CH302 Test Practice Questions

1. The reaction for the synthesis of ammonia
   \[ N_2(g) + 3H_2(g) \rightarrow 2NH_3(g) \]
   is exothermic. Increasing the temperature applied to the system
   I) increases the amount of \( NH_3 \).
   II) decreases the amount of \( NH_3 \).
   III) changes the value of \( K_{eq} \).
   IV) does not change the value of \( K_{eq} \).
   A. I and III only
   B. II and III only
   C. I and IV only
   D. II and IV only

2. Given the following equilibria and equilibrium constants
   \[ K_1 \quad CO(g) + H_2O(g) \leftrightarrow CO_2(g) + H_2(g) \]
   \[ K_2 \quad CH_4(g) + H_2O(g) \leftrightarrow CO(g) + 3H_2(g) \]
   \[ K_3 \quad CH_4(g) + 2H_2O(g) \leftrightarrow CO_2(g) + 4 H_2(g) \]
   The correct expression for \( K_3 \) in terms of \( K_1 \) and \( K_2 \) is
   A. \( K_3 = K_1 + K_2 \)
   B. \( K_3 = K_1 \cdot K_2 \)
   C. \( K_3 = K_1 \cdot K_2 \)
   D. \( K_3 = K_1 \cdot K_2 \)
   E. Cannot be determined from this information.

3. The solubility of a gas such as \( O_2 \) in water (decreases, increases, stays the same) with increasing temperature.

4. For a first-order reaction, after 230 s, 33% of the reactants remain. Calculate the rate constant for the reaction.

5. For the reaction
   \[ Zn + Cu^{2+} (0.100 \text{ M}) \rightarrow Zn^{2+} (0.0100 \text{ M}) + Cu \]
   the change in standard molar Gibbs free energy is -212.27 kJ/mol and the change in molar Gibbs free energy is -217.98 kJ/mol. What is the voltage produced by the cell in which this reaction occurs with the concentrations as shown in the equation and at 25°C?

6. What is the \( H^+ \) ion concentration in a 0.50 mol/L solution of a weak base that has an ionization constant (\( K_b \)) of 2.0 x 10^{-8}?

7. Which is the strongest base: \( ClO^- \), \( ClO_3^- \), \( ClO_4^- \), \( Cl^- \)?

8. In the reaction
   \[ B(OH)_3 + H_2O \rightarrow B(OH)_2O^- + H_3O^+ \]
   \( B(OH)_3 \) is acting as: base / acid / neither.
9. Balance the redox reaction
\[ \text{MnO}_4^- (aq) + \text{NO}_2^- (aq) \rightarrow \text{MnO}_2(s) + \text{NO}_3^- (aq) \]
that occurs in a basic solution. What is the coefficient of \( \text{MnO}_4^- \)?

10. Given the following reaction:
\[ \text{Mg(OH)}_2(s) \leftrightarrow \text{Mg}^{2+} (aq) + 2\text{OH}^- (aq) \]
Increasing the pH of the solution would cause the equilibrium to shift towards the (right, left, no shift).

11. If 2.50 amperes of current are passed for 45 minutes through a solution which contains \( \text{Cu}^{2+} \), how many grams of Cu metal will be produced? Assume no other material is reduced in the process.
A. 0.9g
B. 1.7g
C. 2.2g
D. 2.9g
E. 5.6g

12. Given the reaction \( 2\text{NOCl} (g) \leftrightarrow 2\text{NO} (g) + \text{Cl}_2(g) \quad K_{eq} = 1.6 \times 10^{-5} \)
If 1 mol of NOCl is placed in a 2L container, what is the equilibrium concentration of NO? Make the necessary assumptions to simplify finding your answer.

13. Given the reaction \( 2\text{NOCl} (g) \leftrightarrow 2\text{NO} (g) + \text{Cl}_2(g) \)
Increasing the pressure on the system would result in an equilibrium shift to the (right, left, no shift).

14. Given the following phase diagram,

If the triple point is at 10 atm and 10°C, what would happen if a sample of the substance at 10 atm and 5°C was kept at constant temperature and the pressure was reduced to 0.5 atm?
15. Given the following experimental information for the reaction
\[ \text{NH}_4^+ (aq) + \text{NO}_2^- (aq) \rightarrow \text{N}_2(g) + 2\text{H}_2\text{O}(l) \]
What is the rate law expression for this reaction?

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Initial concentration of ( \text{NH}_4^+ )</th>
<th>Initial concentration of ( \text{NO}_2^- )</th>
<th>Initial Rate ( \text{mol L}^{-1} \text{s}^{-1} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.10 M</td>
<td>0.0050 M</td>
<td>1.35 x 10^{-7}</td>
</tr>
<tr>
<td>2</td>
<td>0.20 M</td>
<td>0.010 M</td>
<td>5.40 x 10^{-7}</td>
</tr>
<tr>
<td>3</td>
<td>0.10 M</td>
<td>0.010 M</td>
<td>2.70 x 10^{-7}</td>
</tr>
</tbody>
</table>

16. A 100 mL sample of a liquid is contained in a 500 mL closed container at 50°C. If the temperature was increased, the vapor pressure of the liquid would (increase/decrease/stay the same).

17. What is \( E^\circ \)cell for the voltaic cell utilizing this reaction: \( \text{Zn(s)} + \text{Cl}_2(g) \rightarrow \text{ZnCl}_2(aq) \)
Given: Standard reduction potentials
\[ \text{Cl}_2(g) + 2\text{e}^- \rightarrow 2 \text{Cl}^- (aq) \quad E^\circ = +1.358 \text{ V} \]
\[ \text{Zn}^{2+} (aq) + 2\text{e}^- \rightarrow \text{Zn(s)} \quad E^\circ = -0.763 \text{ V} \]

18. Calculate the pH of a 0.08 M HCl solution.

19. Calculate the pH of a 1.0 M HCN solution \( (K_a = 6.2 \times 10^{-10})\).

20. Adding HF to water will reduce / increase / have no effect on the pH.

21. Calculate the pH of a solution containing 0.50 M CH\(_3\)COOH, \( K_a = 1.8 \times 10^{-5} \), and 0.50 M sodium acetate, NaCH\(_3\)COO.

Consider the following unbalanced reaction for questions 22 and 23:
\[ \text{Sb} + \text{H}^+ + \text{NO}_3^- \rightarrow \text{Sb}_4\text{O}_6 + \text{NO} + \text{H}_2\text{O} \]

22. What is the oxidizing agent?
A. Sb  
B. H\(^+\)  
C. NO\(_3^-\)  
D. Sb\(_4\)O\(_6\)  
E. NO

23. What is the coefficient for H\(^+\) in the balanced equation (using the set of smallest whole numbers)?
A. 7  
B. 1  
C. 8  
D. 2  
E. 4
24. Which of the following aqueous solutions, formed by mixing the two components in each case, would act as an acid-base buffer solution?
   A. 100 ml of 1M HCl and 100 ml of 1M NaOH
   B. 100 ml of 1M NH₄Cl and 100 ml of 1M NH₃
   C. 100 ml of 1M NH₃ and 100 ml of 1M HC₂H₃O₂
   D. 10 ml of 1M HCl and 100 ml of 1M NaCl

25. The solubility of M₂Y₃ is 1 x 10⁻¹⁰ mole per liter. What is the K_{sp} for the compound?
   A. 3.6 x 10⁻⁴⁹
   B. 6 x 10⁻²⁸
   C. 1 x 10⁻²⁰
   D. 1 x 10⁻⁵⁶

26. If the ionization constant for an acid, HA, is equal to that of a base, BOH, then the solution of the salt, BA, in water (at 25°C) is expected to have a pH
   A. greater than 7.
   B. equal to 7.
   C. less than 7.
   D. which is impossible to predict.

27. Consider the following reaction, initially at equilibrium.
   \[ 4\text{NH}_3(g) + 5\text{O}_2(g) \leftrightarrow 4\text{NO}(g) + 6\text{H}_2\text{O}(g) \]
The addition of more O₂ would:
   A. decrease the number of moles of NH₃ present.
   B. increase the number of moles of NH₃ present.
   C. decrease the number of moles of NO present.
   D. cause no change in the number of moles of H₂O present.

28. At 400°C the reaction \( \text{H}_2(g) + \text{I}_2(g) \leftrightarrow 2\text{HI}(g) \) has an equilibrium constant, \( K_p \), of 50.00. If an equilibrium mixture of H₂, I₂, and HI is such that the partial pressure of H₂ is 0.200 atm., and the partial pressure of I₂ is 0.250 atm., the total pressure of the equilibrium mixture is:
   A. 3.61 atm
   B. 2.03 atm
   C. 0.45 atm
   D. 32.07 atm

29. Consider a reaction which is endothermic and which is accompanied by a decrease in the randomness of the system. This reaction would  ____ spontaneous at  ____ temperature.
   A. be, a high
   B. be, a low
   C. not be, a low
   D. not be, a high
   E. not be, any
30. If the heat of formation, $\Delta H^\circ_f$, of CO$_2$(g) is -94 kcal/mol while the heat of formation, $\Delta H^\circ_f$, of CO(g) is -26 kcal/mol, the enthalpy change would be ___ for the unbalanced reaction below:

$$2\text{CO}(g) + \text{O}_2(g) \rightarrow \text{CO}_2(g)$$

A. -68 kcal/mol  
B. -120 kcal/mol  
C. -136 kcal/mol  
D. -240 kcal/mol  
E. Insufficient information given
1. B
2. C
3. decreases
4. 0.00482 s$^{-1}$
5. 1.13 volts
6. 1.0 x 10$^{-10}$ mol/L
7. ClO$^-$
8. an acid
9. the equation is $2\text{MnO}_4^-(aq) + 3\text{NO}_2^-(aq) \rightarrow 2\text{MnO}_2(s) + 3\text{NO}_3^-(aq) + 2\text{OH}^-(aq)$
10. left
11. C
12. $2 \times 10^{-2}$ M Note a simplifying assumption has been made: 0.5 - 2x $\approx$ 0.5
13. left
14. it would sublime
15. Rate = $(2.7 \times 10^{-4} \text{ L mol}^{-1} \text{ s}^{-1}) [\text{NH}_4^+][\text{NO}_2^-]$
16. increase
17. 2.121 V
18. 1.10
19. 4.60
20. reduce
21. 4.74
22. C the equation is $4\text{Sb} + 4\text{H}^+ + 4\text{NO}_3^- \rightarrow \text{Sb}_4\text{O}_6 + 4\text{NO} + 2\text{H}_2\text{O}$
23. E
24. B
25. A
26. B
27. A
28. B
29. E
30. C