

## Scaling Boxes

**T**he cost of packaging materials and finding enough landfill for garbage and waste materials is becoming a problem for many communities. Some communities are looking at composting as a way to recycle garbage into productive soil.

Composting is a method for turning organic waste into rich soil. Today, many people have compost boxes that break down kitchen waste quickly and with little odor. The secret is in the worms!



### Recipe for a 1-2-3 Compost Box

- Start with an open rectangular wood box that is 1 foot high, 2 feet wide, and 3 feet long. This is a 1-2-3 box.
- Mix 10 pounds of shredded newspaper with 15 quarts of water. Put the mixture in the 1-2-3 box.
- Add a few handfuls of soil.
- Add about 1,000 redworms (about 1 pound).



Every day, mix collected kitchen waste with the soil in the box. The worms will do the rest of the work, turning the waste into new soil. A 1-2-3 box will decompose about 0.5 pound of garbage each day.

## 5.1 Building a Bigger Box

**D**eshondra chose composting as the topic of her science project. She plans to build a compost box at home and to keep records of the amount of soil produced over several weeks. She estimates that her family throws away 1 pound of garbage a day.

### Problem 5.1 Doubling the Volume of a Rectangular Prism

Deshondra wants to build a box that will decompose twice the amount of the 1-2-3 box.

- A. Using grid paper, make scale models of a 1-2-3 box that will decompose 0.5 pound of garbage per day and a box that will decompose 1 pound of garbage per day.
- B.
  1. What are the dimensions of the new box?
  2. How many of the original boxes will fit into the new box?
  3. How is the volume of the new box related to the volume of the original box?
- C. How much plywood is needed to construct an open 1-pound box?

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## 5.2 Scaling Up the Compost Box

In *Stretching and Shrinking*, you studied similar two-dimensional figures. The ideas you learned also apply to three-dimensional figures. For example, two rectangular prisms are similar if the ratios of the lengths of corresponding edges are equal. A 2-4-6 box is similar to the 1-2-3 box.

The *scale factor* is the number that each dimension of one rectangular prism must be multiplied by to get the dimensions of a similar prism. The scale factor from the 1-2-3 box to the 2-4-6 box is 2 because each edge length of the 1-2-3 box must be multiplied by 2 to get the corresponding edge length of the 2-4-6 box.

### Problem 5.2 Applying Scale Factors to Rectangular Prisms

Ms. Fernandez's class decides that building and maintaining a compost is a fascinating project. One student suggests that they could earn money selling worms and soil to a local nursery.

They decide to build different-sized boxes that are similar to the 1-2-3 box. They need to know how much material is needed to build the boxes and how much garbage each box will decompose in a day.

**A.** Copy and complete the table.

**Compost Box Project**

Open Box ( $h-w-\ell$ )	Scale Factor	Surface Area ( $\text{ft}^2$ )	Volume ( $\text{ft}^3$ )	Amount of Garbage Decomposed in a Day	Number of Worms Needed
1-2-3	■	■	■	■	■
2-4-6	■	■	■	■	■
3-6-9	■	■	■	■	■
4-8-12	■	■	■	■	■
■	■	■	■	■	■
■	■	1,024	■	■	■
■	■	■	■	■	■
■	■	■	6,000	■	■

- B.** How is the change in surface area from a 1-2-3 box to a similar box related to the scale factor from the 1-2-3 box to the similar box? Suppose the compost box has a top. Will your answer change? Explain.
- C.** How is the change in volume from a 1-2-3 box to a similar box related to the scale factor from the 1-2-3 box to the similar box? Explain.
- D.** How is the change in decomposed garbage related to the scale factor? Explain.
- E.** Suppose the scale factor between the 1-2-3 box and a similar box is  $N$ . Describe the dimensions, surface area, and volume of the similar box.

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## 5.3 Building Model Ships

**B**uilders and architects often make models of cars, ships, buildings, and parks. A model is useful in determining several aspects of the building process, including structural strength, expense, and appearance.



## Problem 5.3 Similarity and Scale Factors

Natasha builds a model ship from a kit. She tries to picture what the actual ship looks like. The scale factor from the model to the actual ship is 200.

- A.**
1. If the length of the model is 25 centimeters, what is the length of the actual ship?
  2. If the length of the flagpole on the actual ship is 30 meters, what is the length of the flagpole on the model?
- B.** The area of a rectangular floor on the model is 20 square centimeters. What is the area of the floor on the actual ship?
- C.** The cylindrical smoke stack on the model has a height of 4 centimeters and a radius of 1.5 centimeters.
1. What are the dimensions of the smoke stack on the actual ship?
  2. What is the volume of the smoke stack on the actual ship?
  3. What is the surface area of the smoke stack on the actual ship?

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## Did You Know?

Most minerals occur naturally as crystals. Every crystal has an orderly, internal pattern of atoms, with a distinctive way of locking new atoms into that pattern. As the pattern repeats, larger similar-shaped crystals are formed. The shape of the resulting crystal, such as a cube (like salt) or a six-sided form (like a snowflake), is a similar crystal.

As crystals grow, differences in temperature and chemical composition cause fascinating variations. But you will rarely find in your backyard the perfectly shaped mineral crystals that you see in a museum. In order to readily show their geometric form and flat surfaces, crystals need ideal or controlled growing conditions as well as room to grow.



**Go Online** For: Information about growing crystals  
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