KEEP WARM BY CUDDLING UP!

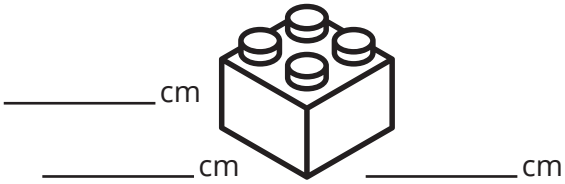
How Surface Area to Volume Ratio Helps Polar Animals Conserve Body Heat

WHAT IS SURFACE AREA TO VOLUME RATIO?

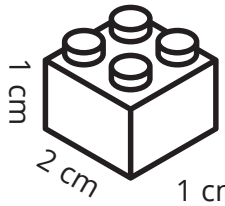
Surface area measures the outside of an object. **Volume** measures its inside. Small objects have a lot of *outside* relative to their *inside*. Bigger objects have more *inside* relative to their *outside*.

YOU CAN TEST THIS USING BUILDING BLOCKS. START SMALL:

1) Measure all the edges of one block. Record your measurements on the diagram below:



2) Now multiply two edges to get the area of one side. For example:



1 cm × 2 cm = 2 cm²

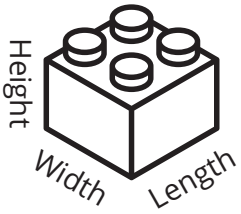
3) Repeat for every side of the block.

Side 1 _____ Side 2 _____ Side 3 _____

Side 4 _____ Side 5 _____ Side 6 _____

4) Add all six sides to get the total **surface area** for this block: _____

5) To measure the **volume** of the block, multiply length × width × height = volume.



1 cm × 2 cm × 2 cm = 4 cm²

6) For this small block, how do **surface area** and **volume** compare?

NOW LET'S SUPERSIZE IT!

Start by snapping four small blocks together to create one large rectangle.

1) Measure all the edges of the large rectangle.

_____

2) Add up the surface area, and multiply the volume.

_____

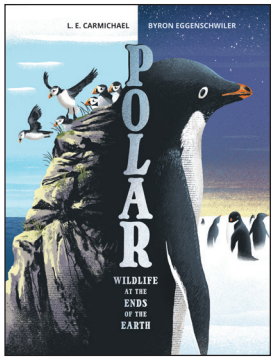
3) How do surface area and volume of the large rectangle compare?

_____

4) How does the surface area to volume ratio of the large rectangle compare to that of one small block?

_____

_____



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HOW DOES SURFACE AREA TO VOLUME RATIO HELP POLAR ANIMALS CONSERVE HEAT?

Birds and mammals are warm-blooded, meaning they make their own body heat. Heat leaves the body through the skin — the animal's *surface*. The more **surface area** relative to **volume**, the faster the heat loss — especially in cold environments like the polar regions.

Small animals stay warm by pretending to be big animals: they cuddle up! Called a huddle, this group of animals has less **surface area**, relative to **volume**, than a single animal: a solitary animal shivers but the huddle stays toasty warm. In Antarctica, huddles get so hot that penguins have to stop cuddling just to cool down!

Test this with your friends or siblings. Cuddle up like a pile of puppies. How soon do you start to sweat? Does changing the size of the huddle change how long you can cuddle up? What about position in the huddle — do the people in the middle get warmer than the people on the edges? Why or why not?

SURVIVE COLD WATER BY REDUCING SURFACE AREA

Mammals lose body heat 90 times faster in cold water than in cold air. The thick **blubber** of whales and seals helps keep their heat inside their bodies, even while swimming in icy polar seas.

Humans aren't so lucky! In cold water, our body temperatures can dip so low that we may die of **hypothermia**. That's why the Life Jacket Association recommends that humans huddle after a boating accident — the huddle keeps everyone warm while waiting for rescuers.

If you're waiting for rescue alone, protect yourself by changing your own **surface area to volume ratio**. Pull your knees into your chest and hug yourself. This balled-up position reduces your **surface area**, keeping you warmer longer. For extra protection, keep your hot head out of the water!

Blubber: a thick layer of body fat just below the skin

Hypothermia: losing heat faster than the body can produce it, causing a dangerous drop in body temperature