

**Chem 121, Spring 2009**  
**Test 4, Form A**

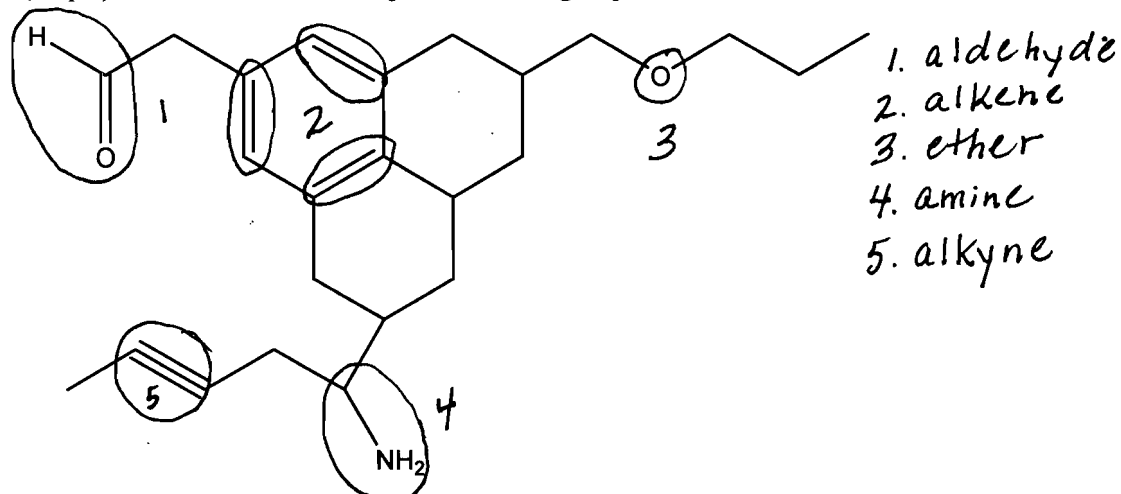
You have 75 minutes to complete this 100 point test. Please mark each answer clearly and show all work. You may use a scientific calculator.

**I. Multiple Choice (15 pts): Circle the best answer.**

- \_\_\_\_\_ is the measure of the ability of a molecule to distort its electron cloud.
  - Energy
  - Wetting
  - Surface tension
  - Polarizability
- Viscosity is affected by \_\_\_\_\_.
  - intermolecular forces
  - molecular size
  - both a and b
  - neither a or b
- \_\_\_\_\_ Law inversely relates pressure and volume at a constant amount and Kelvin temperature.
  - Charles'
  - Boyle's
  - Guy-Lussac's
  - Avogadro's
- Polypeptides are always written so that the N-terminus is:
  - on the right end of the molecule.
  - in the center of the molecule.
  - on the top of the molecule.
  - on the left end of the molecule.
- STP represents conditions where:
  - T = 0 K and P = 0 atm.
  - T = 0 K and P = 1 atm.
  - T = 298 K and P = 0 atm.
  - T = 298 K and P = 1 atm.

**II. Organic Chemistry and Biochemistry (25 pts)**

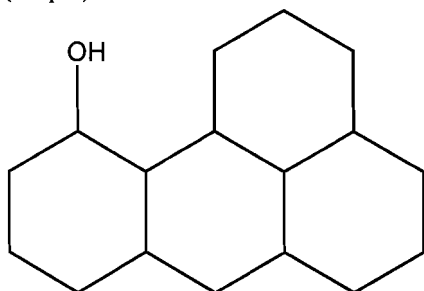
1. (10 pts) Circle and name all major functional groups in the molecule below.



2. (5 pts) Fill-in the blank with the appropriate word.

- The building blocks of proteins are called amino acids.
- The two classes of organic bases that are found in nucleotides are purines and pyrimidines.
- The complimentary base-pairing for AUGGGCAU is UACCCGUA.
- Lipids are a class of biological molecules whose only requirement is that they contain long chains of hydrocarbons.

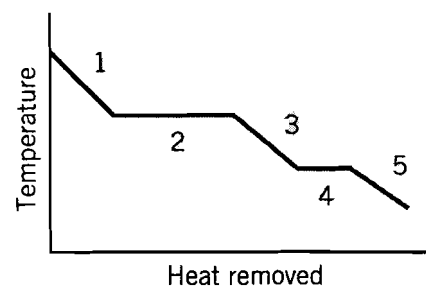
3. (10 pts) Indicate if the molecule below will be soluble or insoluble in water (a polar solvent) and explain why.



This would be insoluble in  $H_2O$ .  
It is a large nonpolar molecule<sup>2</sup> and would only be soluble in a nonpolar solvent because "likes dissolve likes!"

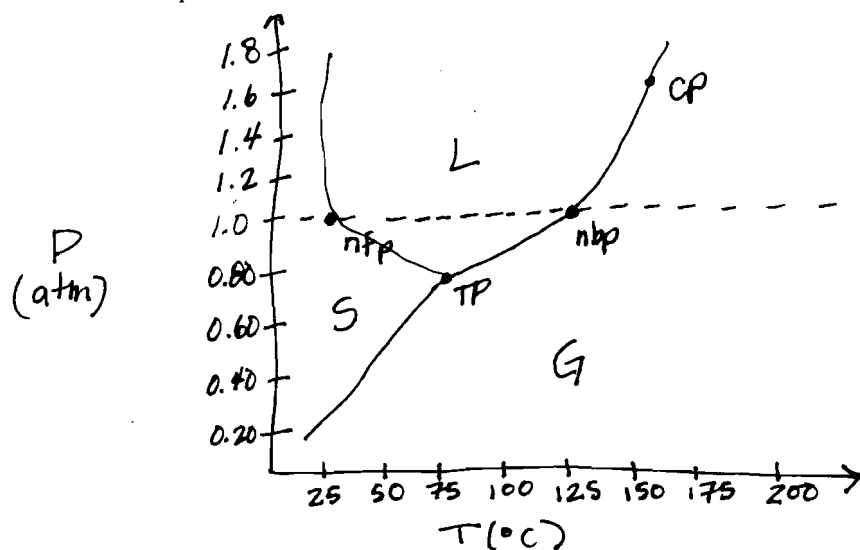
### III. Forces, Trends and Phase Changes (30 pts)

1. (10 pts) Essay: In four to six grammatically complete sentences and using the diagram (at right), identify and describe the curve, making sure that note all five regions.

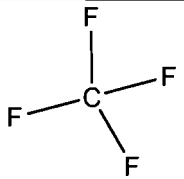
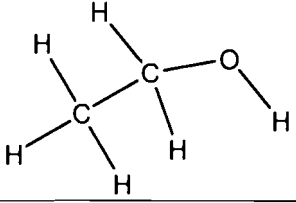
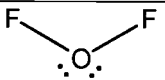


see Lecture notes

2. (10 pts) Draw a phase diagram for a substance that has a nfp of  $25^{\circ}C$ , a nbp of  $125^{\circ}C$ , a triple point at  $0.80\text{ atm}$  and  $75^{\circ}C$ , and a critical point at  $1.6\text{ atm}$  and  $150^{\circ}C$ . Label the axes, the phases, the nfp, the nbp, the triple point and the critical point.



3. (10 pts) For each substance below, list the types of intermolecular forces present and then rank them from lowest to highest boiling point using numbers one through five (1 – 5), so that #1 would have the lowest boiling point and #5 would have the highest boiling point. (Hint: you might want to look at the molecular geometry.)

	Forces Present	Rank
 CF <sub>4</sub> 88	London	2
 CH <sub>3</sub> OH 40	London Dipole H-bond	5
Ar 40	London	1
H-Cl 36	London, Dipole	3
 OF <sub>2</sub> 54	London Dipole	4

**IV. Gases (40 pts):** Show all work for calculations or you will not receive any credit.

1. (5 pts) What volume of O<sub>2</sub> is needed to exactly react with 2.5 L of CH<sub>4</sub> if the reaction temperature and pressure are kept constant throughout?

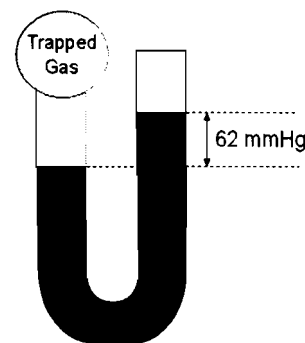


$$2.5 \text{ L CH}_4 \times \frac{2 \text{ mol O}_2}{1 \text{ mol CH}_4} = 5.0 \text{ L O}_2$$

2. (15 pts) An unknown gas with mass of 1.00 g is trapped in the open-ended manometer seen at right. The atmospheric pressure is 745 mmHg.

- a. What is the pressure of the trapped gas in atm?

$$P_{\text{gas}} = 745 \text{ mmHg} + 62 \text{ mmHg} = 807 \text{ mmHg} \times \frac{1 \text{ atm}}{760 \text{ mmHg}} = 1.06 \text{ atm}$$



- b. What is the molar mass of the gas if the volume is 0.500 L and the temperature is 37°C?

$$n = \frac{PV}{RT} = \frac{(1.06 \text{ atm})(0.500 \text{ L})}{(0.0821 \frac{\text{L atm}}{\text{mol K}})(310 \text{ K})} = 0.0208 \text{ mol}$$

$$\text{MM} = \frac{1.00 \text{ g}}{0.0208 \text{ mol}} = 48.19 \text{ g/mol}$$

3. (10 pts) A scuba diving tank usually contains a mixture of nitrogen and oxygen. A typical tank (with a volume of 11.1L) inside an air-conditioned dive shop has a pressure of 204.2 atm at a temperature of 25°C. By the time the diver gets the tank out to the ocean, the temperature has risen to 32°C. What is the new pressure of the gas in the tank?

$V_1 = V_2$   
same tank

$$P_1 = 204.2 \text{ atm}$$

$$T_1 = 25^\circ\text{C} + 273 = 298 \text{ K}$$

$$P_2 = ?$$

$$T_2 = 32 + 273 = 305 \text{ K}$$

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$P_2 = \frac{P_1 T_2}{T_1}$$

$$P_2 = \frac{(204.2 \text{ atm})(305 \text{ K})}{(298 \text{ K})}$$

$$P_2 = 209 \text{ atm}$$

4. (10 pts) What is the mole fraction and mole percent of oxygen and nitrogen in the above tank if the oxygen pressure is 43.9 atm at 32°C?

$$\text{@ } 32^\circ\text{C } P_{O_2} = 43.9 \text{ atm}$$

$$P_{N_2} = 209 \text{ atm} - 43.9 \text{ atm} = 165 \text{ atm}$$

$$P_{\text{tot}} = 209 \text{ atm}$$

$$\chi_{O_2} = \frac{43.9 \text{ atm}}{209 \text{ atm}} = 0.210$$

$$\text{mol \% } O_2 = 21.0\%$$

$$\chi_{N_2} = \frac{165 \text{ atm}}{209 \text{ atm}} = 0.789$$

$$\text{mol \% } N_2 = 78.9\%$$