MULTIPLE CHOICE (3 points each)

1. In the reaction: \( \text{CH}_4 + 2 \text{O}_2 \rightarrow \text{CO}_2 + 2 \text{H}_2\text{O} \), methane (CH\(_4\)) is
   a. an acid   
   b. oxidized   
   c. an oxidizing agent   
   d. reduced

2. A substance is reduced if it
   a. gains oxygen   
   b. gains electrons   
   c. loses electrons   
   d. all of the above

3. In a reaction, the substance undergoing reduction serves as the
   a. oxidizing agent   
   b. electron donor   
   c. reducing agent   
   d. proton

4. In the reaction: \( \text{Fe}_2\text{O}_3 + 3 \text{H}_2 \rightarrow 2 \text{Fe} + 3 \text{H}_2\text{O} \), the reducing agent is
   a. \( \text{Fe}_2\text{O}_3 \)   
   b. \( \text{H}_2 \)   
   c. \( \text{Fe} \)   
   d. \( \text{H}_2\text{O} \)

5. If the pressure on 7.5 L of gas is changed from 0.50 atm to 2.5 atm with the temperature constant, its new
   volume will be
   a. 0.10 L   
   b. 37.5 L   
   c. 5.0 L   
   d. 1.5 L

6. A gas occupies 400 mL at 0°C. What volume will it occupy at 273°C if the pressure remains the same?
   a. 200 mL   
   b. 0 mL   
   c. 800 mL   
   d. 400 mL

7. The solubility of a gas in a liquid
   a. increases with temperature   
   b. increases with the pressure of the gas at the surface of the liquid   
   c. decreases as pressure of the gas at the surface is increased   
   d. depends on the partial pressure of the liquid

8. Which statement about gases is false?
   a. A gas exerts pressure on its container walls.   
   b. Collisions in a gas are perfectly elastic.   
   c. A gas will distribute throughout the entire volume of its container.   
   d. Gases are very dense.

9. What volume will 2.90 moles of \( \text{O}_2 \) occupy at 25.0°C and 1.70 atm pressure? \((r = 0.0821 \text{L(atm)/mol(K)})\)
   a. 3.5 L   
   b. 14.3 L   
   c. 22.4 L   
   d. 41.7 L

10. Which compound exhibits hydrogen bonding?
    a. \( \text{HI} \)   
    b. \( \text{HF} \)   
    c. \( \text{CH}_4 \)   
    d. \( \text{OF}_2 \)

11. The only forces between \( \text{N}_2 \) molecules are
    a. London forces   
    b. hydrogen bonds   
    c. dipole forces   
    d. ionic bonds

12. Which noble gas has the highest boiling point?
    a. Ar   
    b. He   
    c. \( \text{Kr} \)   
    d. Ne

13. Which type of interaction is strongest?
    a. hydrogen bonding   
    b. London forces   
    c. dipole forces   
    d. all are equal in strength
14. Adding heat to a system with a liquid and solid at equilibrium will cause the
   a. temperature to increase         b. amount of solid to decrease
   c. temperature to decrease        d. amount of liquid to decrease

15. The resistance to flow that is observed in some liquids is called:
   a. viscosity                       b. surface tension  c. density          d. hydrogen bonding

16. A solid consisting of particles arranged in a regular, systematic pattern is called
   a. amorphous                      b. crystalline       c. non-compressible  d. ionic

17. What causes the unusual properties of water, including its higher density as a liquid than as a solid, and its
    high heat of vaporization?
   a. London forces                   b. hydrogen bonding  c. covalent bonding  d. low molecular weight

18. If all samples of a mixture have the same composition, the mixture is
   a. saturated                      b. concentrated    c. homogeneous       d. supersaturated

19. Hexane (C₆H₁₄) is a nonpolar solvent. Which of the following is least soluble in hexane?
   a. CH₄                           b. CCl₄             c. C₆H₁₂                   d. NaCl

20. A 5.0 L solution which contains 0.50 mole of solute is
   a. 2.5 M                          b. 1.0 M          c. 0.25 M                d. 0.10 M

21. What mass of NaOH would be required to make 5.0 L of 0.10 M solution?
   a. 20 g                          b. 2.0 g          c. 10 g                  d. 200 g

22. What is the percent-by-mass of a solution made by adding 56 g of KOH to 944 mL of solution?
   a. 1.0%                          b. 5.6%           c. 5.9%                  d. 56%

23. How many particles does each formula unit of CaCl₂ give in solution?
   a. 1                             b. 2              c. 3                       d. 4

24. Osmosis occurs when two solutions of differing concentrations are separated by a(n)
   a. permeable membrane            b. semipermeable membrane
   c. impermeable membrane          d. salt bridge

25. What is the difference between a colloid and a solution?
   a. Colloids are more concentrated than solution.
   b. Colloids are less concentrated than solution.
   c. Colloids have smaller solute particles than solution.
   d. Colloids have larger solute particles than solution.
Complete the table (10 points):

(10 points) Identify the oxidation state of the underlined element in each of the following compounds:

<table>
<thead>
<tr>
<th>Compound</th>
<th>Oxidation State</th>
</tr>
</thead>
<tbody>
<tr>
<td>H₂O</td>
<td>-2</td>
</tr>
<tr>
<td>NH₄⁺</td>
<td>-3</td>
</tr>
<tr>
<td>CaF₂</td>
<td>+2</td>
</tr>
<tr>
<td>SnO₂</td>
<td>+4</td>
</tr>
<tr>
<td>AlCl₃</td>
<td>-1</td>
</tr>
</tbody>
</table>

(5 points) Calculate the moles hydrogen sulfide contained in a 4.15L sample of gas at 62°C and 1.38 atm. (\( r = 0.0821 \text{ mol(l)/atm(K)} \))

\[
P V = nRT
\]
\[
1.38 \text{ atm(4.15L)} = n(0.0821 \text{ mol(L)/mol(K)})(62°C + 273)
\]
\[
n = \frac{1.38 \text{ atm(4.15L)}}{(0.0821(L/\text{atm})/\text{mol(K)})(335°C)}
\]
\[
= 0.21 \text{ mol}
\]

(5 points) A cylinder of oxygen has a volume of 2.00 L. The pressure of the gas is 1.93 atm at 20.0°C. What volume will the oxygen occupy at 0.019 atm, assuming no change in temperature?

\[
P V_1 = P V_2
\]
\[
1.93 \text{ atm(2.00L)} = 0.019 \text{ atm}(x)
\]
\[
x = 203L
\]

(5 points) How many grams of NaCl are required to make 500mL of a solution whose concentration is 0.15M?

\[
molarity = \frac{\text{moles of solute}}{\text{liters of solution}}
\]
\[
0.15M = \frac{x}{0.500L}
\]
\[
x = \text{moles NaCl} = 0.0750 \text{ moles}
\]

formula weight NaCl = 58.45g / mol

\[
g \text{ NaCl} = 0.0750mol(58.45g / mol)
\]
\[
= 4.4g
\]