## Chapter 1

#### Problem Solutions

1.1

- (a) fee: 8 corner atoms × 1/8 = 1 atoms 6 face atoms × 1; = 3 atoms Total of 4 atoms per unit cell
- (b) bcc: 8 corner atoms × 1/8 = 1 atom 1 enclosed atom = 1 atom Total of 2 atoms per unit cell
- (c) Diamond: 8 corner atoms × 1/8 = 1 atom 6 face atoms × ½ = 3 atoms 4 enclosed atoms = 4 atoms Total of 8 atoms per unit cell

1.2

(a) 4 Ga atoms per unit cell

Density = 
$$\frac{4}{(5.65 \times 10^{-4})^{1}} =$$

Density of Ga = 2.22x10° cm<sup>4</sup>

4 As atoms per unit cell, so that

Density of As = 2.22x10<sup>11</sup> cm<sup>-1</sup>

(%)

8 Ge atoms per unit cell

Density = 
$$\frac{8}{(5.65 \times 10^{-4})^5}$$
  $\Rightarrow$ 

Density of Ge = 4.44x10" cm"

1.3

(a) Simple cubic lattice; a = 2r

Unit cell vol =  $\alpha' = (2r)' = 8r'$ 

I atom per cell, so atom vol. = (1)  $\left(\frac{4\pi r'}{3}\right)$ 

Then

$$Ranio = \frac{\left(\frac{4\pi r^2}{3}\right)}{8r^2} \times 100\% \implies Ranio = 52.4\%$$

(b) Face-centered cubic lattice

$$d = 4r = a\sqrt{2} \implies a = \frac{d}{\sqrt{2}} = 2\sqrt{2}r$$
  
Unit cell vol  $= a' = (2\sqrt{2}r)' = 16\sqrt{2}r'$ 

4 atoms per cell, so atom vol. =  $4\left(\frac{4\pi r^3}{3}\right)$ 

Them

$$Ratio = \frac{4\left(\frac{4\pi r^3}{3}\right)}{16\sqrt{2} r^3} \times 100\% \implies Ratio = 74\%$$

(c) Body-centered cubic lattice

$$d = 4r = a\sqrt{3} \Rightarrow a = \frac{4}{\sqrt{3}}r$$

Unit cell vol. = 
$$a' = \left(\frac{4}{\sqrt{3}}r\right)'$$

2 atoms per cell, so atom vol. =  $2\left(\frac{4\pi r^2}{3}\right)$ 

There is

$$Ratio = \frac{2\left(\frac{4 Rr^3}{3}\right)}{\left(\frac{4r}{\sqrt{3}}\right)^2} \times 100\% \implies Ratio = 6.8\%$$

(d) Diamond lattice

Body diagonal =  $d = 8r = a\sqrt{3} \Rightarrow a = \frac{8}{\sqrt{3}}r$ 

Unit cell vol. 
$$= \alpha' = \left(\frac{8p}{\sqrt{3}}\right)'$$

8 atoms per cell, so atom vol.  $8\left(\frac{4\pi^2}{3}\right)$ 

Them.

$$Ratio = \frac{8\left(\frac{4\pi r^2}{3}\right)}{\left(\frac{8r}{\sqrt{3}}\right)^2} \times 100\% \implies Ratio = 3.4\%$$

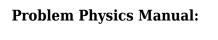
8.4

From Problem 1.3, percent volume of fcc atoms is 74%; Therefore after coffee is ground,

Volume  $= 0.74 \text{ cm}^3$ 

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United States. Department of the Army



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#### **Table of Contents Problem Physics Manual**

- 1. Understanding the eBook Problem Physics Manual
  - The Rise of Digital Reading Problem Physics Manual
  - Advantages of eBooks Over Traditional Books
- 2. Identifying Problem Physics Manual
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
- 3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Problem Physics Manual
  - User-Friendly Interface
- 4. Exploring eBook Recommendations from Problem Physics Manual
  - Personalized Recommendations
  - Problem Physics Manual User Reviews and Ratings
  - Problem Physics Manual and Bestseller Lists
- 5. Accessing Problem Physics Manual Free and Paid eBooks
  - Problem Physics Manual Public Domain eBooks
  - Problem Physics Manual eBook Subscription Services
  - Problem Physics Manual Budget-Friendly Options
- 6. Navigating Problem Physics Manual eBook Formats

- ∘ ePub, PDF, MOBI, and More
- Problem Physics Manual Compatibility with Devices
- Problem Physics Manual Enhanced eBook Features
- 7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Problem Physics Manual
  - Highlighting and Note-Taking Problem Physics Manual
  - Interactive Elements Problem Physics Manual
- 8. Staying Engaged with Problem Physics Manual
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Problem Physics Manual
- 9. Balancing eBooks and Physical Books Problem Physics Manual
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Problem Physics Manual
- 10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
- 11. Cultivating a Reading Routine Problem Physics Manual
  - Setting Reading Goals Problem Physics Manual
  - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Problem Physics Manual
  - Fact-Checking eBook Content of Problem Physics Manual
  - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
- 14. Embracing eBook Trends
  - Integration of Multimedia Elements
  - Interactive and Gamified eBooks

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