Crystal Structures / SOLIDS

1-23-15

① Crystalline

long-range order.

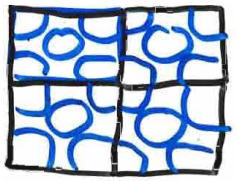
ex: Iron, Ice

↳ PACK REGULARLY

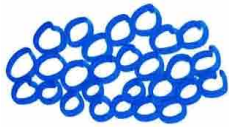
REPEATING UNIT

- UNIT CELL (like bricks in a wall)

UNIT CELL



② Amorphous



irregularly packed

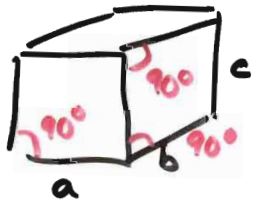
ex: TAR, glass

FOR 3D crystals (solids)

- 14 different kinds of unit cells.
- 7 differently shaped unit cells.

let's just look @ CUBIC unit cells.

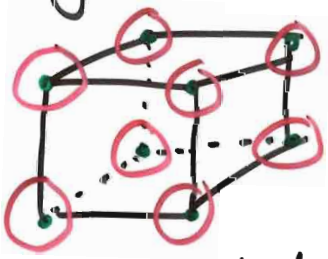
- 3 types. (easy to visualize)



a=b=c

① Simple Cubic.

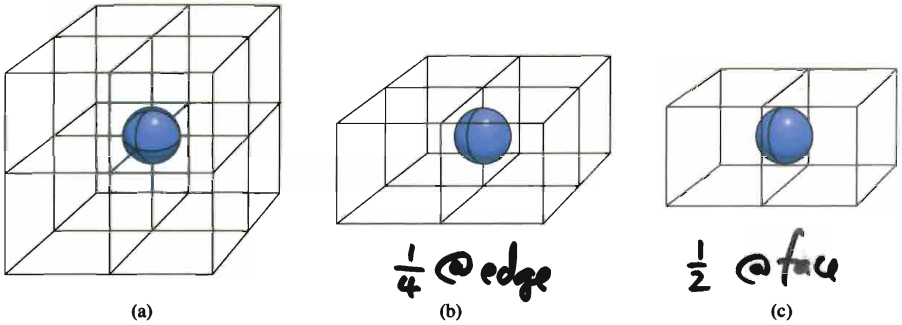
- only has "lattice points" @ 8-corners.



• = lattice point.
- can place atoms, or ions, or molecules

only 1/8 of each atom is inside unit cell @ corners

Fig 12-18



(a) (b) (c)

$\frac{1}{8}$ @ corner

$\frac{1}{4}$ @ edge

$\frac{1}{2}$ @ face

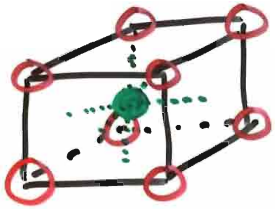
1) Simple cubic

total # atoms / unit cell

$= 8 \times \frac{1}{8} = 1$

ex Po(s)

2) Body-Centered Cubic (BCC)



(corner) $8 \times \frac{1}{8} = 1$

(body) $1 \times 1 = 1$

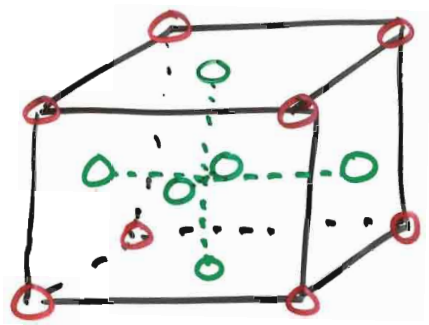
$\overline{\text{2 atoms / unit cell}}$.

a "few" metals pack this way

ex: Ba(s)
Cs(s)
Fe(s)
W(s)

3) Face Centered Cubic (FCC / CCP)

↑ cubic closest pack.



$8 \times \frac{1}{8} = 1$ (corner)

$6 \times \frac{1}{2} = 3$ (faces)

4 atoms / unit cell.

Using X-ray diffraction we can "easily" determine: (1) type of unit cell
(2) dimensions of unit cell.

ex Silver: FCC ✓

edge length = a = 408.7pm.

- What's its d ?

Ag: a = 408.7pm

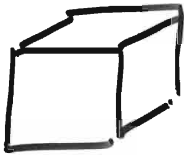
FCC.

$d = \frac{m}{V}$ ← extensive.

↑ intensive

4 atoms of Ag / unit cell.

$(8 \times \frac{1}{8}$ @corners $+ 6 \times \frac{1}{2}$ @faces $) = 4$ Ag.



← 408.7pm →

$V = l^3 = (408.7\text{pm})^3$

$= (408.7 \times 10^{-12}\text{m})^3$

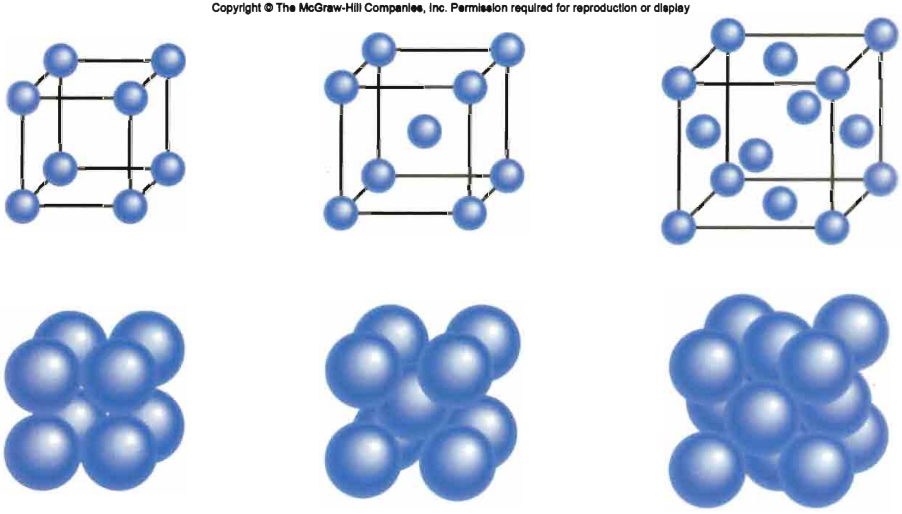
$= 6.8267 \times 10^{-29}\text{m}^3$

$m = 4 \times m_{Ag} = 4 \times \frac{107.9\text{g}}{1\text{mol}} \times \frac{1\text{mol}}{6.022 \times 10^{23}}$

$= 7.167 \times 10^{-22}\text{g}$

$d = m/V = 10.50\text{g/cm}^3$

Fig 12-17



Simple cubic

Body-centered cubic

Face-centered cubic