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# Calculate surface area to volume ratio of a cube

I've recently been experimenting with making spherical ice cubes for cocktails. But why go to all the fuss of making spherical ice cubes? What's wrong with regular ice cubes? The answer is surface area to volume ratio: the volume of the ice provides the cooling effect but the surface area controls how fast the ice melts – the lower the surface area to volume ratio the longer the ice will take to melt for the same cooling effect. Essentially, a lower surface area to volume ratio keeps your drink cold, but stops it from becoming too diluted. A cube with sides of length x will have a volume of x3 and a surface area of 6x2. The surface area to volume ratio for a cube is therefore 6 to 1 (6:1). Of all the Platonic solids (solids with identical faces) the icosahedron has the lowest surface area to volume ratio. Of all the regular shapes a sphere has the lowest possible surface area to volume ratio. That is what makes it particularly well suited for cooling drinks. The production of spherical ice cubes is also quite interesting. They're usually made in an extremely elaborate process using large blocks of ice that are then shaped using metal "presses" (usually made of copper or aluminium as they are very good conductors of heat). What is the surface area of a 6 cm cube? How do you find the surface area and volume of a sphere? What does surface area to volume ratio mean? What are the volume and surface area of the large cube? What is the effect of a large surface area to volume ratio? What shape has the highest volume to surface area ratio? How do you increase surface area without increasing volume? What is the formula for volume? Can volume and surface area be the same? Does surface area or volume increase faster? Surface area per unit volume of an object or collection of objects Graphs of surface area, A against volume, V of the Platonic solids and a sphere, showing that the surface area decreases for rounder shapes, and the surface-area-to-volume ratio decreases with increasing volume. Their intercepts with the dashed lines show that when the volume increases 8 ($2^3$) times, the surface area increases 4 ($2^2$) times. The surface-area-to-volume ratio, also called the surface-to-volume ratio and variously denoted sa/vol or SA:V, is the amount of surface area per unit volume of an object or collection of objects. SA:V is an important concept in science and engineering. It is used to explain the relation between structure and function in processes occurring through the surface AND the volume. Good examples for such processes are processes governed by the heat equation,[1] i.e., diffusion and heat transfer by conduction.[2] SA:V is used to explain the diffusion of small molecules, like Oxygen and Carbon dioxide between air, blood and cells,[3] Water loss by animals,[4] bacterial morphogenesis,[5] organism's Thermoregulation,[6] design of artificial bone tissue,[7] artificial lungs [8] and many more biological and biotechnological structures. For more examples see Glazier.[9] The relation between SA:V and diffusion or heat conduction rate is explained from flux and surface perspective, focusing on the surface of a body as the place where diffusion, or heat conduction, takes place, i.e., the larger the SA:V there is more surface area per unit volume through which material can diffuse, therefore, the diffusion or heat conduction, will be faster. Similar explanation appears in the literature: "Small size implies a large ratio of surface area to volume, thereby helping to maximize the uptake of nutrients across the plasma membrane",[10] and elsewhere.[9][11][12] For a given volume, the object with the smallest surface area (and therefore with the smallest SA:V) is a ball, a consequence of the isoperimetric inequality in 3 dimensions. By contrast, objects with acute-angled spikes will have very large surface area for a given volume. SA:V for balls and N-balls A ball is a three-dimensional object, being the filled-in version of a sphere ("sphere" properly refers only to the surface and a sphere thus has no volume). Balls exist in any dimension and are generically called n-balls, where n is the number of dimensions. Plot of the surface-area:volume ratio (SA:V) for a 3-dimensional ball, showing the ratio decline inversely as the radius of the ball increases. For an ordinary three-dimensional ball, the SA:V can be calculated using the standard equations for the surface and volume, which are, respectively, 4 π r 2 {\displaystyle 4\pi {r^{2}}} and ( 4 / 3 ) π r 3 {\displaystyle (4/3)\pi {r^{3}}} . For the unit case in which r = 1 the SA:V is thus 3. The SA:V has an inverse relationship with the radius - if the radius is doubled the SA:V halves (see figure). The same reasoning can be generalized to n-balls using the general equations for volume and surface area, which are: volume = r n π n / 2 Γ ( 1 + n / 2 ) {\displaystyle r^{n}\pi ^{n/2} \over \Gamma (1+n/2)} ; surface area = n r n − 1 π n / 2 Γ ( 1 + n / 2 ) {\displaystyle nr^{n-1}\pi ^{n/2} \over \Gamma (1+{n/2})} Plot of surface-area:volume ratio (SA:V) for n-balls as a function of the number of dimensions and of radius size. Note the linear scaling as a function of dimensionality and the inverse scaling as a function of radius. So the ratio reduces to n r − 1 {\displaystyle nr^{-1}} . Thus, the same linear relationship between area and volume holds for any number of dimensions (see figure): doubling the radius always halves the ratio. Dimension The surface-area-to-volume ratio has physical dimension L−1 (inverse length) and is therefore expressed in units of inverse distance. As an example, a cube with sides of length 1 cm will have a surface area of 6 cm2 and a volume of 1 cm3. The surface to volume ratio for this cube is thus SA:V = 6 cm 2 1 cm 3 = 6 cm − 1 {\displaystyle {\mbox{SA:V}}={\frac {6~{\mbox{cm}}^{2}}{1~{\mbox{cm}}^{3}}}=6~{\mbox{cm}}^{-1}} . For a given shape, SA:V is inversely proportional to size. A cube 2 cm on a side has a ratio of 3 cm−1, half that of a cube 1 cm on a side. Conversely, preserving SA:V as size increases requires changing to a less compact shape. Physical chemistry This section does not cite any sources. Please help improve this section by adding citations to reliable sources. Unsourced material may be challenged and removed. (February 2014) (Learn how and when to remove this template message) See also: Dust explosion Materials with high surface area to volume ratio (e.g. very small diameter, very porous, or otherwise not compact) react at much faster rates than monolithic materials, because more surface is available to react. An example is grain dust: while grain is not typically flammable, grain dust is explosive. Finely ground salt dissolves much more quickly than coarse salt. A high surface area to volume ratio provides a strong "driving force" to speed up thermodynamic processes that minimize free energy. Biology Cells lining the small intestine increase the surface area over which they can absorb nutrients with a carpet of tuftlike microvilli. The ratio between the surface area and volume of cells and organisms has an enormous impact on their biology, including their physiology and behavior. For example, many aquatic microorganisms have increased surface area to increase their drag in the water. This reduces their rate of sink and allows them to remain near the surface with less energy expenditure.[citation needed] An increased surface area to volume ratio also means increased exposure to the environment. The finely-branched appendages of filter feeders such as krill provide a large surface area to sift the water for food.[13] Individual organs like the lung have numerous internal branchings that increase the surface area; in the case of the lung, the large surface supports gas exchange, bringing oxygen into the blood and releasing carbon dioxide from the blood.[14][15] Similarly, the small intestine has a finely wrinkled internal surface, allowing the body to absorb nutrients efficiently.[16] Cells can achieve a high surface area to volume ratio with an elaborately convoluted surface, like the microvilli lining the small intestine.[17] Increased surface area can also lead to biological problems. More contact with the environment through the surface of a cell or an organ (relative to its volume) increases loss of water and dissolved substances. High surface area to volume ratios also present problems of temperature control in unfavorable environments.[citation needed] The surface to volume ratios of organisms of different sizes also leads to some biological rules such as Allen's rule, Bergmann's rule[18][19][20] and gigantothermy.[21] Fire spread In the context of wildfires, the ratio of the surface area of a solid fuel to its volume is an important measurement. Fire spread behavior is frequently correlated to the surface-area-to-volume ratio of the fuel (e.g. leaves and branches). The higher its value, the faster a particle responds to changes in environmental conditions, such as temperature or moisture. Higher values are also correlated to shorter fuel ignition times, and hence faster fire spread rates. Planetary cooling A body of icy or rocky material in outer space may, if it can build and retain sufficient heat, develop a differentiated interior and alter its surface through volcanic or tectonic activity. The length of time through which a planetary body can maintain surface-altering activity depends on how well it retains heat, and this is governed by its surface area-to-volume ratio. For Vesta (r=263 km), the ratio is so high that astronomers were surprised to find that it did differentiate and have brief volcanic activity. The moon, Mercury and Mars have radii in the low thousands of kilometers; all three retained heat well enough to be thoroughly differentiated although after a billion years or so they became too cool to show anything more than very localized and infrequent volcanic activity. As of April 2019, however, NASA has announced the detection of a "marsquake" measured on April 6, 2019 by NASA's InSight lander.[22] Venus and Earth (r>6,000 km) have sufficiently low surface area-to-volume ratios (roughly half that of Mars and much lower than all other known rocky bodies) so that their heat loss is minimal.[23] Mathematical examples Shape CharacteristicLength a {\displaystyle a} Surface Area Volume SA/V ratio SA/V ratio forunit volume Tetrahedron edge 3 a 2 {\displaystyle {\sqrt {3}}a^{2}} 2 a 3 12 {\displaystyle {\frac {{\sqrt {2}}a^{3}}{12}}} 6 6 a ≈ 14.697 a {\displaystyle {\frac {6{\sqrt {6}}}{a}}\approx {\frac {14.697}{a}}} 7.21 Cube side 6 a 2 {\displaystyle 6a^{2}} a 3 {\displaystyle a^{3}} 6 a {\displaystyle {\frac {6}{a}}} 6 Octahedron side 2 3 a 2 {\displaystyle 2{\sqrt {3}}a^{2}} 1 3 2 a 3 {\displaystyle {\frac {1}{3}}{\sqrt {2}}a^{3}} 3 6 a ≈ 7.348 a {\displaystyle {\frac {3{\sqrt {6}}}{a}}\approx {\frac {7.348}{a}}} 5.72 Dodecahedron side 3 25 + 10 5 a 2 {\displaystyle 3{\sqrt {25+10{\sqrt {5}}}}a^{2}} 1 4 ( 15 + 7 5 ) a 3 {\displaystyle {\frac {1}{4}}(15+7{\sqrt {5}})a^{3}} 12 25 + 10 5 ( 15 + 7 5 ) a ≈ 2.694 a {\displaystyle {\frac {12{\sqrt {25+10{\sqrt {5}}}}}{(15+7{\sqrt {5}})a}}\approx {\frac {2.694}{a}}} 5.31 Capsule radius (R) 4 π a 2 + 2 π a · 2 a = 8 π a 2 {\displaystyle 4\pi a^{2}+2\pi a\cdot 2a=8\pi a^{2}} 4 π a 3 3 + π a 2 · 2 a = 10 π a 3 3 {\displaystyle {\frac {4\pi a^{3}}{3}}+\pi a^{2}\cdot 2a={\frac {10\pi a^{3}}{3}}} 12 5 a {\displaystyle {\frac {12}{5a}}} 5.251 Icosahedron side 5 3 a 2 {\displaystyle 5{\sqrt {3}}a^{2}} 5 12 ( 3 + 5 ) a 3 {\displaystyle {\frac {5}{12}}(3+{\sqrt {5}})a^{3}} 12 3 ( 3 + 5 ) a ≈ 3.970 a {\displaystyle {\frac {12{\sqrt {3}}}{(3+{\sqrt {5}})a}}\approx {\frac {3.970}{a}}} 5.148 Sphere radius 4 π a 2 {\displaystyle 4\pi a^{2}} 4 π a 3 3 {\displaystyle {\frac {4\pi a^{3}}{3}}} 3 a {\displaystyle {\frac {3}{a}}} 4.83598 Examples of cubes of different sizes Side ofcube Side2 Area of asingle face 6 × side2 Area ofentire cube(6 faces) Side3 Volume Ratio ofsurface areato volume 2 2x2 4 6x2x2 24 2x2x2 8 3:1 4 4x4 16 6x4x4 96 4x4x4 64 3:2 6 6x6 36 6x6x6 216 6x6x6 216 3:3 8 8x8 64 6x8x8 384 8x8x8 512 3:4 12 12x12 144 6x12x12 864 12x12x12 1728 3:6 20 20x20 400 6x20x20 2400 20x20x20 8000 3:10 50 50x50 2500 6x50x50 15000 50x50x50 125000 3:25 1000 1000x1000 1000000 6x1000x1000 6000000 1000x1000x1000 1000000000 3:500 See also Compactness measure of a shape Dust explosion Square–cube law Specific surface area References Schmidt-Nielsen, Knut (1984). 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calculate the surface area to volume ratio of a cube whose sides are 6cm long. calculate the surface area to volume ratio for a cube of length 2 cm. calculate the surface area to volume ratio of a cube with 3 cm sides. calculate the surface area to volume ratio for a cube of 3 cm length. how to calculate ratio of surface area to volume. how to do surface area to volume ratio. how do you calculate the surface area to volume ratio of a cube. how to surface area to volume ratio