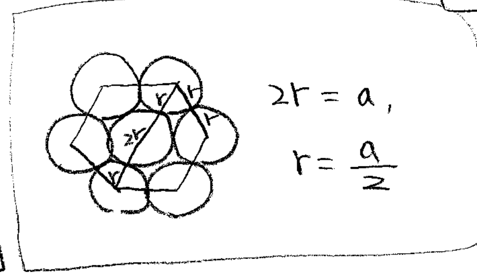
(d) hcp



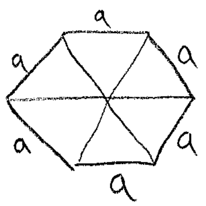
Maximum radius of the sphere $= \frac{a}{2}$

Volume of spheres $= \frac{4}{3}\pi r^3 \times [\underbrace{\frac{1}{6}\times 12}_{\text{12 on corners}} + \underbrace{\frac{1}{2}\times 2}_{\text{2 on faces}} + \underbrace{3}_{\text{3 inside lattice}}]$

$= \frac{4}{3}\pi \times (\frac{a}{2})^3 \times 6 = \pi a^3$

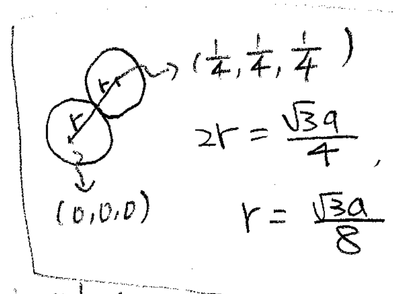
Total Volume $= \underbrace{(6 \times \frac{\sqrt{3}}{4}a^2)}_{\text{bottom area}} \times \underbrace{\sqrt{\frac{8}{3}}a}_{\text{height}} = 3\sqrt{2}a^3$

bottom area



Packing Fraction $= \frac{\pi a^3}{3\sqrt{2}a^3} \sim 0.740$

(e) diamond



Maximum radius of the sphere $= \frac{\sqrt{3}}{8}a$

Volume of spheres $= \frac{4}{3}\pi r^3 \times [\underbrace{\frac{1}{8}\times 8}_{\text{8 on corners}} + \underbrace{\frac{1}{2}\times 6}_{\text{6 on faces}} + \underbrace{4}_{\text{4 inside lattice}}]$

$= \frac{4}{3}\pi (\frac{\sqrt{3}}{8}a)^3 \times 8 = \frac{\sqrt{3}}{16}\pi a^3$

Packing Fraction $= \frac{\sqrt{3}}{16}\pi \sim 0.34$

Note: This value is half of bcc because 2 more spheres can be put into the empty spaces and then it becomes bcc.