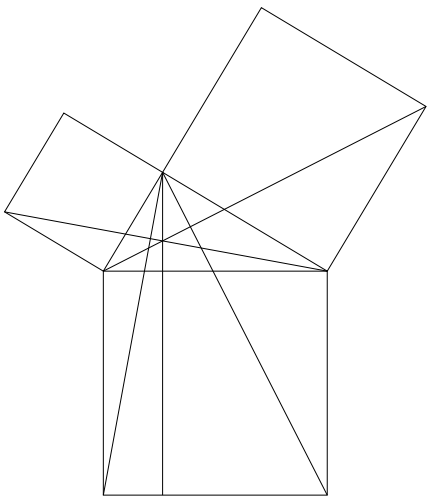
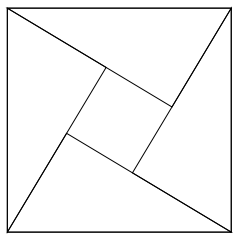
Mathematics 308—February 5, 1996

First homework—due Friday, January 19

Exercise 1. The following two pictures accompany two proofs of the Pythagoras theorem. (The first is from the proof of Proposition 47 in Euclid.)





Write proofs to match the pictures. *Your proofs should not label points and lines unless absolutely necessary. Instead, I want you to use colouring schemes and lots of drawings to explain what is going on.*

There are three diagonal lines which seem to intersect towards the middle of the triangle on the left. Do they in fact intersect, or is it only an artifact of the drawing? Reasons?

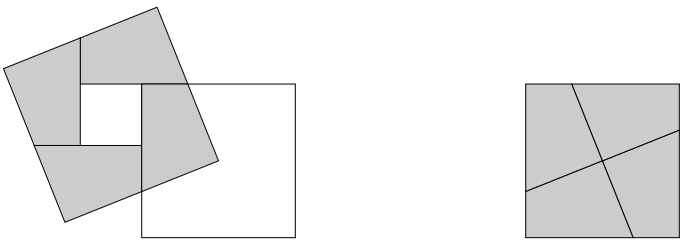
Exercise 2. Write a procedure in `PostScript` which starts with x, y, R and N on the stack and draws a regular polygon of radius R and N sides, with centre at (x, y) and one of the radii at $(x + R, y)$. Use this to draw a regular heptagon of radius 2 inches centred on a page.

Exercise 3. Write a `PostScript` procedure which fills a clipped page with a grid of lines h apart, and gray-ness equal to g. The numbers g and h are on the stack. Use it to draw such a grid with $h = 0.1$ inch, $g = 0.5$. The clipped boundary of the page should be 0.25 inches. The x and y-axes should be black, and the origin at the centre of the page.

Exercise 4. Use `PostScript` to draw the transformed grid you get when you apply the linear transformation

$$\begin{bmatrix} 1 & 2 \\ 1 & 1 \end{bmatrix}$$

to the grid of 21×21 lines, centred at the origin, 2 inches on a side.

Exercise 5. Write a `PostScript` program which (1) draws a framed page with boundary 0.5 inches in width all around the page; (2) clips drawing to that region; (3) includes a procedure which has arguments the parameters of a line $Ax + By = C$ and a point (x_0, y_0) and draws (a) the line inside the drawing region and (b) a dotted perpendicular segment from the point to the line. Illustrate by a sample.

Exercise 6. Here is yet another picture for you to translate into a proof of Pythagoras' Theorem. The first trick is to find the triangle!