



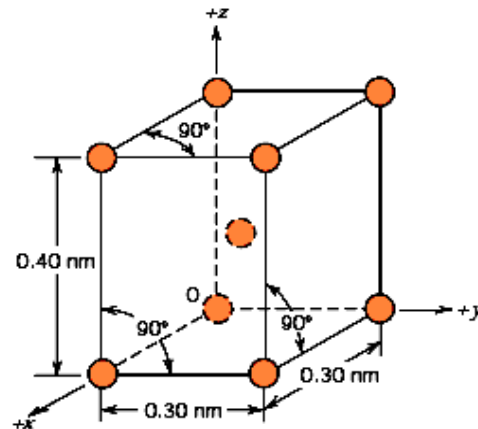
ME 254  
MATERIALS ENGINEERING  
1<sup>st</sup> Semester 1430/1431  
1<sup>st</sup> Med-Term Exam  
(1.5 hrs)



**Question 1**

- a) Classify the materials based on their properties and performance, give some examples.
- b) List the three primary classifications of solid materials, and then cite the distinctive chemical feature of each.
- c) **Differentiate between,**
  - 1. Atomic structure, crystal structure and a crystal system
  - 2. Ionic and metallic bonding.
- d) This is a unit cell for a hypothetical metal:

To which crystal system does this unit cell belong to? What would this crystal structure be called?

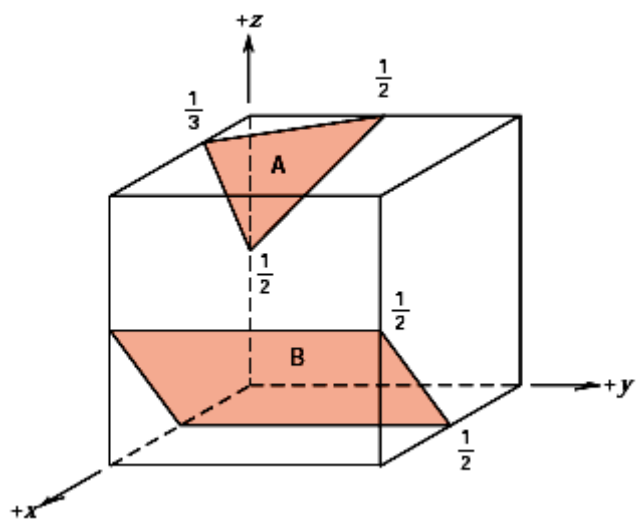


- e) Calculate the radius of an iridium atom given that Ir has an FCC crystal structure, a density of  $22.4 \text{ g/cm}^3$ , and an atomic weight of  $192.2 \text{ g/mol}$ .

**Question 2**

- a) Show that the atomic packing factor for BCC is 0.68.
- b) Within a cubic unit cell, sketch the following directions:
  - (1)  $[110]$ ; (2)  $[121]$ ; (3)  $[012]$ ; (4)  $[111]$ ;
  - (5)  $[103]$

- c) What are the indices for the two planes drawn in the following sketch?



### Question 3

1. Sketch the cesium chloride unit cell and compute its theoretical density, giving that the atomic weight and ionic radii of cesium are 132.91 g/mol and 0.17 nm and that for chlorine are 35.45 g/mol and 0.181 nm respectively.
  
2. Choose the correct answer,
  - A- Covalent bonding requires.....
    - 1) Sharing electron    2) electron transfer    3) free electrons
  - B- Ceramic materials are hard, brittle and thermally insulative because their atomic bonding is .....
    - 1) Metallic bonding    2) ionic bonding    3) secondary bonding
  - C- Polymer materials are relatively weak because their atomic bonding is .....
    - 1) Covalent bonding    2) ionic bonding    3) secondary bonding
  - D. Ionic bonded materials have .....melting temperatures.
    1. High                    2. Low                    3. extremely low

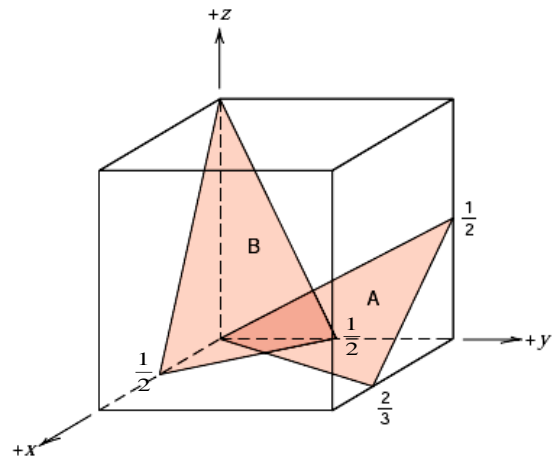


**ME 254**  
**MATERIALS ENGINEERING**  
1<sup>st</sup> Semester 1431/1432  
1<sup>st</sup> Mid-Term Exam  
(1.5 hrs)



**Question 1**

- f) Define the following, isotope and atomic mass.
- g) List the primary classifications of solid materials.
- h) Briefly cite the main differences between ionic, covalent, and metallic bonding.
- i) Draw  $(01\bar{1}1)$  and  $(2\bar{1}\bar{1}0)$  planes within hexagonal unit cells.
- j) Determine the Miller indices for the planes shown in the following unit cell:



**Question 2**

- d) Show that the atomic packing factor for BCC is 0.68.
- e) Compute the linear and planar density value FCC  $[110]$  and  $(110)$  for copper knowing that the atomic radius of the copper is 0.128 nm.
- f) Rhenium has an HCP crystal structure, an atomic radius of 0.137 nm, and a  $c/a$  ratio of 1.615. Compute the volume of the unit cell for Re.
- g) Sketch the unit cell for the Cesium Chloride and Sodium chloride crystal structure, what are the types of unit cells and the coordination number for each.
- h) Within a cubic unit cell, sketch the following directions and planes:
  - (a)  $[\bar{1}10]$ ; (e)  $(\bar{1}\bar{1}\bar{1})$ ;
  - (b)  $[\bar{1}\bar{2}1]$ ; (f)  $(12\bar{2})$ ;
  - (c)  $[0\bar{1}2]$ ; (g)  $(\bar{1}2\bar{3})$ ;
  - (d)  $[1\bar{3}\bar{3}]$ ; (h)  $(0\bar{1}\bar{3})$ .

### **Question 3**

Choose the correct answer,

1. Covalent bonding requires.....
  - a) Sharing electron
  - b) electron transfer
  - c) free electrons
2. Ceramic materials are hard, brittle and thermally isolative because their atomic bonding is .....
  - a) Metallic bonding
  - b) ionic bonding
  - c) secondary bonding
3. Polymer materials are relatively weak because their atomic bonding is .....
  - a) Covalent bonding
  - b) ionic bonding
  - c) secondary bonding
4. Ionic bonded materials have .....melting temperatures.
  - a) High
  - b) Low
  - c) extremely low
5. There are ----- types of crystal systems.
  - a) Three
  - b) Five
  - c) Seven



**ME 254**  
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1<sup>st</sup> Semester 1432/1433  
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(1 hr)



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**Question 1**

(a)

1. Cite the four components that are involved in the design, production, and utilization of materials, and briefly describe the interrelationships between these components.
2. Briefly explain the concept of “nanotechnology” as it applies to materials.
3. Cite three criteria that are important in the materials selection process.
4. **Differentiate between,**
  1. Atomic mass and atomic weight.
  2. Atomic structure and crystal structure
  3. Ionic and metallic bonding.

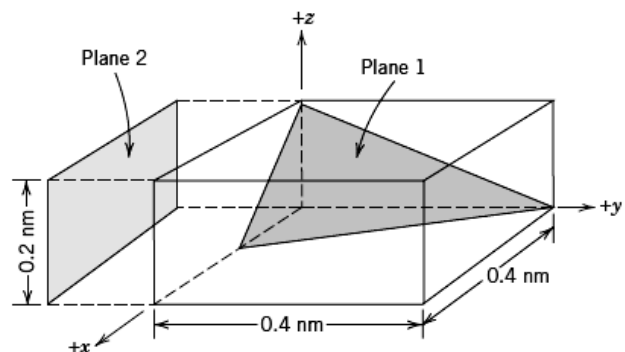
(b)

1. Silicon has three naturally-occurring isotopes: 92.23% of  $^{28}\text{Si}$ , with an atomic weight of 27.9769 amu, 4.68% of  $^{29}\text{Si}$ , with an atomic weight of 28.9765 amu, and 3.09% of  $^{30}\text{Si}$ , with an atomic weight of 29.9738 amu. On the basis of these data, confirm that the average atomic weight of Si is 28.0854 amu.
2. Explain why hydrogen fluoride (HF) has a higher boiling temperature than hydrogen chloride (HCl) (19.4 vs.  $-85\text{ }^\circ\text{C}$ ), even though HF has a lower molecular weight.

**Question 2**

(a)

1. Draw unit cells for simple cubic, face-centered cubic, body centered cubic, and hexagonal close-packed crystal structures.
2. Distinguish between single crystals and polycrystalline materials.
3. Within a cubic unit cell, sketch the following directions:
  - a. [110]; (2) [121]; (3) [012]; (4) [111]; (5) [103]
4. What are the indices for the two planes drawn in the following sketch?



### Question 3

6. Choose the correct answer,

A- Covalent bonding requires.....

- 1) Sharing electron    2) electron transfer    3) free electrons

B- Ceramic materials are hard, brittle and thermally insulative because their atomic bonding is

.....

- 1) Metallic bonding    2) ionic bonding    3) secondary bonding

C- Polymer materials are relatively weak because their atomic bonding is .....

- 1) Covalent bonding    2) ionic bonding    3) secondary bonding

D. Ionic bonded materials have .....melting temperatures.

1. High                      2. Low                      3. extremely low



**ME 254**  
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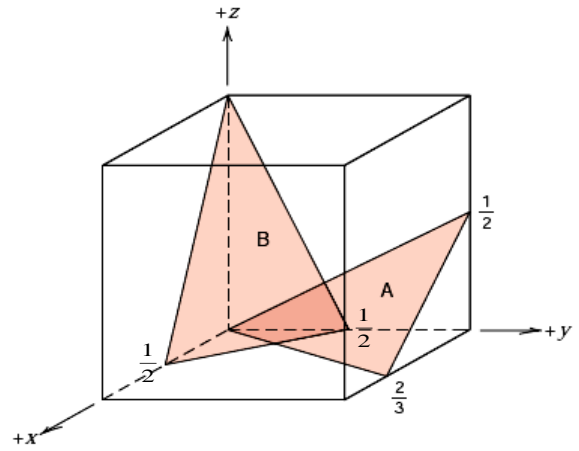


**Question 1**

1. Classify materials and state some mechanical or chemical features for each.
2. Differentiate between, Ionic, covalent and metallic bonding and give examples for each.
3. Calculate the radius of an iridium atom given that Ir has an FCC crystal structure, a density of 22.4 g/cm<sup>3</sup>, and an atomic weight of 192.2 g/mol.

**Question 2**

1. Compute the linear and planar density value FCC [110] and (110) for copper knowing that the atomic radius of the copper is 0.128 nm.
2. Within a cubic unit cell, sketch the following directions.
  - (a)  $[\bar{1}10]$ ;
  - (b)  $[\bar{1}21]$ ;
  - (c)  $[0\bar{1}2]$ ;
  - (d)  $[1\bar{3}3]$ ;



3. What are the indices for the two planes drawn in the following sketch?

**Question 3**

5. Identify the types of microscopic imperfections found in crystalline structures.
6. Calculate the number of vacancies per cubic meter in iron at 850 °C. The energy for vacancy formation is 1.08 eV/atom. Furthermore, the density and atomic weight for Fe are 7.65 g/cm<sup>3</sup> and 55.85 g/mol, respectively.  $K = 8.62 \times 10^5$  eV/K
7. What is the composition, in atom percent, of an alloy that consists of 97 wt% Fe and 3 wt% Si?

**Question 4**

1. State the conditions for complete substitutional solid solubility and explain which of the elements listed form with Cu the three possible solid solution types.

Element	Atomic radius (nm)	Crystal structure	Electro-negativity	Valence
Ni	0.1246	FCC	1.8	+2
Pt	0.1387	FCC	2.2	+2
Cr	0.1241	BCC	1.6	+3
C	0.071	-	-	-

2. Calculate the atomic packing factor for HCP cell.

### **Question 5**

Choose the correct answer,

1. Covalent bonding requires.....  
a) Sharing electron    b) electron transfer    c) free electrons
2. Ceramic materials are hard, brittle and thermally isolative because their atomic bonding is .....  
a) Metallic bonding    b) ionic bonding    c) secondary bonding
3. Polymer materials are relatively weak because their atomic bonding is .....  
a) Covalent bonding    b) ionic bonding    c) secondary bonding
4. Ionic bonded materials have .....melting temperatures.  
a. High    b. Low    c. extremely low
5. In complete solid solution ----- structure will be obtained  
a. new    b. no new    c. amorphous
6. Maximum magnification of the optical microscope is -----  
a. 10,000    b. 50,000    c. 2,000
7. Single crystalline materials are usually -----  
(a) Isotropic    (b) anisotropic    (c) neither
8. There are ----- types of crystal systems.  
a) Three    b) Five    c) Seven
9. Hydrogen bonding is a type of -----  
(a) Ionic bonding    (b) secondary bonding    (c) covalent bonding
10. A [110] direction in FCC unit cell is considered as -----  
(a) close packed direction    (b) body diagonal    (c) edge of the cube