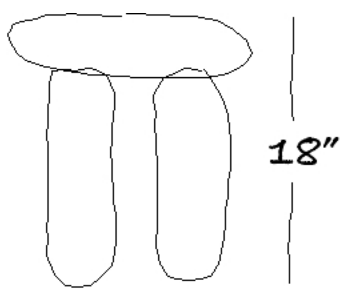
1. Suppose you have a rectangle with sides of length 2 and 5.5. You want to draw a new rectangle whose sides are proportional to those of your original, but with the smaller side having length 3.4. How long must the larger side be? (Give your answer rounded to the nearest 10th.)

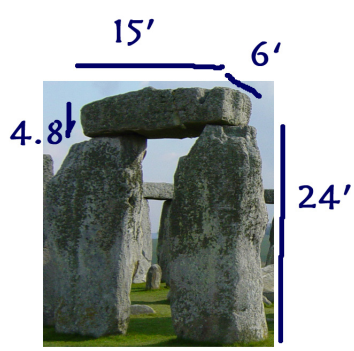
   Recall: In geometry, when two rectangles have the same shape – that is, when their sides are proportional – we say they are **similar**.

2. Suppose you have a right triangle whose legs have length 4 and length 7. You would like to draw a *similar* right triangle whose smaller leg has length 5. How long should the second leg be? How about the hypotenuse? (Round both to the nearest 10th, but use the un-rounded second leg to find the hypotenuse.)

3. The band Spinal Tap has asked you, a set designer, to make a scale model of Stonehenge for one of their performances. They give you a napkin upon which is sketched two upright stones with a horizontal lintel across the top, and a notation that says to make the model 18 inches high. To make a scale model, you need to find measurements of an actual Stonehenge trilithon. You learn that the portion of Stonehenge they sketched is called a *trilithon*, and the piece going across is called a *lintel*. You can't find all the measurements, but combining what you can find with estimations for the rest, you use that the upright stones of the tallest remaining trilithon are 24 feet high, and its lintel is 15 feet wide, 4.8 feet tall, and 6 feet deep.



Spinal Tap's sketch



Tallest trilithon

   (a) The measurements that Spinal Tap gave you are in inches, while the measurements for Stonehenge itself are in feet, and you're not sure whether you need to convert one set or the other so that either everything's in feet or everything's in inches.

i. Calculate the ratio of the width of the actual lintel (the horizontal cross-piece) to its depth in feet. (Round to the nearest 10th.)

ii. Convert both original measurements from part (i) to inches and calculate the ratio again. (Round the ratios to the nearest 10th.)
For those who did not grow up with inches and feet: there are 12 inches per foot.

iii. What do you conclude? As long as all the measurements for one shape (trilithon, triangle, square, etc) are in the same units, does it matter whether the measurements for one shape and its scale model are in the same units?

(b) How tall is the entire Stonehenge trilithon pictured? (This is just arithmetic but you need the result for the next part.)

(c) How wide and deep do you need to make your scale model in order for it to be proportional to the actual trilithon pictured? How tall should the upright stones in your model be? (Round to the nearest 10th of an inch or 100th of a foot.)

4. Recall that in class and in your reading, you've seen Vitruvius' system of proportions for the height of a person (Chapter 1, pp 11-13). If you were going to sketch a person 4" high using that system, how long would you have to make

   (a) the head?

   (b) the face?

   (c) the distance from the bottom of the chin to the bottom of the nostrils?

5. Suppose you want to draw a person using the Vitruvian system, and you know from experience that in order to make a good nose (from the bottom of the nostrils to the line between the eyes), the smallest you can draw it is 1" long. How big should you make your person?

6. The influential architect Le Corbusier based his system of proportions, *The Modulor* (Chapter 1, pp 15-19), on the Golden Ratio, which is an irrational number similar to π in some ways. The Golden Ratio is denoted φ, and it's value is $\varphi = \dfrac{1+\sqrt{5}}{2}$, which is approximately 1.618.

But he did this through incorporating the Golden Ratio throughout a sketch of a man with one arm upraised, having the ratios of the lengths or heights of various portions of the man be this Golden Ratio.

   (a) Le Corbusier began by assuming his man is 183 cm tall from soles of the feet to top of the head. He wanted the ratio of the man's height to the height of his navel to be the Golden ratio. How high above the ground would LeCorbusier need to place the navel? (Round your answer to the nearest 100th.)

   (b) Whether inspired by Vitruvian Man or from his own observation, Le Corbusier wanted the navel to be the midpoint of the man with one arm raised up. Given that, how high above the ground would Le Corbusier need to sketch the fingertips of the upraised arm? (Round your answer to the nearest 100th.)

   (c) Le Corbusier further wanted to divide the total height (to the fingertips of the upraised arm) in a Golden Ratio. That is, he wanted to place some sort of marker at a height y above the ground so that the ratio

$$\frac{\text{height from marker to fingertips of upraised arm}}{\text{height from ground to marker}} = \varphi.$$

   At what height above the ground would LeCorbusier have placed this marker to divide the total height into two pieces whose ratio is the Golden Ratio?

7. You would like to design a web page with two pictures of the Camera degli Sposi side-by-side. For aesthetic reasons, you'd like them to be

the same height, and yet the way the pictures are currently stored on your computer, one is taller than the other.

Picture	Width (in pixels)	Height (in pixels)
Roundel - Camera degli Sposi	605	693
West, North walls, same room	775	546

Fortunately, you can adjust the height and the width of picture files. Of course, if you change the height of a picture, you have to change the width as well, or else you will distort the picture. You want to make the taller picture be the same height as the shorter one.

(a) Which picture will you adjust?

(b) What are the new dimensions of the picture you adjusted? (Round to the nearest whole pixel.)

(I actually do this adjustment all the time for the web pages for this class! The reason we shrink one picture rather than enlarge the other is because when you enlarge a picture it can look fuzzy.)

8. Next, suppose it turns out the web page we were designing above is only about 630 pixels wide. Even after you make the two photos of the Camera degli Sposi the same height, as above, together they will be too wide to fit side by side. Without distorting the pictures, find dimensions for the two photos so that the two widths add up to 630 (or very close to it but less) but so that the photos are still the same height as each other. (Since you are making each picture narrower, naturally their heights will also need to change.) Round answers to the nearest pixel.

   (You may do this using algebra, or simply by experimenting. Just be sure to show that your end result satisfies the requirements – widths add to 630 or close to it (can't be over), heights are equal, pictures not distorted.)

9. Find and photocopy a photo of a painting that includes a standing person. This painting must show the person from top (crown) of the head to bottom of feet (and the person must not be bent over in any

way). It must also show a fully extended hand *or* a fully extended foot. Ideally, the foot or hand would not be fore-shortened in any way, so that you can get an accurate sense of how long it is. (You may use something you print out from the web, but be aware that photos on the web are often slightly distorted, so your result may not reflect the truth of the actual painting. It may also be easier to find such a painting by browsing through a book of paintings.)

Once you've photocopied or printed out the painting, carefully measure the height of the person, as well as the length of their head, and the length of their foot or hand. Are these lengths close to the proportions you'd expect if the artist were using the Vitruvian system of proportions? (Calculate the proportions to the nearest 10th.)

(Include the copy of the painting you used with the measurements you found on it, clearly labeled. Wherever you do these calculations - on the painting or on the page of your homework, of course clearly label them as well.)