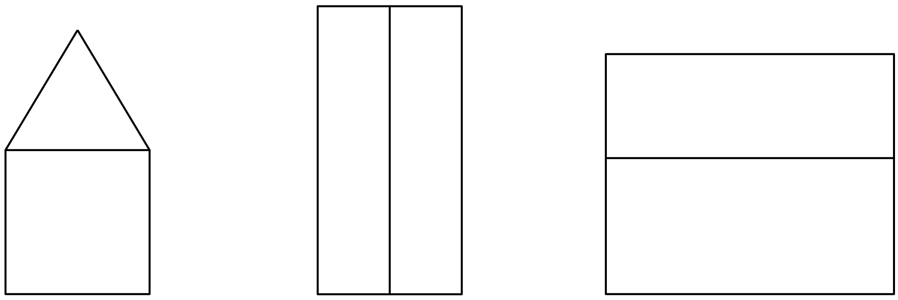
**3rd Task**

A house is on flat ground and there is a sun that moves in a semicircular path (rising and setting) illuminating the house. The scene is also illuminated by a spotlight. As an object the sun is represented by a sphere which is derived from a regular tetrahedron with recursive subdivision.

**A. HOME & Territory**

The house consists of the main building and the triangular "roof". The main building is a rectangular parallelepiped whose center coincides with the principle of axes and whose edges are parallel to the x, y, z axes. The dimensions of the parallelepiped are 20 on the z axis (depth) and 10 on the x and y axes (width & height respectively). The "roof" consists of two rectangular parallelepipeds which, together with the top side of the parallelepiped described above, form an equilateral triangle (when observed from the front) and two triangles, on the front and back of the house, which "close" the triangular opening left by the other two pieces (see figure).



You can build the "house" any way you want. The house consists of two materials:

- The roof of the house is made of greyish sheet metal which has a metallic appearance. Set a high gloss factor (e.g. 100).
- The main house is made of walls with a matte surface. Set zero directional reflection coefficients and diffuse reflection & ambient light reflection coefficients that give the house a reddish color when sunlight falls on it (see below).

The house sits on a green flat grass lawn that is matte surface. Try (menu choice) a) one large polygon to represent the ground and b) several (~100) co-planar polygons (for better shading results) on the y=0 plane.

**B. Sun-Spotlight**

As an object, the sun is modelled by a sphere created by the recursive subdivision of a tetrahedron (see below). The material of the sphere has zero reflection coefficients and emission coefficients that give it a yellow colour. The orbit of the sphere is as follows: it starts at the point (-50,0,0) and follows a semi-circular path of radius 50 in the 'sky'

ending at the point (50,0,0). Then it starts again from (-50,0,0), repeating the same movement all the time. The light emitted by the sun is modelled by a point light source which moves in the same way as the sphere, being at its centre. The source emits directional and diffuse reflection light that gradually increases from (0.3, 0.3, 0.3) at sunrise (- 50,0,0) to (1,1,1) at apogee (noon) and gradually decreases to (0.3, 0.3,
0.3) in the west.
The spotlight (GL_SPOT_CUTOFF $30^0$ ) is located in a corner of the roof of the house and illuminates the grass with white light. Through a menu this light is turned on and off.

**C Lighting calculation**
Objects (house & ground) are shaded with smooth or flat shading (menu selection). The vertical vectors at the vertices of the polygons are the
"real" perpendicular vectors of polygons, which should be calculated with an appropriate function that calculates the outer product of two edges of the polygon. For the sphere, the calculation of the perpendicular vectors is not required since we assume that it does not reflect light. Assume that the observer is close to the scene, for a complete calculation of Phong's reflection equation.

**D. Movement of the observer**

The position from which we view the scene (camera position) is changed by the user. The camera constantly "looks" at the beginning of the axes (using gluLookAt) and moves in a circle of radius 70 located on the plane y=40 and centered at the point (0,40,0). By pressing the right/left mouse button or two keyboard keys the camera moves each time by some amount to the right/left on the circle.

**E. Retroactive subdivision**
We start from a regular tetrahedron inscribed on a unit sphere point3
v[]={{{0.0, 0.0, 1.0}, {0.0, 0.942809, -0.33333},
{-0.816497, -0.471405, -0.333333}, {0.816497, -0.471405, -0.333333}};
Subdivide the edges of each (equilateral) triangle (side of the quadrilateral) into two equal parts and join the corresponding points so that the triangle is divided into four equilateral triangles. We then move the three new points so that they are placed on the unit sphere. Repeat the process recursively for each of the four new triangles. Number of repetitions = 4.

Use depth buffer and double buffering. Any attempt to achieve additional realism, e.g. projection shadows or other types of shadows, will be appreciated. The sample executable is indicative.