4.0 3-D

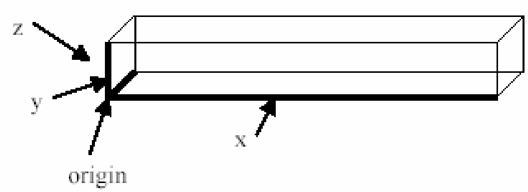
Overview: In this activity participants are introduced to three-dimensional graphing and to extend the Pythagorean Theorem to three dimensions.

Objective: **Mathematics TEKS**
G(c.3) The student identifies and applies patterns from right triangles to solve problems, including special right triangles (45-45-90 and 30-60-90) and triangles whose sides are Pythagorean Triples.
G(d.1.A) The student describes, and draws cross sections and other slices of three-dimensional objects.
G(d.2.C) The student develops and uses formulas including distance and midpoint.
G(e.1.C) The student develops, extends, and uses the Pythagorean Theorem.
Mathematics TAKS
Objective 6: The student will demonstrate an understanding of geometric relationships and spatial reasoning.
Objective 7: The student will demonstrate an understanding of two- and three dimensional representations of geometric relationships and shapes.

Terms: coordinate axes, coordinate plane, octant, Pythagorean Theorem.

Materials: shoe boxes, centimeter rulers, and markers

Procedure: Have students choose one bottom corner of the shoebox to be their origin. Have students use their markers to trace the edges of the three edges that intersect at the point that has been designated the origin and label these edges as the x, y and z axes as shown in the diagram below:



Aid students as they work through the problems on the worksheet

1. **Points in three dimensions are named by ordered triples. The origin is named by the ordered triple (0,0,0). Using a centimeter as a unit, determine the ordered triples for the other vertices of the shoebox.**
   Answers will vary, one possible set of answers is (31, 0, 0), (0, 18.5, 0), (0,0,10), (31, 18.5,0), (31, 0, 10), (0, 18.5, 10) (31, 18.5, 10)

2. **All of the vertices of this shoebox have coordinates that are nonnegative numbers. How many shoeboxes would we need to meet at the origin to cover positive and negative coordinates for *x*, *y* and *z*?**
   8
3. **Points are on the *xy* coordinate plane if the *z* coordinate is 0. How many vertices are on the *xy* plane? What are the coordinates of these vertices?**
   4 – (0,0,0), (31,0,0), (0,18.5, 0), (31, 18.5, 0)

4. **How many vertices are on the *xz* plane? What are the coordinates of these vertices?**
   4- (0,0,0), (0,0,10), (31, 0,0), (31, 0, 10)

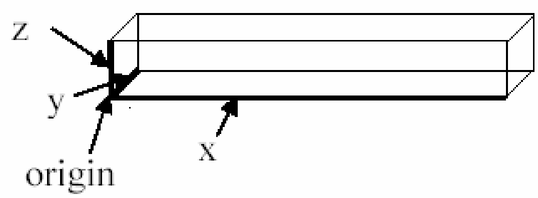
5. **How many vertices are on the *yz* plane? What are the coordinates of these vertices?**
   4 – (0,0,0), (0,18.5, 0), (0,0,10), (0,18.5, 10)

6. **There should be one point that is not on neither the *xy*, *xz* nor *yz* planes. What is the coordinate of this point?**
   (31,18.5,10)

7. **What is the distance from the origin to the point found in the previous question? Calculate this distance then use a ruler to check this measurement.**
   This distance can be calculated in a variety of ways. Students may first use the Pythagorean Theorem or the distance formula (treating the points as if they were in the two dimensions and ignoring coordinate) to find the distance from (0,0,0) to (31,18.5,0). This distance is 36.1 cm, then using the Pythagorean Theorem again for the triangle with lengths of 36.1 cm and 10 cm to get a final distance of 37.5 cm. The Pythagorean Theorem can be extended to three dimensions by the formula: $d = \sqrt{x^2 + y^2 + z^2}$

Student Activity: 3-D

Using the shoebox provided label the vertex and the x, y and z axes as shown below:



1. Points in three dimensions are named by ordered triples. The origin is named by the ordered triple (0,0,0). Using a centimeter as a unit, determine the ordered triples for the other vertices of the shoebox.

2. All of the vertices of this shoebox have coordinates that are nonnegative numbers. How many shoeboxes would we need to meet at the origin to cover positive and negative coordinates for *x, y* and *z*?

3. Points are on the *xy* coordinate plane if the y coordinate is 0. How many vertices are on the *xy* plane? What are the coordinates of these vertices?

4. How many vertices are on the *xz* plane? What are the coordinates of these vertices?

5. How many vertices are on the *yz* plane? What are the coordinates of these vertices?

6. There should be one point that is not on neither the *xy*, *xz* nor *yz* planes. What is the coordinate of this point?

7. What is the distance from the origin to the point found in the previous question?