**Activity 8.2.4 Coordinates in Higher Dimensions**

Coordinate concepts extend easily into the fourth dimension.  For example in two dimensions a point has two coordinates (*x*, *y*) and in three dimensions a point has three coordinates
(*x*, *y*, *z*).  So naturally in four dimensions a point may be represented with four coordinates.  Similarly the distance formula and equations for lines and circles may be extended into higher dimensions.

The following chart shows how concepts from two-dimensional geometry were extended in
Unit 6 to three-dimensional space.

|  |  |
| --- | --- |
| 2 dimensions | 3 dimensions |
| 2 axes, 4 quadrants | 3 axes, 8 octants |
| point represented by (*x*, *y*) | point represented by (*x*, *y*, *z*) |
| distance formula: *d* = $\sqrt{(x\_{2}-x\_{1})^{2}+(y\_{2}-y\_{1})^{2}}$ | distance formula: *d* = $\sqrt{(x\_{2}-x\_{1})^{2}+(y\_{2}-y\_{1})^{2}+(z\_{2}-z\_{1})^{2}}$ |
| Equation of a circle:  *x*2 + *y*2 = *r*2 | Equation of a sphere:  *x*2 +*y*2 + *z*2 = *r*2 |
| Equation of a line (standard form): *ax + by = c* | Equation of a plane (standard form): *ax + by + cz = d* |
| Equation of a line (slope-intercept or function form):  *y = mx + b* | Equation of a plane (function form); *z = mx + ny  + c* |
| Vector [∆*x*, ∆*y*] | Vector [∆*x*, ∆*y*, ∆*z*] |

Extend the ideas above to the fourth dimension to find each of the following:

1. number of axes and number of regions in the coordinate system.
2. representation of a point.
3. distance formula.
4. equation of a hypersphere.
5. equation of a hyperplane in standard form.
6. equation of a hyperplane in function form.
7. vector.