You will have 55 minutes to complete the test. Follow the instructions carefully.
- The answers to the multiple choice questions must be filled out on the answer sheet provided using a #2 pencil.
- Write your name on this test AND on the answer sheet. Indicate the test KEY ID in the KEY ID box on the answer sheet. You will lose 2 points for failing to do these items.
- You may use a calculator, but no books, notes or other information may be used.
- A periodic table and table of atomic masses is available.
- You may write on this test.
- Turn in both test and MC sheet.
- Below are some useful relationships—not all will be used.

\[
T_K = T_C + 273.15 \quad T_F = T_C \left( \frac{9^\circ F}{5^\circ F} \right) + 32^\circ F
\]

\[
D = \frac{m}{V}
\]

\[
R = 8.314 \text{ J}(\text{K-mol})
\]

1 amu = 1.66054 \times 10^{-27} \text{ kg}

1 ft = 12 in

1 yd = 3 ft

1 mile = 5280 feet

1 lb = 16 oz

1 atm = 760 torr (mm Hg) = 101.325 kPa

\[
R = 8.314 \frac{kPa \cdot L}{mol \cdot K} = 0.0821 \frac{L \cdot atm}{mol \cdot K}
\]

\[
PV = nRT
\]

\[
q = ms\Delta T
\]

A compound is probably soluble if it contains one of the following:

Cations: Group 1A: K⁺, Na⁺, K⁺, Rb⁺, Cs⁺, and NH₄⁺

Anions: Halides: Cl⁻, Br⁻, I⁻ (except Ag⁺, Hg²⁺, and Pb²⁺)

NO₃⁻, ClO₄⁻, and acetate (CH₃CO₂⁻)

SO₄²⁻ (except Ba²⁺, Hg²⁺, and Pb²⁺)

Sulfates of Ag⁺ and Ca²⁺ are slightly soluble

Hydroxides of Ba²⁺, Sr²⁺, and Ca²⁺ are slightly soluble

- Please do not remove this page from the test.

Total Points (2.5 x # correct) ________
Review Sheet ________
Grade ________ %
MULTIPLE CHOICE QUESTIONS
Mark the correct (best) answer on the score sheet provided.

1. A solution is prepared by dissolving 2 g of KCl in 100 g of H₂O. In this solution, H₂O is the
   A) solute.
   B) solvent.
   C) solution.
   D) solid.

2. Water is a polar solvent, hexane is a nonpolar solvent. Which of the following is a soluble system?
   A) vegetable oil in water
   B) benzene in hexane
   C) ionic Ni(NO₃)₂ in hexane
   D) all of the above are soluble systems.

3. Consider the following four liquids:
   1. water: highly polar, H-bonding
   2. butanol: slightly polar, some H-bonding
   3. chloroform: slightly polar, no H-bonding
   4. octane: nonpolar, no H-bonding
   Which pair of liquids is not mutually soluble?
   A) water and butanol
   B) water and octane
   C) butanol and chloroform
   D) chloroform and octane

4. Purified water, with no solute present, is able to conduct electricity (recall the demonstration in class).
   A) True
   B) False

5. When table sugar, sucrose, is added to pure water and dissolves, the solution
   A) conducts electricity because sucrose is a strong electrolyte.
   B) conducts electricity because sucrose is a weak acid,
   C) does not conduct electricity because sucrose is a nonelectrolyte
   D) does not conduct electricity because sucrose breaks down into glucose and fructose.

6. CaCl₂ would be considered a ___ given:
   CaCl₂(s) → Ca²⁺(aq) + 2Cl⁻(aq)
   A) nonelectrolyte.
   B) weak electrolyte.
   C) strong electrolyte.
   D) supersaturated solution.

7. Which of the following ionic compounds is likely to be soluble in water?
   A) AgI
   B) Hg₂(NO₃)₂
   C) BaSO₄
   D) Ca(OH)₂

8. Which of the following is not soluble in water?
   A) Na₂S
   B) NH₄OH
   C) CuSO₄
   D) Fe(OH)₃

9. When solutions of KCl and AgNO₃ are mixed, a precipitate forms. Which of the following is the balanced net ionic equation for the double replacement reaction that occurs?
   A) KCl(aq) + AgNO₃(aq) → KNO₃(aq) + AgCl(s)
   B) Ag⁺(aq) + Cl⁻(aq) → AgCl(s)
   C) K⁺(aq) + NO₃⁻(aq) → KNO₃(s)
   D) K⁺(aq) + Cl⁻(aq) + Ag⁺(aq) + NO₃⁻(aq) → K⁺(aq) + NO₃⁻(aq) + AgCl(s)

10. The brine tank of a water softener contains lumps of salt, NaCl, in water. Some of the salt dissolves, such that the brine can be considered:
    A) saturated because the salt water brine is in contact with solid NaCl.
    B) precipitated because solid NaCl is present.
    C) unsaturated because not all the salt dissolved.
    D) a weak electrolyte because solid NaCl cannot conduct electricity.

11. What is the molarity of a solution that contains 37.28 g of KCl (74.55 g/mol) in 2.00 L of solution?
    A) 0.50 M
    B) 4.0 M
    C) 0.25 M
    D) 2.0 M
12. How many grams of glucose are needed to prepare 400 mL of a 2.0% (m/v) glucose solution?

A) 800. g
B) 0.0050 g
C) 8.0 g
D) 2.0 g

13. Vinegar is a 5.0% (m/v) solution of acetic acid (\(\text{C}_2\text{H}_4\text{O}_2\text{H}\), 60.05 g/mol). What is the molar concentration of acetic acid?

A) \(\frac{5.0 \text{ g} \times 1000 \text{ mL}}{60.05 \text{ g} \times \text{L}}\)
B) \(\frac{5.0 \text{ g} \times 1 \text{ mol}}{60.05 \text{ g} \times \text{L}}\)
C) \(\frac{5.0 \text{ g} \times 60.05 \text{ mol}}{100 \text{ mL} \times \text{L}}\)
D) 0 of the above

14. 200 mL of a solution containing 1.0 g/L of sucrose is diluted to 500 mL. The final concentration will be

A) 0.20 g/L
B) 0.40 g/L
C) 1.0 g/L
D) 2.5 g/L

15. Given the reaction:

\[
Pb(NO_3)_2(aq) + 2KCl(aq) \rightarrow PbCl_2(s) + 2KNO_3(aq)
\]

Which of the following expressions calculates the number of grams of PbCl_2 that can be formed from 25.0 mL of 0.750 M KCl with excess Pb(NO_3)_2?

A) \(\frac{25.0 \times 0.750}{278.1}\)
B) \(\frac{25.0 \times 0.750 \times 278.1}{2}\)
C) \(\frac{0.0250 \times 0.750 \times 2 \times 278.1}{2}\)
D) \(\frac{0.0250 \times 0.750 \times 278.1}{2}\)

16. A solution with the same osmotic pressure as the blood is

A) isotonic to the blood.
B) hypotonic to the blood.
C) hypertonic to the blood.
D) non-tonic to the blood.

17. Which starch solution will decrease in volume as osmosis occurs?

A) 4%
B) 10%
C) Neither exerts osmotic pressure.
D) They exert equal osmotic pressures.

18. Which of the following also occurs in this system?

A) Water flows equally in both directions.
B) There is a net flow of water from the 4% starch solution into the 10% starch solution.
C) There is a net flow of water from the 10% starch solution into the 4% starch solution.
D) Starch moves out of the 10% starch solution into the 4% starch solution.

19. Reaction rates are determined by all of the following factors except:

A) the number of collisions between molecules.
B) the orientation of molecules during collisions.
C) the value of the equilibrium constant.
D) the activation energy of the reaction.

20. Which of the following would decrease the rate of a reaction?

A) Adding more reactant.
B) Lowering the temperature.
C) Removing some of the product.
D) Adding a catalyst.

21. In a lightproof container, H_2O_2(aq) can be stored indefinitely, even though the decomposition reaction is very exothermic and will proceed violently when a catalyst is added. The catalyst:

A) provides an alternate reaction path with a smaller activation energy.
B) lowers the activation energy of the reaction.
C) is a reactant that speeds up the reaction.
D) provides the energy needed to ignite the reaction.
22. Flammable liquids such as methanol, CH₃OH, can be stored in air indefinitely, even though the combustion reaction with oxygen is very exothermic and will proceed explosively when ignited. The solution is stable because
A) the equilibrium constant lies far towards the reactants.
B) the forward and reverse reaction rates are equal under the conditions stated.
C) the activation barrier for the reaction is too large for the molecules to overcome under the given conditions.
D) room temperature is too low for a reaction to occur.

23. Refrigerating perishable foods affects biochemical reactions by
A) increasing concentrations of antioxidants.
B) removing bacteria.
C) decreasing the rate of reactions affecting spoilage.
D) catalyzing the removal of harmful chemicals from the foods.

24. When a reaction system is at equilibrium
A) the reaction rate in the forward direction has decreased to zero.
B) the rates of the forward and reverse reactions are equal and opposite.
C) the rate in the reverse reaction has reached a maximum.
D) the amounts of reactants and products are equal.

25. Consider the following expression for an equilibrium constant:

$$K_c = \frac{[N_2O][H_2O]^3}{[O_2]^4[NH_3]^2}$$

Which reaction corresponds to this expression?
A) $N_2O(g) + 3H_2O(g) \leftrightarrow 2O_2(g) + 2NH_3(g)$
B) $2O_2(g) + 2NH_3(g) \leftrightarrow N_2O(g) + 3H_2O(g)$
C) $N_2O(g) + H_2O(g) \leftrightarrow O_2(g) + NH_3(g)$
D) $2O_2(g) + N_2O(g) \leftrightarrow 2NH_3(g) + 3H_2O(g)$

26. For a chemical reaction, the activation energy for the forward reaction is $+112$ kJ and the enthalpy of reaction is $\Delta H = -66$ kJ. Which of the following diagrams illustrates this data?
27. Consider the reaction:
\[ \text{Cl}_2(g) + H_2O(g) \leftrightarrow CO(g) + H_2(g) \]
Which of the following is the equilibrium constant expression for this reaction?

A) \[ K_c = \frac{[CO][H_2]}{[H_2O][Cl_2]} \]
B) \[ K_c = \frac{[CO][H_2]}{[Cl_2][H_2O]} \]
C) \[ K_c = \frac{[H_2O]}{[CO][H_2]} \]
D) \[ K_c = \frac{[Cl_2][H_2O]}{[CO][H_2]} \]

28. The position of the equilibrium for a reaction system where \( K = 7.2 \times 10^{-8} \) can be described as being favored to the _____; the concentrations of products is relatively _____.

A) left, small  
B) right, small  
C) left, large  
D) right, large

Consider the reaction between oxygen and ozone:
\[ 3O_2(g) + \text{heat} \leftrightarrow 2O_3(g) \]
for which \( \Delta H = +68 \) kcal and \( K = 3 \times 10^{-29} \).

29. At equilibrium, the system would contain:

A) mostly \( O_2 \)  
B) mostly \( O_3 \)  
C) about equal amounts of each  
D) neither

30. What is the effect of adding \( O_2 \)?

A) The reaction is unchanged.  
B) The reaction shifts to the right (to products).  
C) The reaction shifts to the left (to reactants).  
D) The value of \( K \) decreases.

31. What is the effect of decreasing the volume?

A) The reaction is unchanged.  
B) The reaction shifts to the right (to products).  
C) The reaction shifts to the left (to reactants).  
D) The value of \( K \) decreases.

32. What is the effect of increasing the temperature?

A) The reaction is unchanged.  
B) The reaction shifts to the right (to products).  
C) The reaction shifts to the left (to reactants).  
D) More molecules of both species are created.

33. The reaction below is studied at a high temperature.
\[ \text{PCl}_3(g) \rightarrow \text{PCl}_5(g) + \text{Cl}_2(g) \]
At equilibrium, the concentrations of the gases are as follows:
\[ \text{PCl}_3 = 1.8 \times 10^{-2} \text{ mol/L} \]
\[ \text{PCl}_5 = 5.6 \times 10^{-2} \text{ mol/L} \]
\[ \text{Cl}_2 = 3.8 \times 10^{-4} \text{ mol/L} \]
Which expression gives the value of \( K \)?

A) \[ K = \frac{(1.8 \times 10^{-2})(5.6 \times 10^{-2})}{(3.8 \times 10^{-4})} \]
B) \[ K = \frac{(5.6 \times 10^{-2})(3.8 \times 10^{-4})}{(1.8 \times 10^{-2})} \]
C) \[ K = \frac{(5.6 \times 10^{-2})(3.8 \times 10^{-4})}{(1.8 \times 10^{-2})} \]
D) \[ K = (5.6 \times 10^{-2})(3.8 \times 10^{-4})(1.8 \times 10^{-2}) \]

34. Carbon monoxide binds to hemoglobin 140 times more strongly than oxygen does. What does this tell you about the equilibrium constants for the two reactions of hemoglobin with carbon monoxide and oxygen?

A) The equilibrium constant for the binding of CO to hemoglobin is greater.  
B) The equilibrium constant for the binding of oxygen to hemoglobin is greater.  
C) The concentration of carbon monoxide at equilibrium is twice that of oxygen.  
D) The equilibrium constant for the binding of CO to \( O_2 \) is 140.

35. Treatment of carbon monoxide poisoning can be accomplished by the use of pure oxygen for breathing. This is an example of the use of _____ in a clinical setting.

A) the ideal gas law  
B) Le Chatelier's principle  
C) Henry's law  
D) a precipitation reaction

Postscript

- Remember, if you're not part of the solution, you're part of the precipitate!
- What do you call a tooth in a glass of water? A one molar solution.
- Activation Energy is the useful quantity of energy available in one cup of coffee.
- Old chemists never die, they just reach equilibrium.