

1) a) There are 13 atoms in the cell

2) b) $APf = \frac{\text{Volume of atoms in unit cell}}{\text{Volume of unit cell}}$

$$= \frac{13}{23.6}$$

$$= 0.55 \text{ atom APf}$$

c) Volume of cube = $\left(\frac{7R}{\sqrt{2}}\right)^3$

$$R = 0.142 \text{ nm}$$

$$= \frac{(13)(0.142 \times 10^{-9})^3}{\sqrt{2}}$$

$$\underline{V = 2.63 \times 10^{-29} \text{ m}^3}$$

$$d) \rho = \frac{n A}{V_c N_A}$$

atomic weight = 53.5 g/mol

$$\rho = \frac{(13)(53.5)}{(2.63 \times 10^{-29})(6.022 \times 10^{23})}$$

$$= 4.4 \text{ g/cm}^3$$

Materials assessment

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2) Molybdenum Volume
Bcc

$$R = 0.1363 \text{ nm}$$

$$V = \left(\frac{4R}{\sqrt{3}} \right)^3$$

$$V = \left(\frac{(4) \times (0.1363 \times 10^{-9})}{\sqrt{3}} \right)^3$$

$$V = 3.12 \times 10^{-29} \text{ m}^3$$

Density of Molybdenum

$$V = 3.12 \times 10^{-29}$$

$$A = \text{molar mass} \quad 95.96 \text{ g/mol}$$

$$\rho = \frac{(4) \times (95.96)}{(3.12 \times 10^{-29}) \times (6.022 \times 10^{23})}$$

$$= 10.2 \text{ g/cm}^3$$

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2) Nickel volume =
fcc

$$\text{Radius} = 0.1246 \text{ nm}$$

$$4R = \sqrt{2}a$$

$$a = \frac{4R}{\sqrt{2}}$$

$$V = a^3 = \left(\frac{4R}{\sqrt{2}} \right)^3$$

$$V = \frac{(4)(0.1246 \times 10^{-9})^3}{\sqrt{2}} \\ = 4.38 \times 10^{-29} \text{ m}^3$$

Nickel density

$$\rho = \frac{nA}{VCNA}$$

$$V = 4.38 \times 10^{-29} \text{ m}^3$$

$$A = 58.69 \text{ g/mol}$$

$$\rho = \frac{(4) \times (58.69)}{(4.38 \times 10^{-29})(6.022 \times 10^{23})}$$

$$= 8.9 \text{ g/cm}^3$$

materials assessment

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3) for Alloy A assume the Structure is simple cubic. Do this by working out the density.

$$\rho = \frac{n_A A}{V_C N_A}$$

Atomic weight = 77.4 g/mol
Atomic radius = 0.125×10^{-9} m

$$= \frac{(1)(77.4)}{((2)(0.125 \times 10^{-9}))^3 (6.022 \times 10^{23})}$$

$$= 8.22 \text{ g/cm}^3 - \text{Simple cubic}$$

which is the same as the density of alloy A in the table.

This means that crystal structure is Simple cubic.

for Alloy B assume the Structure is simple cubic. same process as last time

$$\rho = \frac{n_B A}{V_C \cdot N_A}$$

Atomic weight = 107.6 g/mol
Atomic radius = 0.133 nm

$$= \frac{n_B \cdot A}{(2R)^3 N_A}$$

$$= \frac{(1)(107.6)}{((2)(0.133 \times 10^{-9}))^3 (6.022 \times 10^{23})}$$

$= 9.49 \text{ g/cm}^3$ - it is not a simple cubic as the density is not the same as the one in the table

Now assume Alloy B is fcc Structure

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

$$= \frac{n A}{(2\sqrt{2}R)^3 N_A}$$

$$= \frac{(4)(107.6)}{(2\sqrt{2})(0.133 \times 10^{-9})^3 (6.022 \times 10^{23})}$$

$$= 13.42 \text{ g/cm}^3 - \text{fcc}$$

This answer shows that Alloy B is a ~~face centered~~ fcc Structure as the density worked out is the same as in the table.

for Alloy C assume the Structure is Simple Cubic Structure.

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

$$= \frac{n A}{(2R)^3 N_A}$$

$$= \frac{(1)(127.3)}{(12)(0.142 \times 10^{-9})^3 (6.022 \times 10^{23})}$$

$= 9.23 \text{ g/cm}^3$ - This answer means that it is a simple cubic Structure.

Materials assessment

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Alloy A = Simple cubic Structure

Alloy B = fcc

Alloy C = Simple Cubic Structure

Materials Assessment Shay Beer

4/a) Head 0 0 0

tail $\begin{bmatrix} 0 & 1 & 1 \\ 0 & 1 & 1 \end{bmatrix}$

B) Head 0 1 1

tail $\begin{matrix} a & b & c \\ 1 & \frac{b}{2} & 1 \\ 2 & 1 & 2 \\ \hline -2 & 0 & -1 \end{matrix}$

C) = Head $\begin{matrix} a & b & c \\ 1 & 1 & 1 \end{matrix}$

tail $\begin{matrix} a & b & c \\ \frac{a}{2} & \frac{b}{2} & 0 \\ \frac{1}{2} & \frac{1}{2} & 0 \\ \hline 1 & 1 & 0 \\ \hline 0 & 0 & 1 \end{matrix}$

D) Head $\begin{matrix} 1 & \frac{a}{2} & 0 \\ 1 & \frac{1}{2} & 0 \\ 2 & 1 & 0 \end{matrix}$

tail $\begin{matrix} = \frac{a}{2} & 0 & 1 \\ \frac{1}{2} & 0 & 1 \\ 1 & 0 & 2 \\ \hline 1 & 0 & -2 \end{matrix}$

Materials Assessment

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$$\text{SA)} \quad \begin{array}{ccc} u' & v' & w' \\ 1 & -1 & 0 \end{array}$$

$$u = \frac{1}{3} (2u' - v') = \frac{1}{3} (2(1) - (-1)) = 1$$

$$v = \frac{1}{3} (2v' - u') = \frac{1}{3} (2(-1) - (1)) = -1$$

$$t = -(u + v) = -(1 + (-1)) = 0$$

$$w'' = w' = 0$$

$$u = 1 \quad v = -1 \quad t = 0 \quad w = 0$$

$$\begin{bmatrix} 1 & -1 & 0 & 0 \end{bmatrix}$$

$$5b) \text{ Head} \quad \begin{array}{ccc} u' & v' & 0 \\ 1 & 1 & 0 \end{array}$$

$$u = \frac{1}{3}(2u' - v') = \frac{1}{3}(2(1) - (1)) = \frac{1}{3}$$

$$v = \frac{1}{3}(2v' - u') = \frac{1}{3}(2(1) - (1)) = \frac{1}{3}$$

$$t = -(u + v) = -\left(\frac{1}{3} + \frac{1}{3}\right) = -\frac{2}{3}$$

$$w = w' = 0$$

$$u = \frac{1}{3} \quad v = \frac{1}{3} \quad t = -\frac{2}{3} \quad w = 0$$

$$\begin{bmatrix} 1 & 1 & -2 & 0 \end{bmatrix}$$

$$c) \text{ Head} = \begin{array}{ccc} u' & v' & w' \\ 0 & 0 & 1 \end{array}$$

$$u = \frac{1}{3}(2u' - v') = \frac{1}{3}(2(0) - (0)) = 0$$

$$v = \frac{1}{3}(2v' - u') = \frac{1}{3}(2(0) - (0)) = 0$$

$$t = -(u + v) = -(0 + 0) = 0$$

$$w = w' = 1$$

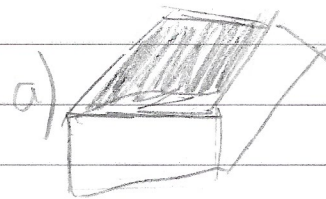
$$u = 0 \quad v = 0 \quad t = 0 \quad w = 1$$

$$\begin{bmatrix} 0 & 0 & 0 & 1 \end{bmatrix}$$

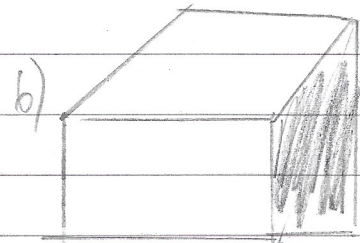
Materials assessment

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b) a) $\begin{matrix} \infty a & \infty b & 1c \\ \infty & \infty & 1 \\ (0 & 0 & 1) \end{matrix}$



b) $\begin{matrix} \infty a & 1b & \infty c \\ \infty & \infty & \infty \\ (0 & 1 & 0) \end{matrix}$



c) $\begin{matrix} \infty a & 1b & \infty c \\ \infty & 1 & \infty \\ (0 & 1 & 0) \end{matrix}$

d) $\begin{matrix} \infty a & \infty b & 1c \\ 1 & \infty & 1 \\ (1 & 0 & 1) \end{matrix}$

e) $\begin{matrix} 1a & 1b & \infty c \\ 1 & 1 & \infty \\ (1 & 1 & 0) \end{matrix}$

f) $\begin{matrix} \infty a & 1b & 1c \\ \infty & 1 & 1 \\ (0 & 1 & 1) \end{matrix}$