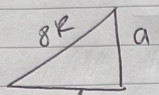


Materials Science

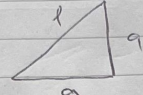
Q4.

a) $9 + 3 + 1$
 $= 13 \text{ atoms}$

b)



$$1^2 + a^2 = 8R^2$$



$$a^2 + a^2 = (8R^2)$$

$$a^2 + a^2 + a^2 = 8R^2$$

$$3a^2 = 8R^2$$

$$a = \frac{8}{\sqrt{3}} R$$

$$\frac{13 \times \left(\frac{4}{3} \times \pi\right) \times R^3}{a^3} \Rightarrow$$

$$\frac{13 \times \left(\frac{4}{3} \times \pi\right) \times R^3}{\left(\frac{8}{\sqrt{3}}\right)^3 \times R^3} = \frac{13 \times \frac{4}{3} \times \pi}{\left(\frac{8}{\sqrt{3}}\right)^3}$$

$$= 0.55$$

c)

$$V = a^3$$

$$V = \left(\frac{8}{\sqrt{3}}\right)^3 \times (0.142 \times 10^{-9})^3$$

$$V = 2.82 \times 10^{-22} \text{ cm}^3$$

d) Atomic weight = 53.5 g/mol

$$\rho = \frac{13 \times 53.5}{2.82 \times 10^{-22} \times 6.022 \times 10^{23}}$$

$$\rho = 4.09 \text{ g/cm}^3$$

e) The theoretical density is less than 12 g/cm^3 thus meaning that it can be used for its intended use

Q2.

Nickel

$$V = a^3$$

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

$$V = \left(\frac{4 \times 0.1246 \times 10^{-7}}{\sqrt{2}} \right)^3$$

$$V = 4.38 \times 10^{-23} \text{ cm}^3$$

$$\rho = \frac{4 \times 58.69}{4.38 \times 10^{-23} \times 6.022 \times 10^{23}} = 8.9$$

$$\text{APF} = \frac{4 \times \frac{4}{3} \times \pi \times (0.1246 \times 10^{-7})^3}{4.38 \times 10^{-23}} = 0.74$$

Molybdenum

$$V = a^3$$

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

$$V = \left(\frac{4 \times 0.1363 \times 10^{-7}}{\sqrt{3}} \right)^3$$

$$V = 3.12 \times 10^{-23} \text{ cm}^3$$

Q2 CONT:

$$APF = \frac{2 \times \frac{4}{3} \pi \times (0.1363 \times 10^{-7})^3}{3.12 \times 10^{-23}}$$

$$\underline{APF = 0.68}$$

$$P = \frac{2 \times 95 \times 962}{3.12 \times 10^{-23} \times 6.02 \times 10^{23}}$$

$$\underline{P = 10.21}$$

The atomic packing fraction of nickel is 0.68 which is smaller than molybdenum which was 0.74 which means that molybdenum is more densely packed than nickel. This can be also seen by comparing the theoretical densities. Molybdenum has a higher theoretical density than nickel. However, nickel has a higher volume per unit cell than molybdenum.

$$\begin{array}{ll} \text{Q3.} & \text{FCC} \Rightarrow 4 \text{ atoms } (a = \frac{4}{\sqrt{2}}R) \quad \text{SC} = 1 \text{ atom} \\ & \text{BCC} \Rightarrow 2 \text{ atoms } (a = \frac{4}{\sqrt{3}}R) \quad (a = 2R) \end{array}$$

Alloy A has a simple cubic structure

$$A \Rightarrow P = \frac{1 \times 77.4}{\frac{4}{3} \pi (2 \times 0.125 \times 10^{-7})^3 \times 6.022 \times 10^{23}}$$

$$\underline{P = 8.22} \quad \therefore A \text{ has a simple cubic structure.}$$

Q3 CONT.

$$B \Rightarrow \rho = \frac{4 \times 107.6}{\left(\frac{4}{\sqrt{2}} \times 0.133 \times 10^{-7}\right)^3 \times 6.022 \times 10^{23}}$$

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

thus meaning that alloy B is a face centred cubic.

$$C \Rightarrow \rho = \frac{1 \times 127.3}{\left(2 \times 0.142 \times 10^{-7}\right)^3 \times 6.022 \times 10^{23}}$$

$$C = 9.23$$

thus meaning that alloy C is a simple cubic structure.

Q4.

$$A [0 \bar{1} \bar{1}], \quad B [-2 \ 1 \ 0]$$

$$C [1 \ 1 \ 2], \quad D [1 \ 1 \ \bar{2}]$$

Q5

$$A \begin{pmatrix} 1 & -1 & 0 \\ u' & v' & w' \end{pmatrix}$$

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

$$v = \frac{1}{3}(2(1) - (-1)) = 1, \quad w = 0$$

$$\text{A} \Rightarrow [1 \ 1 \ 0]$$

$$B. \begin{pmatrix} 1 & 1 & 0 \\ u' & v' & w' \end{pmatrix}$$

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

$$v = \frac{1}{3}(2(1) - 1) = \frac{1}{3}, \quad w = 0$$

$$B \rightarrow [1 \ 1 \ \bar{2} \ 0]$$

$$C. \begin{pmatrix} 0 & 0 & 1 \\ u' & v' & w' \end{pmatrix}$$

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

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

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

$$w = 1$$

$$C \rightarrow [0 \ 0 \ 0 \ 1]$$

QUESTION 6

a) (001) , b) ~~(001)~~ (100)

c) (010)

d) (101)

e) (110)

f) (011)