MGF 1106 and BSC 1086 topic: “Surface to Volume Ratio”

Learning outcomes (corresponding to broader course objectives)

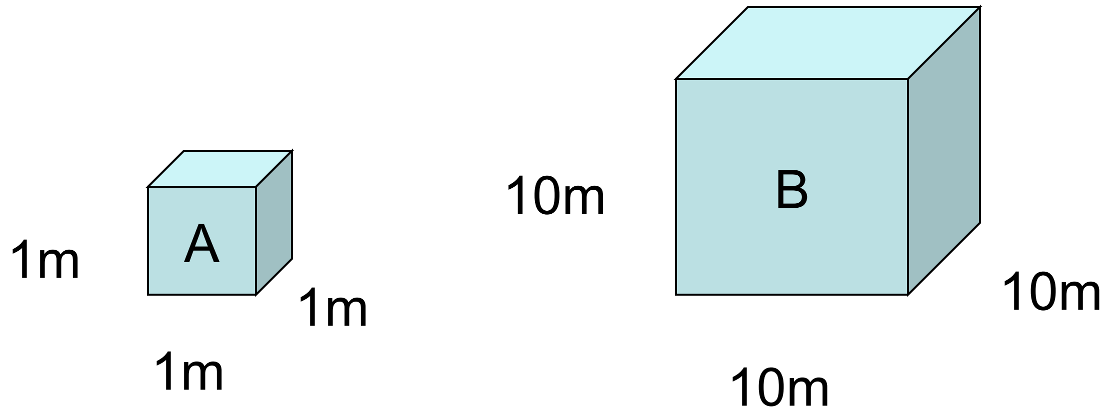
the student will be able to…

- compute surface area, volume and express them in a ratio (SA/V.)
- explain the relationship of SA to volume
- apply the surface area to volume ratio to real world examples (Human Anatomy)
- generate graphs representing surface to volume ratios
- make a prediction about the effect of changes in surface to volume ratio
- collaborate with fellow students on related SA/V problems

Introduction: the mathematical concept of Surface Area to Volume can be used to explain many features of living things including people. The goal of this module is to help students learn about surface to volume ratios and how they relate to real world situations.

For the mathematics instructor: A larger object of the same relative shape will have increase the volume faster than its surface area (think of blowing up a balloon – it seems like it takes a lot of air going in for a relatively less increase in the size of the balloon on the “outside”.) This LOWER surface area to volume ratio for the larger item will cause the object to lose heat at a slower relative rate. If the volume remains the same and the surface area changes there will also be a relationship to the loss of heat (if we flatten something out its surface area will get greater relative to its volume and heat will be lost faster as the SA/V ratio has increased.)

Surface to Volume Ratio



Review the basics

Surface area is equal to the total space of all of the sides or surface of an object.

For a cube, the surface area is calculated by adding the measurements of length times width for each side.

Write the formula for area: A =

How many sides does the cube have?______

Find the area of *each* _side_ of the cubes above:

cube A ________ cube B________

Calculate the **<u>surface area</u>** of each cube:

cube A________ cube B_________

Volume is the space occupied by the object. In the case of the cube, it would be the length times the width times the height.

Write the formula for volume: V =

Calculate the **<u>volume</u>** of each cube:

cube A________ cube B_________

Do not forget to include the correct units of measure for each measurement above!

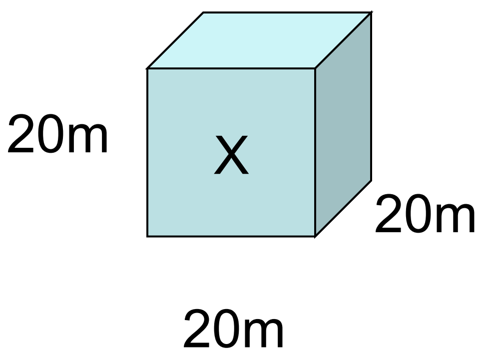
A ratio of surface area to volume can be expressed as SA/V. Using the surface areas and volumes you calculated for cubes A and B above, calculate the SA/V ratios of each. What are the units of the ratio?

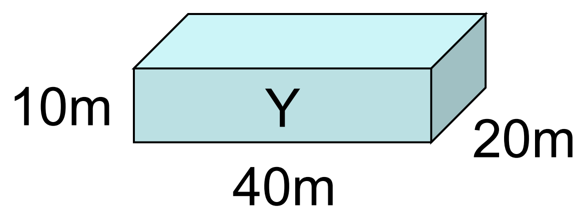
Cube A_________ Cube B__________

Do cubes A and B have the same proportions?

Which cube has a greater surface area to volume ratio?

The effects of shape on surface to volume ratio





Calculate the:

surface area for X________ and Y________.

volume ratio for X________ and Y________.

SA/V ratio for X________ and Y________.

Which shape has more surface area?

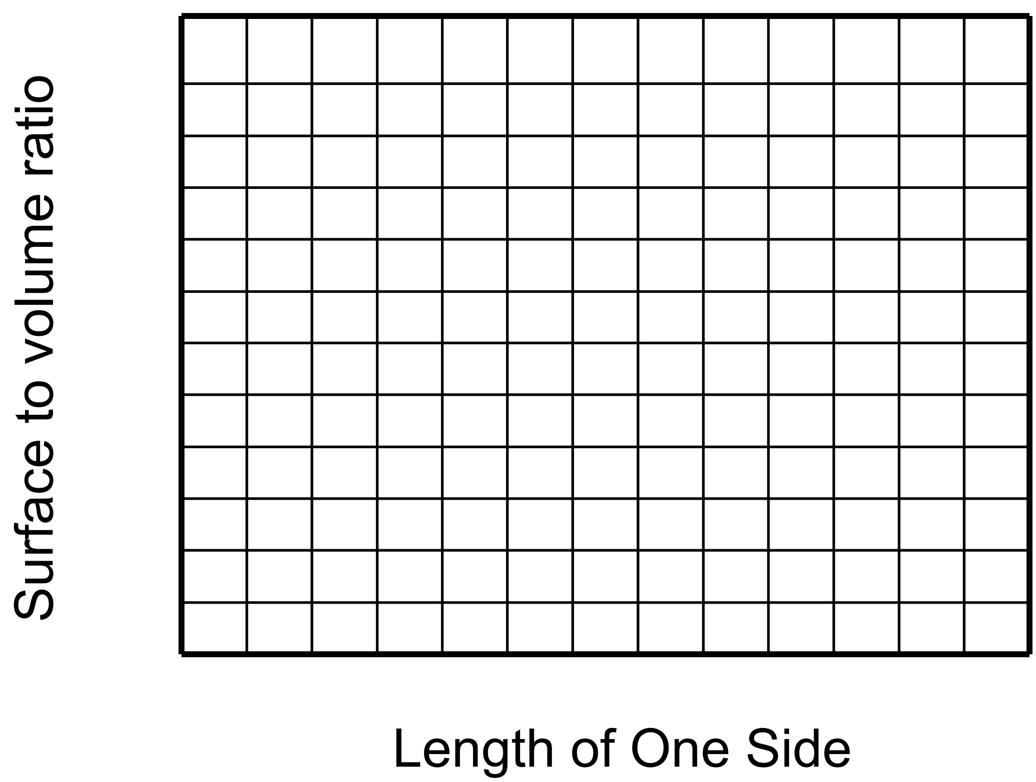
Which shape has the greater SA/V ratio?

How does shape affect SA/V ratio?

Graphing

Calculate the surface to volume ratio of each of the following cubes given their dimensions:

Cube	**dimensions**	**surface area**	**volume**	**SA/V ratio**
Cube A	1x1x1m	____________	____________	____________
Cube B	10x10x10m	____________	____________	____________
Cube C	20x20x20	____________	____________	____________
Cube D	30x30x30	____________	____________	____________
Cube E	40x40x40	____________	____________	____________



Application of Surface to Volume Ratio on Human Anatomy and Physiology

Imagine a more complex shaped object like a human body. The exposed surface area can be important in heat regulation because heat can be gained and lost through the surface.

If you have two people of the same proportions but one is much larger than the other overall, how would that affect the relative gain and loss of heat?

Consider two people of the same volume, but one is tall and thin with long arms and legs while the other is short and round with stubby arms and legs. How would the transfer of heat across their surface areas differ? Can you explain how this might be a biological adaptation of humans to different climates around the world?