Summary: Characteristics of Crystalline Solids

Crystal Type	Types of Particles Joined	Conditions for Formation	Type of Attraction Between Particles	Physical Properties of the Crystal (hardness of the crystal, melting point, boiling point, solubility in water, electrical conductivity)
Ionic Solids	positively charged metal ions with negatively charged non-metal ions	- form when ΔEN between the bonding ions is greater than 1.70	Strong electrostatic attractions between ions (and LDFs) Very strong. 600-4000 kJ/mol	-hard, brittle solids -high melting points -most dissolve in polar solvents such as water -conduct electricity in solution (are electrolytes) eg. NaCl, MgI_2, KBr, $CaSO_4$
Network Solids (Covalent)	group IV atoms (carbon and silicon)	-form when atoms from group IV can form covalent bonds with each other or to other ions in large arrays in two or three dimensions	Covalent bonds in 2 or 3 dimensions. Very strong. 300-800 kJ/mol.	-very hard, brittle solids -atoms are all covalently bonded to one another, so network solids are insoluble in most solvents -generally do not conduct electricity (except graphite) as pure substances or in solution eg. diamond, graphite and SiO_2 (as quartz or mica)
Metallic Solids	neutral metal atoms	-when metal atoms are together, they "pool" their electrons in a loosely held "sea" of electrons which surround the positively charged metal nuclei	Metallic bonds. Strong. 50-800 kJ/mol	-hard, malleable solids that are lustrous -good conductors of electricity and heat as solids -generally insoluble in water (they are non-polar) eg. pure Zn, Al, Pb, Fe and alloys (think about the properties of aluminum foil)
Molecular (Covalent) Solids a) Polar	non-metal atoms of very different electronegativities	-non-metal atoms with ΔEN between 0.50 and 1.70 share valence electrons unequally to form polar covalent bonds - the bonded electrons are shifted toward the more EN atom	Electrostatic attraction between dipoles and LDFs. Intermediate strength. Can be strengthened by hydrogen bonding.	-dipole-dipole attraction between partially charged regions of the molecule (δ- and δ+) hold the atoms together as soft solids (many **small** polar compounds are liquids at SATP, eg. H_2O, CH_2O, CH_3CH_2OH , CH_3COOH) -are soluble in polar solvents such as water or alcohols -do not conduct electricity in their pure form or in solution eg. $C_6H_{12}O_6$ (glucose), $C_2H_2O_4$ (oxalic acid in kidney stones) and proteins
b) Non-Polar	non-metal atoms of very similar electronegativities	-non-metal atoms with ΔEN of less than 0.50 share valence electrons equally to form pure (non-polar) covalent bonds - random motion of electrons in atoms creates temporary, very weak dipoles which create weak attraction between molecules	London dispersion forces (LDFs) only. Very weak. 0-50 kJ/mol	-London dispersion forces (LDFs) between molecules are very weak -large, straight pure non-polar molecules may have sufficient dispersion forces to hold the molecules into a very soft solid (eg. paraffin wax and animal fats) (many small non-polar substances are gases and liquids at SATP) -are non-polar so do not dissolve in polar solvents such as water -do not conduct electricity in their pure form or in solution

In general: as **polarity** of molecules increases, attraction between them increases so melting point and boiling point increase
as **size** of molecules increases, attraction between them increases so melting point and boiling point increase