rightleftarrows 2HI_{(g)}$ $K_{eq} = 10$

D. $N_{2(g)} + O_{2(g)} \rightleftarrows 2NO_{(g)}$ $K_{eq} = 1.0 \times 10^{-31}$

6. Consider the following equilibrium reaction:

$$N_2O_{4(g)} \rightleftarrows 2NO_{2(g)}$$



At time t_1, heat is applied to the system. Which of the following best describes the equilibrium reaction and the change in K_{eq}?

A. exothermic and K_{eq} increases

B. exothermic and K_{eq} decreases

C. endothermic and K_{eq} increases

D. endothermic and K_{eq} decreases

7. Consider the following: **(1 m**

$$PCl_{3(g)} + Cl_{2(g)} \rightleftarrows PCl_{5(g)} \qquad K_{eq} = 0.45 \text{ at } 227°C$$

Initially, a 1.00 L flask is filled with 0.100 mol PCl_3, 0.100 mol Cl_2, and 0.100 mol PCl_5 at 227°C. Use K_{Trial} to predict the change in $[Cl_2]$ as equilibrium is established.

	K_{Trial}	$[Cl_2]$
A.	$K_{Trial} > K_{eq}$	increases
B.	$K_{Trial} < K_{eq}$	increases
C.	$K_{Trial} > K_{eq}$	decreases
D.	$K_{Trial} < K_{eq}$	decreases

8. Consider the following equilibrium reaction:

$$2ICl_{(g)} \rightleftarrows I_{2(g)} + Cl_{2(g)}$$

Some ICl is added to an empty flask. How do the reaction rates change as the system approaches equilibrium?

	forward rate	reverse rate
A.	increases	increases
B.	increases	decreases
C.	decreases	increases
D.	decreases	decreases

9. In an equilibrium system, continuing microscopic changes indicate that the equilibrium is

A. dynamic.
B. complete.
C. exothermic.
D. spontaneous.

10. Consider the following equilibrium:

$$4CuO_{(s)} + \text{energy} \rightleftarrows 2Cu_2O_{(s)} + O_{2(g)}$$

The equilibrium will shift to the right as a result of

A. adding $CuO_{(s)}$.

B. removing $O_{2(g)}$.

C. adding a catalyst.

D. decreasing the temperature.

11. Consider the following equilibrium:

$$N_{2(g)} + 3H_{2(g)} \rightleftarrows 2NH_{3(g)}$$

The volume of the system is decreased. The equilibrium shifts

A. left since the reverse rate is greater than the forward rate.
B. left since the forward rate is greater than the reverse rate.
C. right since the reverse rate is greater than the forward rate.
D. right since the forward rate is greater than the reverse rate.

12. Consider the following equilibrium:

$$2SO_{3(g)} \rightleftarrows 2SO_{2(g)} + O_{2(g)} \qquad \Delta H = +198\,\text{kJ}$$

When the temperature is increased, the equilibrium will shift

A. left with K_{eq} becoming larger.

B. right with K_{eq} becoming larger.

C. left with K_{eq} becoming smaller.

D. right with K_{eq} becoming smaller.

13. Starting with equal concentrations of reactants, which of the following will be closest to completion at equilibrium?

A. $CO_{(g)} + Cl_{2(g)} \rightleftarrows COCl_{2(g)}$ $\qquad K_{eq} = 22$

B. $PCl_{3(g)} + Cl_{2(g)} \rightleftarrows PCl_{5(g)}$ $\qquad K_{eq} = 2.9 \times 10^{-2}$

C. $CO_{(g)} + Cl_{2(g)} \rightleftarrows COCl_{2(g)}$ $\qquad K_{eq} = 4.5 \times 10^{-9}$

D. $CH_3O_{2(g)} + NO_{2(g)} \rightleftarrows CH_3O_2NO_{2(g)}$ $\qquad K_{eq} = 2.1 \times 10^{-12}$

14. Consider the following equilibrium: **(1 m**

$$2COF_{2(g)} \rightleftarrows CO_{2(g)} + CF_{4(g)}$$

At equilibrium, a 1.00 L container contains 7.07×10^{-4} mol COF_2, 1.00×10^{-3} mol CO_2, and 1.00×10^{-3} mol CF_4. What is the value of K_{eq}?

A. 7.07×10^{-4}
B. 1.41×10^{-3}
C. 0.500
D. 2.00

15. Consider the following reaction:

$$2ICl_{(g)} \rightleftarrows I_{2(g)} + Cl_{2(g)}$$

A closed container is initially filled with $ICl_{(g)}$. What are the changes in the rate of the forward reaction and $[I_2]$, as the system approaches equilibrium?

	Rate of forward reaction	$[I_2]$
A.	decreases	increases
B.	decreases	decreases
C.	increases	increases
D.	increases	decreases

16. The entropy of a system is a term used to describe

A. randomness.
B. heat content.
C. average kinetic energy.
D. stored chemical energy.

17. Consider the following equilibrium: $Cu^{2+}_{(aq)} + 4Br^{-}_{(aq)} + \text{energy} \rightleftarrows CuBr_4^{2-}{}_{(aq)}$

blue *colourless* *green*

Which of the following will cause this equilibrium to change from blue to green?

A. adding $NaBr_{(s)}$
B. adding $NaNO_{3(s)}$
C. adding a catalyst
D. decreasing the temperature

18. Consider the following equilibrium:

$$Ni_{(s)} + 4CO_{(g)} \rightleftarrows Ni(CO)_{4(\ell)} \qquad \Delta H = -160.8\,kJ$$

Which of the following will cause this equilibrium to shift to the left?

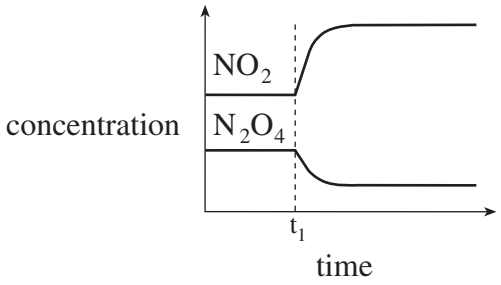
A. add some CO
B. decrease the volume
C. remove some $Ni(CO)_4$
D. increase the temperature

19. Consider the following equilibrium: **(1 mark)**

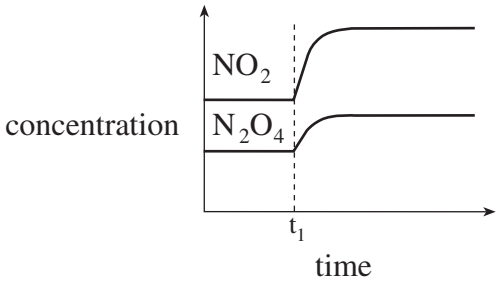
$$N_2O_{4(g)} + \text{energy} \rightleftarrows 2NO_{2(g)}$$

Which of the following shows the relationship between concentration and time as a result of adding a catalyst at time = t_1?

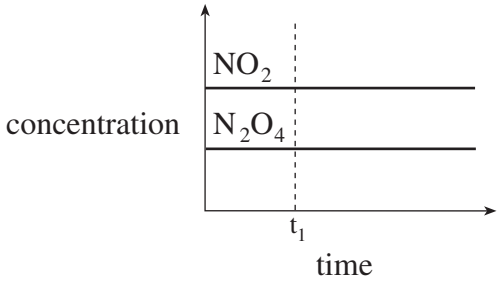
A.



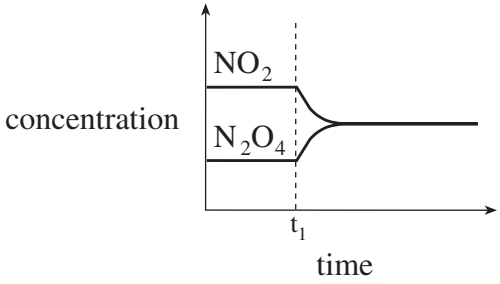
B.



C.



D.



20. Consider the following equilibrium:

$$H_2S_{(g)} + I_{2(s)} \rightleftarrows 2HI_{(g)} + S_{(s)}$$

What is the equilibrium expression for this reaction?

A. $K_{eq} = \dfrac{[HI]^2}{[H_2S]}$

C. $K_{eq} = \dfrac{[HI]^2[S]}{[H_2S][I_2]}$

B. $K_{eq} = \dfrac{[H_2S]}{[HI]^2}$

D. $K_{eq} = \dfrac{[H_2S][I_2]}{[HI]^2[S]}$

21. Consider the following equilibrium:

$$CO_{(g)} + H_2O_{(g)} \rightleftarrows CO_{2(g)} + H_{2(g)} \qquad K_{eq} = 5.0$$

At equilibrium, the $[CO] = 0.20\,\text{mol/L}$, $[H_2O] = 0.30\,\text{mol/L}$, and $[H_2] = 0.90\,\text{mol/L}$. Calculate the equilibrium $[CO_2]$.

A. 0.013 mol/L
B. 0.066 mol/L
C. 0.33 mol/L
D. 1.0 mol/L

22. Consider the following:

$$CO_{2(g)} + CF_{4(g)} \rightleftarrows 2COF_{2(g)} \qquad K_{eq} = 0.50$$

In a reaction container the initial concentrations are:
$[CO_2] = 0.50\,\text{mol/L}$, $[CF_4] = 0.50\,\text{mol/L}$, $[COF_2] = 0.30\,\text{mol/L}$

To reach equilibrium, the reaction will proceed

A. left since Trial $K_{eq} < K_{eq}$
B. left since Trial $K_{eq} > K_{eq}$
C. right since Trial $K_{eq} < K_{eq}$
D. right since Trial $K_{eq} > K_{eq}$

23. All chemical equilibriums must have

A. $K_{eq} = 1$
B. [reactants] = [products].
C. rate forward = rate reverse.
D. mass of reactants = mass of products.

24. Consider the following equilibrium reaction:

$$4HCl_{(g)} + O_{2(g)} \rightleftarrows 2H_2O_{(g)} + 2Cl_{2(g)} + 111.4\,\text{kJ}$$

For the forward reaction, how do enthalpy and entropy change?

	Enthalpy	Entropy
A.	increases	decreases
B.	decreases	decreases
C.	increases	increases
D.	decreases	increases

25. Consider the following equilibrium:

$$CH_3Cl_{(aq)} + OH^-_{(aq)} \rightleftarrows CH_3OH_{(aq)} + Cl^-_{(aq)}$$

The equilibrium will shift to the left as a result of the addition of

A. HNO_3
B. KNO_3
C. NaOH
D. CH_3Cl

26. Consider the following equilibrium at 25°C :

$$Ni_{(s)} + 4CO_{(g)} \rightleftarrows Ni(CO)_{4(\ell)}$$

For this reaction

A. $K_{eq} = [CO]^4$

B. $K_{eq} = \dfrac{1}{[CO]^4}$

C. $K_{eq} = \dfrac{[Ni(CO)_4]}{[CO]^4\,[Ni]}$

D. $K_{eq} = \dfrac{[Ni(CO)_4]}{[CO]^4}$

27. Consider the following equilibrium:

$$2COF_{2(g)} \rightleftarrows CO_{2(g)} + CF_{4(g)} \qquad K_{eq} = 2.00$$

At equilibrium, $[CO_2] = 0.050\,\text{mol/L}$ and $[CF_4] = 0.050\,\text{mol/L}$.
What is $[COF_2]$ at equilibrium?

A. 0.0012 mol/L
B. 0.035 mol/L
C. 0.050 mol/L
D. 0.22 mol/L

28. Consider the following equilibrium:

$$H_2O_{(g)} + Cl_2O_{(g)} \rightleftarrows 2HOCl_{(g)} \qquad K_{eq} = 0.0900$$

Initially, a 1.00 L flask is filled with 0.100 mol of H_2O, 0.100 mol of Cl_2O and 0.100 mol of HOCl. As equilibrium is established, the reaction proceeds to the

A. left because $K_{Trial} > K_{eq}$
B. left because $K_{Trial} < K_{eq}$
C. right because $K_{Trial} > K_{eq}$
D. right because $K_{Trial} < K_{eq}$

29. Consider the following:

$$2SO_{2(g)} + O_{2(g)} \rightleftarrows 2SO_{3(g)}$$

Initially, SO_3 is added to an empty flask. How do the rate of the forward reaction and $[SO_3]$ change as the system proceeds to equilibrium?

	Forward Rate	$[SO_3]$
A.	decreases	increases
B.	decreases	decreases
C.	increases	increases
D.	increases	decreases

30. Consider the following reaction:

$$N_{2(g)} + 3H_{2(g)} \rightleftarrows 2NH_{3(g)} + \text{energy}$$

What positions do minimum enthalpy and maximum entropy tend toward?

	Minimum Enthalpy	Maximum Entropy
A.	reactants	products
B.	reactants	reactants
C.	products	products
D.	products	reactants

31.

$$\mathbf{CO_{2(g)} + H_{2(g)} \rightleftarrows H_2O_{(g)} + CO_{(g)}}$$

Which two stresses will each cause the equilibrium to shift to the left?

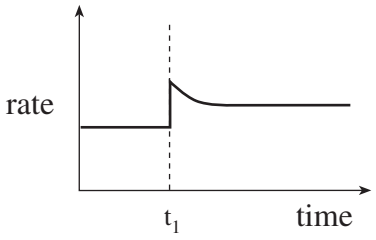
A. increase $[H_2]$, increase $[CO]$
B. decrease $[H_2]$, increase $[H_2O]$
C. increase $[CO_2]$, decrease $[CO]$
D. decrease $[CO_2]$, decrease $[H_2O]$

32.

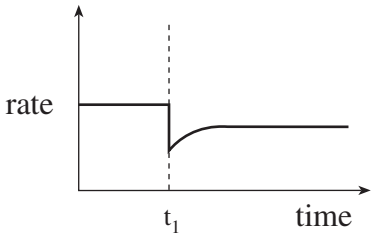
$$\mathbf{CO_{2(g)} + H_{2(g)} \rightleftarrows H_2O_{(g)} + CO_{(g)}}$$

Which of the following graphs represents the forward rate of reaction when $H_2O_{(g)}$ is added to the above equilibrium at time = t_1 ?

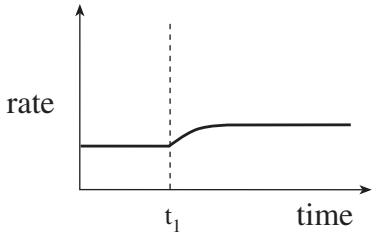
A.



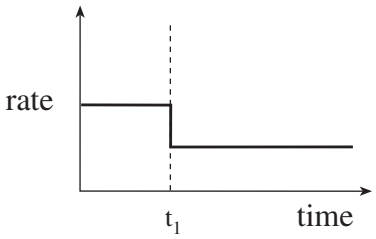
B.



C.



D.



33. Consider the following:

$$2NH_{3(g)} \rightleftarrows N_{2(g)} + 3H_{2(g)}$$

Initially, some NH_3 is placed into a 1.0 L container. At equilibrium there is 0.030 mol N_2 present. What is the $[H_2]$ at this equilibrium?

A. 0.010 mol/L
B. 0.030 mol/L
C. 0.060 mol/L
D. 0.090 mol/L

34. Which reaction has the following equilibrium expression?

$$K_{eq} = \frac{[NO_2]^4[H_2O]^6}{[NH_3]^4[O_2]^7}$$

A. $4NH_{3(g)} + 7O_{2(g)} \rightleftarrows 4NO_{2(g)} + 6H_2O_{(g)}$

B. $4NH_{3(aq)} + 7O_{2(g)} \rightleftarrows 4NO_{2(aq)} + 6H_2O_{(\ell)}$

C. $4NO_{2(aq)} + 6H_2O_{(\ell)} \rightleftarrows 4NH_{3(g)} + 7O_{2(g)}$

D. $4NO_{2(g)} + 6H_2O_{(g)} \rightleftarrows 4NH_{3(g)} + 7O_{2(g)}$

35. What will cause the K_{eq} for an exothermic reaction to increase?

A. increasing [reactants]
B. decreasing [products]
C. increasing the temperature
D. decreasing the temperature

36. Consider the following equilibrium:

$$PCl_{5(g)} \rightleftarrows PCl_{3(g)} + Cl_{2(g)} \qquad K_{eq} = 9.0 \times 10^{-2}$$

In a 1.0 L container an equilibrium mixture contains 6.0×10^{-3} mol PCl_5 and 1.0×10^{-2} mol PCl_3. How many moles of Cl_2 are also present at equilibrium?

A. 5.4×10^{-6} mol
B. 6.7×10^{-4} mol
C. 5.4×10^{-2} mol
D. 1.5×10^{-1} mol

37. Consider the following:

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

Initially, HI is added to an empty flask. How do the rates of the forward and reverse reactions change as the system proceeds to equilibrium?

	Forward Rate	Reverse Rate
A.	increases	increases
B.	increases	decreases
C.	decreases	decreases
D.	decreases	increases

38. Consider the following reaction: $2H_2O_{(\ell)} + \text{energy} \rightarrow 2H_{2(g)} + O_{2(g)}$

Determine the enthalpy and entropy changes for the above reaction?

	Enthalpy	Entropy
A.	increases	decreases
B.	decreases	increases
C.	increases	increases
D.	decreases	decreases

39.

$$\mathbf{2\,CO_{(g)} + O_{2(g)} \rightleftarrows 2CO_{2(g)} + energy}$$

Which of the following two stresses will each cause the system to shift to the right?

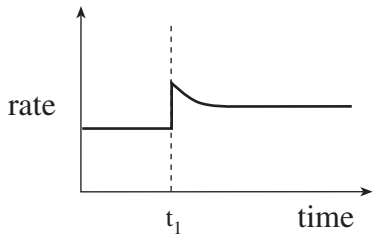
A. increase temperature, increase volume
B. decrease temperature, increase volume
C. increase temperature, decrease volume
D. decrease temperature, decrease volume

40.

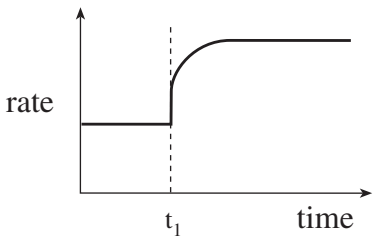
$$\mathbf{2\,CO_{(g)} + O_{2(g)} \rightleftarrows 2CO_{2(g)} + energy}$$

Which of the following shows the forward rate of reaction when the temperature of the system is increased at time = t_1 ?

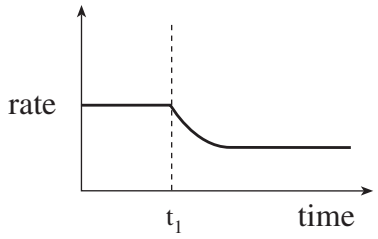
A.



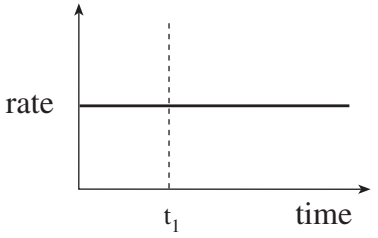
B.



C.



D.



41. Consider the following:

$$2SO_{2(g)} + O_{2(g)} \rightleftarrows 2SO_{3(g)}$$

Initially, 0.030 mol SO_2 and 0.030 mol O_2 are placed into a 1.0 L container. At equilibrium, there is 0.020 mol O_2 present. What is the $[SO_2]$ at equilibrium?

A. 0.010 mol/L
B. 0.020 mol/L
C. 0.030 mol/L
D. 0.040 mol/L

42. What is the equilibrium expression for the following system?

$$CaCO_{3(s)} + 2HF_{(g)} \rightleftarrows CaF_{2(s)} + H_2O_{(g)} + CO_{2(g)}$$

A. $K_{eq} = \dfrac{[HF]^2}{[H_2O][CO_2]}$

C. $K_{eq} = \dfrac{[H_2O][CO_2]}{[CaCO_3][HF]^2}$

B. $K_{eq} = \dfrac{[H_2O][CO_2]}{[HF]^2}$

D. $K_{eq} = \dfrac{[CaF_2][H_2O][CO_2]}{[CaCO_3][HF]^2}$

43. What will cause the K_{eq} for an endothermic reaction to decrease?

A. adding a catalyst
B. increasing the surface area
C. increasing the temperature
D. decreasing the temperature

44. Consider the following equilibrium:

$$N_{2(g)} + O_{2(g)} \rightleftarrows 2NO_{(g)}$$

An equilibrium mixture consists of 1.0×10^{-1} mol N_2 , 2.0×10^{-1} mol O_2 and 3.0×10^{-3} mol NO in a 1.0 L container. What is the value of K_{eq} ?

A. 4.5×10^{-4}
B. 2.2×10^{-4}
C. 1.5×10^{-1}
D. 3.0×10^{-1}

45. Consider the following:

$$2HBr_{(g)} \rightleftarrows H_{2(g)} + Br_{2(g)}$$

Initially, HBr is added to an empty flask. How do the rate of the forward reaction and the [HBr] change as the system proceeds to equilibrium?

	Forward Rate	[HBr]
A.	decreases	decreases
B.	decreases	increases
C.	increases	increases
D.	increases	decreases

46. $2SO_{2(g)} + O_{2(g)} \rightleftarrows 2SO_{3(g)} + \text{energy}$

Which of the following two stresses will each cause the system to shift to the right?

A. decrease temperature, decrease $[O_2]$

B. increase temperature, increase $[SO_3]$

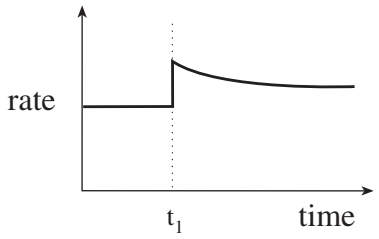
C. increase temperature, decrease $[SO_3]$

D. decrease temperature, increase $[SO_2]$

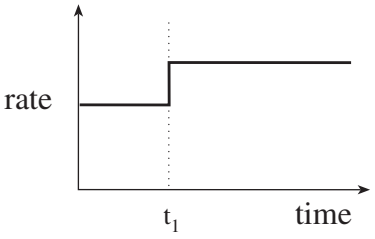
47. $2SO_{2(g)} + O_{2(g)} \rightleftarrows 2SO_{3(g)} + \text{energy}$

Which of the following graphs shows the **reverse** rate of reaction when a catalyst is added to the equilibrium at time = t_1 ? **(1**

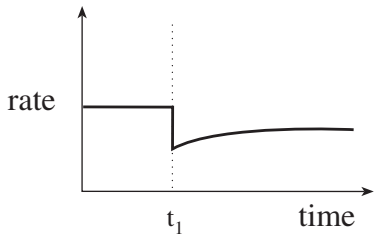
A.



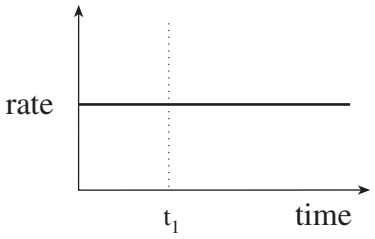
B.



C.



D.



48. Consider the following:

$$2N_{2(g)} + O_{2(g)} + \text{energy} \overset{?}{\rightleftarrows} 2N_2O_{(g)}$$

What positions do minimum enthalpy and maximum entropy tend toward?

	Minimum Enthalpy	Maximum Entropy
A.	products	products
B.	products	reactants
C.	reactants	products
D.	reactants	reactants

49. Consider the following:

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

Initially, some HI is placed into a 1.0 L container. At equilibrium there is 0.010 mol H_2, 0.010 mol I_2 and 0.070 mol HI present. How many moles of HI were initially added to the container?

A. 0.060 mol
B. 0.070 mol
C. 0.080 mol
D. 0.090 mol

50. What is the equilibrium expression for the following system?

$$4Fe_{(s)} + 3O_{2(g)} \rightleftarrows 2Fe_2O_{3(s)}$$

A. $K_{eq} = [O_2]^3$

B. $K_{eq} = \dfrac{1}{[O_2]^3}$

C. $K_{eq} = \dfrac{[Fe_2O_3]^2}{[Fe]^4[O_2]^3}$

D. $K_{eq} = \dfrac{[2Fe_2O_3]}{[4Fe][3O_2]}$

51. What will cause the value of K_{eq} for an endothermic reaction to increase?

A. increasing [products]
B. decreasing [products]
C. increasing the temperature
D. decreasing the temperature

52. Consider the following equilibrium:

$$N_2O_{4(g)} \rightleftarrows 2NO_{2(g)}$$

An equilibrium mixture contains 4.0×10^{-2} mol N_2O_4 and 1.5×10^{-2} mol NO_2 in a 1.0 L flask. What is the value of K_{eq} ?

A. 5.6×10^{-3}
B. 3.8×10^{-1}
C. 7.5×10^{-1}
D. 1.8×10^{2}

53. Consider the following:

$$2NH_{3(g)} \rightleftarrows N_{2(g)} + 3H_{2(g)}$$

Initially, NH_3 is added to an empty flask. How do the rates of the forward and reverse reactions change as the system proceeds to equilibrium?

	Forward Rate	Reverse Rate
A.	increases	increases
B.	increases	decreases
C.	decreases	increases
D.	decreases	decreases

54. Consider the following:

$$H_{2(g)} + Br_{2(\ell)} \overset{?}{\rightleftarrows} 2HBr_{(g)} + \text{energy}$$

What positions do minimum enthalpy and maximum entropy tend toward?

	Minimum Enthalpy	Maximum Entropy
A.	products	products
B.	products	reactants
C.	reactants	products
D.	reactants	reactants

55. $H_{2(g)} + I_{2(g)} \rightleftarrows 2HI_{(g)} + \text{energy}$

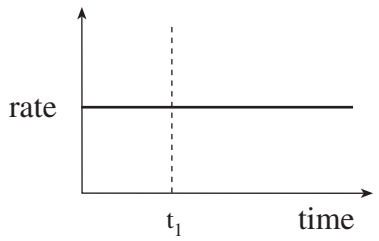
Which of the following stresses will **not** cause a shift in equilibrium?

A. decrease $[I_2]$
B. increase $[H_2]$
C. decrease volume
D. increase temperature

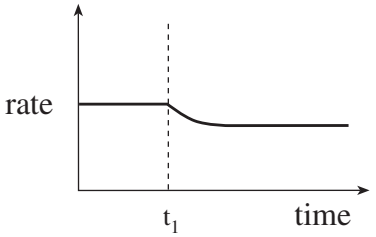
56. $H_{2(g)} + I_{2(g)} \rightleftarrows 2HI_{(g)} + \text{energy}$

Which of the following shows the **reverse** rate of reaction when the volume is decreased at time = t_1 ?

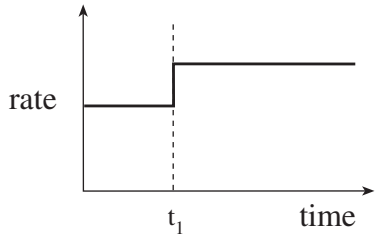
A.



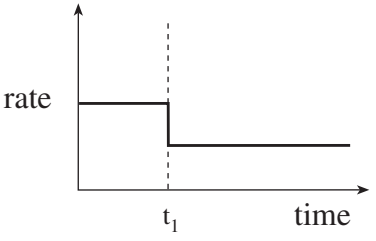
B.



C.



D.



57. Consider the following:

$$2SO_{3(g)} \rightleftarrows 2SO_{2(g)} + O_{2(g)}$$

Initially, some SO_3 is placed into a 3.0 L container. At equilibrium there is 0.030 mol SO_2 present. What is the $[O_2]$ at equilibrium?

A. 0.0050 mol/L
B. 0.010 mol/L
C. 0.015 mol/L
D. 0.030 mol/L

58. Which reaction has the following equilibrium expression?

$$K_{eq} = \frac{[PCl_5]}{[PCl_3][Cl_2]}$$

A. $PCl_{3(g)} + Cl_{2(g)} \rightleftarrows PCl_{5(g)}$
B. $PCl_{3(g)} + Cl_{2(\ell)} \rightleftarrows PCl_{5(g)}$
C. $PCl_{5(g)} \rightleftarrows PCl_{3(g)} + Cl_{2(g)}$
D. $PCl_{5(g)} \rightleftarrows PCl_{3(g)} + Cl_{2(\ell)}$

59. What will cause the value of K_{eq} for an exothermic reaction to decrease?

A. increasing the pressure
B. increasing the temperature
C. decreasing the temperature
D. decreasing the surface area

60. Consider the following equilibrium:

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

An equilibrium mixture contains 1.0×10^{-3} mol H_2 , 2.0×10^{-3} mol I_2 and 1.0×10^{-2} mol HI in a 1.0 L container. What is the value of K_{eq} ?

A. 2.0×10^{-2}
B. 5.0×10^{1}
C. 5.0×10^{3}
D. 1.0×10^{4}

61. Which of the factors below is **not** a condition necessary for equilibrium?

A. a closed system
B. a constant temperature
C. equal forward and reverse reaction rates
D. equal concentrations of reactants and products

62. In order for a chemical reaction to go to completion, how must the entropy and enthalpy change?

	Entropy	Enthalpy
A.	increases	increases
B.	increases	decreases
C.	decreases	increases
D.	decreases	decreases

63. Consider the following equilibrium system: $2SO_{2(g)} + O_{2(g)} \rightleftarrows 2SO_{3(g)}$ $K_{eq} = 1.2 \times 10^{4}$

If additional SO_2 is added to the system, what happens to the equilibrium and the value of K_{eq} ?

	Equilibrium	K_{eq}
A.	shifts left	decreases
B.	shifts right	increases
C.	shifts right	no change
D.	no change	no change

64. Consider the following equilibrium system:

$$N_{2(g)} + 3H_{2(g)} \rightleftarrows 2NH_{3(g)}$$

Determine the changes in reaction rates as a catalyst is added.

	Forward Rate	Reverse Rate
A.	increases	increases
B.	increases	decreases
C.	decreases	increases
D.	decreases	decreases

65. Consider the following equilibrium system:

$$2KClO_{3(s)} \rightleftarrows 2KCl_{(s)} + 3O_{2(g)}$$

Which of the following is the equilibrium constant expression?

A. $K_{eq} = [O_2]^3$

B. $K_{eq} = \dfrac{1}{[O_2]^3}$

C. $K_{eq} = \dfrac{[KClO_3]^2}{[KCl]^2[O_2]^3}$

D. $K_{eq} = \dfrac{[KCl]^2[O_2]^3}{[KClO_3]^2}$

66. Consider the following equilibrium: $CO_{2(g)} + 2H_2O_{(g)} \rightleftarrows CH_{4(g)} + 2O_{2(g)}$

Which of the options below indicates that the reactants are favoured?

A. K_{eq} is zero.

B. K_{eq} is very large.

C. K_{eq} is slightly less than 1.

D. K_{eq} is slightly greater than 1.

67. Consider the following equilibrium: $N_2O_{4(g)} + \text{energy} \rightleftarrows 2NO_{2(g)}$

How are K_{eq} and $[N_2O_4]$ affected by the addition of Ne (an inert gas) into the container at constant volume.

	K_{eq}	$[N_2O_4]$
A.	no change	no change
B.	no change	increases
C.	increases	decreases
D.	decreases	increases

68. Consider the following equilibrium: $Cl_{2(g)} + 2NO_{(g)} \rightleftarrows 2NOCl_{(g)} \qquad K_{eq} = 5.0$

At equilibrium, $[Cl_2] = 1.0\,M$ and $[NO] = 2.0\,M$. What is the $[NOCl]$ at equilibrium?

A. $0.80\,M$
B. $0.89\,M$
C. $4.5\,M$
D. $10\,M$

69. For the equilibrium system $Cu_{(s)} + 2Ag^{+}_{(aq)} \rightleftarrows 2Ag_{(s)} + Cu^{+2}_{(aq)}$

We would know the system is at equilibrium because

A. $[Cu^{+2}] = [Ag^{+}]$

B. $2[Cu^{+2}] = [Ag^{+}]$

C. the mass of $Cu_{(s)}$ remains constant.

D. the mass of the entire system remains constant.

70. For the reacting system: $2Li_{(s)} + 2H_2O_{(\ell)} \overset{?}{\rightarrow} 2LiOH_{(aq)} + H_{2(g)} \qquad \Delta H = -433\,kJ$

What will entropy and enthalpy factors favour?

	Entropy	Enthalpy
A.	products	reactants
B.	products	products
C.	reactants	reactants
D.	reactants	products

71. Consider the following equilibrium: $N_{2(g)} + 3H_{2(g)} \rightleftarrows 2NH_{3(g)}$

If some Ne gas is added at a constant volume then how will $[N_2]$, $[H_2]$ and K_{eq} be affected?

	$[N_2]$	$[H_2]$	K_{eq}
A.	increases	increases	decreases
B.	decreases	decreases	increases
C.	decreases	increases	does not change
D.	does not change	does not change	does not change

72. What is the effect of adding a catalyst to an equilibrium system?

A. The value of E_a increases.

B. The value of K_{eq} increases.

C. Forward and reverse rates increase.

D. The concentration of products increases.

73. Consider the following equilibrium: $2CrO_4^{2-}{}_{(aq)} + 2H^+_{(aq)} \rightleftarrows Cr_2O_7^{2-}{}_{(aq)} + H_2O_{(\ell)}$

What is the K_{eq} expression?

A. $\dfrac{\left[CrO_4^{2-}\right]^2\left[H^+\right]^2}{\left[Cr_2O_7^{2-}\right]}$

C. $\dfrac{\left[Cr_2O_7^{2-}\right]}{\left[2CrO_4^{2-}\right]\left[2H^+\right]}$

B. $\dfrac{\left[Cr_2O_7^{2-}\right]}{\left[CrO_4^{2-}\right]^2\left[H^+\right]^2}$

D. $\dfrac{\left[Cr_2O_7^{2-}\right]\left[H_2O\right]}{\left[CrO_4^{2-}\right]^2\left[H^+\right]^2}$

74. A container is initially filled with pure SO_3. After a period of time, the following equilibrium is established:

$$2SO_{2(g)} + O_{2(g)} \rightleftarrows 2SO_{3(g)} \qquad K_{eq} = 7.0 \times 10^{25}$$

What does this equilibrium mixture contain?

A. mostly products

B. mostly reactants

C. $\frac{3}{5}$ reactants and $\frac{2}{5}$ products

D. equal amounts of reactants and products

75. Consider the following equilibrium:

$$2CO_{(g)} + O_{2(g)} \rightleftarrows 2CO_{2(g)} \qquad K_{eq} = 4.0 \times 10^{-10}$$

What is the value of K_{eq} for $2CO_{2(g)} \rightleftarrows 2CO_{(g)} + O_{2(g)}$?

A. 4.0×10^{-10}

B. 2.0×10^{-5}

C. 5.0×10^{4}

D. 2.5×10^{9}

76. Consider the following equilibrium:

$$H_{2(g)} + Br_{2(g)} \rightleftarrows 2HBr_{(g)} \qquad \Delta H = -36\,kJ$$

How could the value of K_{eq} be increased?

A. add H_2
B. add HBr
C. increase the pressure
D. reduce the temperature

77. In which of the following will entropy and enthalpy factors favour the establishment of an equilibrium?

A. $CaCO_{3(s)} + 178\,kJ \xrightarrow{?} CaO_{(s)} + CO_{2(g)}$

B. $Mg_{(s)} + 2HCl_{(aq)} \xrightarrow{?} MgCl_{2(aq)} + H_{2(g)} + 425\,kJ$

C. $2C_{(s)} + 2H_{2(g)} \xrightarrow{?} C_2H_{4(g)} \qquad \Delta H = +52.3\,kJ$

D. $2\,C_2H_{6(g)} + 7O_{2(g)} \xrightarrow{?} 4CO_{2(g)} + 6H_2O_{(g)} \qquad \Delta H = -1560\,kJ$

78. Consider the following equilibrium:

$$CO_{(g)} + 2H_{2(g)} \rightleftarrows CH_3OH_{(g)} \qquad \Delta H = -91\,kJ$$

Which of the factors below would increase the concentration of CH_3OH at equilibrium?

A. an addition of CO
B. an increase in the volume
C. a decrease in the pressure
D. an increase in the temperature

79. Consider the following equilibrium: $PCl_{3(g)} + Cl_{2(g)} \rightleftarrows PCl_{5(g)}$

If the volume of the system is decreased, how will the reaction rates in the new equilibrium compare with the rates in the original equilibrium?

	Forward Rate	Reverse Rate
A.	increases	increases
B.	increases	decreases
C.	decreases	decreases
D.	decreases	increases

80. Consider the following equilibrium:

$$\underset{\text{colourless}}{H_{2(g)}} + \underset{\text{purple}}{I_{2(g)}} \rightleftarrows \underset{\text{colourless}}{2HI_{(g)}} \qquad \Delta H = -71.9\,\text{kJ}$$

Which of the following would allow you to conclude that the system has reached equilibrium?

A. The pressure remains constant.
B. The reaction rates become zero.
C. The colour intensity remains constant.
D. The system shifts completely to the right.

81. Consider the following equilibrium: $Fe_2O_{3(s)} + 3CO_{(g)} \rightleftarrows 2Fe_{(s)} + 3CO_{2(g)}$

Identify the equilibrium constant expression.

A. $K_{eq} = \dfrac{[CO_2]^3}{[CO]^3}$

C. $K_{eq} = \dfrac{[CO_2]^3[Fe]^2}{[Fe_2O_3][CO]^3}$

B. $K_{eq} = \dfrac{[CO_2]}{[CO]}$

D. $K_{eq} = \dfrac{[Fe_2O_3][CO]^3}{[CO_2]^3[Fe]^2}$

82. Consider the following equilibrium system:

$$2NO_{(g)} + Cl_{2(g)} \rightleftarrows 2NOCl_{(g)} \qquad \Delta H = -77\,\text{kJ}$$

In which direction will the equilibrium shift and what happens to the value of K_{eq} when the temperature of the system is increased?

	Shift	K_{eq}
A.	right	increases
B.	right	decreases
C.	left	increases
D.	left	decreases

83. Consider the following equilibrium:

$$CO_{(g)} + 2H_{2(g)} \rightleftarrows CH_3OH_{(g)}$$

At equilibrium it was found that $[CO] = 0.105\,\text{mol/L}$, $[H_2] = 0.250\,\text{mol/L}$ and $[CH_3OH] = 0.00261\,\text{mol/L}$. Which of the following is the equilibrium constant value?

A. 9.94×10^{-2}
B. 0.398
C. 2.51
D. 10.0

84. Consider the following equilibrium: $H_{2(g)} + I_{2(g)} \rightleftarrows 2HI_{(g)}$

How will the forward and reverse equilibrium reaction rates change when additional H_2 is added to the system?

	Forward Rate	Reverse Rate
A.	increase	increase
B.	increase	decrease
C.	decrease	increase
D.	no change	no change

85.

$$H_2O_{(g)} + CO_{(g)} \rightleftarrows CO_{2(g)} + H_{2(g)}$$

This equilibrium will shift right as the result of the addition of some extra H_2O. How will this shift affect the concentrations of the other gases?

	$[CO]$	$[CO_2]$	$[H_2]$
A.	increases	decreases	decreases
B.	increases	increases	decreases
C.	decreases	increases	increases
D.	decreases	decreases	increases