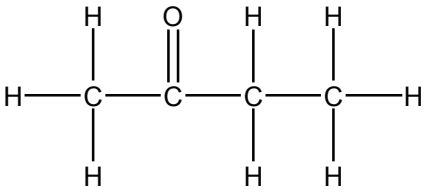
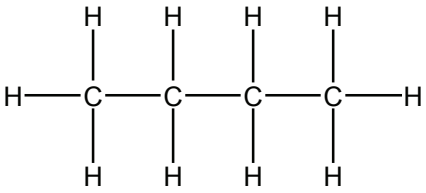
NMSI Super Problem: Intermolecular Forces

Answer the following questions using your knowledge of intermolecular forces and molecular structure. Your response must include specific information about all substances in each question.

a. The structures for butanone, $CH_3COCH_2CH_3$, and *n*-butane, $CH_3CH_2CH_2CH_3$, are shown below.





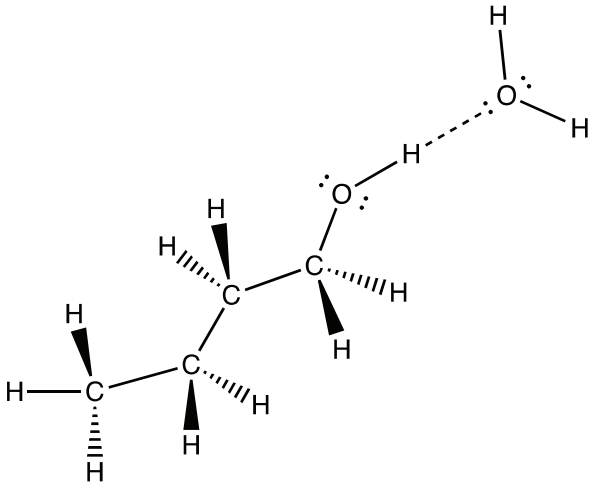
Identify the type of intermolecular forces in

i. Butanone

ii. *n*-butane

b. Butanone is much more soluble in H_2O than is *n*-butane. Account for this difference.

c. The substance *n*-butanol ($CH_3CH_2CH_2CH_2OH$) is shown below forming a hydrogen bond with a water molecule, as represented with a dashed line. There are 2 more locations where a water molecule would hydrogen bond with *n*-butanol. Draw both water molecules in their correct orientation where they would hydrogen bond with the *n*-butanol molecule.



d. Predict whether the enthalpy of vaporization, $\Delta H°_{vap}$, for *n*-butanol will be greater than 32.2 kJ mol^{-1}; less than 21.0 kJ mol^{-1}; or between 21.0 kJ mol^{-1} and 32.2 kJ mol^{-1}. Explain.

Substance	$\Delta H°_{vap}$ **(kJ** $\mathbf{mol^{-1}}$**)**
n-butane ($CH_3CH_2CH_2CH_3$)	21.0
Butanone ($CH_3COCH_2CH_3$)	32.2
n-butanol ($CH_3CH_2CH_2CH_2OH$)	?

e. Consider the three chloride compounds and the information in the table below.

Substance	Melting Point
PCl_3	– 93.9°C
KCl	776°C
NaCl	801°C

Account for the difference in melting points.

The table below provides information about three of the noble gases.

Substance	Boiling Point (K)	Solubility in Water ($cm^3\ kg^{-1}$)
Ne	27.3	10.5
Ar	?	?
Xe	166.6	108.1

f. Neon has a much lower boiling point than xenon. Explain.

g. Xenon is much more soluble in water than neon. Explain.

h. Would argon's solubility in water be greater than or less than that of xenon?

i. Given samples of liquid argon and liquid xenon – in separate, identical, closed containers at the same temperature – which would have the greatest vapor pressure?