



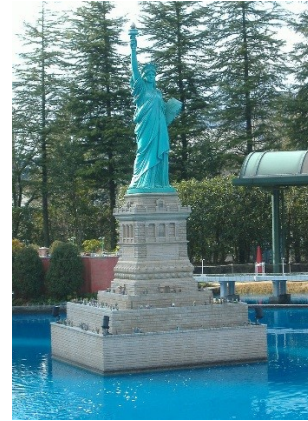
Scale Models

Take a look at the images below. One of them is a photo of the Statue of Liberty, located in New York City. The other is a photo of a scale model of the Statue of Liberty, located in Tobu, Japan. Can you tell which is which?

A **scale model** is an exact replica or copy of something that is made either larger or smaller. The scale model of the Statue of Liberty is 25 times smaller than the real thing. We would say the **scale factor** is $1/25$.



The Statue of Liberty is 350 feet tall from its base to the torch tip.



This scale model of the Statue of Liberty is 12.22 feet tall. It is $1/25$ the size of the original.

Sometimes the opposite can happen. Something that is small can be scaled up to make it larger, like an eyeball or a molar.



This tooth is 15 times larger than the one you have in your mouth!



All the better to see you with! This scale model is five times larger than an actual human eye.

Discuss: Aside from being fun, what other purpose might scale models serve? How do scale models help you learn about real life objects?



Scale Factors

Mostly everything you see in the San Diego Model Railroad Museum is a scale model: the trains, buildings, mountains, animals, even the people! But the scale models are not all the same size. In fact, model railroaders use several different scale factors to create their **layouts**.



Southern Pacific-Santa Fe Tehachapi Pass HO-scale Layout: The glue stick is there so you can better see the relative size.



Cabrillo & Southwestern O-scale Layout: The glue stick is there so you can better see the relative size.

Scale Factors of Model Trains as Fractions

Type	Scale Factor
Z	1/220
N	1/160
HO	1/87
O	1/48
G	1/32

NB: This table shows scales represented at the SDMRM.

Think: How is the table above organized: from smallest to largest or the other way around?



Working with Scale

Scaling Down? Use this formula:

Real Size ÷ Denominator of Scale Factor = Scale Size



Did You Know...?

LeBron's favorite movie is "Gladiator?"

NBA all-star LeBron James is six feet eight inches tall (6'8"). If we wanted to make a G-scale model of him, what size would that model have to be?

Step 1: Convert LeBron's height into inches.

$$12 \times 6 = 72''$$
$$72 + 8 = 80''$$

Step 2: Divide height by the G-scale factor denominator

$$80 \div 32 = 2.5$$

Answer: A G-scale model of LeBron would be 2.5 inches tall.



**Scaling Up? Use this formula:
Scale Size x Scale Factor Denominator = Real Size**



Did You Know...?

Godzilla's favorite movie is "Frozen?"

A Z-scale model of movie monster Godzilla is 1.57 feet tall. If we wanted to discover Godzilla's height in "real-life," how would we do it?

Step 1: Convert Godzilla's scale height into inches.

$$1.57 \times 12 = 18.84$$

Step 2: Multiply height by Z-scale denominator.

$$18.84 \times 220 = 4144.8$$

Step 3: Convert inches into feet.

$$4144.8 \div 12 = 345.4$$

Answer: In "real life," Godzilla is 345.4 feet tall.



Scaling Up in Three Dimensions

In the previous examples, we only scaled up or down using one dimension, height. Objects in the real world, however have three dimensions: length, width and height. In order to create an accurate scale model, you must deal with all three of these. Examine the images below. Use what you know to discover the size of these trains in real-life.

1

Nonstandard Unit of Measure - Twizzlers: This train is two Twizzlers long. "Help, my tongue is red!"



TRAIN FACTS

G-SCALE ENGINE

LENGTH: 13 inches

WIDTH: 6 inches

HEIGHT: 4 $\frac{3}{4}$ inches

What size is this engine in real life? Use the white space to show your work.





2

Nonstandard Unit of Measure – Oreos: This train is six Oreos long.
“Quick, somebody get the milk!”



TRAIN FACTS

O-SCALE ENGINE

LENGTH: $13 \frac{1}{4}$ inches

WIDTH: $2 \frac{1}{2}$ inches

HEIGHT: $3 \frac{3}{4}$ inches

What size is this engine in real life? Use the white space to show your work.





3

Nonstandard Unit of Measure – Cheetos: This train is five Cheetos long. “Orange fingers and not a napkin in sight!”



TRAIN FACTS

HO-SCALE ENGINE

LENGTH: 11 ½ inches

WIDTH: 1 ½ inches

HEIGHT: 2 ½ inches

What size is this engine in real life? Use the white space to show your work.





4

Nonstandard Unit of Measure – Skittles: “This train is eight and a half Skittles long. “Skittles, eww!”



TRAIN FACTS

N-SCALE ENGINE

LENGTH: 4 ½ inches

WIDTH: 2/3 inches

HEIGHT: 1 ¼ inches

What size is this engine in real life? Use the white space to show your work.





5

Nonstandard Unit of Measure – Tic Tac: This train is seven and a half Tic Tacs long. “Ahh, minty fresh!”



TRAIN FACTS

Z-SCALE ENGINE

LENGTH: 4 inches

WIDTH: 2/3 inches

HEIGHT: 3/4 inches

What size is this engine in real life? Use the white space to show your work.





Scaling Down in Three Dimensions

Use what you know to scale these famous train engines down to the indicated scale factor.

6



TRAIN NAME: Big Boy – First Built in 1941

LENGTH: 85 feet

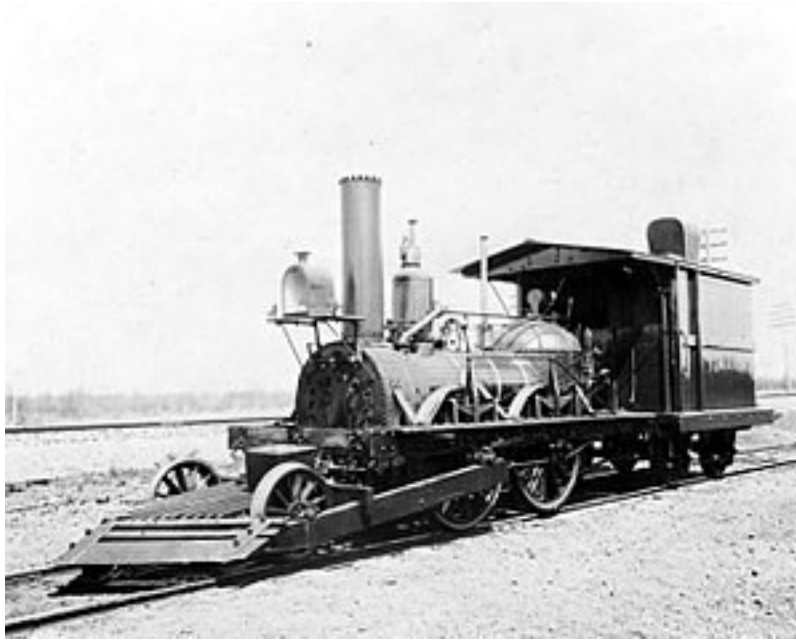
WIDTH: 11 feet

HEIGHT: 16 feet

Calculate the dimensions of a G-scale model of Big Boy. Use the white space to show your work.



7



TRAIN NAME: John Bull - First Built in 1831

LENGTH: 36 feet and $\frac{1}{4}$ inches

WIDTH: 7 feet $\frac{1}{2}$ inch

HEIGHT: 11 feet $\frac{1}{2}$ inch

Calculate the dimensions of an HO-scale model of John Bull. Use the white space to show your work.



Relative Size and Scale



Same train, five scales.

In the photograph above, you can see five different scale versions of the same Santa Fe locomotive. Solve the problems below to determine how much larger each scale locomotive is from the others.

Method #1

How much larger is the G-scale locomotive from the Z-scale locomotive?

Divide the scale factors as fractions:

$$1/32 \div 1/220 = 6 \frac{7}{8}$$

Method #2

How much larger is the G-scale locomotive from the Z-scale locomotive?

Convert scale factors into decimals then divide.

$$.03125 \div .0045454 = 6.87$$

Answer: The G-scale locomotive is 6.9 time larger than the Z-scale locomotive. (Answer has been rounded.)



Solve the following problems:

8

How much larger is the N-scale locomotive from the Z-scale locomotive?

9

How much larger is the HO-scale locomotive from the N-scale locomotive?

10

How much larger is the O-scale locomotive from the HO-scale locomotive?





Vocabulary

1. **layouts:** scale model train representations of real or imagined railroad lines
2. **scale factor:** the ratio which shows how much larger or smaller a scaled object is to its real-life counterpart
3. **scale model:** an exact copy of an object made either larger or smaller.

Research and Write:

Research to find out five facts about either the John Bull or Big Boy engines.

Answer Key

1. $L = 34.7$ feet, $W = 16$ feet, $H = 12.7$ feet
2. $L = 54$ feet, $W = 10$ Feet, $H = 15$ feet
3. $L = 83$ feet, $W = 10.87$ feet, $H = 18.12$ feet
4. $L = 60$ feet, $W = 8.9$ feet, $H = 16.7$ feet
5. $L = 73.73$ feet, $W = 12.2$ feet, $H = 13.75$ feet
6. $L = 2.7$ feet, $W = 4.1$ inches, $H = 6$ inches
7. $L = 5$ inches, $W = 1.03$ inches, $H = 1.59$ inches
8. 1.37 times larger
9. 1.8 times larger
10. 1.8 times larger