Crystal Type	Particles in Crystal	Principal Attractive Forces Between Particles	Melting Point	Electrical Conductivity of Liquid	Characteristics of Crystal	Conditions for Formation	Examples
Ionic crystals	Positive and negative ions	Electrostatic attractions between ions. Very strong: 600–4000 kJ/mol	High	High. They also conduct electricity in solution.	Hard, brittle. Most dissolve in polar solvents.	Formed between atoms with a large difference (≥ 1.7) in electronegativity.	All salts All metal hydrides KCl CaF_2 CsBr MgO $BaCl_2$ NaCl
Covalent network crystals	Atoms	Covalent bonds. Very strong: 300–800 kJ/mol	Very high	Poor	Very hard. Insoluble in most ordinary liquids. Covalent bonds extend from one atom to another in a continuous pattern.	Most formed by two elements of Group 14 or by elements whose average periodic group number is 14	Diamond AlN SiC $CuCl_2$ BeO Mg_2Sn Mg_2Si
Metallic crystals	Positive metal atom kernels and mobile valence electrons	Metallic bonds. Strong: 50–600 kJ/mol	Most are high	Very high	Most are hard, malleable, ductile. High thermal conductivity. Generally insoluble in liquids. Usually soluble in molten metals.	Formed by elements with low first ionization energies and vacant valence levels.	Cu Bi Zn Fe Li Pt Ca Pb La V Cr $CuZn_3$
Molecular crystals (a) Polar	Polar molecules	Dipole-dipole forces. Intermediate strength. Can be strengthened by hydrogen bonds.	Intermediate	Very low	More fragile than ionic crystals. Most are soluble in polar solvents. Usually liquids or solids at room temperature.	Formed from molecules with asymmetrical charge distributions. Polar covalent bonds are formed between atoms having a moderate difference (0.4–1.6) in electronegativity.	All acids Many organic compounds PF_3 H_2O NH_3 SO_3 $CHCl_3$
(b) Nonpolar	Atoms or nonpolar molecules	Dispersion forces. Weak. 0–5 kJ/mol	Low	Extremely low	Very soft. Most are soluble in nonpolar or slightly polar solvents. Usually gases at room temperature.	Formed from atoms or from molecules containing symmetrical charge distributions. Nonpolar covalent bonds are formed between like atoms or atoms having a small difference (0–0.3) in electronegativity.	All diatomic molecules Cl_2 Ar S_8 H_2 I_2 CH_4 CCl_4 Ne N_2 CO_2 BF_3 SF_6

Name ______________________ Date ____________ Class ____________

Types of Bonds

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Choose words from the list to fill in the blanks in the paragraphs.

Word List

bond energy
electronegativity
hydrogen bond
ionic crystal
crystal lattice
network solid
polar molecule
polarity
potential energy
van der Waals force

__(1)__ is a measure of the attraction of an atom for electrons in a chemical bond. This attraction accounts for the degree of ionic or covalent character, or __(2)__, of a bond between atoms. An electrically neutral, chemically bonded combination of atoms that has excess positive charge at one end and excess negative charge at the other is called a(n) __(3)__. In a(n) __(4)__, covalent bonds extend from one atom to another in a continuous, highly extended pattern. In a(n) __(5)__, charged particles occur in a regular pattern called a(n) __(6)__.

A bond such as that between a hydrogen atom of one water molecule and the oxygen atom of another is called a(n) __(7)__. A weak force of attraction between molecules that arises because of shifting positions of electrons is called a(n) __(8)__.

__(9)__ is a measure of the strength of a chemical bond. Generally, a chemical change will tend to occur if it leads to a lower state of __(10)__.

1. ____________
2. ____________
3. ____________
4. ____________
5. ____________
6. ____________
7. ____________
8. ____________
9. ____________
10. ____________