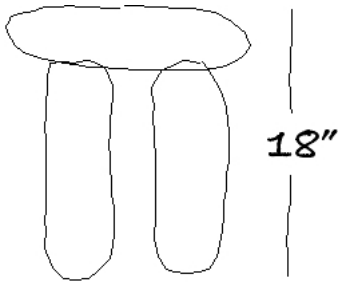
1. Suppose you have a rectangle with sides of length 2 and 5.5. You would like to draw a new rectangle whose sides are proportional to those of your original, but with the smaller side having length 3.4. How long must the larger side be?

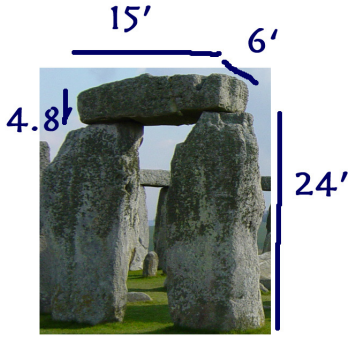
   Note: You may recall from geometry that when two rectangles have the same shape – that is, when their sides are proportional – we say they are *similar*.

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?

3. You are a set-designer. You've been asked by the band Spinal Tap 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" high. You do your research, and you learn that the portion of Stonehenge they sketched for you is called a *trilithon*, and that at Stonehenge, three trilithons remain. It's difficult to find measurements, but you learn that the upright stones of the tallest trilithon are 24′ high, and that the lintel is 15′ wide. You carefully estimate that the lintel is 4.8′ tall, and 6′ deep.



Spinal Tap's sketch



a 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. First calculate the ratio of the width of the lintel (the horizontal cross-piece) to its depth in feet, and then convert both measurements to inches and calculate the ratio again. What do you conclude?

(b) How tall is the entire trilithon?

(c) How wide and deep do you need to make your scale model? How tall should the upright stones in your model be?

4. Recall that in class and in your reading, you've seen Vitruvius' system of proportions for the height of a person. 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. Le Corbusier based his system of proportions, *The Modulor*, on the Golden Ratio, which is $\varphi = \dfrac{1+\sqrt{5}}{2} \approx 1.618$.

   (a) He began with a 183 cm man. He wanted the ratio of the man's height to the height of his navel to be the Golden ratio. How high does the navel need to be?

   (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 should the fingertips of the upraised arm be?

   (c) Le Corbusier further wanted to divide the total height (to the fingertips of the upraised arm) in a Golden Ratio. At what height should a marker of some sort be placed 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

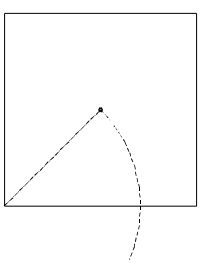
   Fortunately, you can adjust the height and the width of picture files. Of course, if you change the height of a picture, you have to change the width as well, or else you will distort the picture. You want to make the taller picture be the same height as the shorter one. Which picture will you adjust,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

   (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.)

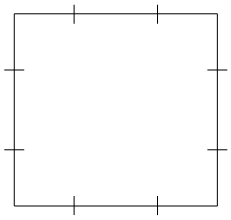
8. Next, suppose it turns out the web page we were designing above is only about 630 pixels wide. But even after you make the two photos of the Camera degli Sposi the same height, together they will still be too wide to fit side by side. Without distorting the pictures, find dimensions for the two photos 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. (They of course should *not* be the same height as you found in the previous problem!)

   (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.)

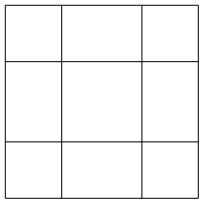
9. In the following exercises, we'll be investigating the Sacred Cut in more detail. (See pages 20-21 of Chapter 1 to review)



Cutting one side

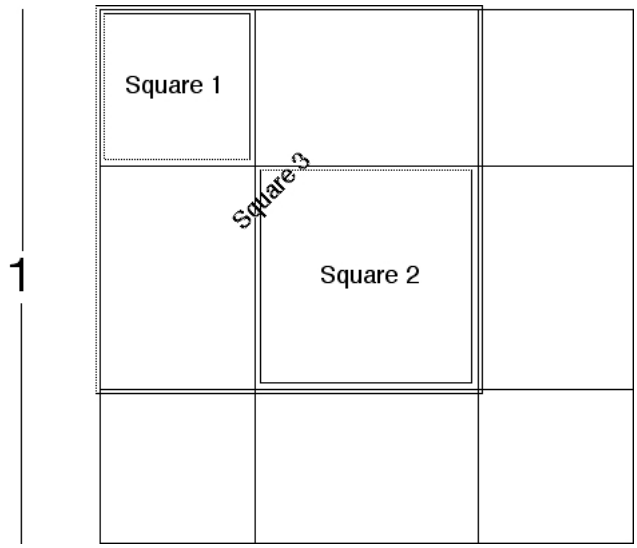


2 cuts per corner



Connecting the cuts

(a) Use the Pythagorean theorem, addition and subtraction to figure out how long the sides of each smaller square is, if the original square has side 1 (Squares 1, 2, and 3 in the diagram below).



(b) Consider the large square in the upper-left corner composed of two smaller squares and two rectangles (labeled Square 3 in the above diagram). Show that the area of this square is one half that of the original square.

(c) Suppose you started with a square of side 7, rather than side 1 as shown above, but still wanted to divide it as shown above. The placement of every cut, and the lengths of the sides of every sub-square, should all be in the same proportion. Using proportion, rather than geometry, figure out the side of the three smaller squares (Squares 1,2, and 3 in the above diagram) that would be created by doing the above construction.

10. Find and photocopy a photo of a painting that includes a standing person, showing the person's head *and* a complete hand or foot. (If you can avoid using the web, do - shapes get distorted on the web, so your results may not reflect those of the actual 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?

    (Please include the copy of the painting you used. Also, clearly label and specify the measurements you found, and clearly label the calculations you were doing!)