Surface Area to Volume Ratio

(and heat transfer)

An object's **Surface Area to Volume Ratio** is like a way of describing how close every internal part of it is to its surface.

It is worked out by dividing an object's surface area by its volume:

$$\text{S.A.:Vol Ratio} = \frac{\text{Surface Area}}{\text{Voume}}$$

A high **S.A.:Vol Ratio** shows that every part of an object is quite close to the edge. This means heat energy can get in and out quickly, as there is only a short distance from the edge to the middle.

For example…

Small Cube: 

Side length= 1cm

Volume = 1cm x 1cm x 1cm = $1cm^3$

Surface Area = 6 x (1cm x 1cm) = $6cm^2$

S.A.:Vol Ratio = $\frac{6}{1} = 6$

A low **SA:Vol Ratio** means that there are parts of the object that are a long way from the edge. This means that heat energy takes longer to get in or out, as there is a longer distance from the edge to the middle.

For example…

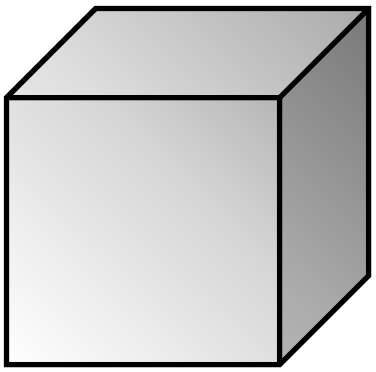
Large Cube:

Side length= 10cm

Volume = 10cm x 10cm x 10cm = $1000cm^3$

Surface Area = 6 x (10cm x 10cm) = $600cm^2$

S.A.:Vol Ratio = $\frac{600}{1000} = 0.6$



HIGH S.A.:Vol Ratio:	*LOW S.A.:Vol Ratio*
Heats/cools QUICKLY	***Heats/cools SLOWLY***

Complete the table to work out the Surface Area: Volume Ratios for the cubes, and then answer the questions:

Cube	Side Length	Volume / cm^3	Surface Area / cm^2	S.A.:Vol Ratio
A	2			
B	15			
C	0·5			
D	7·5			
E	5			

1. What is the relationship between size and S.A.:Vol Ratio: _____

   _____

2. Which cube would heat up the fastest? _____

3. Which cube would remain warm the longest? _____

4. Why is an advantage for polar bears to be large? _____

   _____

5. Why is being large a disadvantage for African elephants? _____

   _____

6. Why do African elephants have large, flat ears? _____

   _____

ANSWERS – ONLY LOOK AT THESE AFTER YOU HAVE TRIED ON YOUR OWN!

Cube	Side Length	Volume / cm^3	Surface Area / cm^2	S.A.:Vol Ratio
A	2	2x2x2 = 8cm^3	(2x2)+(2x2)+(2x2)+(2x2)+(2x2)+(2x2) = 24 cm^2	24/8 = 3
B	15	15x15x15 = 3375cm^3	(15x15)+(15x15)+(15x15)+(15x15)+(15x15)+(15x15) = 1350 cm^2	1350/3375 = 0.4
C	0·5	0.5x0.5x0.5 = 0.125cm^3	1.5 cm^2	12
D	7·5	7.5x7.5x7.5= 422 cm^3	337.5 cm^2	0.8
E	5	5x5x5=125cm^3	150 cm^2	1.2

1. What is the relationship between size and S.A.:Vol Ratio: Bigger size = smaller ratio

2. Which cube would heat up the fastest? Cube C (highest ratio)

3. Which cube would remain warm the longest? Cube B (lowest ratio – heat energy takes longer to get out)

4. Why is an advantage for polar bears to be large? If they are large, they will have a small surface area to volume ratio, therefore they will not cool down as fast in the Arctic

5. Why is being large a disadvantage for African elephants? Since they are large, they will have small surface area to volume ratio, this means it takes them a long time to cool down, which is a disadvantage in a hot climate.

6. Why do African elephants have large, flat ears? To increase their surface area, so that their surface area to volume ratio can be higher, and therefore that they can cool down faster