Multiple Choice

1) The mass in gram of $7.7 \times 10^{22}$ atom of potassium "K" is:
   A) 4.5 B) 5.0 C) 5.5 D) 4.0

2) The number of BaCl$_2$ molecules present in 34.6 g of BaCl$_2$ compound is:
   A) $3.0 \times 10^{22}$ B) $3.0 \times 10^{23}$ C) $2.0 \times 10^{21}$ D) $1.0 \times 10^{23}$

3) The percent by mass of phosphorous "P" in the phosphate rock Ca$_{10}$F$_2$(PO$_4$)$_6$ is:
   A) 19.85 B) 18.42 C) 17.63 D) 16.25

4) 11.2 g of iron "Fe" is heated in excess oxygen to give 16.0 g of iron oxide having the empirical formula:
   A) FeO B) Fe$_3$O$_4$ C) Fe$_2$O$_3$ D) FeO$_2$

5) The mass in gram of table sugar "C$_{12}$H$_{22}$O$_{11}$" in 300 mL of 0.15 M solution of table sugar is:
   A) 12.5 B) 13.8 C) 14.3 D) 15.4

6) The gas which has a density of 1.0 g/L at a pressure of 1.5 atm and 20$^\circ$C is most likely:
   A) CH$_4$ B) N$_2$ C) O$_2$ D) CO$_2$

7) The pair of gas mixture that could be most easily separated by gaseous effusion is:
   A) O$_2$ and Ar B) O$_2$ and Kr C) He and Ne D) CO$_2$ and Xe

8) One of the following statements is incorrect:
   A) At the same temperature, the average kinetic energy of H$_2$ molecules and that O$_2$ molecules are equal.
   B) Gas molecules exert no intermolecular forces on each other
   C) Deviations from ideal gas law are greater low temperature and high pressure.
   D) The average molecular speed at 25$^\circ$C of Ar is greater than that of Kr.

9) The specific heat of silver "Ag" is 0.24 J/g $^\circ$C, therefore the molecular heat capacity of silver in J/mol $^\circ$C is:
   A) 25.9 B) 27.3 C) 28.5 D) 30.8

10) The heat of combustion of vaniline "C$_8$H$_8$O$_3$" is $-25.4$ kJ/g. In a bomb calorimeter that has a total heat capacity of 6350.0 J/$^\circ$C (for the calorimeter and the water) 1.25 g of vaniline was combusted consequently, the temperature rise (in $^\circ$C) should be:
    A) 3.5 B) 4.5 C) 4.5 D) 5.0
11) The symbol $\Delta H_f^\circ [\text{HNO}_3(l)]$ refers to one of the following reactions occurring at 25°C:

A) $\text{H}(g) + \text{N}(g) + 3\text{O}(g) \rightarrow \text{HNO}_3(l)$
B) $\frac{1}{2} \text{H}_2(g) + \frac{1}{2} \text{N}_2(g) + \frac{3}{2} \text{O}_2(g) \rightarrow \text{HNO}_3(l)$
C) $\text{H}_2(g) + \text{N}_2(g) + 3\text{O}_2(g) \rightarrow 2\text{HNO}_3(g)$
D) $\text{H}_2(g) + \text{N}_2(g) + 3\text{O}_2(g) \rightarrow 2\text{HNO}_3(l)$

12) The solubility of gas in water usually increases with

A) Increasing the partial pressure of the gas and increasing the temperature.
B) Decreasing the partial pressure of the gas and increasing the temperature.
C) Decreasing the partial pressure of the gas and decreasing the temperature.
D) Increasing the partial pressure of the gas and decreasing the temperature.

13) The molar mass of a certain protein is 25000 g/mol. The osmotic pressure (in torr) at 27°C of an aqueous solution prepared from 1.34 g of this protein (a nonelectrolyte) in enough water to make 100.0 mL of solution is:

A) 10  B) 11  C) 12  D) 14

14) The reaction $\text{A} + 2\text{B} \rightarrow \text{products}$, was found to follow the rate law:

\[ \text{rate} = k[\text{A}]^2[\text{B}] \]

Predict by what factor the rate of this reaction will increase when the concentration of A is tripled and the concentration of B is also tripled.

A) 8  B) 12  C) 18  D) 27

15) The reaction $2\text{A} + \text{B} \rightarrow \text{products}$, was found to follow the rate law?

\[ \text{rate} = k[\text{A}][\text{B}]^3 \]

The units for the rate constant are:

A) $\text{mol}^3 \text{L}^{-3} \text{s}^{-1}$  B) $\text{mol}^3 \text{L}^{-3} \text{s}^{-1}$  C) $\text{mol}^4 \text{L}^{-4} \text{s}^{-1}$  D) $\text{mol}^4 \text{L}^{-4} \text{s}^{-1}$

16) For a chemical reaction at equilibrium:

A) The activation energy for the forward reaction and that for the reverse reaction must be equal.
B) The activation energy for the endothermic reaction is always greater than that for the exothermic reaction.
C) The activation energy for the exothermic reaction is always greater than that for the endothermic reaction.
D) The activation energy has nothing to do with the enthalpy of the reaction.

17) Solid phosphorous pentachloride "PCl$_5$" decomposes to liquid phosphorous trichloride "PCl$_3$" and chlorine gas according to the following equilibrium reaction:

\[ \text{PCl}_5(s) \rightleftharpoons \text{PCl}_3(l) + \text{Cl}_2(g) \]

At a certain temperature and when the reaction reached equilibrium: 0.4 mol of PCl$_5$, 0.6 mol of PCl$_3$ and 0.6 mol of Cl$_2$ are present inside the 500 mL closed reaction vessel. Therefore, the $K_c$ value is:

A) 1.80  B) 1.44  C) 1.2  D) 1.5
18) Consider the following equilibrium reaction:

\[ \text{CH}_4(g) + \text{H}_2\text{O}(g) \rightleftharpoons \text{CO}(g) + 3\text{H}_2(g) \]

At 1500°C when \( K_c = 6.4 \) an equilibrium mixture of these gases was found to have \([\text{CO}] = 0.30 \text{ M}\), \([\text{H}_2] = 0.8 \text{ M}\) and \([\text{CH}_4] = 0.4 \text{ M}\). Therefore, the equilibrium concentration of \(\text{H}_2\text{O}(g)\) in this mixture was:

A) 0.06 M  
B) 1.0 M  
C) 0.024 M  
D) 0.2 M

19) At 773°C, the equilibrium reaction:

\[ \text{CO}(g) + 2 \text{H}_2(g) \rightleftharpoons \text{CH}_3\text{OH}(g) \]

has \( K_c = 0.4 \), therefore, \( K_p \) for this reaction at 773°C is:

A) \( 9.93 \times 10^{-5} \)  
B) \( 4.52 \times 10^{-5} \)  
C) 2950  
D) 1611

20) Using the following equilibria:

\[ 2\text{CH}_4(g) = \text{C}_2\text{H}_6(g) + \text{H}_2(g) \]  \( K_c = 9.5 \times 10^{-13} \)
\[ \text{CH}_4(g) + \text{H}_2\text{O}(g) = \text{CH}_3\text{OH}(g) + \text{H}_2(g) \]  \( K_c = 2.8 \times 10^{21} \)

Consequently, for the following equilibrium:

\[ 2\text{CH}_3\text{OH}(g) + \text{H}_2(g) = \text{C}_2\text{H}_6(g) + 2\text{H}_2\text{O}(g) \]

the \( K_c \) value is:

A) \( 2.66 \times 10^{-33} \)  
B) \( 7.45 \times 10^{-54} \)  
C) \( 3.39 \times 10^8 \)  
D) \( 1.21 \times 10^{29} \)

21) At high temperature, 2.0 mol of HBr gas was placed in a 4.0 L closed and empty reaction vessel where it decomposed according to the following equilibrium reaction:

\[ 2\text{HBr}(g) \rightleftharpoons \text{H}_2(g) + \text{Br}_2(g) \]

At equilibrium, the concentration of \(\text{Br}_2\) was measured to be 0.12 M. Therefore, the \( K_c \) value for this equilibrium at this temperature is:

A) \( 818 \times 10^{-3} \)  
B) \( 4.65 \times 10^{-3} \)  
C) 0.213  
D) 0.554

22) At 450°C, hydrogen iodide HI(g) decomposes according to the following equilibrium having \( K_c = 0.015625 \).

\[ 2\text{HI}(g) \rightleftharpoons \text{H}_2(g) + \text{I}_2(g) \]

A 0.66 mol of HI sample was injected into a 2.0 L reaction vessel hold at 450°C till equilibrium was reached. At equilibrium, the concentration of HI was:

A) 0.297  
B) 0.152  
C) 0.508  
D) 0.264

23) For the following equilibrium reaction:

\[ 2\text{SO}_2(g) + \text{O}_2(g) = 2\text{SO}_3(g) \]  \( \Delta H^o = -198 \text{ kJ} \)

Which one of the following factors would cause the equilibrium constant to increase:

A) Compress the gas mixture into a small volume to increase the total pressure.  
B) Increase the container volume to reduce the total pressure.  
C) Remove the SO\(_3\) produced.  
D) Decrease the reaction temperature.
24) In which one of the following solutions will acetic acid CH₃COOH (a weak acid) have the greatest degree of ionization?

A) 0.1 M CH₃COOH plus 0.1 M CH₃COONa
B) 0.1 M CH₃COOH plus 0.2 M CH₃COONa
C) 0.1 M CH₃COOH plus 0.3 M CH₃COONa
D) 0.1 M CH₃COONa

25) Formic acid HCOOH is a weak monoprotic acid that has $K_a = 1.7 \times 10^{-4}$. The pH value of 0.50 M formic acid solution is:

A) 3.77  B) 2.03  C) 4.03  D) 4.63

26) Ammonia (NH₄OH) is a weak base that has $K_b = 1.8 \times 10^{-5}$. The pH value of a 0.25 M ammonia solution is:

A) 2.67  B) 4.74  C) 11.33  D) 9.45

27) Which of the following sets form a conjugated acid/base pair?

1) NH₄⁺/NH₃  2) H₂CO₃/CO₃²⁻  3) H₃PO₄/H₂PO₄⁻  4) NH₃/NH₂⁻

A) All of them  B) 1 and 3 only  C) 3 and 4 only  D) 1, 3 and 4 only

28) Knowing that $K_b$ for the weak base (NO₂⁻) is $2.2 \times 10^{-11}$. Calculate the hydrogen ion concentration [H⁺] of a 0.50 M nitrous acid (HNO₂) solution.

A) $1.5 \times 10^{-2}$ M  B) $3.3 \times 10^{-6}$ M  C) $4.7 \times 10^{-6}$ M  D) $4.5 \times 10^{-4}$ M

29) Which of the following sets cannot form a buffer solution?

1. HNO₃/NaNO₃ (strong acid and its salt)
2. HCN/NaCN (weak acid and its salt)
3. NH₄OH/NH₄Cl (weak base and its salt)
4. HCl/NaCl (strong acid and its salt)

A) 2, 3  B) 1, 3  C) 2, 4  D) 1, 4

30) The pH value of 1.2 M C₂H₅NH₂ (ethylamine, a weak base) solution is 12.41. Calculate the $K_b$ value for ethylamine.

A) $1.3 \times 10^{-25}$  B) $3.2 \times 10^{-13}$  C) $5.5 \times 10^{-4}$  D) $1.2 \times 10^{-9}$

31) Calculate the pH of a buffer solution which contains 0.25 M benzoic acid C₆H₅COOH and 0.15 M sodium benzoate C₆H₅COONa. Given $K_a = 6.5 \times 10^{-5}$.

A) 4.19  B) 3.97  C) 6.5  D) 4.83