CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)
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Project Number
S1209

Project Title
The Geometry of Close Packing Spheres

Abstract

Objectives/Goals
The objective is to determine whether different types of packing arrangements (hexagonal, face centered, or body centered close packing) affect the packing density of spheres. The specific purpose is to determine whether a hexagonal close packing arrangement produces the highest packing density in three dimensions, as this is true in two dimensions.

Methods/Materials
Three-dimensional models of each type of packing lattice were researched and created inside a cube in Lightwave (a 3D modeling program). The packing density of each situation was calculated by dividing the total volume of spheres in each cube by the volume of the cube using the formulas for the volumes of spheres, spherical caps, and cubes. The different packing densities were recorded and compared. All of the calculations of the packing density were repeated until they were consistent with current literature on packing density.

Results
Body centered cubic close packing calculated a packing density of 67.88%. Face centered cubic close packing had a packing density of 52.36%. Hexagonal close packing has a density of 74.46%.

Conclusions/Discussion
The results of this experiment were consistent with the hypothesis and the preliminary research done. The densest packing arrangement could be recreated to ship ping-pong balls or some similar application where packing density saves money and space. When studying crystals, if it is possible to determine the packing arrangement, then the crystal can be assigned an overall density due to the packing arrangement of it's atoms.

Summary Statement
The intuitive perception is correct that the closest packing of spheres in two-dimensions forms the basis for the closest packing arrangement of spheres in three-dimensions.

Help Received
Richard Hurley helped work in Lightwave. Bruce Rawles helped define packing arrangements by providing sources for reference.