

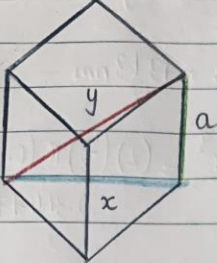
Materials Assignment

Apologies for the inconvenience if this assignment was meant to be typed I haven't had access to a computer until today and so was unable to type it.

1.

a. 13

b.



$$\begin{aligned}
 x^2 &= 2a^2 \\
 y^2 &= 2a^2 + a^2 \\
 &= 3a^2 \\
 y &= \sqrt{3}a \\
 4r &= \sqrt{3}a
 \end{aligned}$$

$$\begin{aligned}
 a &= \frac{4r}{\sqrt{3}} \\
 r &= \frac{\sqrt{3}a}{4}
 \end{aligned}$$

$$\text{APF} = \frac{\text{Total no. Atoms}}{\text{Volume of Cell}}$$

$$= \frac{(13)\left(\frac{4}{3}\right)\pi\left(\frac{\sqrt{3}a}{4}\right)^3}{a^3} = 0.552642 \approx 0.55$$

c.

$$\text{Volume of cube} = a^3 = \left(\frac{4r}{\sqrt{3}}\right)^3$$

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

$$= 2.82 \times 10^{-28} \text{ m}^3$$

d.

$$\rho = \frac{NA}{V_c N_A} = \frac{(13)(53.5)}{(2.82 \times 10^{-28})(6.022 \times 10^{23})}$$

$$= 4.0955 \rightarrow 4.10 \text{ g/cm}^3$$

e. Semi conductors should have four valence electrons this ensures covalent bonds can be formed. The above atom has this structure so would be suitable

2. NICKLE

Atomic weight: ~~89 g/cm³~~ 58.69 g/mol

Structure: FCC

Atomic radius: 0.2946 nm

$$APF = \frac{4 \times \frac{4}{3} \pi r^3}{(2r\sqrt{2})^3} = \frac{4 \times \frac{4}{3} \pi (0.2946)^3}{0.833255^3}$$

$$= 0.74$$

$$\text{Volume of cell} = (2r\sqrt{2})^3$$

$$= 5.79 \times 10^{-28} \text{ m}^3$$

Theoretical density

$$P = \frac{nA}{V_c N_A} = \frac{4 \times 58.69}{(5.79 \times 10^{-28}) \times 6.022 \times 10^{23}}$$

$$= 0.67 \text{ g/cm}^3$$

Molybdenum

Atomic weight: ~~10.3 g/cm³~~ 95.96 g/mol

Structure: BCC

Atomic radius: 0.1363 nm

$$APF = \frac{2 \times \frac{4}{3} \pi r^3}{\left(\frac{4r}{\sqrt{3}}\right)^3} = \frac{(2) \left(\frac{4}{3}\right) \pi (0.1363)^3}{0.314771^3}$$

$$= 0.68$$

$$\text{Volume of cell} = \left(\frac{4r}{\sqrt{3}}\right)^3$$

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

Theoretical density

$$P = \frac{nA}{V_c N_A} = \frac{2 \times 95.69}{(3.12 \times 10^{-29}) \times 6.022 \times 10^{23}}$$

$$= 10.19 \text{ g/cm}^3$$

Nickle and molybdenum are both transition metals. Molybdenum can be seen to have a smaller volume cell. Both are naturally occurring stable isotopes. Molybdenum is ductile with a high melting point and so is Nickle.

$$3. \quad \rho = \frac{nA}{V_c N_A}$$

	Atomic Weight	density	Radius
A	77.4	8.22	0.125
B	107.6	13.42	0.133
C	127.3	9.23	0.142

FCC
 $a = 2r\sqrt{2}$
 $n = 4$

BCC
 $a = \frac{4r}{\sqrt{3}}$
 $n = 2$

SC
 $a = 2r$
 $n = 1$

$$A \quad 8.22 = \frac{(77.4)n}{a^3 (6.022 \times 10^{23})}$$

FCC - 11.633
 BCC - 10.69
 SC - 8.22

$$B \quad 13.42 = \frac{(107.6)n}{a^3 (6.022 \times 10^{23})}$$

FCC - 13.42
 BCC - 12.33
 SC - 9.49

$$C \quad 9.23 = \frac{(127.3)n}{a^3 (6.022 \times 10^{23})}$$

FCC - 13.05
 BCC - 11.99
 SC - 9.23

Structure a = Simple cubic as $\frac{(77.4) \times 1}{(2 \times 1.25 \times 10^{-8})^3 \times 6.022 \times 10^{23}} = 8.22 \text{ g/cm}^3$

Structure b = face centered cubic as $\frac{(107.6) \times 4}{(2 \times 1.33 \times 10^{-8} \sqrt{2})^3 \times 6.022 \times 10^{23}} = 13.42 \text{ g/cm}^3$

Structure c = Simple cubic as $\frac{(127.3) \times 1}{(2 \times 1.42 \times 10^{-8})^3 \times 6.022 \times 10^{23}} = 9.23 \text{ g/cm}^3$

4.

A

	x	y	z
Head	0a	0b	0c
Tail	0a	b	c
Difference	0a	-b	-c
values	0	-1	-1

Direction A is $[0\bar{1}\bar{1}]$

B

	x	y	z
Head	0a	b	c
Tail	a	b/2	c
difference	-a	b/2	0
values	-2	1	0

Direction B is $[\bar{2}10]$

C

	x	y	z
Head	a	b	c
Tail	a/2	b/2	0c
difference	a/2	b/2	c
values	1	1	2

Direction C is $[112]$

D

	x	y	z
Head	a	b/2	0c
Tail	a/2	0/b	c
difference	a/2	b/2	c
values	1	1	-2

Direction D is $[11\bar{2}]$

5.

$$a. \begin{array}{cccc} u' & v' & t' & w' \\ 1 & -1/2 & 0 & 0 \end{array} \quad (1\bar{1}0)$$

$$u = 1/3(2u' - v') = 1/2$$

$$v = 1/3(2v' - u') = 1/3$$

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

$$(010)$$

[1100]

$$b. \begin{array}{cccc} u' & v' & t' & w' \\ 1 & 1 & 0 & 1/3 \end{array} \quad (11\bar{1})$$

$$u = 1/3(2u' - v') = 1/3$$

$$v = 1/3(2v' - u') = 1/3$$

$$t = -(u+v) = -2/3$$

$$\begin{array}{cccc} u & v & t & w \\ 1/3 & 1/3 & -2/3 & 0 \end{array}$$

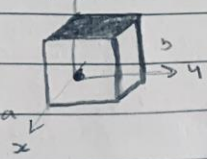
[1120]

$$c. \begin{array}{cccc} u' & v' & t' & w' \\ 0 & 0 & 0 & 1 \end{array}$$

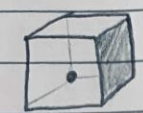
$$w = w'$$

[0001]

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b. 

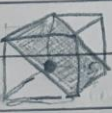
a	b	c
∞	∞	1
∞	∞	1
(001)		

b. 

a	b	c
∞	1	∞
∞	1	∞
(010)		

c. 

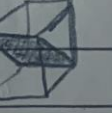
a	b	c
∞	∞	∞
∞	∞	∞
$(\bar{1}00)$		

d. 

a	b	c
∞	1	1
∞	1	1
(011)		

e. 

a	b	c
∞	∞	∞
∞	∞	∞
$(\bar{1}01)$ $(\bar{1}10)$		

f. 

a	b	c
∞	∞	∞
∞	∞	∞
$(\bar{1}01)$		