This project involves using the Perspective Theorem to draw a perspective image of a 3-dimensional house, and has two parts to it.

The first part is to use the Perspective Theorem, Excel (or some other spreadsheet), and 17 given relevant points on a 3-dimensional dollhouse to draw the outline of the house in perspective.

The idea behind the second part is to finish the house, first in 3 dimensions and then in two. First, come up with **3 dimensional coordinates** for some finishing touches that would actually fit on the house. Some ideas: windows, a door or two, perhaps a yard or a chimney (where the bottom vertices of the chimney should preferably actually lie on the roof, although that gets hard). For the 3 dimensional coordinates, you should really be thinking about *where* a door (or window, or chimney) would be: which coordinates would stay the same as the wall it lies in, and which would be different. Once you have decided upon 3 dimensional coordinates for your decorative features, find the perspective images of those new points and add them to your graph of the house.

The first part of the project requires that you understand, in the Perspective Theorem, which axis the viewer's eye is on, and that you pay attention to the given picture of the 3D house and use it to think about which key points on the house would have the same x-coordinate, which would have the same y-coordinate, and which would have the same z-coordinate. Which will have larger x-coordinates, and which will have smaller (and same for y and z)? I'm giving you the finished picture, so this thought process will help you identify before you ever use the Perspective Theorem which of the given points corresponds to which key points on the house.

The second part of the project asks you to expand upon the knowledge gained in the first part and to figure out where additional features of the house would be in the 3-dimensional coordinate system – finding the coordinates of a front door, for instance, *in 3-space*– and then *converting them* using the Perspective Theorem.

If you are tempted to simply draw the extra features in, in 2-space, using the laws of perspective, you might as well wait until Project 7.

For the details of this project, see the next pages.

For this project, you don't need to write an accompanying paragraph.

Possible points: A plot of a house which has been extensively personalized *using 3 dimensional points converted to 2 dimensional points* can receive up to 35 points. Converting and plotting in 2D only the given points can earn up to 20 points.

Part I: The goal of this part is to use the perspective theorem to draw the perspective image of a "real" 3 dimensional feature-less dollhouse, given the xyz-coordinates of 17 key points on that house. Both the featureless house and the points on the house are shown below.
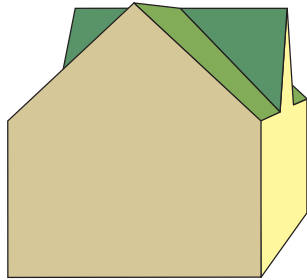
Points	x	y	z
A	-12	-18	81
B	-12	-6	93
C	-12	3	99
D	-12	-18	117
F	-12	-6	105
G	-30	-6	105
H	-12	-6	81
I	-30	-6	81
J	-30	-18	81

Points	x	y	z
K	-30	-18	117
L	-30	-6	117
M	-21	3	117
N	-12	-6	117
O	-30	-6	93
P	-30	3	99
Q	-21	3	99
R	-21	3	81

The viewpoint you will be drawing for is a viewer standing 15 units back from the picture plane.

Use Excel (or some other spreadsheet) to calculate the perspective images of the 17 points given above, assuming the viewer is located 15 units back from the picture plane.

It may help you to get a feel for how the various features are oriented to also see the top view and side view of the house and the viewer, relative to the picture plane and the z-axis. As you can see, the viewer is 15 units to one side of the picture plane while the house is between 81 and 117 units on the other side of the picture plane.

TOP VIEW

SIDE VIEW
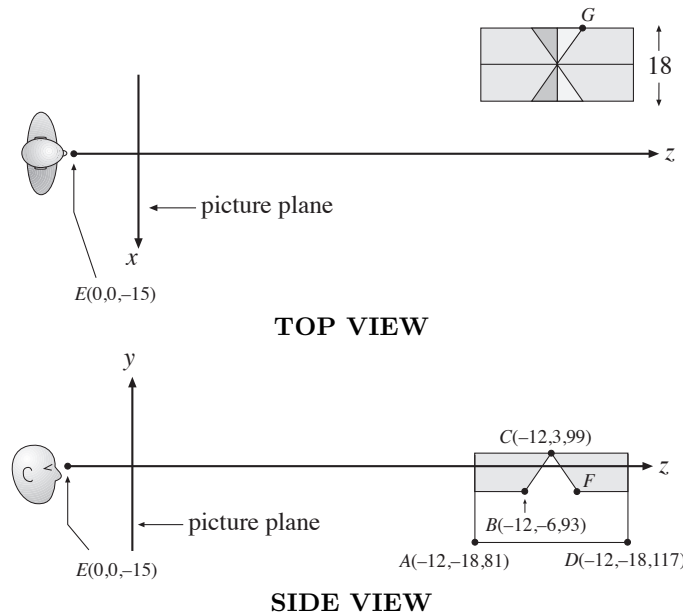
Plot the resulting 2 dimensional perspective points (by hand; Excel will do it, but it looks better if you do it by hand, and you can follow more easily which point is which, labeling them as you go.)

Part II: The resulting house, which should look virtually identical to the first figure, is featureless. The purpose of the next part is to add features to the real 3-dimensional house and then use your Excel spreadsheet to calculate their locations in the perspective image.

Specifically: decide where on the house you want a door (or two), a couple of windows, a yard – maybe even a chimney. Looking at your drawing so far and the corresponding points *in 3-space*, figure out *correct* 3-space coordinates for each of these features. Add these coordinates to the x, y, and z columns of your Excel spreadsheet and use it to calculate the perspective images of each of these points.

For example: suppose you want to add a door to the front of the house. All of the points corresponding to the front of the house have z-coordinate $z = 81$, so the four corners that define the door will have to have 81 as their z-coordinates. Since the x-coordinates of the house go from -12 to -30, the exact middle of the house has as its x-coordinate $x = -21$. So if you want your door to be centered, you might use $x = -23$ and $x = -19$, or similarly spread out points.

Add the resulting 2-dimensional perspective images to your graph, connect the relevant dots (don't connect a point on a door to a point on a window!), and then color and shade your drawing if you like.