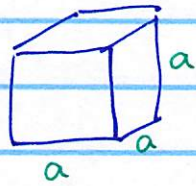
1/30/2019

Interesting application:

- imagine we have a "tiny crystal" of a special form of iron whose unit cell is fcc w/ edge length of 544pm. (x-ray diffraction) face-centered cubic

What is its density? $d = m/V$ (typically g; cm^3 or mL)



$V = a^3$

m = mass of fe atoms in unit cell.

$$V = \left(544\,\text{pm} \times \frac{10^{-12}\,\text{m}}{\text{pm}} \times \frac{\text{cm}}{10^{-2}\,\text{m}}\right)^3 = (544 \times 10^{-10}\,\text{cm})^3 = 1.6099 \times 10^{-22}\,\text{cm}^3$$
$$= 1.6099 \times 10^{-22}\,\text{cm}^3$$

fcc: 8 atoms @ corners, 6 atoms @ faces.

$$\#\text{atoms} = 8 \times \left(\tfrac{1}{8}\right) + 6 \times \left(\tfrac{1}{2}\right) = 4 \text{ atoms of Fe}$$

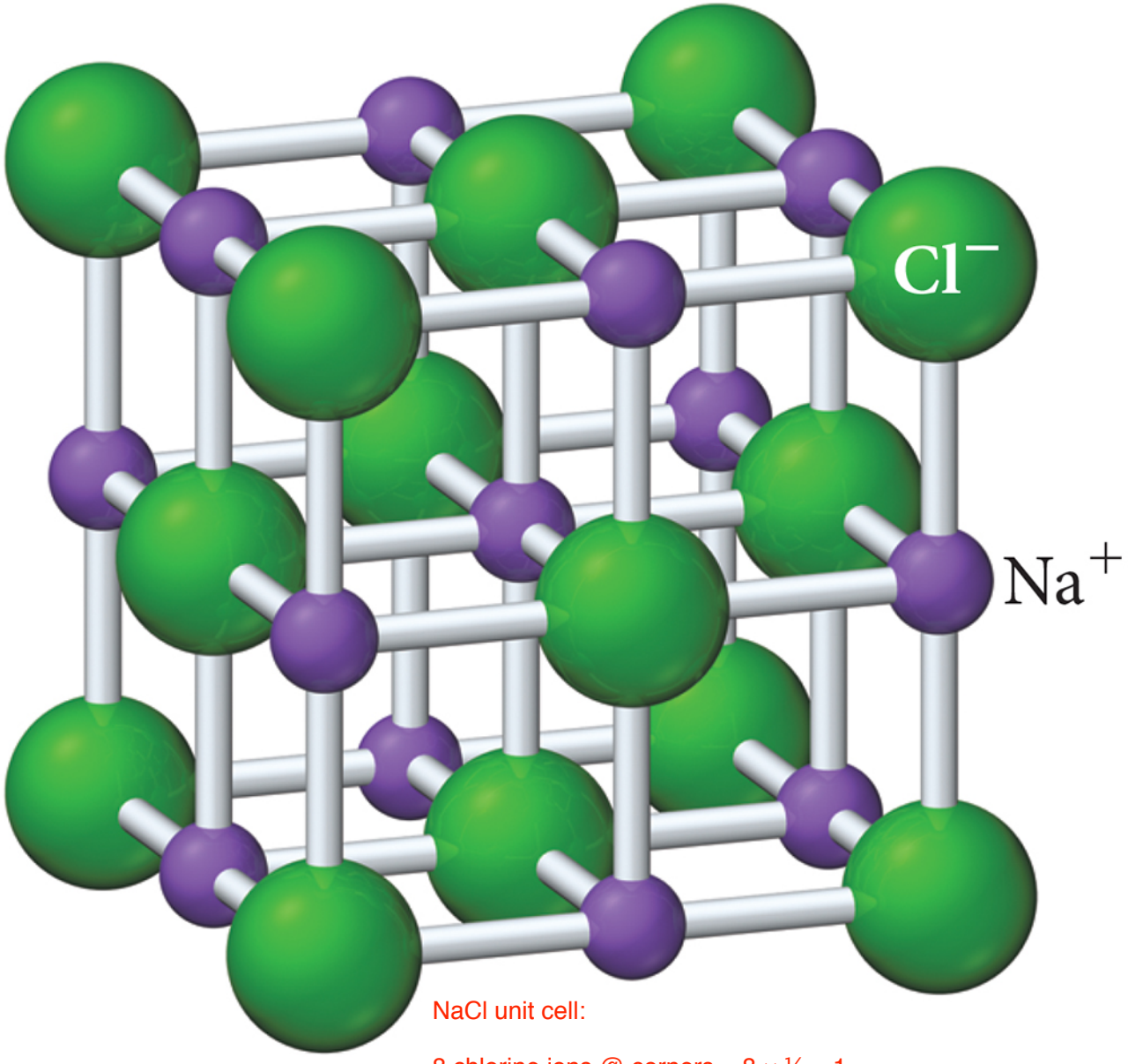
$$1\text{ mol Fe atoms} = 55.85\,\text{g} = 6.022 \times 10^{23}\text{ atoms Fe}$$

$$1\text{ atom Fe} = \frac{55.85\,\text{g}}{6.022 \times 10^{23}} = 9.27433 \times 10^{-23}\,\text{g}$$

$$4\text{ atoms Fe} = 4 \times m_{Fe} = 3.70973 \times 10^{-22}\,\text{g}$$

$$d = m/V = 2.304\,\text{g/cm}^3$$

Sodium chloride (NaCl)

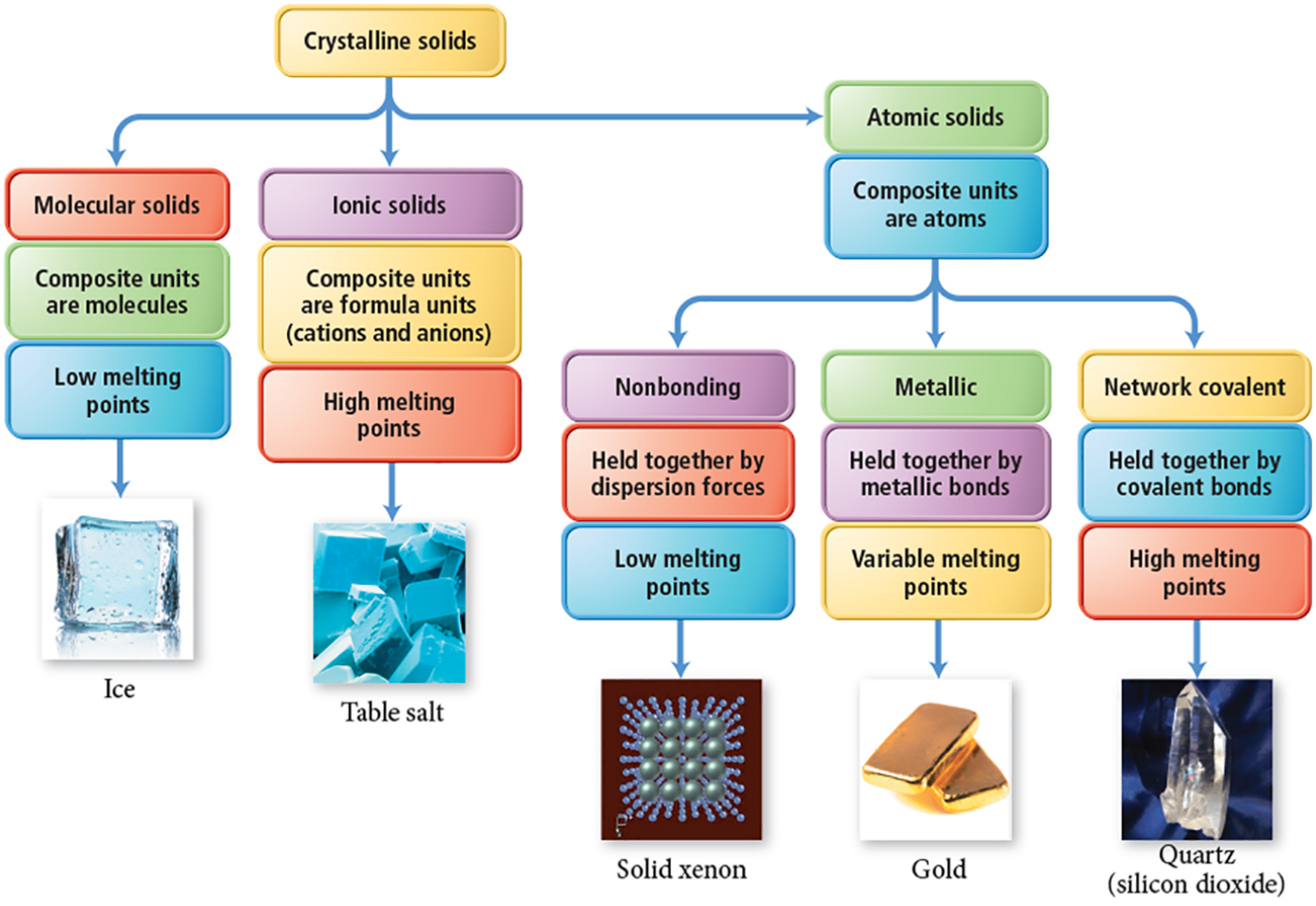


NaCl unit cell:

8 chlorine ions @ corners = 8 × ⅛ = 1
6 chlorine ions @ edges = 6 × ½ = 3
• Total chlorine ions = 4 / unit cell

12 sodium ions @ edges = 12 × ¼ = 3
1 sodium ion @ center = 1 × 1 = 1
• Total sodium ions = 4 / unit cell

Formula: 4 Na ions : 4 Cl ions = 1:1 = NaCl

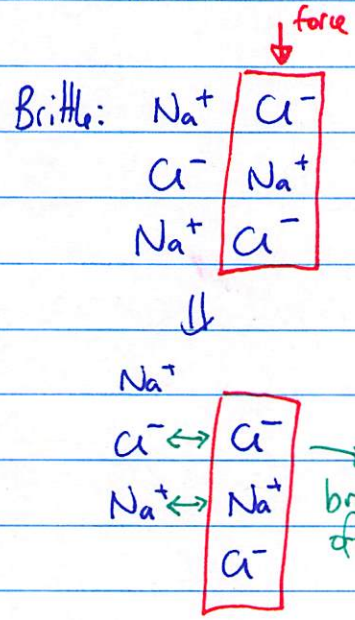


Kinds of crystalline solids

Molecular	Ionic	Atomic (Solids)	Building blocks
IMFs (LDF, d-d, H-Bonds)	ion-ion (ionic bond)	:	held together by...
low mp.	V. high mp / brittle		properties
$CH_4(s)$ $-180^\circ C$			
$H_2O(s)$ $0^\circ C$	ex: $NaCl(s)$, $800^\circ C$		
Sucrose (s) ~200°C	$Al_2O_3(s)$, $2000^\circ C$		greater attraction
$C_{12}H_{22}O_{11}(s)$			

- molecules on lattice points in unit cells

- cations/anions on lattice points in unit cells



Atomic Solids

Non-Bonding	Metallic	Network Covalent
LDF	Metallic bonds. - e^- sea Ch9.11	} held together by
low mp.	moderate → high mp	} properties
ex: Xe(s) -110°C	ex: Na(s) 100°C	
He(s) -272°C	Mg(s) 650°C	
	Al(s) 660°C