Things to discuss:
-Beer's Law

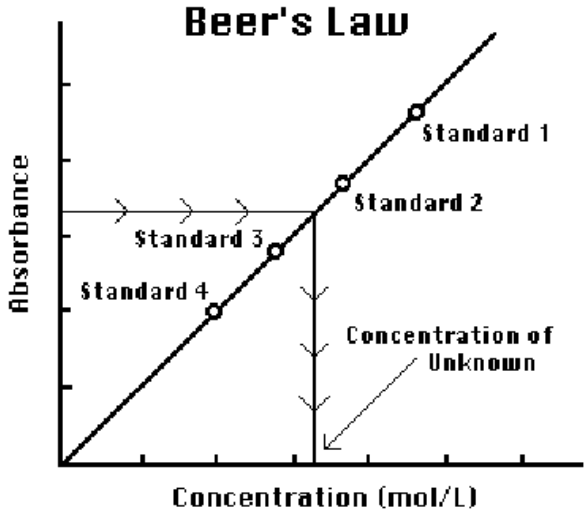
$A = \varepsilon lc$

A = absorbance

ε = absorptivity

l = pathlength

c = concentration



Things to discuss:
-Choosing the correct spectroscopy
-Visible/UV (aka UV-Vis)

"Ultraviolet/visible radiation is associated with transitions in electronic energy levels and so can be used to probe electronic structure."

-Infrared (aka IR)

"Infrared radiation is associated with transitions in molecular vibrations and so can be used to detect the presence of different types of bonds. "

[4.115] Federal regulations set an upper limit of 50 parts per million (ppm) of NH_3 in the air in a work environment [that is, 50 molecules of $NH_3(g)$ for every million molecules in the air]. Air from a manufacturing operation was drawn through a solution containing 1.00×10^2 mL of 0.0105 *M* HCl. The NH_3 reacts with HCl as follows:

$$NH_3(aq) + HCl(aq) \longrightarrow NH_4Cl(aq)$$

After drawing air through the acid solution for 10.0 min at a rate of 10.0 L/min, the acid was titrated. The remaining acid needed 13.1 mL of 0.0588 *M* NaOH to reach the equivalence point. **(a)** How many grams of NH_3 were drawn into the acid solution? **(b)** How many ppm of NH_3 were in the air? (Air has a density of 1.20 g/L and an average molar mass of 29.0 g/mol under the conditions of the experiment.) **(c)** Is this manufacturer in compliance with regulations?

4.101 Hard water contains Ca^{2+}, Mg^{2+}, and Fe^{2+}, which interfere with the action of soap and leave an insoluble coating on the insides of containers and pipes when heated. Water softeners replace these ions with Na^+. **(a)** If 1500 L of hard water contains 0.020 *M* Ca^{2+} and 0.0040 *M* Mg^{2+}, how many moles of Na^+ are needed to replace these ions? **(b)** If the sodium is added to the water softener in the form of NaCl, how many grams of sodium chloride are needed?

4.94 You choose to investigate some of the solubility guidelines for two ions not listed in Table 4.1, the chromate ion (CrO_4^{2-}) and the oxalate ion ($C_2O_4^{2-}$). You are given 0.01 *M* solutions (A, B, C, D) of four water-soluble salts:

Solution	Solute	Color of Solution
A	Na_2CrO_4	Yellow
B	$(NH_4)_2C_2O_4$	Colorless
C	$AgNO_3$	Colorless
D	$CaCl_2$	Colorless

When these solutions are mixed, the following observations are made:

Expt Number	Solutions Mixed	Result
1	A + B	No precipitate, yellow solution
2	A + C	Red precipitate forms
3	A + D	Yellow precipitate forms
4	B + C	White precipitate forms
5	B + D	White precipitate forms
6	C + D	White precipitate forms

(a) Write a net ionic equation for the reaction that occurs in each of the experiments. **(b)** Identify the precipitate formed, if any, in each of the experiments.

4.86 An 8.65-g sample of an unknown group 2A metal hydroxide is dissolved in 85.0 mL of water. An acid–base indicator is added and the resulting solution is titrated with 2.50 *M* HCl(*aq*) solution. The indicator changes color signaling that the equivalence point has been reached after 56.9 mL of the hydrochloric acid solution has been added. **(a)** What is the molar mass of the metal hydroxide? **(b)** What is the identity of the metal cation: Ca^{2+}, Sr^{2+}, Ba^{2+}?

4.62 **(a)** Calculate the molarity of a solution made by dissolving 12.5 grams of Na_2CrO_4 in enough water to form exactly 550 mL of solution. **(b)** How many moles of KBr are present in 150 mL of a 0.275 *M* solution? **(c)** How many milliliters of 6.1 *M* HCl solution are needed to obtain 0.100 mol of HCl?

13.5 Which of the following is the best representation of a saturated solution? Explain your reasoning. [Section 13.2]

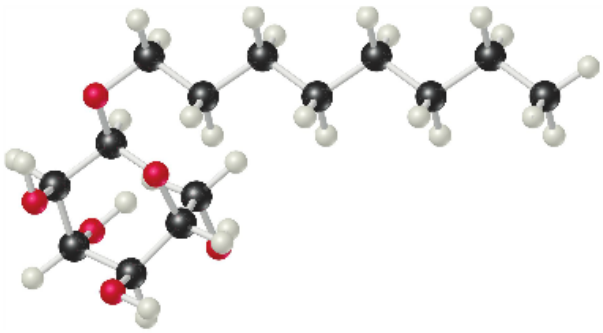
(a) (b) (c)

13.9 The figure shows two identical volumetric flasks containing the same solution at two temperatures.

(a) Does the molarity of the solution change with the change in temperature? Explain.

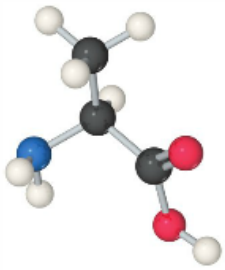
(b) Does the molality of the solution change with the change in temperature? Explain. [Section 13.4]

13.12 The molecule *n*-octylglucoside, shown here, is widely used in biochemical research as a nonionic detergent for "solubilizing" large hydrophobic protein molecules. What characteristics of this molecule are important for its use in this way? [Section 13.6]



13.17 An ionic compound has a very negative ΔH_{soln} in water. Would you expect it to be very soluble or nearly insoluble in water? Explain in terms of the enthalpy and entropy changes that accompany the process.

13.30 Would you expect alanine (an amino acid) to be more soluble in water or in hexane? Explain.



Alanine

13.41 A solution is made containing 14.6 g of CH_3OH in 184 g H_2O. Calculate (**a**) the mole fraction of CH_3OH, (**b**) the mass percent of CH_3OH, (**c**) the molality of CH_3OH.

13.53 Describe how you would prepare each of the following aqueous solutions, starting with solid KBr: (**a**) 0.75 L of 1.5×10^{-2} *M* KBr, (**b**) 125 g of 0.180 *m* KBr, (**c**) 1.85 L of a solution that is 12.0% KBr by mass (the density of the solution is 1.10 g/mL), (**d**) a 0.150 *M* solution of KBr that contains just enough KBr to precipitate 16.0 g of AgBr from a solution containing 0.480 mol of $AgNO_3$.

13.62 How does increasing the concentration of a nonvolatile solute in water affect the following properties: **(a)** vapor pressure, **(b)** freezing point, **(c)** boiling point; **(d)** osmotic pressure?