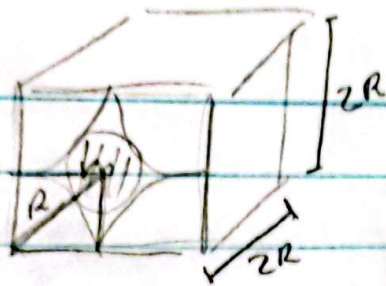
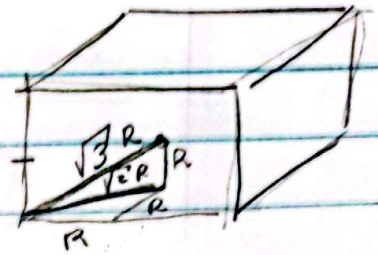


4-6



$r = ?$



$r = \text{radius of the small spheres}$

$R = \text{radius of the large spheres}$

$$R + r = d/2 \quad d = \sqrt{3} \cdot 2R$$

$$R + r = \frac{\sqrt{3} \cdot 2R}{2} \rightarrow r = R(\sqrt{3} - 1)$$

$$V_{\text{solid}} = V_R + V_r = \frac{4\pi}{3} \left[R^3 + (0.732R)^3 \right] = 5.83 R^3$$

$$V_{\text{cube}} = (2R)^3 = 8R^3$$

$$\phi = 1 - \frac{5.83}{8} \Rightarrow \boxed{\phi = 27\%}$$

$$\frac{44.6 - 27}{47.6} = 43.3\% \text{ reduction in porosity}$$