

SIC 102

Exam I

1. Benzene (C_6H_6) melts at $5.5\text{ }^\circ\text{C}$ and boils at $80.1\text{ }^\circ\text{C}$. Suppose you start with a 1.0 L flask of benzene at $0\text{ }^\circ\text{C}$ and you heat the benzene at a constant rate to $100\text{ }^\circ\text{C}$. 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 ($^\circ\text{C}$)	bp ($^\circ\text{C}$)
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 $-7.2\text{ }^\circ\text{C}$ and boils at $58.7\text{ }^\circ\text{C}$. 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 $3.5\text{ g Br}_2 / 100\text{ mL}$ 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?

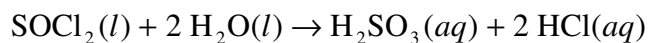
e) What volume of pure bromine would be required to make 2.50 L of saturated bromine solution?

4. Suppose you have a bottle of pure water, a bottle of 1 m CaCl_2 , and a bottle of 1 m glucose ($\text{C}_6\text{H}_{12}\text{O}_6$). Rank these solutions in order of increasing melting point and explain your answer.

5. Thionyl chloride (SOCl_2) melts at $-104\text{ }^\circ\text{C}$ and boils at $76\text{ }^\circ\text{C}$. 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 $-51\text{ }^\circ\text{C}$ to $-50\text{ }^\circ\text{C}$ compare to the amount of energy required to heat the same sample from $70\text{ }^\circ\text{C}$ to $71\text{ }^\circ\text{C}$? Explain.

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



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 $-196\text{ }^{\circ}\text{C}$. The molar mass of N_2 is 28.01 g/mol and $\Delta H_v = 5.577\text{ kJ/mol}$.

a) Suppose 250 g of $\text{N}_2(l)$ at $-196\text{ }^{\circ}\text{C}$ 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 $4.184\text{ J/g}\cdot^{\circ}\text{C}$. Assuming that the water does not freeze, how much does its temperature drop during this process?