CHEMWHIZ QUICK REFERENCE

TOPIC 18

Intermolecular Forces & Phase Changes

Identifying IMFs, their trends, phase transitions and diagrams, heating curves, and crystalline solids.

01 Identify the main IMF

METHOD

Ionic solid → ionic attraction; ionic dissolved → ion-dipole. Polar molecule with H on F/O/N → hydrogen bonding; other polar → dipole-dipole; nonpolar → London dispersion (present in all). Geometry sets polarity: symmetric polar bonds cancel (nonpolar); a lone pair on the central atom breaks symmetry (polar).

02 IMF strength & properties

CORE RULE

Ionic > hydrogen bonding > dipole-dipole > dispersion (at similar size). But a big polarizable nonpolar molecule can beat a small polar one (I_2 > HCl). Stronger IMF → higher boiling point, viscosity, surface tension; lower vapor pressure.

03 Phase transitions

REFERENCE

Transition	Name	Heat
solid → liquid	melting	endo
liquid → solid	freezing	exo
liquid → gas	vaporization	endo
gas → liquid	condensation	exo
solid → gas	sublimation	endo
gas → solid	deposition	exo

04 Temperature is flat during a phase change

CORE RULE

During a phase change T stays constant: heat changes potential energy (breaking/forming IMFs), not kinetic. Phase change: $Q = \Delta H \times$ moles (ΔH_{fus} or ΔH_{vap}). Within one phase: $Q = m \cdot s \cdot \Delta T$.

05 Water heating curve (per mole/gram)

METHOD

Up to 5 steps: warm ice (s = 2.09 J/g·°C) → melt at 0 °C (6.02 kJ/mol) → warm water (4.18) → boil at 100 °C (40.7 kJ/mol) → warm steam (1.84). Sum only the segments the path crosses; convert mass → moles (÷ 18.015) for the ΔH steps.

06 Non-water substances

WATCH OUT

Use the water defaults (ΔH_{fus} 6.02, ΔH_{vap} 40.7 kJ/mol) ONLY for water. For any other substance, take its own ΔH_{fus}, ΔH_{vap}, and specific heats from the problem; all constants must match the named substance.

07 Phase diagram

CORE RULE

Regions: solid (low T, high P), liquid (middle), gas (high T, low P). Lines = two phases coexist. Triple point: all three coexist. Critical point: end of the liquid-gas line (supercritical beyond). Normal boiling point: liquid-gas line at 1 atm.

08 Crystalline solids

REFERENCE

Type	Bonding	Properties
Ionic	ion attractions	hard, brittle; conducts only molten/dissolved; high MP
Metallic	electron sea	shiny, malleable; conducts; variable MP
Covalent network	3D covalent	very hard; insulator; very high MP
Molecular	IMFs	soft; insulator; low MP

09 Unit-cell density

CORE RULE

$\rho = n \cdot M / (N_A \cdot a^3)$, n = atoms per cell (SC 1, BCC 2, FCC 4). Convert edge a from pm to cm first (1 pm = 10^{-10} cm) for ρ in g/cm³. Rearrange to solve for a, M, or n.

10 Atomic radius by cell type

REFERENCE

Cell	Atoms/cell	Radius
SC	1	$r = a/2$
BCC	2	$r = a\sqrt{3}/4$
FCC	4	$r = a\sqrt{2}/4$

11 Identify the element

CORE RULE

After computing M from density + cell data, match within ±0.5 g/mol of the tabulated mass AND confirm the crystal structure. Near-mass elements need the cell-type check: Co (58.93, hcp) and Ni (58.69, fcc) differ by only ~0.24 g/mol, so structure is what distinguishes them.