CH 222 Sample Exam
Exam II Name: _____ Lab Section: _____

**Part I:** Multiple Choice Questions (100 Points) *Use a scantron sheet for Part I.* There is *only* one best answer for each question.

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1. A sample of gas (24.2 g) initially at 4.00 atm was compressed from 8.00 L to 2.00 L at constant temperature. After the compression, the gas pressure was _____ atm.

   a. 4.00
   b. 2.00
   c. 1.00
   d. 8.00
   e. 16.0

2. A balloon originally had a volume of 4.39 L at 44 °C and a pressure of 729 torr. The balloon must be cooled to _____°C to reduce its volume to 3.78 L (at constant pressure).

   a. 38
   b. 0
   c. 72.9
   d. 273
   e. 546

3. If 50.75 g of a gas occupies 10.0 L at STP, 129.3 g of the gas will occupy _____ L at STP.

   a. 3.92
   b. 50.8
   c. 12.9
   d. 25.5
   e. 5.08

4. The reaction of 50 mL of $Cl_2$ gas with 50 mL of $CH_4$ gas via the equation below will produce a total of _____ mL of products (assume pressure and temperature are kept constant.)

$$Cl_2(g) + CH_4(g) \rightarrow HCl(g) + CH_3Cl(g)$$

   a. 100
   b. 50
   c. 200
   d. 150
   e. 250

5. The pressure of a sample of $CH_4$ gas (6.022 g) in a 30.0 L vessel at 402 K is _____ atm.

   a. 2.42
   b. 6.62
   c. 0.413
   d. 12.4
   e. 22.4

6. The density of $N_2O$ at 1.53 atm and 45.2 °C is _____ g/L.

   a. 18.2
   b. 1.76
   c. 0.388
   d. 9.99
   e. 2.58

7. Automobile air bags use the decomposition of sodium azide as their source of gas for rapid inflation per the reaction below. What mass (g) of $NaN_3$ is required to provide 40.0 L of $N_2$ at 25.0 °C and 763 torr?

$$2\ NaN_3(s) \rightarrow 2\ Na(s) + 3\ N_2(g)$$

   a. 1.64
   b. 1.09
   c. 160
   d. 71.1
   e. 107

8. A vessel contained $N_2$, Ar, He, and Ne. The total pressure in the vessel was 987 torr. The partial pressures of nitrogen, argon, and helium were 44.0, 486, and 218 torr, respectively. The partial pressure of neon in the vessel was _____ torr.

   a. 42.4
   b. 521
   c. 19.4
   d. 239
   e. 760

9. Of the following, _____ has the highest boiling point.

   a. $N_2$
   b. $Br_2$
   c. $H_2$
   d. $Cl_2$
   e. $O_2$

10. Of the following, _____ is an exothermic process.

   a. melting
   b. subliming
   c. freezing
   d. boiling
   e. All of the above are exothermic.

11. The heat of fusion of water is 333 J/g. The conversion of 50.0 g of ice at 0.0 °C to liquid water at 22.0 °C requires how many kilojoules (kJ) of heat?

   a. $3.8 \times 10^2$
   b. 21.3
   c. 17.2
   d. 0.469
   e. Insufficient data are given.

12. Of the following, _____ is the most volatile.

   a. $CBr_4$
   b. $CCl_4$
   c. $CF_4$
   d. $CH_4$
   e. $C_6H_{14}$

13. Potassium metal crystallizes in a body-centered cubic structure with a unit cell edge length of 5.31 Å. The radius of a potassium atom is _____ Å.

    a. 1.33
    b. 1.88
    c. 2.30
    d. 2.66
    e. 5.31

14. As a solid element melts, the atoms become _____ and they have _____ attraction for one another.

    a. more separated, more
    b. more separated, less
    c. closer together, more
    d. closer together, less
    e. larger, greater

15. Which one of the following exhibits dipole-dipole attraction between molecules?

    a. $XeF_4$
    b. $AsH_3$
    c. $CO_2$
    d. $BCl_3$
    e. $Cl_2$

16. Based on the following information, which compound has the strongest intermolecular forces?

| **Substance** | **$\Delta H_{vap}$ (kJ/mol)** |
|---|---|
| Argon (Ar) | 6.3 |
| Benzene ($C_6H_6$) | 31.0 |
| Ethanol ($C_2H_5OH$) | 39.3 |
| Water ($H_2O$) | 40.8 |
| Methane ($CH_4$) | 9.2 |

    a. Argon
    b. Benzene
    c. Ethanol
    d. Water
    e. Methane

17. The vapor pressure of any substance at its normal boiling point is

    a. 1 bar
    b. 1 torr
    c. 1 atm
    d. equal to atmospheric pressure
    e. equal to the vapor pressure of water

18. The solubility of oxygen gas in water at 25 °C and 1.0 atm pressure of oxygen is 0.041 g/L. The solubility of oxygen in water at 3.0 atm and 25 °C is _____ g/L.

    a. 0.041
    b. 0.014
    c. 0.31
    d. 0.12
    e. 3.0

19. A sample of potassium nitrate (49.0 g) is dissolved in 101 g of water at 100 °C with precautions taken to avoid evaporation of any water. The solution is cooled to 30.0 °C and a small amount of precipitate is observed. This solution is _____.

    a. hydrated
    b. placated
    c. saturated
    d. unsaturated
    e. supersaturated

20. The concentration of urea in a solution prepared by dissolving 16 g of urea in 39 g of $H_2O$ is _____% by mass. The molar mass of urea is 60.0 g/mol.

    a. 29
    b. 41
    c. 0.29
    d. 0.41
    e. 0.48

21. The concentration of KBr in a solution prepared by dissolving 2.21 g of KBr in 897 g of water is _____ molal.

    a. 2.46
    b. 0.0167
    c. 0.0207
    d. $2.07 \times 10^{-5}$
    e. 0.0186

22. A solution is prepared by dissolving 15.0 g of $NH_3$ in 250.0 g of water. The density of the resulting solution is 0.974 g/mL. The molarity of $NH_3$ in the solution is _____.

    a. 0.00353
    b. 0.882
    c. 60.0
    d. 3.24
    e. 3.53

23. The concentration of sodium chloride in an aqueous solution that is 2.23 M and that has a density of 1.01 g/mL is _____% by mass.

    a. 2.21
    b. 7.83
    c. 45.3
    d. 12.9
    e. 10.1

24. The vapor pressure of pure water at 25 °C is 23.8 torr. What is the vapor pressure (torr) of water above a solution prepared by dissolving 18.0 g of glucose (a nonelectrolyte, MW = 180.0 g/mol) in 95.0 g of water?

    a. 24.3
    b. 23.4
    c. 0.451
    d. 0.443
    e. 23.8

25. Determine the freezing point (°C) of a 0.015 molal aqueous solution of $MgSO_4$. The molal freezing-point-depression constant of water is 1.86 °C/m. *Note:* Check your van't Hoff factor!

    a. -0.056
    b. -0.028
    c. -0.17
    d. -0.084
    e. 0.000

**Part II:** Short Answer / Calculation. *Show all work!*

1. A 1.44-g sample of an unknown pure elemental gas occupies a volume of 0.335 L at a pressure of 1.00 atm and a temperature of 100.0 °C. Use this information to determine the identity of the unknown gas. (10 points)

**Part II:** Short Answer / Calculation *(continued) Show all work!*

2. The fluorocarbon $C_2Cl_3F_3$ has a normal boiling point of 47.6 °C. The specific heats of $C_2Cl_3F_3$(l) and $C_2Cl_3F_3$(g) are 0.910 J/g-K and 0.670 J/g-K, respectively. The heat of vaporization of the compound is 27.49 kJ/mol. Calculate the heat required to convert 50.0 g of the compound from the liquid at 5.0 °C to the gas at 80.0 °C in **kilojoules** (kJ). (10 points)

3. What is the molar mass of a nonelectrolyte if 6.02 grams dissolved in 30.0 grams of benzene freezes at –1.55 °C? The freezing point of pure benzene is 5.50 °C and the freezing point depression constant, $K_{fp}$, is –5.12 °C/m. (10 points)

**Extra Credit Question:** The nonelectrolyte compound in problem #3 is found to have the following: **49.31%C, 6.90 %H, and 43.79 %O**. Determine the **empirical and molecular formulas** for the unknown compound. (5 points)