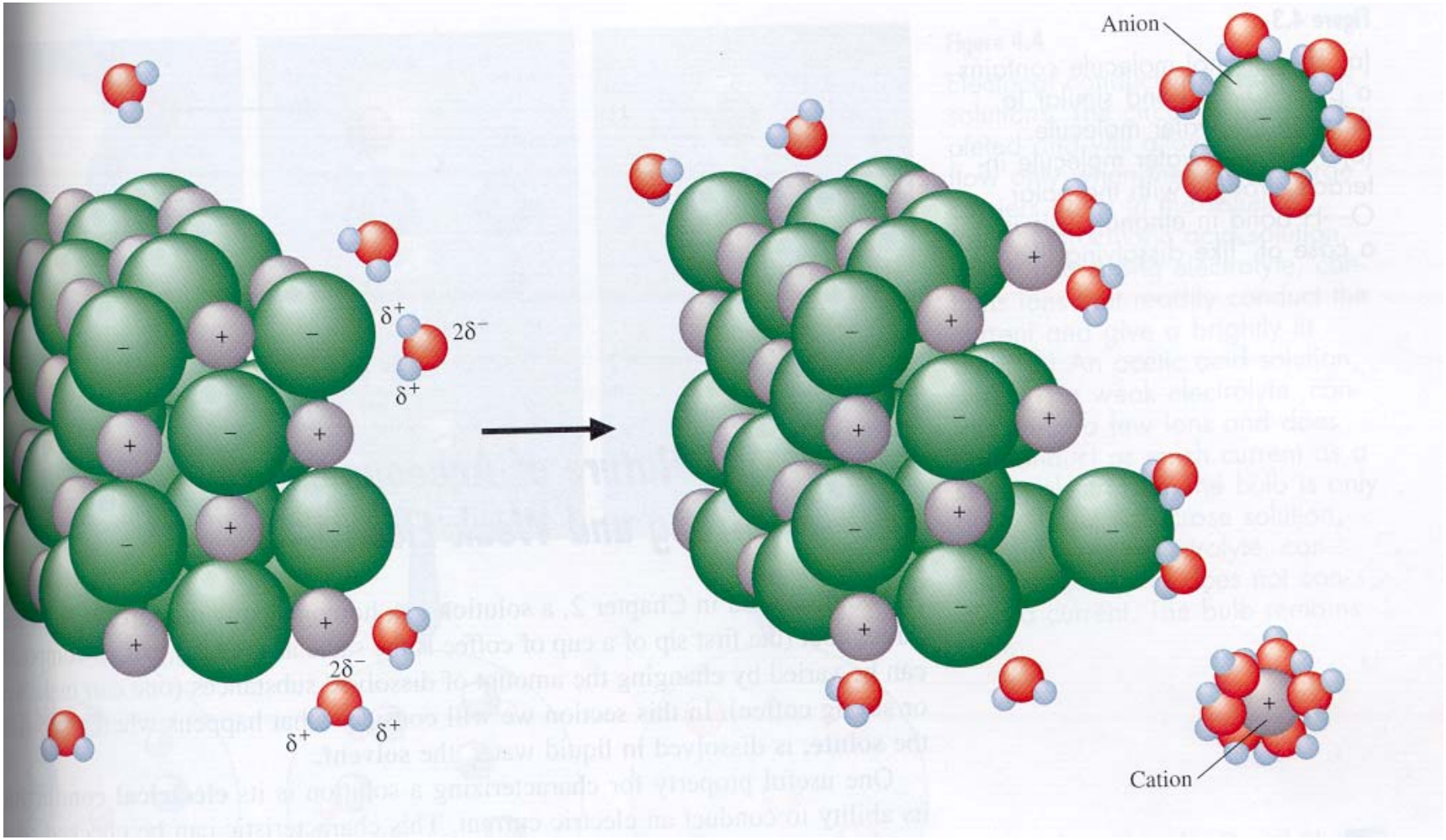
Solutions and Solubility

Why Things Dissolve

- Substances will dissolve if they are attracted to each other.
- Polar substances will dissolve other polar substances since they have both positive and negative ends to attract.
- Non-polar substances will dissolve non-polar substances since they can induce dipoles in order to attract.
- Polar substances can dissolve ionic substances since the polar ends of the molecules can attract both ions in an ionic compound.

Hydration

- When an ionic compound is put into water, there is an attraction between the polar water and the two ions.
- If the attraction is strong enough, then the ions will begin to be pulled off. This usually takes several water molecules to surround the ion to accomplish the task.
- The ions are then said to be hydrated.
  - The negative ion is hydrated by the positive ends of the water molecules.
  - The positive ion is hydrated by the negative ends of the water molecules.



- Water molecules “pull apart ions”.
- Also called dissociation.

Solubility

- A solute (substance being dissolved) is said to be soluble if it is highly likely to break apart and dissolve in the solvent (substance doing the dissolving).
- If there is no apparent limit to the amount of dissolving that can occur, then we say the substances are miscible.
- Insoluble means that a substance does not have a high probability of breaking apart (although some does).
- Slightly soluble means that a substance has some probability of breaking apart.

Solutions

- Solutions are dynamic.
- Some of the solvent is constantly going into solution while other particles are recrystallizing.
- There is a balance (equilibrium) that occurs where the rate of dissolving and the rate of recrystallization become equal.
- That does not mean the amounts will be equal!
- That's why even substances that are insoluble can dissolve in water, only in very small amounts.
- That doesn't mean they aren't harmful.

Some are better than others!

- If the strength of the attraction between the solute particles is large, then the water molecules attraction may not be strong enough to pull it apart very often. Thus insoluble.
- If the strength of attraction between the solute particles is small, then the substance will be soluble.
- This is also related to other ideas like entropy (move toward disorder), and the common-ion effect (whether there is already one of the ions in the solution to begin with lowering the probability of any more dissolving)

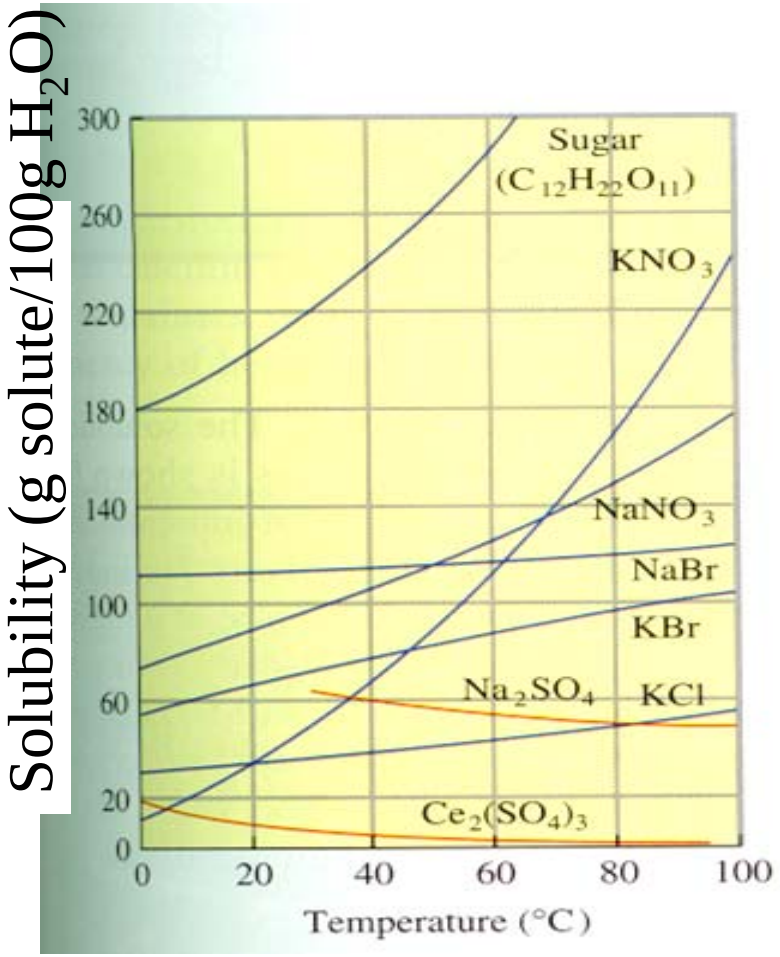
Results of dissolving

- If an ionic compound dissolves, it will conduct electricity, so it is called an electrolyte.
  - The ions become free to roam.
- When two substances mix, their total volume is less than the sum of the two individual volumes.
  - The solute can fill up spaces between the solvent particles.
- Mixtures will have a slope to the heating curve during a phase change.
- The freezing point will be lowered and the boiling point will be raised in the solvent (will discuss and calculate later in the course.)

T and P effects on solubility

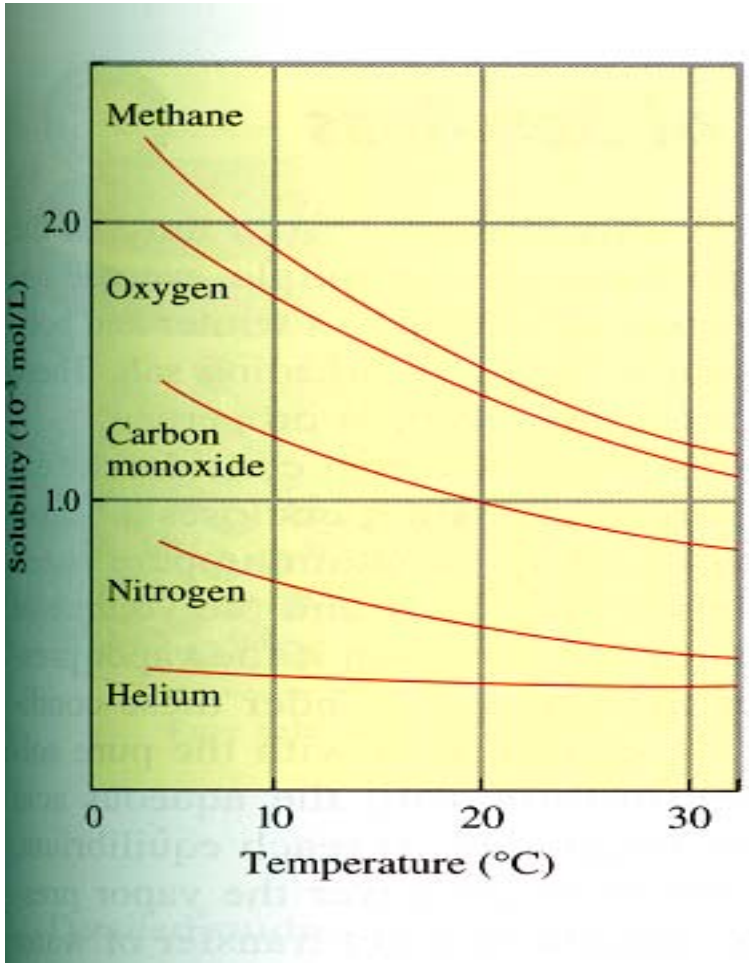
- Increasing the temperature tends to increase the solubility of a solid in water.
  - Water molecules can move around faster and attract more ions.
- Increasing temperature will lower solubility of gases.
  - Their already weak attraction is lowered as the gas molecules gain kinetic energy.
- Pressure only changes the solubility of gases and is a direct relationship.
  - More pressure pounds the gas into the solution.

Solubility curves



- This graph shows how much solute can be dissolved in 100g of water at a given temperature.
- The line represents the saturation point, or the point at which no more can be dissolved.
- These are all solids.

Gas solubility curve



- The saturation point of gases goes down with increasing temperature.
- The solubility of gases is about 10000 times less than that of solids.

Saturation

- The point at which no more solute can dissolve in that amount of solvent at a given temperature and pressure is called the saturation point.
- If you can add more, then the solution is said to be unsaturated.
- If you dissolved more than you should be able, you made a supersaturated solutions.
- Saturation points are determined by heating up solvent, dissolving a known quantity of solute, and determining what temperature the solute begins to recrystallize.

Supersaturated

- When the solvent is heated, you can sometimes get a large amount of solute to dissolve.
- When you cool it down, some solutes reach a somewhat stable state in the solution and will not recrystallize without some outside interaction.
- Shaking, scratching, adding another crystal are all enough to cause recrystallization to occur.
- It will then happen very quickly.

Ways to increase rate of dissolution

- Stirring – moves the saturated parts of the solution away from the solute and brings in the unsaturated parts of the solution to encourage more hydration. (kool-aid)
- Increase surface area – breaking up particles of the solute will increase the surface area that hydration can take place making it dissolve faster. (sugar packet vs. sugar cube)
- Neither of these things will increase the <u>amount</u> that you can dissolve.

Increase dissolution part 2

- Change the temperature – make conditions more favorable for dissolving and it will happen faster.
- Increase amount of solvent – make it harder to make any region saturated and the solute will dissolve quicker.
- Both of these also increase the amount of solvent that can be dissolved.