where x is the length of the bottom face diagonal, which is equal to $4R$. Furthermore, y is the unit cell edge length, which is equal to $2R\sqrt{2}$ (Equation 3.1). Thus, using the above equation, the length z may be calculated as follows:

$$z = \sqrt{(4R)^2 + (2R\sqrt{2})^2} = \sqrt{24R^2} = 2R\sqrt{6}$$

Therefore, the expression for the linear density of this direction is

$$LD_{111} = \frac{\text{number of atoms centered on [111] direction vector}}{\text{length of [111] direction vector}}$$

$$= \frac{1 \text{ atom}}{2R\sqrt{6}} = \frac{1}{2R\sqrt{6}}$$

(b) From the table inside the front cover, the atomic radius for copper is 0.128 nm. Therefore, the linear density for the [100] direction is

$$LD_{100}(Cu) = \frac{1}{2R\sqrt{2}} = \frac{1}{(2)(0.128 \text{ nm})\sqrt{2}} = 2.76 \text{ nm}^{-1} = 2.76 \times 10^9 \text{ m}^{-1}$$

While for the [111] direction

$$LD_{111}(Cu) = \frac{1}{2R\sqrt{6}} = \frac{1}{(2)(0.128 \text{ nm})\sqrt{6}} = 1.59 \text{ nm}^{-1} = 1.59 \times 10^9 \text{ m}^{-1}$$