1. Suppose you have a rectangle with sides of length 2 and 5.5. You would like to draw another rectangle whose sides are proportional those of your original, but with smaller side of length 3.4. How big 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 designing a web page with two pictures that you would like to place side by side. For aesthetic reasons, you'd like them to be the same height, and yet the way the pictures are currently stored, one is taller than the other. Fortunately, when you include images in a web page, you can adjust the height and the width of the 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. In each case, 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 did both of these pairs, and many more, to make the first day's web pages!)

   | | Picture | Width (pixels) | Height (pixels) |
   |---|---|---|---|
   | (a) | Garden Houses at Ostia | 265 | 346 |
   | | Villa Cornaro | 410 | 283 |

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

4. 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, 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. (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 the same, pictures not distorted.)

5. You are a set-designer. A band named Spinal Tap asks you to make a scale model "of Stonehenge". 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 at Stonehenge, there are three remaining *trilithons* (that's what the part they sketched is called). It's difficult to find measurements, but you learn that the upright stones of the tallest trilithon are $24'$ high, and that the lintel (that has fallen off) is $15'$ wide. You carefully estimate that the lintel is $4.8'$ tall, and $6'$ deep.

   (a) How tall would the trilithon be if the lintel were put back on?

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

6. Recall that in class, we saw Vitruvius' system of proportions for the height of a person. (For a reminder of this system, go to the *In-Class Displays and Works* through the electronic reserves, and choose *February 2nd.*) If you were going to sketch a person 4" high, how long would you have to make

   (a) the head?

   (b) the face?

   (c) the palm?

   (d) the foot?

   (e) the length from the top of the the breast with the bottom of the neck to the crown?

   (f) the length from the middle of the breast to the crown?

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

7. Suppose you want to draw a person using the Vitruvian system, and you know 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?

8. Suppose you want to draw a self-portrait, and you want the "mini-you" to be 12 inches tall. If you are going to draw *yourself* to scale,

   (a) how long should you make your hand?

   (b) how long should you make your head?

   (For this problem, you of course need to specify your height, the length of your hand, and the length of your head (from crown to chin). **Please** make reading your solutions easy by clearly writing this information at the beginning. (You of course don't need to actually draw a self-portrait, although you're welcome to.)

9. Le Corbusier built 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.

10. In the following exercises, we'll be investigating the Sacred Cut in more detail. To remind yourself of the construction of the Sacred Cut, go to *In Class Displays and Works* and choose *February 2*.

    (a) Use the Pythagorean theorem, along with some basic addition and subtraction, to figure out how long the sides of each smaller square is, if the original square has side 1.

(b) Show that the area of the large square in the corner is one half that of the original square.

(c) Suppose you started with a square of side 7. Using proportion, rather than geometry, figure out the side of the three smaller squares that would be created by doing the above construction.

11. Find and photocopy a photo of a painting that includes a standing person. (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, the length of their foot, and the length of their hand. Are these lengths in close to the proportions you'd expect if the artist were using the Vitruvian system of proportions?

(Please clearly label and specify the measurements you found, and clearly label the calculations you were doing!)