Understanding Solubility

- "Solubility" refers to the ability of an ionic compound to dissolve in water. More soluble means more dissolves.
- There is no such thing as "completely insoluble." Solubility is relative. Rather than applying the dualism of soluble vs. insoluble, it is more accurate to talk about *degree of solubility*.
- At the macroscopic level, a common threshold for determining solubility is 0.1 to 1 gram per 100 mL of water.
- At the particle level, when an ionic solid dissolves in water, it breaks apart into single ions which then become surrounded by water molecules.

13

Solubility of Some Common Sulfate Compounds (at 25ºC)

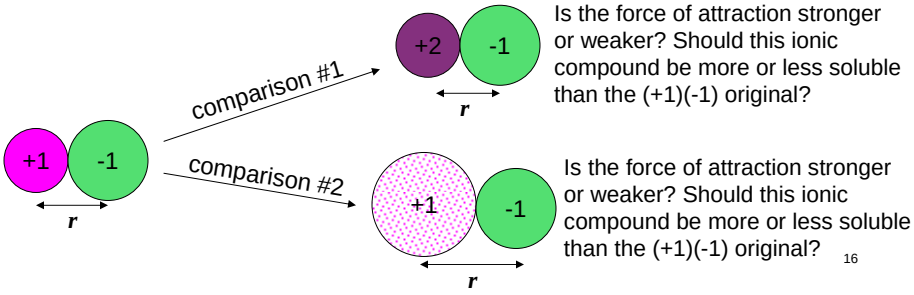
Formula	Solubility ($g/100cm^3$)	Solubility (mol/L)
$BaSO_4$	0.00246	0.00010
$PbSO_4$	0.00425	0.00014
$SrSO_4$	0.0113	0.00060
Hg_2SO_4	0.060	0.0012
$CaSO_4$	0.209	0.0150
Ag_2SO_4	0.57	0.018
Na_2SO_4	4.76	0.335
$MgSO_4$	26.0	2.16

14

What Holds Ionic Solids Together?

Coulomb's Law: $F = \frac{k\,Q_+\,Q_-}{r^2}$

- F: Force of attraction
- k: proportionality constant
- Q_+: Charge on positive ion
- Q_-: Charge on negative ion
- r: distance between ions



Is the force of attraction stronger or weaker? Should this ionic compound be more or less soluble than the (+1)(-1) original?

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16

Solubility: Physical Principles

- The force of attraction between oppositely charged ions is proportional to the magnitude of the charges of those ions.
- During dissociation, oppositely charged ions in the solid phase are separated from each other and dissolved in water.
- This suggests that:
  - If a salt is composed of highly charged ions, it is not very soluble.
  - If a salt is composed of ions with lower charges, it is probably soluble.
- General rule to use as a starting point: any salt involving a +1 cation or a -1 anion is *likely* to be soluble.

Acknowledgment: Blake, B. (2003) *J. Chem. Ed.* **80**, 1348.

17