1. Consider the reaction;
$CH_3Cl\ (g) + 3Cl_2\ (g) \rightarrow CCl_4\ (g) + 3HCl\ (g)$

$[CH_3Cl\ ]$ (M)	$[Cl_2\ ]$ (M)	Initial Rate (mol/L.s)
0.050	0.050	0.014
0.100	0.050	0.029
0.100	0.100	0.041
0.200	0.200	0.115

What is the overall order of the reaction?

A. 3/2 (three half-order)

B. 2 (second-order)

C. 3 (third-order)

D. 1/2 (one half- order)

2. For the reaction; $A(g) + 1/2\ B(g) \rightarrow 2C(g)$
When C is increasing at a rate of 0.025 mol/L.s, how fast is B decreasing?

A. 0.050 mol/L.s

B. 0.013 mol/L.s

C. 0.0063 mol/L.s

D. 0.025 mol/L.s

3. The following reaction was monitored as a function of time;
$AB \rightarrow A + B$
A plot of 1/[AB] versus time yields a straight line with slope 0.055 L/mol.s. If the initial concentration of AB is 0.250 M, and the reaction mixture initially contains no products, what is the concentration of A after 75 seconds?

A. 0.26 M

B. 1.2 M

C. 0.74 M

D. 0.13 M

4. If a temperature increases from 20.0 ^{o}C to 35.0 ^{o}C triples the rate constant for a reaction, what is the value of the activation energy for the reaction?

A. 23.4 kJ/mol

B. 122 kJ/mol

C. 55.0 kJ/mol

D. 83.7 kJ/mol

5. The rate law for the reaction;
$2H_2(g) + 2NO(g) \rightarrow N_2(g) + 2H_2O(g)$
is rate = k $[NO]^2$ $[H_2]$. Which of the following is/are acceptable mechanism(s)?

Mechanism I
$H_2 + NO \rightarrow H_2O + N$ (slow)
$N + NO \rightarrow N_2 + O$ (fast)
$O + H_2 \rightarrow H_2O$ (fast)

Mechanism II
$H_2 + 2NO \rightarrow N_2O + H_2O$ (slow)
$N_2O + H_2 \rightarrow N_2 + H_2O$ (fast)

Mechanism III
$2NO \rightleftharpoons N_2O_2$ (fast equilibrium)
$N_2O_2 + H_2 \rightarrow N_2O + H_2O$ (slow)
$N_2O + H_2 \rightarrow N_2 + H_2O$ (fast)

A. Only mechanism I

B. Both mechanisms II and III

C. Only mechanism II

D. Both mechanisms I and II

6. The activation energy of the following reaction at 298 K,
$2NH_3(g) \rightarrow N_2(g) + 3H_2(g)$
is 335 kJ/mol without a catalyst. If the reaction is catalyzed, the activation energy is 163 kJ/mol at 298 K. How many times faster is the reaction on the catalyst surface at 298 K?

A. 2.85×10^{15}

B. 1.41×10^{30}

C. 1.25×10^{35}

D. 4.52×10^{10}

7. Which is correct?

A. A catalyst is a substance that speeds up a reaction without being consumed itself.

B. A catalyst provides a new pathway for the reaction with a higher activation energy.

C. A homogeneous catalyst is one that is not present in the same phase as the reacting molecules.

D. A heterogeneous catalyst is one that is present in the same phase as the reacting molecules.

8. Which of the following is a Lewis acid?

A. H_2O

B. CO_2

C. I^-

D. NH_3

9. Determine the pH of a 0.250 *M* HNO_2 solution at 25°C.
(K_a of $HNO_2 = 4.0 \times 10^{-4}$)

A. 3.39

B. 5.24

C. 2.00

D. 6.51

10. One mole of a weak acid, HA, was dissolved in 2.0 L of water. After the system had come to equilibrium, the concentration of HA was found to be 0.45 *M*. Calculate K_a for HA.

A. 3×10^{-2}

B. 2.4×10^{-4}

C. 6×10^{-3}

D. 5.3×10^{-1}

11. What is the percent ionization in 0.010 *M* NH_3 solution at 25 ^oC? ($K_b = 1.8 \times 10^{-5}$)

A. 1.3%

B. 4.2%

C. 39%

D. 12%

12. What is the pH of a 5.1×10^{-6} *M* $Ca(OH)_2$ solution at 25^oC?

A. 12.2

B. 4.99

C. 8.71

D. 9.01

13. Arrange the following 0.10 *M* solution in order of most acidic to most basic.
KOH, KCl, KCN, NH_4Cl, HCl

A. HCl > NH_4Cl > KCN > KCl > KOH

B. KOH > KCN > KCl > NH_4Cl > HCl

C. HCl > KCl > NH_4Cl > KCN > KOH

D. HCl > NH_4Cl > KCl > KCN > KOH

14. Calculate the pH of a 2.0 *M* H_2SO_4 solution. ($K_{a2} = 1.2 \times 10^{-2}$)

A. -0.33

B. -0.82

C. 1.94

D. 2.32

15. Find K_c for the following reaction at 298 K;

$2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$ $K_p = 2.2 \times 10^{12}$

A. 4.2×10^{8}

B. 2.7×10^{15}

C. 7.4×10^{11}

D. 5.4×10^{13}

16. At a particular temperature, a 3.0 L flask contains 2.4 mol Cl_2, 1.0 mol NOCl, and 0.0045 mol NO. Calculate K_c at this temperature for the following reaction.

$2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g)$

A. 3.7×10^{6}

B. 5.4×10^{-3}

C. 4.1×10^{8}

D. 1.7×10^{-5}

17. Consider the following reaction;

$a\ A(g) \rightleftharpoons b\ B\ (g)$

If the data below represents equilibrium partial pressures of A and B under different initial conditions, find the values of *a* and *b*.

P_A (atm) P_B(atm)
4.0 2.0
2.0 1.4
1.0 1.0
0.50 0.71
0.25 0.50

A. $a = 3$; $b = 2$

B. $a = 2$; $b = 1$

C. $a = 1$; $b = 2$

D. $a = 1$; $b = 1$

18. What will happen to the number of moles of SO_3 in equilibrium with SO_2 and O_2 in the reaction;

$2SO_3\ (g) \rightleftharpoons 2SO_2(g) + O_2\ (g)\ \Delta H^o = 197$ kJ

when the pressure is increased by decreasing the volume of the reaction container?

A. No effect on the moles of SO_3.

B. The moles of SO_3 will increase.

C. The moles of SO_3 will decrease.

D. The moles of O_2 will increase.

19. At 25 ^{o}C, $K_p = 5.3 \times 10^5$ for the reaction;

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

When a certain pressure of $NH_3(g)$ is put into an otherwise empty rigid vessel at 25 ^{o}C, equilibrium is reached when 50.0% of the original $NH_3(g)$ has decomposed. What was the original partial pressure of $NH_3(g)$ before any decomposition occur?

A. 2.1×10^{-3} atm

B. 5.3×10^{-4} atm

C. 2.5×10^{-1} atm

D. 1.37×10^{-5} atm

20. Which is correct?

A. Equilibrium constant for a reaction is independent of temperature.

B. For a reaction at a given temperature, equilibrium constant depends only on the amounts of reactants that are mixed together initially.

C. For a reaction at a given temperature, there are many equilibrium positions with only one value for equilibrium constant.

D. For a reaction at a given temperature, there are many values for equilibrium constant but only one equilibrium position.