1) Calculate the radius of Lithium atom, given that Li has an BCC crystal structure, density of 0.534 g/cm³, and an atomic weight of 6.94 g/mol.

\[ \rho = \frac{n \times \frac{A}{N_a}}{a^3} \]

\[ n = 2 \text{ (BCC)} \]
\[ a = \frac{4}{\sqrt{3}} \text{ (BCC)} \]

\[ \Rightarrow \rho = \frac{2 \times \frac{A}{N_a}}{\left(\frac{4}{\sqrt{3}} \right)^3} \]

\[ (0.534 \text{ g/cm}^3) = \frac{6.94 \text{ g/mol}}{6.022 \times 10^{23} \text{ atoms/mol}} \cdot \left(\frac{4}{\sqrt{3}} \right)^3 R^3 \]

\[ \Rightarrow R = 0.15189 \times 10^{-3} \text{ cm} \approx 0.152 \text{ nm} \]

2) Below are listed the atomic weight, density, and atomic radius for three hypothetical alloys. For each determine whether its crystal structure is FCC, BCC or simple cubic and then justify your determination.

<table>
<thead>
<tr>
<th>Alloy</th>
<th>Atomic Weight (g/mol)</th>
<th>Density (g/cm³)</th>
<th>Atomic radius (nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>26.98</td>
<td>2.70</td>
<td>0.143</td>
</tr>
<tr>
<td>Y</td>
<td>55.85</td>
<td>7.87</td>
<td>0.124</td>
</tr>
</tbody>
</table>

The type of crystal structure can be found by "trial and error method."

\[ \rho = \frac{n \times \frac{A}{N_a}}{a^2} \]

\[ n = 1, a = 2R \]

\[ \rho = \frac{1 \times 26.98}{6.022 \times 10^{23}} \cdot \left(\frac{4}{\sqrt{3}} \times 0.143 \times 10^{-3}\right)^3 \approx 2.70 \neq 1.84 \text{ (Not SC)} \]

\[ n = 2, a = 4/\sqrt{3} R \]

\[ \rho = \frac{2 \times 26.98}{6.022 \times 10^{23}} \cdot \left(\frac{4}{\sqrt{3}} \times 0.143 \times 10^{-3}\right)^3 \approx 2.70 \neq 2.44 \text{ (Not BCC)} \]

\[ n = 4, a = 2\sqrt{2} R \]

\[ \rho = \frac{4 \times 26.98}{6.022 \times 10^{23}} \cdot \left(\frac{2\sqrt{2}}{0.143 \times 10^{-3}}\right)^3 \approx 2.70 = 2.70 \text{ (FCC)} \]
3) Within a cubic unit cell, sketch the following directions and planes:

[001], [121], [021]
(101), (121), (132)

4) Determine the indices for the directions shown in the following cubic unit cell:

A → Carry to the origin
    Projections
    \[ \begin{align*}
    x &= 0 \\
    y &= 0 \\
    z &= 0
    \end{align*} \]

B → Multiply by 2
    Projections
    \[ \begin{align*}
    x &= a \\
    y &= a \\
    z &= a
    \end{align*} \]

C → Carry to the origin
    Projections
    \[ \begin{align*}
    x &= 0 \\
    y &= 0 \\
    z &= 0
    \end{align*} \]

D → Carry to the origin
    Projections
    \[ \begin{align*}
    x &= a \\
    y &= a \\
    z &= a
    \end{align*} \]

5) Considering BCC crystal structure, compute the linear density of [101] direction and planar density of (101) plane.