SIC 102
Exam I

1. Benzene (C_6H_6) melts at 5.5 °C and boils at 80.1 °C. Suppose you start with a 1.0 L flask of benzene at 0 °C and you heat the benzene at a constant rate to 100 °C. Sketch a plot of the temperature of benzene vs. time and label the melting and boiling points on the graph.

2. The following chart lists physical properties for several compounds:

Name	Structure	Molar Mass (g/mol)	Density (g/mL)	mp (°C)	bp (°C)
anisole	$C_6H_5OCH_3$	108.14	0.995	-37	154
aniline	$C_6H_5NH_2$	93.13	1.022	-6.2	184
toluene	$C_6H_5CH_3$	92.14	0.867	-93	111

Explain the trends in melting point and boiling point in terms of intermolecular interactions.

3. Bromine (Br_2) is a liquid that melts at -7.2 °C and boils at 58.7 °C. It has a molar mass of 159.81 g / mol and a density of 3.119 g / mL.

a) How many moles of bromine are present in 1.00 L of pure bromine?

b) What is the molarity of pure bromine?

c) Bromine has a solubility of 3.5 g Br_2 / 100 mL in aqueous solution. How many moles of bromine are present in 1.00 L of saturated bromine solution?

d) What is the molarity of saturated bromine solution?

e) What volume of pure bromine would be required to make 2.50 L of saturated bromine solution?

4. Suppose you have a bottle of pure water, a bottle of 1 m $CaCl_2$, and a bottle of 1 m glucose ($C_6H_{12}O_6$). Rank these solutions in order of increasing melting point and explain your answer.

5. Thionyl chloride ($SOCl_2$) melts at -104 °C and boils at 76 °C. It has a molar mass of 118.97 g / mol and a density of 1.631 g / mL.

a) How does the energy required to heat a sample of thionyl chloride from -51 °C to -50 °C compare to the amount of energy required to heat the same sample from 70 °C to 71 °C? Explain.

b) Thionyl chloride reacts with water to form sulfurous acid and hydrochloric acid:

$$SOCl_2(l) + 2\ H_2O(l) \rightarrow H_2SO_3(aq) + 2\ HCl(aq)$$

What mass of thionyl chloride is necessary in order to produce 0.500 L of a 0.250 M HCl solution?

6. The cryogen liquid nitrogen boils at -196 °C. The molar mass of N_2 is 28.01 g / mol and ΔH_v = 5.577 kJ / mol.

a) Suppose 250g of $N_2(l)$ at -196 °C are poured into a 1.00 L container of water. How much energy does the nitrogen absorb as it boils off?

b) The density of water is 1.00 g / mL, and its heat capacity is 4.184 J / g · °C. Assuming that the water does not freeze, how much does its temperature drop during this process?