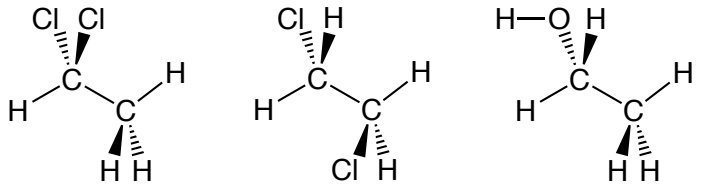
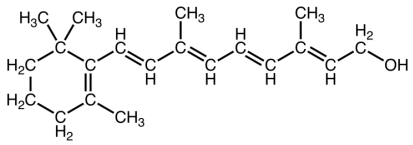
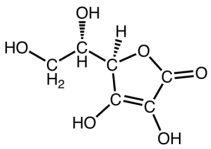
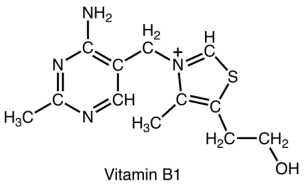
1. Arrange the following in order of increasing boiling points and explain your answer.
   a) N_2, NH_4Cl, NH_3

   b) 

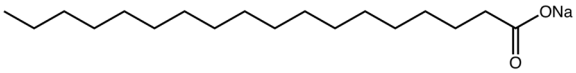
2. Vitamins are essential for your health. Which of the following vitamins are more soluble in water or more soluble in oil?


Vitamin A


Vitamin C


Vitamin B1

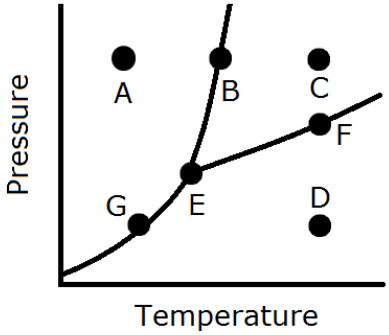
3. Nonpolar substances like oils are typically insoluble in water and difficult to clean off. For dissolving such molecules in water, soap is typically used. Explain why soap (molecular structure given below) can dissolve both oil and water.



4. The following is the phase diagram for a substance.
   a) Which of the following points on the phase diagram represents a …
      (i) Solid (ii) Gas
      (iii) Triple point (iv) Melting point

   b) On the diagram, connect the points that would correspond to the following transformations:
      (i) Vaporization (ii) Freezing (iii) Condensation

   c) If the substance had *stronger* intermolecular interactions, what changes would be observed in the phase diagram?

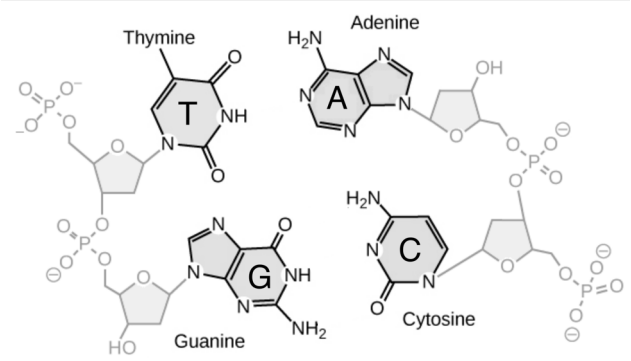


5. Sketch a phase diagram for element X, which has a triple point at 152 K and 0.371 atm, a boiling point of 166 K at 1.00 atm, and a melting point of 161 K at 1.00 atm. Mark the coordinates of key points on your graph.

   Will this element sublime at 1.00 atm?

If you have extra time:

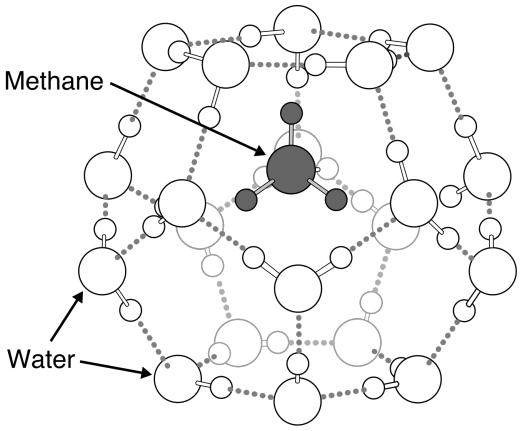
6. Deoxyribonucleic acid (DNA) is a class of vital biological macromolecules comprised of two helical strands held together by hydrogen bonds between base pairs Adenine-Thymine (A–T) or Cytosine-Guanine (C–G) as shown to the right.



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

7. 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?



   b) How does this differ from the intermolecular interactions among just water molecules?