GEOL3010 Mineral Densities Problem Set 6

1. a.-c.The pyroxene enstatite ($MgSiO_3$) occurs in three different polymorphs. Clinoenstatite is monoclinic with cell edges *a* = 9.605Å, *b* = 8.813Å, *c* = 5.166, β = 108.46º and Z = 8. Protoenstatite is orthorhombic with *a* = 9.251Å, *b* = 8.773Å, *c* = 5.337, and Z = 8. Orthoenstatite is orthorhombic with *a* = 18.216Å, *b* = 8.813Å, *c* = 5.179, and Z = 16. Calculate the density of each.

MgO 40.312 **ρ = (Z*Fw)/A*V**
SiO_2 60.086
100.398g

a. Clinoenstatite

V = *a*b*c*sin β **ρ = 8*100.398/6.02*10^{23}*4.1480*10^{-22}**
V=9.605*8.813*5.166*sin 108.46º **ρ = 3.217 g/cm^3**
V= 414.80$Å^3$

b. Protoenstatite

V = 9.251*8.773*5.337 **ρ = 8*100.398/6.02*10^{23}*4.3315*10^{-22}**
V = 433.15 **ρ = 3.080 g/cm^3**

c. Orthoenstatite

V = 18.216*8.813*5.179 **ρ = 16*100.398/6.02*10^{23}*8.3142*10^{-22}**
V = 831.42 **ρ = 3.2094 g/cm^3**

d. Orthoferrosilite ($FeSiO_3$) is isostructural with orthoenstatite, but has cell edges *a* = 18.418Å, *b* = 9.078Å, *c* = 5.237. Compute its ideal density.

Fw = SiO_2 + FeO = 60.086 + 71.846 = 131.932g
V = 18.418*9.078*5.237 = 875.619
ρ = (Z*Fw)/A*V
ρ = 16*131.932/6.02*10^{23}*8.7562*10^{-22}
ρ = 4.005 g/cm^3

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2. The garnet end-member pyrope $Mg_3Al_2Si_3O_{12}$ is cubic, has a density of 3.58 g/cm^3, and Z of 8. Calculate the cubic cell edge.

$\rho = (Z*Fw)/A* a^3$
$a = [Z*Fw)/A*\rho]^{1/3}$
$a = [8*403.157/6.02*10^{23}*3.58]^{1/3}$
$a = 1.1438*10^{-7} = 11.438Å$

Fw = 3MgO + Al2O3 + 3SiO2 =
Fw = 3*40.312 + 101.963 + 3*60.086 = 403.157

3. The common sulfide mineral pyrite (FeS_2) has a density of 5.02 g/cm^3 and a unit cell edge of 5.42Å. Calculate Z, the number of formula units per cell.

$\rho = (Z*Fw)/A* a^3$
$Z = \rho*A*a^3/Fw$
$Z = 5.02*6.02*10^{23}*(5.42*10^{-8})^3/119.975$
$Z = 4.001 = 4$

Fw = Fe + 2S = 55.847 + 2*32.064 = 119.975g