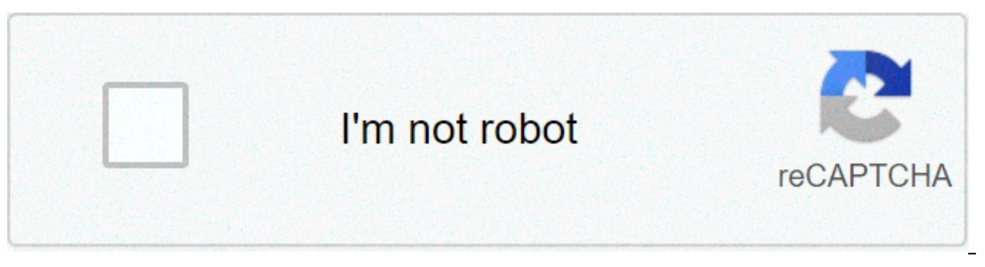

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Total volume occupied by atoms in bcc structure

This is the case of the CCP (simple closed cube packaging) and FCC (face-centered cubic packing closed) Imagine sitting in a cubic room. Now place some large balls of each of the vertices of the room so that the center of the sphere and vertex coincide. You will see that a portion of the ball goes outside the chamber. In chemistry, this is called sharing. If your room is immersed in all directions from other rooms, it shares a sphere with 7 other rooms. (4 upper and lower 4) So, a single particle is shared by 8 rooms. The part in your room is 1/8 and the number of such particles are 8 (as a cubic room has 8 vertices) Net particles in your room $ = \ frac {1} {8} \ cdot 8 = 1 $ Then, in CCP of the space occupied by all eight particles is substantially equal to that of a single particle. Now as assumed in question, the particles are tightly packed, the radius of the field is equivalent to half the length of the edge. In other words the edge length is twice the radius of the sphere. $$ \ pu {packing efficiency = \ displaystyle \ frac {\ text {Volume of ball}} {\ text {cube Volume}}} $$ $$ = z \ cdot \ frac {\ frac {4} {3 } \ pi r ^ 3} {(2r) ^ 3} $$ (Here $ Z $ is the net contribution of the particles, for the current example is equal to 1) Calculation of this you'll get packing efficiency $ \ approximately 52.4% $ Now imagine putting another area in the room, but this time, at the face centers. (Do this for each face). Now the particle in the center is shared by only 2 rooms. Yours and the room that it's in front of you. Therefore, each particle has net contribution of the way. Since a cube has six faces, the net contribution of all the balls in the center of the sphere are of $$ \ frac {1} {2} \ cdot 6 = 3 $$ Add the corner already existing particles to it (whose net contribution it is 1 as we know) So the total number of particles in the FCC are $ 3 + 1 = 4 $ If you are good at imagining things that might have observed that now spheres does not fit to reduce their size . So we have to falsify the hypothesis that two times the radius of the sphere is the length of the edge. Balls are reduced. I want you to imagine the face of the room now. There is little space between two spheres on a corner, but not between the center of the sphere and corner spheres. Draw a diagonal line in the sphere that passes through the diameter of the central sphere. Now using the Pythagorean theorem: $$ \ pu {(\ text {Edge of cube}) ^ 2 + (\ text {Edge of cube}) ^ 2 = (\ text {diagonal cube}) ^ 2} $$ Let edge to be 'A': $$ (A) ^ 2 + (A) = D ^ 2 ^ 2 $$ $$ 2 (A) ^ 2 = D ^ 2 $$ © Since the central spheres have any space with those corners . So 4 (radius of the sphere) = diagonal length $$ \ sqrt {2} A = D $$ $$ \ sqrt {2} A = 4r $$ $$ \ sqrt {2} A / 4 = r $$ There is to go. You have found the radius of the sphere. Now put it in packing efficiency formula and take $ $ Z = 4 You will find it somewhere near 72% On a sidenote: Note that simple cube has only one sphere that occupies almost 50% of the cube space. While face-centered has 6 + 8 = 14 smaller spheres which occupy almost 70% of all the space in the cube. It 's like comparing apples and bananas. You might think that the FCC is better than CCP as it uses space wisely. © But since the CCP, the particle size is large then PCC is more suitable for the particles of that size and FCC for smaller sizes. Although we are able to discuss with hexagonal packing CCP. In the crystallography, the atomic packaging factor (APF), packaging efficiency or the fraction of packaging is the fraction of the volume in a crystal structure that is occupied by constituent particles. It is a quantity without size and less and less than one unit. In atomic systems, the APF is calculated assuming by convention that Atoms are rigid spheres. The spheres ray is taken to be the maximum value such that the atoms do not overlap. For single-component crystals (those containing only one type of particle), the Packaging fraction is represented mathematically from apf = n particles v electment cell v {displaystyle mathrm {apf} = {frac {n _ {mathrm { particle}} v _ {mathrm {particle}}} {v _ {text {unit}}}}} Where is NParticle nParticle Number of particles in the unit cell, VParticle is the volume of each particle, and the volume is the volume occupied by the unitary cell. It can be demonstrated mathematically that for single-component structures, the most dense layout of the atoms has an APF of about 0.74 (see Kepler Conjecture), obtained from close structures. For multiple structures (as with interstitial alloys), the APF can exceed 0.74. The atomic packaging factor of a unitary cell is relevant to the study of material science, where it explains many material properties. For example, metals with a high atomic packaging factor will have a higher "processability" (malleability or ductility), similar to how a road is more smooth when the stones are closer, allowing metal atoms to slip others More easily. Single crystal structures Component packaging of common balls taken from atomic systems are listed below with their corresponding fraction of packaging. Close-up hexagonal (HCP): 0.74 [1] Cubic centered on the face (FCC): 0.74 [1] (also called Cubic Close-up, CCP) Cubic Body (BCC): 0.68 [1] Simple Cubico: 0, 52 [1] Diamond Cubic: 0.34 Most metals takes the HCP, FCC or BCC structure. [2] Simple cubic cellular cubic unit for simple cubic packaging, the number of atoms per unit cell is one. The side of the unit of the unit is in length 2R, where R is the radius of the atom. APF = N Atoms V Atom V Cell of Unity = 1 Ã ¢

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