Taxonomy of Defects: Classify by Dimensionality

0-dimensional: point defects
1-dimensional: line defects
2-dimensional: interfacial defects
3-dimensional: bulk defects

Point Defects

- localized disruption in regularity of the lattice
- on and between lattice sites

1. Substitutional Impurity
   - occupies normal lattice site
   - dopant ☺, e.g., P in Si; or B in $C_{(diamond)}$
   - alloying element ☺, e.g., Mg in Al; or Ni in Au
   - contaminant ☹, Li^+ in NaCl

2. Interstitial Impurity
   - occupies position between lattice sites
   - alloying element ☺, e.g., C in Fe; or H in $LaNi_5$
   - contaminant ☹, H in Fe

3. Vacancy
   - unoccupied lattice site
   - formed at time of crystallization
   - formed in service under extreme conditions

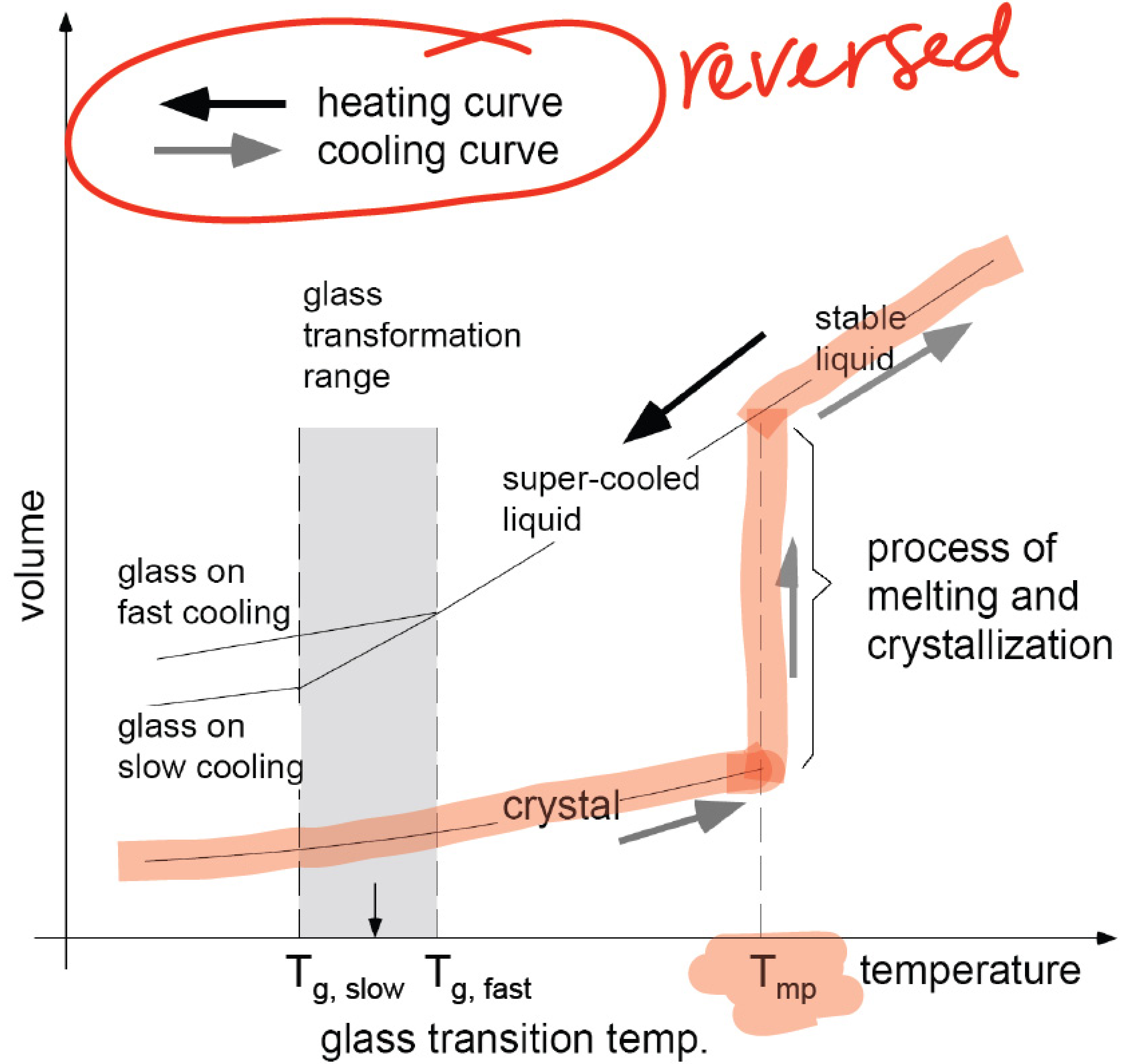
Point Defects in Ionic Crystals

- special issues associated with the need to maintain global charge neutrality

1. Schottky Imperfection
   - formation of equivalent (not necessarily equal) numbers of cationic and anionic vacancies

2. Frenkel Imperfection
   - formation of an ion vacancy and an ion interstitial

3. F-Center
   - formation of an ion vacancy and bound electron



heating curve
cooling curve
reversed
glass
transformation
range
stable
liquid
super-cooled
liquid
process of
melting and
crystallization
glass on
fast cooling
glass on
slow cooling
crystal
volume
$T_{g, slow}$
$T_{g, fast}$
T_{mp}
temperature
glass transition temp.

TABLE 14.6 Properties of reactions that obey zeroth-, first-, and second-order rate laws

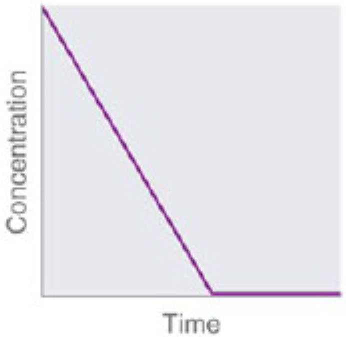
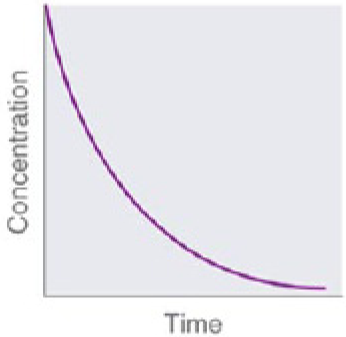
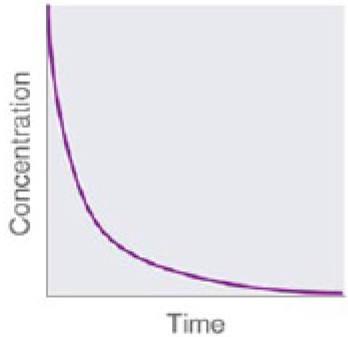
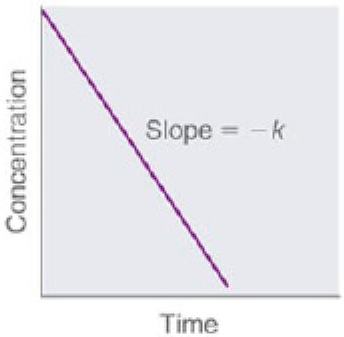
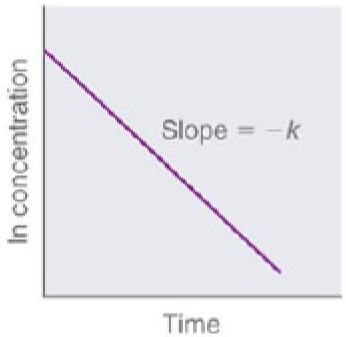
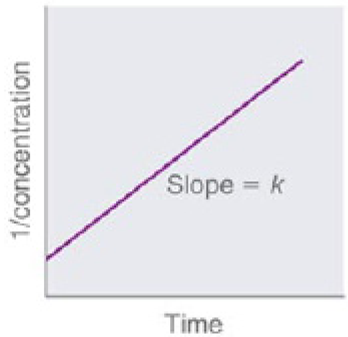
	Zeroth Order	**First Order**	**Second Order**
Differential rate law	$\text{Rate} = -\frac{\Delta[\text{A}]}{\Delta t} = k$	$\text{Rate} = -\frac{\Delta[\text{A}]}{\Delta t} = k[\text{A}]$	$\text{Rate} = -\frac{\Delta[\text{A}]}{\Delta t} = k[\text{A}]^2$
Concentration vs. time			
Integrated rate law	$[\text{A}] = [\text{A}]_0 - kt$	$[\text{A}] = [\text{A}]_0 e^{-kt}$ or $\ln[\text{A}] = \ln[\text{A}]_0 - kt$	$\frac{1}{[\text{A}]} = \frac{1}{[\text{A}]_0} + kt$
Straight-line plot to determine rate constant			
Relative rate vs. concentration	[A], M — Rate, M/s 1 — 1 2 — 1 3 — 1	[A], M — Rate, M/s 1 — 1 2 — 2 3 — 3	[A], M — Rate, M/s 1 — 1 2 — 4 3 — 9
Half-life	$t_{1/2} = \frac{[\text{A}]_0}{2k}$	$t_{1/2} = \frac{0.693}{k}$	$t_{1/2} = \frac{1}{k[\text{A}]_0}$
Units of *k*, rate constant	M/s	1/s	$M^{-1} \cdot \text{s}^{-1}$

Table 8.7

Solubility Rules for Ionic Compounds in Water

Soluble Ionic Compounds

The Na^+, K^+, and NH_4^+ ions form *soluble ionic compounds*. Thus, NaCl, KNO_3, and $(NH_4)_2CO_3$ are *soluble ionic compounds*.

The nitrate ion (NO_3^-) forms *soluble ionic compounds*. Thus, $Cu(NO_3)_2$ and $Fe(NO_3)_3$ are soluble.

The chloride (Cl^-), bromide (Br^-), and iodide (I^-) ions usually form *soluble ionic compounds*. Exceptions include ionic compounds of the Pb^{2+}, Hg_2^{2+}, Ag^+, and Cu^+ ions. $CuBr_2$ is soluble, but CuBr is not.

The sulfate ion (SO_4^{2-}) usually forms *soluble ionic compounds*. Exceptions include $BaSO_4$, $SrSO_4$, and $PbSO_4$, which are insoluble, and Ag_2SO_4, $CaSO_4$, and Hg_2SO_4, which are slightly soluble.

Insoluble Ionic Compounds

Sulfides (S^{2-}) are usually *insoluble*. Exceptions include Na_2S, K_2S, $(NH_4)_2S$, MgS, CaS, SrS, and BaS.

Oxides (O^{2-}) are usually *insoluble*. Exceptions include Na_2O, K_2O, SrO, and BaO, which are soluble, and CaO, which is slightly soluble.

Hydroxides (OH^-) are usually *insoluble*. Exceptions include NaOH, KOH, $Sr(OH)_2$, and $Ba(OH)_2$, which are soluble, and $Ca(OH)_2$, which is slightly soluble.

Chromates (CrO_4^{2-}), phosphates (PO_4^{3-}), and carbonates (CO_3^{2-}) are usually *insoluble*. Exceptions include ionic compounds of the Na^+, K^+, and NH_4^+ ions, such as Na_2CrO_4, K_3PO_4, and $(NH_4)_2CO_3$.