EE 362 Electronic, Magnetic, & Opt. Prop. of Mat'ls Quiz 1 (Spring 2024)

Name Key A

Instructions: Open book & notes. Place answers in indicated spaces and show all work for credit.

Lead sulfide (PbS) was one of the earliest Group IV – VI semiconductors discovered (used in infrared light detectors). It has a simple cubic structure with a lattice constant of 5.936 Å. Find the atomic number and weight of lead and sulfur. Then, find the atomic volume density as well as mass density of PbS.

		Atomic #	Atomic wt
Per Appendix C, of text	Pb	82	207.21
	S	16	32.06

$$N_{Pb} = \frac{4 \text{ corners}}{\text{cell}}\left(\frac{1/8 \text{ atom}}{\text{corner}}\right) = \frac{1/2 \text{ atom}}{\text{cell}} = N_S$$

$$\text{atomic vol. density}_{PbS} = \frac{\#\text{atoms}}{\text{volume}} = \frac{N_{Pb} + N_S}{a^3}$$

$$= \frac{1/2 + 1/2}{(5.936 \times 10^{-10})^3} = 4.781 \times 10^{27} \frac{\text{atoms}}{m^3}$$

$$\text{mass density}_{PbS} = \frac{\text{mass/unit cell}}{\text{volume}} = \frac{\left(N_{Pb}\,\text{At. Wt}_{Pb} + N_S\,\text{At. Wt}_S\right)/N_A}{a^3}$$

$$= \frac{(1/2)207.21 + 1/2(32.06)}{\left(6.02214 \times 10^{23} \frac{\text{atom}}{\text{g}}\right)(5.936 \times 10^{-10})^3}$$

$$= 949{,}785.9 \text{ g/m}^3 = 0.9498 \text{ g/cm}^3$$

atomic number $_{Pb}$ = 82

atomic weight $_{Pb}$ = 207.21

atomic number $_S$ = 16

atomic weight $_S$ = 32.06

atomic vol. density $_{PbS}$ = 4.781×10^{27} atoms/m^3 = 4.781×10^{21} atoms/cm^3

mass density $_{PbS}$ = 0.9498×10^6 g/m^3 = 0.9498 g/cm^3

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Name Key B

Instructions: Open book & notes. Place answers in indicated spaces and show all work for credit.

Lead selenide (PbSe) was one of the earliest Group IV – VI semiconductors discovered (used in infrared light detectors). It has a simple cubic structure with a lattice constant of 6.12 Å. Find the atomic number and weight of lead and selenium. Then, find the atomic volume density as well as mass density of PbSe.

Per Appendix C, Pb 82 207.21

Se 34 78.96

$N_{Pb} = \frac{4 \text{ corners}}{\text{cell}} \left(\frac{1/8 \text{ atom}}{\text{corner}}\right) = 1/2 \text{ atom/cell} = N_{Se}$

$\text{atomic vol. density}_{PbSe} = \frac{N_{Pb} + N_{Se}}{a^3} = \frac{1/2 + 1/2}{(6.12 \times 10^{-10} m)^3}$

$= 4.3626 \times 10^{27} \text{ atoms}/m^3$

$\text{mass density}_{PbSe} = \frac{\text{mass}}{\text{vol.}} = \frac{1/2(207.21) + 1/2(78.96)}{(6.02214 \times 10^{23} \frac{\text{atoms}}{g})} \Big/ (6.12 \times 10^{-10})^3$

$= 1{,}036{,}546.988 \; g/m^3$

$= 1.0365 \; g/cm^3$

atomic number $_{Pb}$ = 82

atomic weight $_{Pb}$ = 207.21

atomic number $_{Se}$ = 34

atomic weight $_{Se}$ = 78.96

atomic vol. density $_{PbSe}$ = $4.3626 \times 10^{27} \frac{\text{atoms}}{m^3}$ $= 4.3626 \times 10^{21} \frac{\text{atoms}}{cm^3}$

mass density $_{PbSe}$ = $1.0365 \times 10^6 \; g/m^3$ $= 1.0365 \; g/cm^3$