APS110H1f2024 - Sept 16 2024

September 16, 2024 8:59 AM

Density

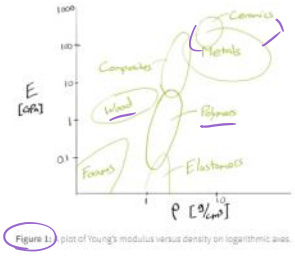
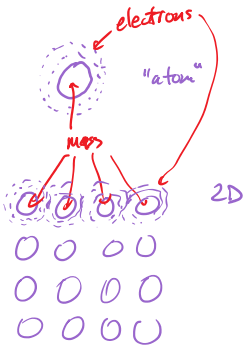
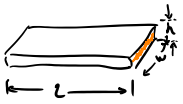


Figure 1: plot of Young's modulus versus density on logarithmic axes.

Q:





h 4.0 mm = 0.4 cm

w 15.4 mm = 15.4 cm

L 406.2 mm = 40.62 cm

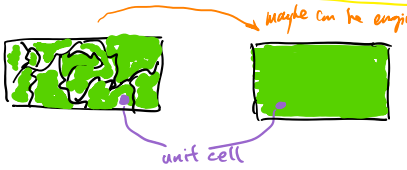
area $\Rightarrow A = h \times w$

mass $\Rightarrow m = A \times L \times \rho$

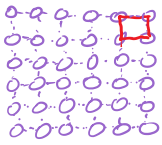
$= h \times w \times L \times \rho$

ρ = density

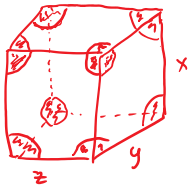
FYI ☺



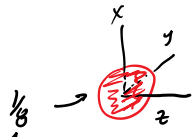
2D



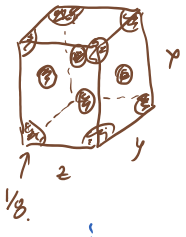
3D unit cell - data available

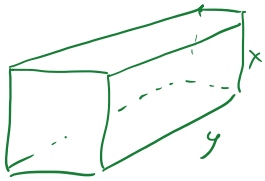


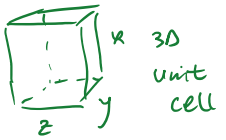
metal



"square"







1/8% - CuO - 100%

also applies to the ceramics

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Density

metal

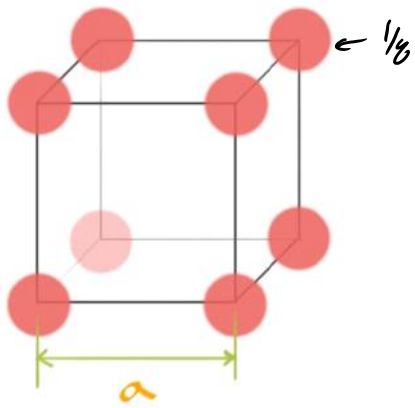
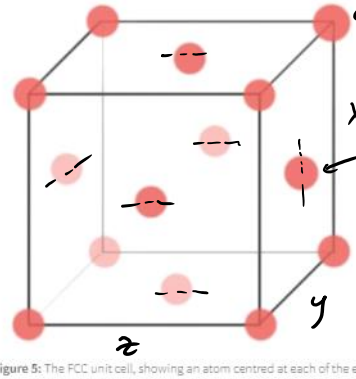


Figure 4: The simple cubic unit cell, showing an atom centred at each of the eight corners of a cube. The lighter red dots are the atoms located on the hidden parts of the cube. The cube edge length is known as the lattice parameter and is denoted with the letter a.

metal



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

$\Rightarrow 4$ atoms in unitcell $= n$

$\leftarrow \frac{1}{2} \times 6 = 3$

unit cell

FCC = face central cubic

Figure 5: The FCC unit cell, showing an atom centred at each of the eight corners of a cube as well as one atom centred at the very centre of each of the six cube faces. The lighter red dots are the atoms located on the hidden parts of the cube.

$$\text{density} = \rho = \frac{\text{mass of atoms}}{\text{volume of unit cell}} = \frac{m}{V} \left(\frac{g}{cm^3} \text{ or } \frac{kg}{m^3}\right)$$

# of atoms in the unit ← molar mass

$$\rho = \frac{n \cdot A}{V_c \cdot N_A}$$

Avagadro's number $= 6.023 \times 10^{23}$

nano ← volume of unit cell $= x \times y \times z$

1 nano gram $= 1 \times 10^{-9}$ gram

1 gram $= 1 \times 10^{9}$ nano gram

Ceramics

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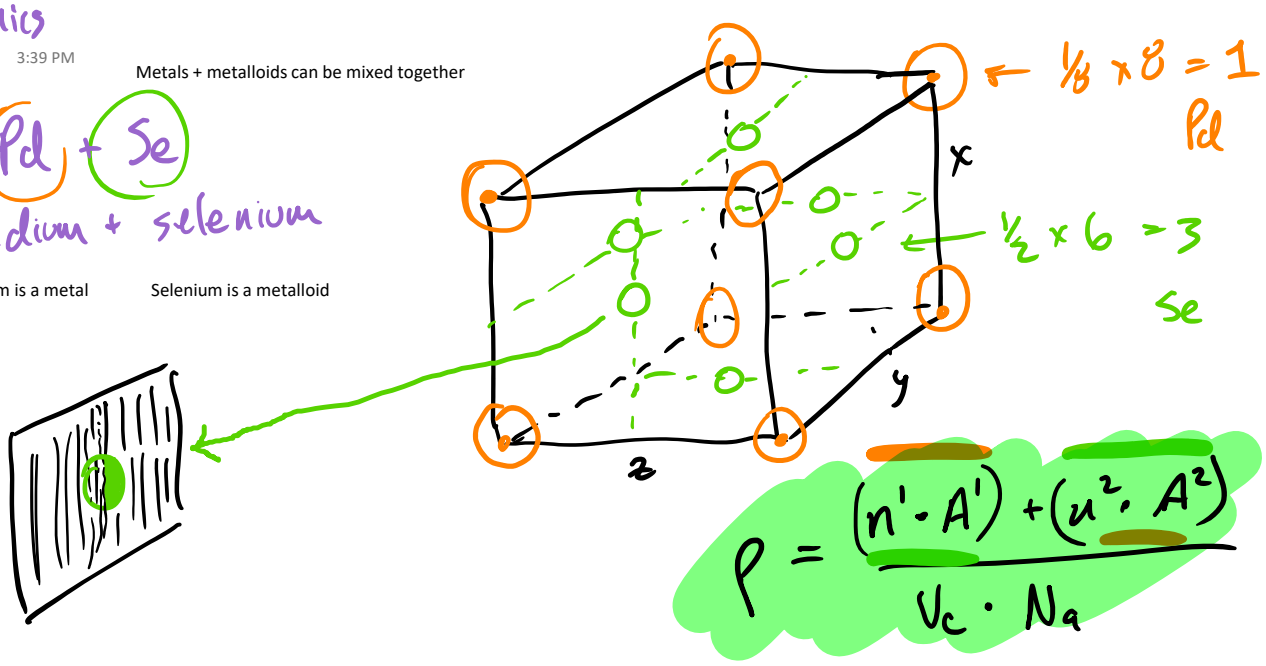
Metals + metalloids can be mixed together

Pd + Se

palladium + selenium

Palladium is a metal

Selenium is a metalloid



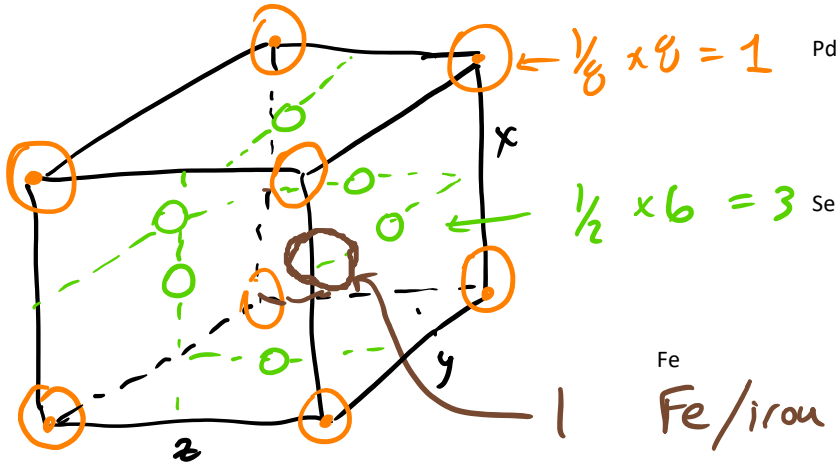
$$\rho = \frac{(n' \cdot A') + (n^2 \cdot A^2)}{V_c \cdot N_a}$$

FYI - the atomic radius was not considered for this artwork and discussion - if data found you will atomic radiuses

Another example

another example
3 metals present.

3 metals present



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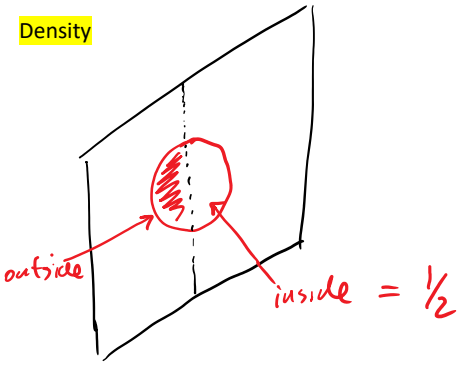
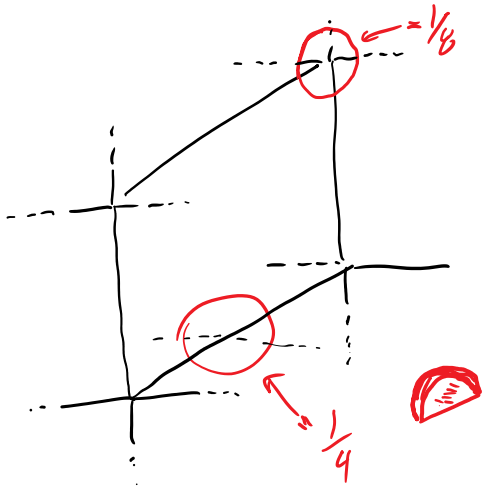
Density





$NaCl = Na^+ + Cl^-$

cation = C, anion = A

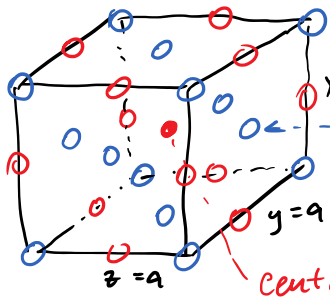
C: 1+

A: 1−

density $\rho = \frac{(n_A \cdot A_A) + (n_C \cdot A_C)}{V_C \cdot N_A}$

V_C: volume of unit cell; N_A: Avagadro's number

$a^3 = x \cdot y \cdot z$



1/8 × 8 = 1

1/2 × 6 = 3

central = 1

1/4 × 12 = 3

Cl 3+1 = 4

Na 3+1 = 4

4 = 4

$PdSe$ — another example. $PdSe = Pd^{2+} Se^{2-}$

$SiO_2 = Si^{4+} + 2O^{2-}$

Periodic Table

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