Unit 2 Pre-Test Reaction Equilibrium

Multiple Choice

Identify the choice that best completes the statement or answers the question.

1. Consider the following equilibrium system:

$$2HF(g) \rightleftarrows F_2(g) + H_2(g)$$

Which of the following will have the same effect on the position of equilibrium as does increasing pressure?
   a. adding F_2
   b. removing F_2
   c. removing HF
   d. adding a catalyst

2. Consider the following system at equilibrium:

$$2HCN(g) \rightleftarrows H_2(g) + C_2N_2(g)$$

If some H_2 is added and a Trial K_{eq} is calculated, which of the following is correct?
   a. Trial $K_{eq} > K_{eq}$ and equilibrium shifts left.
   b. Trial $K_{eq} < K_{eq}$ and equilibrium shifts left.
   c. Trial $K_{eq} < K_{eq}$ and equilibrium shifts right.
   d. Trial $K_{eq} > K_{eq}$ and equilibrium shifts right.

3. What is true for reacting systems that spontaneously go to completion?
   a. They are exothermic and their entropy increases.
   b. They are exothermic and their entropy decreases.
   c. They are endothermic and their entropy increases.
   d. They are endothermic and their entropy decreases.

Use the following equilibrium to answer questions 4 and 5.

$$C(s) + 2H_2(g) \rightleftarrows CH_4(g) \qquad \Delta H = -74 \text{ kJ}$$

4. If the volume of the system is decreased, which of the following occurs?

	Equilibrium Shift	**Net Change [CH_4]**
a.	left	increases
b.	left	decreases
c.	right	increases
d.	right	decreases

5. Which of the following will have the same effect on the position of the equilibrium, as that of adding carbon?
   a. removing H_2
   b. adding a catalyst
   c. decreasing volume
   d. decreasing temperature

6. Consider the equilibrium:

$$CH_4(g) + H_2O(g) \rightleftarrows CO(g) + 3H_2(g) \qquad K_{eq} = 5.7$$

A 1.0 L container is filled with 2.5 mol CH_4 , 0.25 mol H_2O, 1.2 mol CO and 2.2 mol H_2.
Which of the following occurs?

	Reaction proceeds	**Pressure**
a.	left	increases
b.	left	decreases
c.	right	increases
d.	right	decreases

7. Consider the following:

$$\text{energy } NH_4SH(s) \rightleftarrows NH_3(g) + H_2S(g)$$

Which of the following describes how enthalpy and entropy change in the forward direction?

	Enthalpy	**Entropy**
a.	increasing	increasing
b.	increasing	decreasing
c.	decreasing	decreasing
d.	decreasing	increasing

8. Consider the following reactions:

I	$Na_2O(s) \rightleftarrows 2Na(l) + ½\ O_2(g)$	$K_{eq} = 2 \times 10^{-25}$
II	$Na_2O_2(s) \rightleftarrows 2Na(l) + O_2(g)$	$K_{eq} = 5 \times 10^{-29}$
III	$2Na_2O(s) \rightleftarrows 4Na(l) + O_2(g)$	$K_{eq} = 3 \times 10^{-14}$

Which of the following lists the reactions in order, from the greatest $[O_2]$ at equilibrium, to the least $[O_2]$ at equilibrium?
   a. I, II, III
   b. I, III, II
   c. III, I, II
   d. III, II, I

9. Methanol (CH_3OH) is produced according to the following equilibrium equation:

$$CO(g) + 2H_2(g) \rightleftarrows CH_3OH(g) + \text{energy}$$

Which conditions would favour a high yield of methanol?

	Temperature	**Pressure**
a.	low	low
b.	low	high
c.	high	low
d.	high	high

10. Consider the following equilibrium equation:

$$N_2H_6CO_2(s) \rightleftarrows 2NH_3(g) + CO_2(g)$$

Initially, 0.245 mol $N_2H_6CO_2$ is placed in a 1.0 L container. At equilibrium, $[CO_2]$= 0.18 M. What is the value of K_{eq}?

a. 5.8×10^{-3}
b. 2.3×10^{-2}
c. 3.2×10^{-2}
d. 6.5×10^{-2}

11. Consider the following:

I	$PCl_5(g) \rightleftarrows PCl_3(g) + Cl_2(g)$	$K_{eq} = 7.8 \times 10^{-3}$
II	$COCl_2(g) \rightleftarrows CO(g) + Cl_2(g)$	$K_{eq} = 2.2 \times 10^{-10}$
III	$2NCl_3(g) \rightleftarrows N_2(g) + 3Cl_2(g)$	$K_{eq} = 1.0 \times 10^{11}$

Which of the following correctly lists the equilibria in order from most favouring products to least favouring products?

a. I, II, III
b. II, I, III
c. III, I, II
d. III, II, I

12. Consider the following equilibrium:

$$2BN(s) + 3Cl_2(g) \rightleftarrows 2BCl_3(g) + N_2(g) \qquad K_{eq} = 1.6 \times 10^{-3}$$

At equilibrium, there were 0.30 mol BN , 2.8 mol Cl_2 and 0.10 mol N_2 in a 2.0 L container. How many moles of BCl_3 were present?

a. 0.044 mol
b. 0.088 mol
c. 0.21 mol
d. 0.59 mol

13. Consider the following equilibrium:

$$PH_3BCl_3(s) \rightleftarrows PH_3(g) + BCl_3(g)$$

Which of the following correctly represents the $[PH_3]$ at equilibrium?

a. $[PH_3] = \dfrac{K_{eq}}{[BCl_3]}$

b. $[PH_3] = \dfrac{[BCl_3]}{K_{eq}}$

c. $[PH_3] = \dfrac{[BCl_3]}{[PH_3BCl_3]\,K_{eq}}$

d. $[PH_3] = \dfrac{[PH_3BCl_3]\,K_{eq}}{[BCl_3]}$

14. Consider the following equilibrium system:

$$Ni(s) + 4CO(g) \rightleftarrows Ni(CO)_4(g) \qquad \Delta H = -603 \text{ kJ}$$

Which of the following statements is correct?

a. Increasing [CO] will increase K_{eq}.
b. Increasing temperature will increase K_{eq}.
c. Increasing temperature will decrease K_{eq}.
d. Decreasing $[Ni(CO)_4]$ will decrease K_{eq}.

15. Consider the following equilibrium system:

$$2BN(s) + 3Cl_2(g) \rightleftarrows 2BCl_3(g) + N_2(g) \qquad K_{eq} = 1.6 \times 10^{-3}$$

At equilibrium, there are 0.30 mol BN, 1.1 mol Cl_2 and 0.20 mol BCl_3 in a 2.0 L container. How many moles of N_2 are present in this equilibrium?

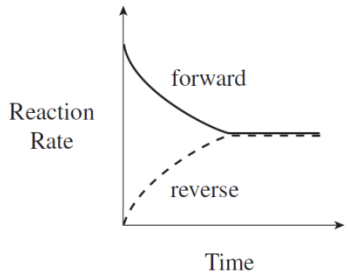
a. 0.0012 mol
b. 0.027 mol
c. 0.053 mol
d. 0.018 mol

16. A student places some HI(g) into a closed reaction container and the following equilibrium is established:

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

Which of the following describes the forward and reverse reaction rates?

a.



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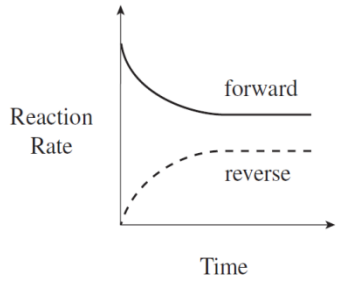

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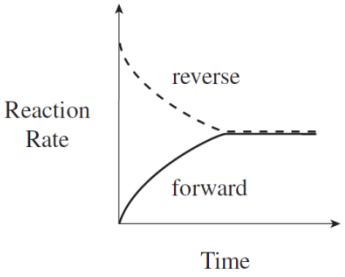

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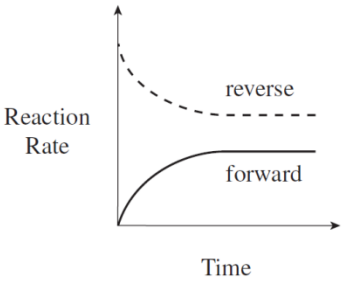


17. Consider the following equilibrium equation:

$$2NO_2(g) \rightleftarrows N_2O_4(g)$$
brown colourless

Some NO_2 is placed in a 1.0 L container. As the system approaches equilibrium, how are the colour and reverse reaction rate affected?

	Colour	**Reverse reaction rate**
a.	becomes darker brown	decreases
b.	becomes darker brown	increases
c.	becomes lighter brown	decreases
d.	becomes lighter brown	increases

18. Consider the equilibrium system:

$$\text{energy} + C(s) + 2H_2(g) \rightleftarrows CH_4(g)$$

In which of the following will the two changes shift the equilibrium in the same direction?

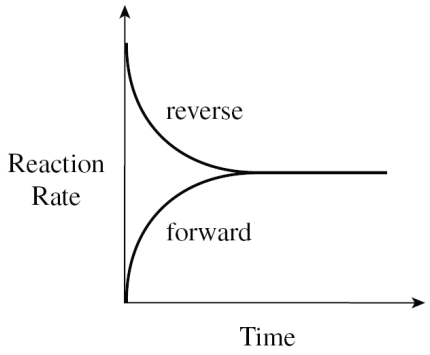
a. removing CH_4 and adding C(s)
b. adding H_2 and increasing volume
c. adding C(s) and increasing temperature
d. decreasing the temperature and adding CH_4

19. Consider the following equilibrium equation:

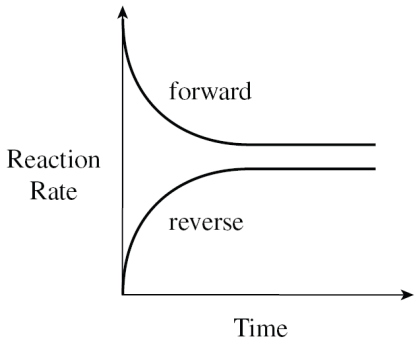
$$H_2O(g) + CO(g) \rightleftarrows H_2(g) + CO_2(g)$$

Some H_2 and CO_2 were placed in a 1.0 L container and equilibrium was established. Which of the following describes the forward and reverse reaction rates?

a.



c.



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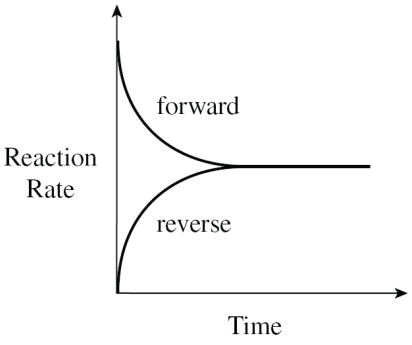

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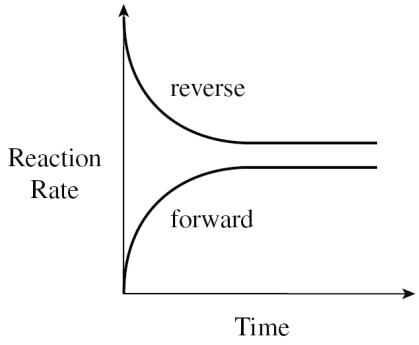


20. Which of the following shows the correct result for a chemical reaction when the corresponding changes in entropy and enthalpy occur?

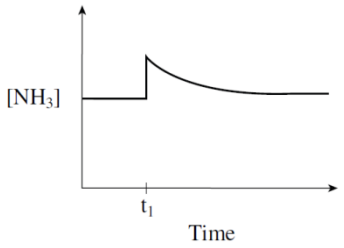
	Entropy	**Enthalpy**	**Result**
a.	increasing	increasing	reacts completely
b.	increasing	decreasing	reacts completely
c.	increasing	decreasing	no reaction
d.	decreasing	decreasing	no reaction

Use the following equilibrium to answer question 21.

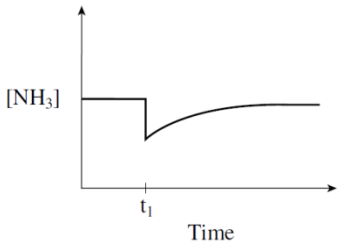
$$NH_4Cl(s) \rightleftarrows NH_3(g) + HCl(g)$$

21. Which of the following describes the change in $[NH_3]$ when the volume of the equilibrium system is decreased at time t_1 ?

a.



c.



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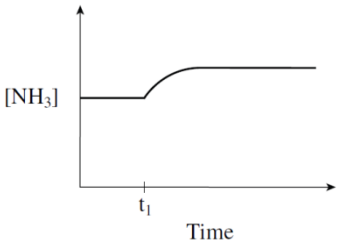

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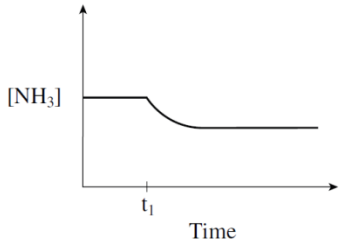


22. Consider the equilibrium:

$$CH_4(g) + H_2O(g) \rightleftarrows CO(g) + 3H_2(g) \qquad K_{eq} = 5.7$$

A 1.0 L container is filled with 1.2 mol CH_4, 1.8 mol H_2O, 0.50 mol CO and 0.25 mol H_2. In which direction will the reaction proceed and what will happen to the pressure of the system?

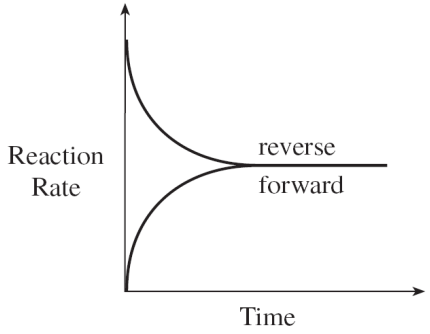
	Direction	**Pressure**
a.	left	decreases
b.	left	increases
c.	right	decreases
d.	right	increases

23. Consider the following equilibrium equation:

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

Some NO was placed in a 1.0 L container and equilibrium was established. Which of the following describes what happens to the forward and reverse reaction rates?

a.



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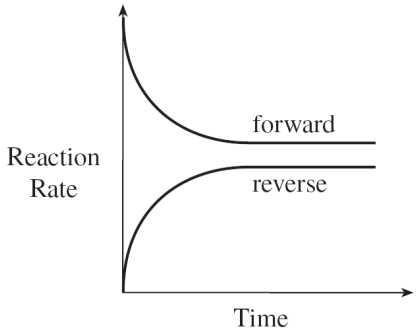

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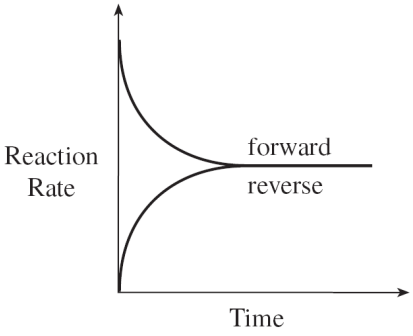

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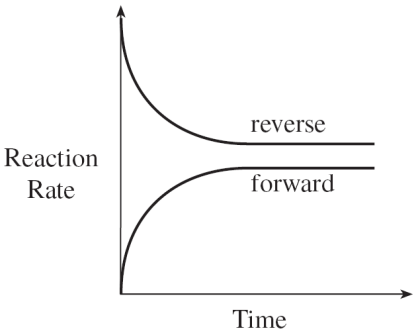


24. Consider the following equilibrium system:

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

An equilibrium mixture of NO(g), $O_2(g)$ and $NO_2(g)$ is transferred from a 1.0 L container to a 2.0 L container. Which reaction is favoured and what happens to the $[NO_2]$?

	Reaction Favoured	**$[NO_2]$**
a.	reverse	increases
b.	reverse	decreases
c.	forward	increases
d.	forward	decreases

25. Consider the equilibrium:

$$H_2(g) + FeO(s) \rightleftarrows H_2O(g) + Fe(s)$$

The following chemicals are placed in separate 1.0 L containers.

Container I	H_2, H_2O
Container II	Fe, FeO
Container III	H_2O, Fe
Container IV	H_2, H_2O, FeO

In which container(s) will the equilibrium be established?

a. Container III only
b. Container IV only
c. Containers I and II only
d. Containers III and IV only

26. Consider the following system at equilibrium:

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

Some O_2 is added to the equilibrium. Which of the following describes how the forward and reverse reaction rates change as a new equilibrium is being established?

	Forward Rate	**Reverse Rate**
a.	increases	decreases
b.	increases	increases
c.	decreases	increases
d.	decreases	decreases

27. Consider the equilibrium system:

$$N_2(g) + 3Cl_2(g) \rightleftarrows 2NCl_3(g) \qquad \Delta H = +460 \text{ kJ}$$

Which of the following describes what happens when some NCl_3 is added?

	Equilibrium Shift	**Value of K_{eq}**
a.	right	remains constant
b.	right	increases
c.	left	remains constant
d.	left	decreases

28. Which of the following reactions would be expected to go to completion?

a. $Cl_2(g) \rightleftarrows Cl_2(aq) + 25kJ$

b. $H_2(g) + CO_2(g) + 41kJ \rightleftarrows CO(g) + H_2O(g)$

c. $2NO_2(g) \rightleftarrows 2NO(g) + O_2(g)$ $\Delta H = +114kJ$

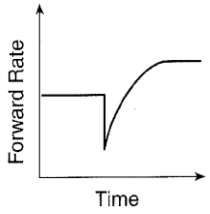
d. $C_3H_8(g) + 5O_2(g) \rightleftarrows 3CO_2(g) + 4H_2O(g)$ $\Delta H = -2200\ kJ$

29. Consider the following equilibrium:

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

After the volume has been decreased, the system shifts to establish a new equilibrium. Which of the following describes how the forward reaction rate changes as a result of decreasing volume?

a.



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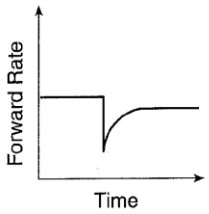

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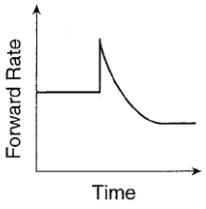

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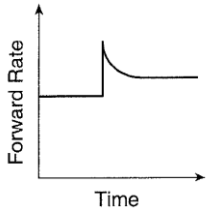

30. Consider the equilibrium system:

$$energy + C(s) + 2H_2(g) \rightleftarrows CH_4(g)$$

In which of the following will the two changes shift the equilibrium in the same direction?

a. removing CH_4 and adding C(s)
b. adding H_2 and increasing volume
c. adding C(s) and increasing the temperature
d. decreasing the temperature and adding CH_4

Use the following equilibrium to answer questions 31 and 32.

$$2NO(g) \rightleftarrows N_2(g) + O_2(g) \qquad \Delta H = +181kJ$$

31. Which of the following pairs of stresses cause the same shift to the above equilibrium?

a. adding a catalyst and decreasing volume
b. increasing pressure and increasing [NO]
c. decreasing $[N_2]$ and decreasing temperature
d. decreasing temperature and increasing volume

32. If some O_2 is injected into the above equilibrium system, which of the following is correct?

	Equilibrium Shift	**Net Change [O_2]**
a.	left	increase
b.	left	decrease
c.	right	increase
d.	right	decrease

33. Considering enthalpy and entropy factors, in which of the following will reaction not occur?

I	$Cl_2(g) \rightleftarrows Cl_2(aq)$	$\Delta H = -25kJ$
II	$CO(g) + 2H_2(g) \rightleftarrows CH_3OH(g)$	$\Delta H = -91kJ$
III	$Mg(s) + 2HCl(aq) \rightleftarrows MgCl_2(aq) + H_2(g)$	$\Delta H = -425kJ$
IV	$3CO_2(g) + 4H_2O(g) \rightleftarrows C_3H_8(g) + 5O_2(g)$	$\Delta H = +2200\ kJ$

a. I and II only
b. III only
c. IV only
d. I, II and III only

34. Consider the following:

$$\text{energy} + 6CO_2(g) + 6H_2O(l) \rightleftarrows C_6H_{12}O_6(s) + 6O_2(g)$$

Which of the following describes how enthalpy and entropy change in the forward direction?

	Enthalpy	**Entropy**
a.	increases	decreases
b.	increases	increases
c.	decreases	increases
d.	decreases	decreases

35. Consider the equilibrium system:

$$\text{energy} + CaCO_3(s) \rightleftarrows CaO(s) + CO_2(g)$$

Which of the following could be true?

	Stress	K_{eq}
a.	increase pressure	no change
b.	decrease $[CO_2]$	increase
c.	increase volume	increase
d.	decrease temperature	no change

36. Consider the equilibrium:

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

Initially, 2.1 mol SO_2 and 1.5 mol O_2 were placed in a 2.0 L container. At equilibrium, $[SO_3]$ = 0.60 M. Which of the following is the value of K_{eq}?

a. 0.25
b. 1.8
c. 4.0
d. 12

37. Consider the following system at equilibrium:

$$2NH_3(g) + CO_2(g) \rightleftarrows N_2H_6CO_2(s) + \text{energy}$$

Which of the following is correct when the volume of the system is decreased?

	Equilibrium Shift	Amount of CO_2
a.	left	increases
b.	left	decreases
c.	right	increases
d.	right	decreases

38. Consider the following equilibrium equation:

$$MgO(s) + SO_2(g) + \tfrac{1}{2}\, O_2(g) \rightleftarrows MgSO_4(s)$$

Which expression represents the $[O_2]$ at equilibrium?

a. $[O_2] = \dfrac{1}{K_{eq}\,[SO_2]}$

b. $[O_2] = (K_{eq}\,[SO_2])^2$

c. $[O_2] = \left(\dfrac{1}{K_{eq}\,[SO_2]}\right)^2$

d. $[O_2] = \dfrac{[MgSO_4]}{K_{eq}\,[MgO][SO_2]}$

39. Consider the following equilibrium equation:

$$NO_2Cl(g) \rightleftarrows NO_2(g) + \tfrac{1}{2}\, Cl_2(g) \qquad K_{eq} = 0.75$$

Which of the following is the K_{eq} value for:

$$2NO_2Cl(g) \rightleftarrows 2NO_2(g) + Cl_2(g)$$

a. 0.56
b. 0.75
c. 0.87
d. 1.5

40. Consider the following equilibrium:

$$N_2(g) + O_2(g) \rightleftarrows 2NO(g) \qquad K_{eq} = 8.1 \times 10^{-3}$$

Which of the following is the K_{eq} value for:

$$NO(g) \rightleftarrows \tfrac{1}{2}\, N_2(g) + \tfrac{1}{2}\, O_2(g)$$

a. 8.1×10^{-3}
b. 9.0×10^{-2}
c. 11
d. 1.2×10^{2}

Problem

41. (**4 marks)**

Consider the equilibrium: $N_2(g) + O_2(g) \rightleftarrows 2NO(g)$ $K_{eq} = 4.2 \times 10^{-8}$

If 0.275 mol N_2 and 0.275 mol O_2 are initially placed in a 3.0 L container, calculate the equilibrium concentration of NO that results.

42. **(4 marks)**

Consider the following equilibrium:

$$2NCl_3(g) \rightleftarrows N_2(g) + 3Cl_2(g) \qquad K_{eq} = 3.3 \times 10^{-8}$$

Some NCl_3 is initially placed in a 1.0 L container. At equilibrium, 1.38×10^{-2} mol Cl_2 is present. Calculate the $[NCl_3]$ present initially.

43. **(4 marks)**

Consider the following equilibrium:

$$2H_2(g) + S_2(g) \rightleftarrows 2H_2S(g)$$

Initially, 9.0×10^{-4} mol S_2 and 1.1×10^{-2} mol H_2S are placed in a 1.0 L container. At equilibrium, there is 8.6×10^{-3} mol H_2S present. Calculate K_{eq} .

44. **(4 marks)**

Consider the following equilibrium reaction:

$$2BrCl(g) \rightleftarrows Br_2(g) + Cl_2(g) \qquad K_{eq} = 0.145$$

Some BrCl was placed into a 2.0 L container and allowed to reach equilibrium.
At equilibrium, $[Br_2]$ was 0.34 M. How many moles of BrCl were initially placed in the container?

45. **(4 marks)**

Consider the following system at equilibrium:

$$O_2(g) + 2F_2(g) <\!\!-\!\!> 2OF_2(g)$$

A stress is applied by removing some F_2 and a new equilibrium is established. Describe how the forward and reverse reaction rates are instantly affected by the stress and how they then change until a new equilibrium is reached.

Unit 2 Pre-Test Reaction Equilibrium Multiple Choice Answers

MULTIPLE CHOICE

1. D	9. B	17. D	25. D	33. C
2. A	10. B	18. D	26. C	34. A
3. A	11. C	19. A	27. C	35. A
4. C	12. D	20. B	28. D	36. C
5. B	13. A	21. A	29. D	37. D
6. B	14. C	22. D	30. D	38. C
7. A	15. C	23. A	31. A	39. A
8. C	16. A	24. B	32. A	40. C