Characteristics of Crystalline Solids

Crystal Type		Particles in Crystal	Principle Attractive Forces Between Particles	Melting Points	Electrical Conductivity of Solid of Liquid	Characteristics of the Crystal	Conditions for Formation	Examples
Ionic Crystals		Cations and Anions	Electrostatic Attractions between ions Very Strong 600-4000 kJ/mol	High	Solid – Low Liquid – High	Hard, Brittle. Most dissolve in polar substances such as water.	Formed between atoms of widely-differing electronegativities.	
Covalent Network Crystals		Atoms	Covalent Bonds Very Strong 300-800 kJ/mol	Very High	Very Low (exception – graphite)	Very Hard. Insoluble in most ordinary liquids	Most are formed by two elements of Group IV or by elements whose average periodic group is 4	
Metallic Solids		Metallic Cations with delocalized electrons	Metallic Bonds Strong 50-800 kJ/mol	Most are High	Solid – High Liquid - High	Most are hard, malleable, ductile. High thermal conductivity. Generally insoluble in liquids. Generally Soluble in molten metals.	Formed by electropositive elements (low electronegativity)	
Molecular Crystals	Polar	Polar Molecules	Electrostatic attractions between dipoles. Intermediate Strength Can be strengthened by hydrogen bonding	Intermediate	Solid – Very Low Liquid – Very Low	More fragile than ionic crystals. Most are soluble in polar solvents such as water.	Formed from asymmetrical molecules containing polar bonds. Such bonds are formed between atoms having moderate differences in electronegativity	
	Non-Polar	Non-Polar Molecules	Van der Waals forces Weak 0-50 kJ/mol	Low	Solid – Very Low Liquid – Very Low	Very soft. Most are soluble in non-polar solvents such as ethers, hexane	Formed from atoms or symmetrical molecules containing onl lo-polarity covalent bonds. Such bonds are formed between atoms having a small difference in electronegativity	

Investigating Solid Types

_____ 1. A substance is a white solid, which melts at a temperature greater than 700oC. The substance is extremely hard and not workable. It is a poor conductor of heat and electricity in both its solid and liquid states. How would you classify the substance?
   a. Ionic
   b. Network
   c. Molecular
   d. Metallic
   e. Atomic

_____ 2. A substance is a silvery white solid, which melts at 675oC to give a silvery liquid. The substance conducts electricity in both its solid and its liquid states. How would you classify the substance?
   a. Ionic
   b. Network
   c. Molecular
   d. Metallic
   e. Atomic

_____ 3. A substance is a white powder, which melts at 660oC to give a transparent liquid. The substance does not conduct electricity in its solid state but it does in its liquid state. How would you classify the substance.
   a. Ionic
   b. Network
   c. Molecular
   d. Metallic
   e. Atomic

4. Supposed that you have a sample of an unknown solid. Outline the steps that you would take to identify the type of solid it is. Indication the possible results for each type of solid