1. 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!)

   (a)

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

   (b)

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

2. The web page we were designing above is only about 630 pixels wide. For the second pair – the two photos of the Camera degli Sposi –even after you make them 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.)

3. 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, 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 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?

4. 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?

5. 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.)

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. In the following exercises, we'll be investigating the Sacred Cut in more detail.

   (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.

8. 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!)

9. Consider a single house in Herculaneum, *The House of the Tuscan Colonnade*, analyzed by the Watts – the same people whose work on the Garden Houses of Ostia we discussed in class. The floor plan, from their paper, is shown below.

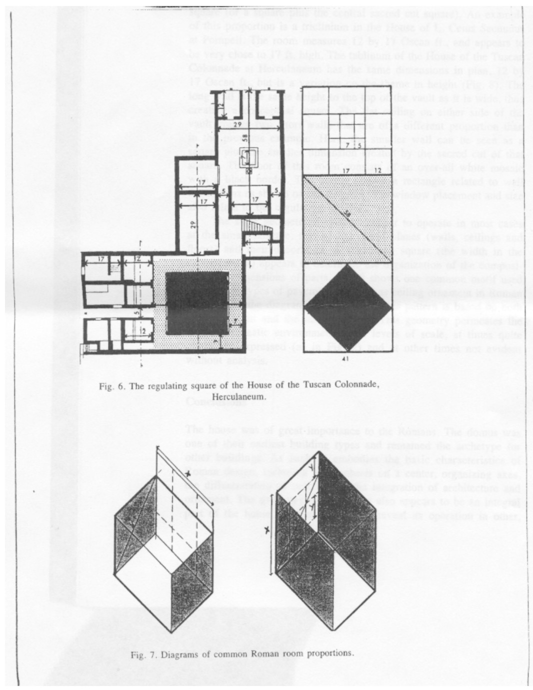

Fig. 6. The regulating square of the House of the Tuscan Colonnade, Herculaneum.

Fig. 7. Diagrams of common Roman room proportions.

The Watts measure the dimensions in Oscan feet – the Oscans were an early Italic people who built the original walls and towers of Pompeii, and may have founded Herculaneum. As you can see in the floor plan, the Watts found the following dimensions:

5 12 17 29 41

Check to see whether ratios of these numbers fall within the acceptance ranges of Sacred Cut ratios that we developed in class.

10. Suppose you are going to be testing several works of art and architecture to see whether your favorite ratio appears. As we did in class, you are assuming that your measurements will be within 1% of the actual lengths, and so you are assuming that the ratios will be off from the actual ratio of the lengths by no more than 2%. Find the *acceptance range* for your ratio, if your favorite ratio is:

    (a) The Golden Ratio, $(1+\sqrt{5})/2$.

(b) $(\sqrt{7}-\sqrt{5})/3$.

11. Suppose a Golden Ratio fanatic measures his box of cereal one morning and finds that the height of the box is 12.2" and the width is 7.8".

    (a) Is the ratio of the height to the width within our acceptance range for the Golden Ratio?

    (b) If the fanatic re-measures and decides he had been off by 1% in each of his measurements, might he be able to claim his cereal box was designed using the Golden Ratio, using our acceptance range?

12. Suppose you measure the length and width of a rectangle, paying attention to how accurately you are measuring. Your results:

$$\text{width } = 3 \text{ feet } \pm .02\% \qquad \text{length } = 6 \text{ feet } \pm .02\%.$$

    (a) Find the value of the ratio of the measured length to the measured width.

    (b) Find the range of values that the *actual* ratio of length to width could fall in. (That is, take into account the errors your measurements could have had.) *Remember:* the errors are percents, so you'll need to calculate what the actual error range is.

    (c) By what percent from the calculated ratio could the actual ratio vary?