

# Properties of Substances and Mixtures

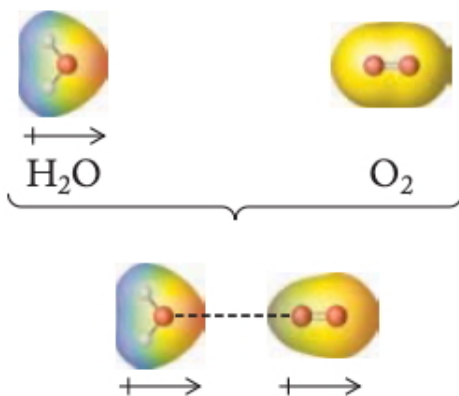
## Unit 3 Whiteboard Set

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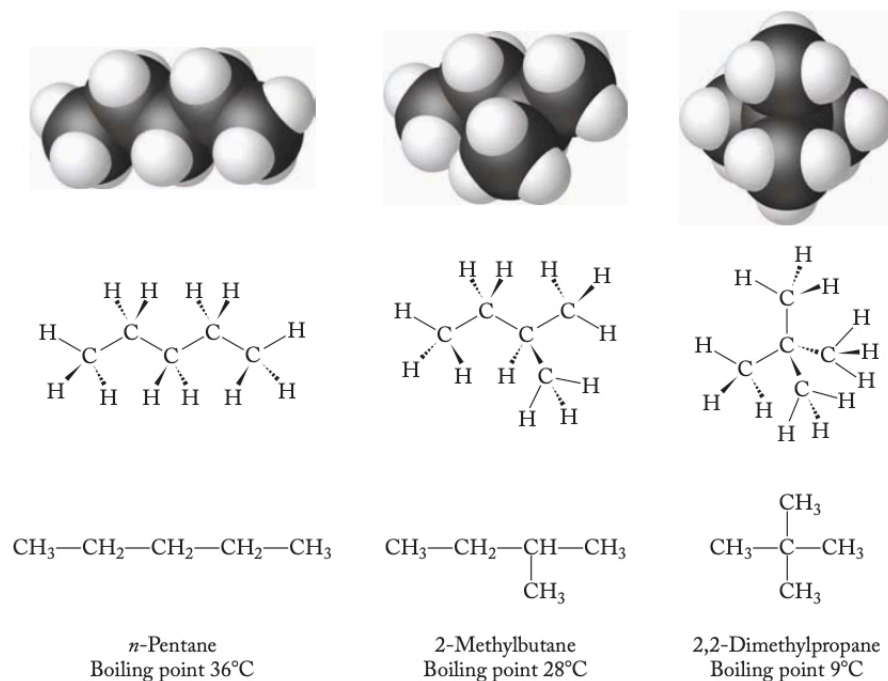
### Problem Set Questions

1. List the ionic compounds  $\text{CaO}$ ,  $\text{NaF}$ , and  $\text{CaF}_2$  in order of decreasing strength of attraction between their ions. Use the  $F_{\text{coulombic}}$  equation and the radii of each ion (found on the Wikipedia entry, **Ionic Radius**) to justify your answer.
2. The two strands of DNA in our cells are held together by intermolecular forces. Draw and identify the intermolecular forces present in the attraction between the Guanine and Cytosine base pairs.
3. Dimethyl ether ( $\text{C}_2\text{H}_6\text{O}$ ) has a molar mass of  $46.07 \text{ g mol}^{-1}$  and a boiling point of  $-24.9 \text{ }^\circ\text{C}$ . Ethanol has the same formula and therefore the same molar mass but has a boiling point of  $78.5 \text{ }^\circ\text{C}$ . Research the structures for these two molecules and use them to explain this difference in boiling point.
4. The diagram below shows the before and after of an interaction of a water molecule and an oxygen molecule using *electron density mapping*.
  - (a) Explain what the color represents.
  - (b) What type of intermolecular force forms between the water molecule and the oxygen molecule?



5. Explain which of the following compounds would be expected to dissolve in water, *a*) acetone or *b*) carbon tetrachloride.
6. Bottles of compressed  $\text{O}_2$  carried by climbers ascending tall mountains such as Mt. Everest or K2 have an internal volume of  $5.90 \text{ L}$ . Assume that the bottle has been filled with  $\text{O}_2$  to a pressure of  $138 \text{ atm}$  at  $25 \text{ }^\circ\text{C}$ .
  - (a) Assuming oxygen is behaving as an ideal gas, what is the mass of  $\text{O}_2$  in grams in the bottle?
  - (b) Explain if you believe the  $\text{O}_2$  molecules are behaving as an ideal gas in these conditions. If not, would the van der Waals equation predict a measured pressure higher or lower than the ideal gas law?

7. The diagram below shows the three possible **isomers** for  $C_5H_{12}$  and their respective boiling points.



Explain the reasoning for the difference in these boiling points using the definition of **polarizability** (*the relative ease with which the electron cloud in a molecule, ion, or atom can be distorted, inducing a temporary dipole*) to justify your answer.

8. A chemist was investigating a new food dye. They began by constructing a calibration curve of the dye by plotting the absorption measurements for five known concentrations. The standard curve is shown in Figure 1 below.
- What would have been the measured transmittance of the dye sample with a concentration of  $2.0 \times 10^{-2} \text{ mol L}^{-1}$
  - A drink sample using the dye has an Absorption value of 0.9. Calculate the concentration of dye in this drink sample.
  - Suppose the chemist put the drink sample in a cuvette that had not completely dried after rinsing with water. Describe the effect this would have on the calculated concentration of dye.

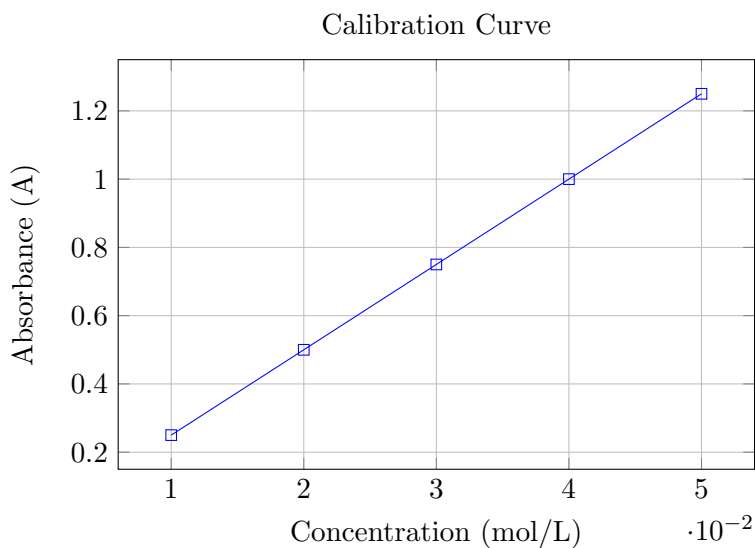


Figure 1: Calibration Curve for Dye Solution