CHEM 103
R&R 19
26 June 2024
Adapted from a 25 June 2020 document

1. Predict which substance in each of the following pairs would have the stronger IMFs:

SeO_2 or SO_2

bonds more polar, same geometry
⇒ molecule more polar

$CH_3CH_2CH_2NH_2$ or $H_2NCH_2CH_2NH_2$

more H-bonding opportunities.

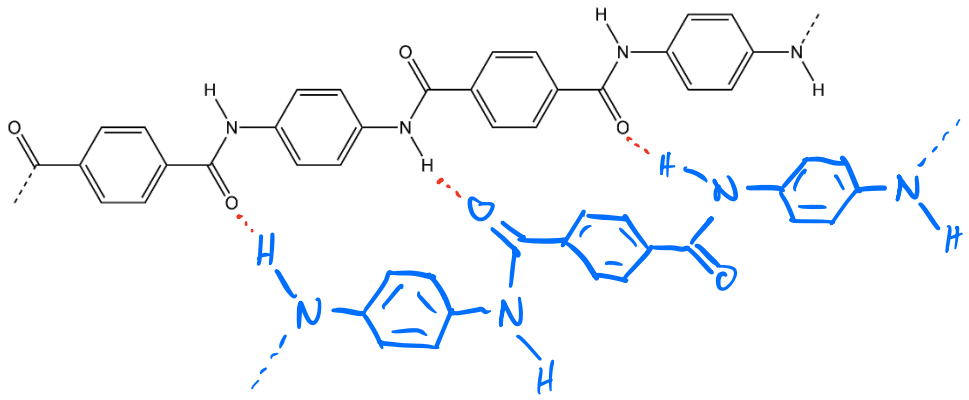
CH_3CH_3 or CH_2O

C=O bond is polar

CH_3OH or CH_2O

H-bonding > dipole-dipole

2. The structure of Kevlar is shown below. Use IMFs to explain why Kevlar is a strong material.



There's a lot of hydrogen bonding!

3. The partial pressure of oxygen was observed to be 156 torr in air with a total atmospheric pressure of 743 torr. Calculate the mole fraction of O_2 present.

$$\chi_{O_2} = \frac{P_{O_2}}{P_{total}} = \frac{156 \text{ torr}}{743 \text{ torr}} = 21.0\%$$

4. The partial pressure of CH_4 (g) is 0.175 atm and that of O_2 (g) is 0.250 atm in a mixture of the two gases.

a. What is the mole fraction of each gas in the mixture?

$$\chi_{CH_4} = \frac{P_{CH_4}}{P_{total}} = \frac{0.175\ atm}{0.175\ atm + 0.250\ atm} = 0.412$$

$$\chi_{O_2} = \frac{P_{O_2}}{P_{total}} = \frac{0.250\ atm}{0.175\ atm + 0.250\ atm} = 0.588$$

b. If the mixture occupies a volume of 10.5 L at 65 °C, calculate the total number of moles of gas in the mixture.

$$n = \frac{PV}{RT} = \frac{(0.425\ atm)(10.5\ L)}{\left(.08206\ \frac{atm \cdot L}{mol \cdot K}\right)(338.15\ K)} = 0.161\ mol\ gas$$

c. Calculate the number of grams of each gas in the mixture.

$$0.161\ mol\ gas \cdot \frac{0.412\ mol\ CH_4}{mol\ gas} \cdot \frac{16.04\ g\ CH_4}{mol\ CH_4} = 1.06\ g\ CH_4$$

$$0.161\ mol\ gas \cdot \frac{0.588\ mol\ O_2}{mol\ gas} \cdot \frac{32.00\ g\ O_2}{mol\ O_2} = 3.03\ g\ O_2$$

5. A person accidentally swallows a drop of liquid oxygen, O_2 (l), which has a density of 1.149 g/mL. Assuming the drop has a volume of 0.050 mL, what volume of gas will be produced in the person's stomach at body temperature (37 °C) and a pressure of 1.0 atm?

$$PV = nRT \Rightarrow V = \frac{1}{P} RT \cdot n$$

$$V = \frac{1}{1.0\ atm} \cdot \frac{0.08206\ atm \cdot L}{mol \cdot K} \cdot 310.15\ K \cdot \left(0.050\ mL \cdot \frac{1.149\ g}{mL} \cdot \frac{mol}{32.00\ g}\right)$$

$$= 0.0457\ L = 46\ mL$$

6. For each pair of compounds, pick the one with the higher boiling point. Explain your reasoning.

a. CH_3OH or CH_3SH

O–H bond is more polar ⇒ stronger dipoles. (H-bonding, even!)

b. CH_3OCH_3 or CH_3CH_2OH

H-bonding is available rather than just dipole-dipole interactions.

c. CH_4 or CH_3CH_3

larger ⇒ more polarizable ⇒ stronger LDFs.

d. $CH_3CH_2CH_2CH_3$ or $CH_3CH(CH_3)CH_3$

less branched ⇒ more polarizable ⇒ stronger LDFs.