

1. The following compounds contain a central C=O functional group.



- (a) If you have pure solutions of each, arrange the compounds in order of increasing boiling points. Explain your answer.

HCOH
Dipole-Dipole
London Dispersion

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CH₃COCH₃
Dipole-Dipole
London Dispersion

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NH₂COCH₃
Hydrogen Bonding
Dipole-Dipole
London Dispersion
{221 °C}

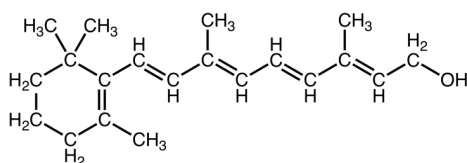
{-19 °C}

{56 °C}

- (b) Why might FCOF have a lower boiling point than the three compounds above?

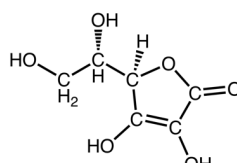
The bond dipoles mostly cancel out and the FCOF molecule is significantly *less* polar than HCOH, CH₃COCH₃, and NH₂COCH₃, so IMFs are weaker overall, and it boils at -85 °C.

2. Which vitamins would be more soluble in water and which more soluble in oil?



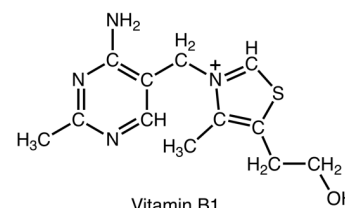
Vitamin A

Oil Soluble
Most nonpolar chains



Vitamin C

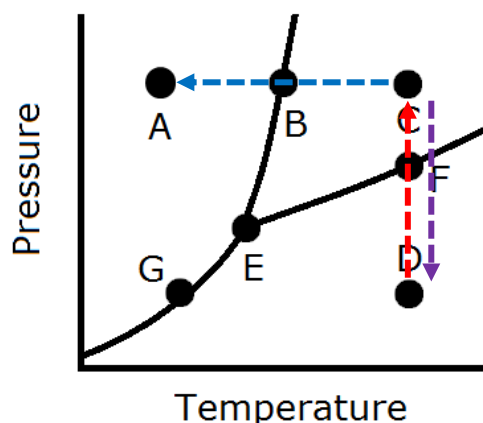
Water Soluble
Polar: Hydrogen Bonding



Vitamin B1

Water Soluble
Polar: Charged & Hydrogen Bonding

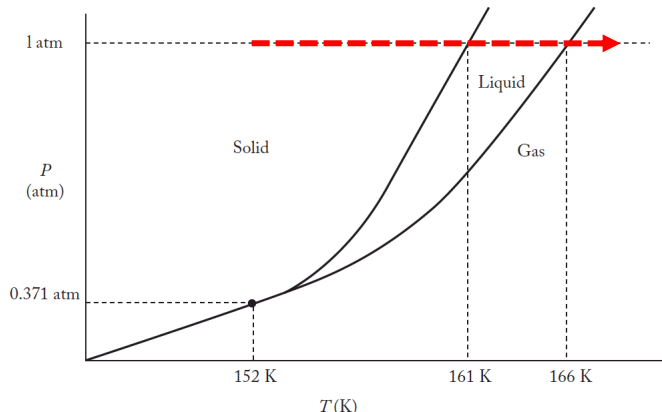
3. Consider the following phase diagram for an unknown substance.



- (a) Which of the following points on the phase diagrams above represents a ...
 (i) Solid (A) (ii) Gas (D) (iii) Triple point (E) (iv) Melting Point (B)
- (b) On the diagram, connect the points that would correspond to the following transformations.
 (i) Vaporization (ii) Freezing (iii) Condensation

4. Sketch a phase diagram for element X, which has a triple point at 152 K and 0.371 atm, a boiling point of 166 K at 1.00 atm, and a melting point of 161 K at 1.00 atm. Mark the coordinates of key points on your graph.

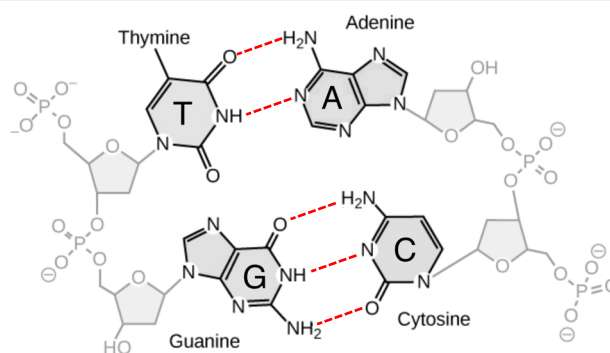
Will this element sublime at 1.00 atm?



Sublimation is the transition from the solid phase to the gas phase directly.

This substance cannot sublime at 1.00 atm because it passes through the liquid state first.

5. Deoxyribonucleic acid (DNA) is a class of vital biological macromolecules comprised of two helical strands held together by hydrogen bonds between base pairs Adenine-Thymine (A-T) or Cytosine-Guanine (C-G) as shown to the right.



- (a) Draw in the missing hydrogen bonds for the A-T and C-G base pairs. **Drawn in red.**
 (b) Which of the two hydrogen-bonded pairs would be harder to break? Explain your answer.

The C-G pair because it has 3 hydrogen bonds vs. 2 hydrogen bonds for the A-T pair.

6. Methane gas (CH_4) is not soluble in water (its solubility is 22.7 mg/L). However, methane water clathrates, which are commonly found in polar ice caps and sometimes called “fire ice,” trap up to 120 g of CH_4 in 1 L of ice.

- (a) The structure of the methane water clathrate is shown to the right. What is the main intermolecular interaction between methane and the water molecules?

London Dispersion

- (b) How do these interactions differ in liquid water and methane?

Liquid water forms a denser network of hydrogen bonds. Ice is less dense and has large cavities.

