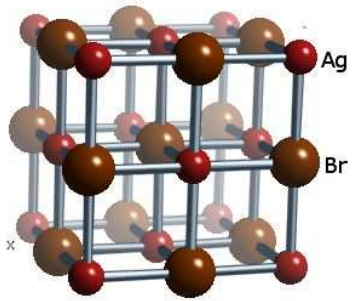
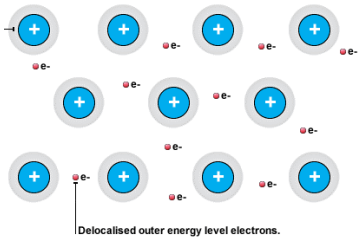
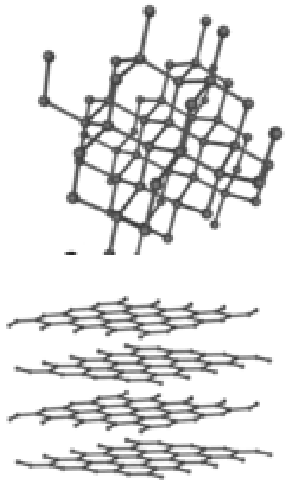
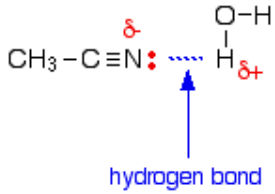
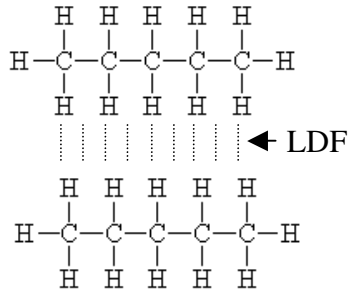
Crystalline Solids and their Classification by the Nature of Bonding and Inter-molecular Attraction

Ionic Solids	Metallic Solids	Covalent Network Solids	Covalent Polar solids	Covalent Non-polar Solids
How to Recognize Them: • metal + non-metal • ΔEN > 1.70	How to Recognize Them: • two or more metals • ΔEN very small	How to Recognize Them: • contains C or Si • C as graphite or diamond • SiO_2 (sand)	How to Recognize Them: • two or more non-metals • asymmetrical molecule • very polar if ΔEN is 0.50 – 1.70	How to Recognize Them: • two or more non-metals • molecule is symmetrical shape &/or ΔEN is small eg. C - H
What Holds the Solid Together: • ions have full + and – charges which are strongly attracted in 3-D, forming a crystal lattice • essentially held together by ionic bonds in 3 dimensions • strength of ionic bonding increases as the charge on the ion increases 	What Holds the Solid Together: • metal atoms have low IE and EN so they pool their valence electrons forming positive ions in a delocalized "electron sea" • metal atoms are held together by the mutual attraction of the metal ions for the valence electrons • strength of metallic bonding increases as # valence e- increases (→ on PT) 	What Holds the Solid Together: • atoms are covalently bonded by shared electrons in three dimensions (2D for graphite) to form one huge molecule 	What Holds the Solid Together: • because of larger ΔEN and asymmetry, regions in the molecule have permanent partial charges (δ- and δ+) called dipoles • dipole-dipole attraction between adjacent molecules (δ- attract δ+) and this holds the molecules to one another • strength of dipole-dipole attraction increases as ΔEN increases • H-bonding is a very strong type of dipole-dipole attraction 	What Holds the Solid Together: • because of random motion of electrons in atoms and molecules, very small, temporary charges are created which induce the opposite charge on nearby atoms. These temporary charges attract one atom or molecule to the other (London Dispersion Forces) 
Physical Properties: • ion to ion attraction is very strong (essentially have ionic bonds in three dimensions) • very high melting and boiling points • ionic compounds are extremely polar so they are usually soluble in water	Physical Properties: • metallic bonding is strong • high to very high melting and boiling points • delocalized electrons allow good conductivity of heat and electricity, malleability • non-polar (low ΔEN) so they are not soluble in water	Physical Properties: • covalent bonds in 3-D • very high melting and boiling points • non-polar (low ΔEN) and the atoms are tightly bonded in 3-D so they are not soluble in water	Physical Properties: • as ΔEN increases, the amount of charge on the molecules increases, the polarity of the molecule increases and the strength of inter-molecular attraction increases • medium melting and boiling points; mp and bp increase as ΔEN and inter-molecular attraction increases • solubility in water increases as ΔEN and polarity increase	Physical Properties: • molecules are non-polar and essentially uncharged • low inter-molecular attraction so there are low melting and boiling points • do not dissolve in water because they are not polar (likes dissolve likes) • dissolve well in non-polar solvents like gasoline and mineral oil

Solids held together by bonding (intra-molecular attraction) in three dimensions. All have high melting points.

Solids held together by van der Waal's forces (weaker inter-molecular attraction) so melting points are low.