**How Did He Do It?**

**Benjamin Banneker’s Clock**

Benjamin Banneker was born a free man in Maryland on November 9, 1731. A land-owning farmer of modest means, Banneker nevertheless lived a life of unusual achievement.

But it was his clock invention that really propelled the reputation of Benjamin Banneker. Sometime in the early 1750s, Benjamin borrowed a pocket watch from a wealthy acquaintance, took the watch apart and studied its components and inner workings. He made a drawing of each component, then reassembled the watch and returned it, fully functioning, to its owner. From his drawings Banneker then proceeded to carve, out of wood, enlarged replicas of each part. Calculating the proper number of teeth for each gear and the necessary relationships between the gears, he completed construction of a working wooden clock in 1753. The clock was amazingly precise. As the result of the attention his self-made clock received, Banneker was able to start up his own watch and clock repair business.

Banneker’s clock kept accurate time and struck the hours for over 50 years until it was destroyed along with most of Banneker’s other belongings in a mysterious house fire that took place on the day of Banneker’s funeral. Benjamin Banneker has been credited for making the first clock to be built completely in America.



An important mathematical aspect of Benjamin Banneker’s accomplishment was the concept of scales and proportions. **Scale** refers to the size of an object (a whole) in relationship to another object (another whole). It is not always possible to draw on paper the actual size of real-life objects such as the real size of a car, an airplane. Also, as the case with Banneker’s clock, objects too small may need to be enlarged. We need scale drawings to represent the size like the one you see here.

In art the size relationship between an object and the human body is significant. In experiencing the scale of an artwork we tend to compare its size to the size of our own bodies.

**Proportion** refers to the relative size of parts of a whole (elements within an object). We often think of proportions in terms of size relationships within the human body.

To find the **scale factor** we use **ratios** to set up proportions. **Proportional** means having the same ratio. A **scale factor** is the ratio of the model measurement to the actual measurement in simplest form. A model car with the scale factor of 1:20 means that the car is 1/20 times the size of the actual car. It also means that the car is 20 times the size of the model.

Solving proportions is simply a matter of stating the ratios as fractions, setting the two fractions equal to each other, [cross-multiplying](http://www.purplemath.com/modules/ratio2.htm#crossmultiply), and solving the resulting equation. You'll probably start out by just solving proportions, like this:

* **Find the unknown value in the proportion:  2 : *x* = 3 : 9.**

2**:** *x* = 3**:** 9

First, convert ratios to fractional form:

 / x = 3 / 9

Then solve the proportion with cross multiplication:

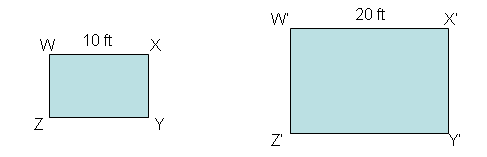
 / x = 3 / 9   
9(2) = *x*(3)   
18 = 3*x*   
**6 = *x***

You try!

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | **1.** | |  |  |  | | --- | --- | --- | | 76 | = | 46 | | *c* | 36 | | | |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | **2.** | |  |  |  | | --- | --- | --- | | 72 | = | 52 | | *d* | 51 | | |
| |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | **3.** | |  |  |  | | --- | --- | --- | | 8 | = | 99 | | 18 | *c* | | | |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | **4.** | |  |  |  | | --- | --- | --- | | 68 | = | 87 | | 18 | *b* | | |
| |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | **5.** | |  |  |  | | --- | --- | --- | | 78 | = | 55 | | 51 | *a* | | | |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | **6.** | |  |  |  | | --- | --- | --- | | 47 | = | 94 | | *b* | 52 | | |

If you are given two shapes and need to find the scale factor, you must know which one was the original and which one is the image or the new shape. Then you need to know the length of corresponding sides and set them up in a ratio like so:

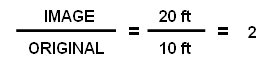
What scale factor was used to dilate (enlarge or shrink) the rectangle WXYZ to rectangle W’X’Y’Z’?



First, determine which shape is the original and which is the image.

Since the smaller one does not have the “prime” marks (the little apostrophes) it must be the original one and the one with the marks is the image.

So we set up our ratio like the one above using the lengths given.



So the scale factor is 2.

