UNIT 3 VECTORS IN THREE DIMENSIONS

# 3.1 Three Dimensional Vectors

## 3-DIMENSIONAL SPACE

To this point, we have been working with vectors in 2-dimenisional space. Now, we will expand our discussion to 3-dimensional space.

|  |  |
| --- | --- |
| The **2-dimensional coordinate system** is built around a set of two axes that intersect at right angles and one particular point called the origin. Points in the plane are described by ordered pairs and vectors in standard position by . | Diagram showing the 2-dimensional coordinate system with a vector and its coordinates. |
| The **3-dimensional coordinate system** is built around a set of three axes that intersect at right angles and one particular point again called the origin. Points in the plane are described by ordered triples and vectors in standard position by . | Diagram showing the 3-dimensional coordinate system with a vector and its coordinates. |

## THE DISTANCE BETWEEN TWO POINTS IN 2 & 3-DIMENSIONAL SPACE

In **two-dimensional space**, the distance between two points say and is given by the distance formula

|  |  |
| --- | --- |
| Diagram showing two points in a 2-dimensional coordinate system and the distance between them. |  |

In **three-dimensional space**, the distance between two points say and is given by the distance formula

|  |  |
| --- | --- |
|  | Diagram showing two points in a 3-dimensional coordinate system and the distance between them. |

The distance between the two points and is

Example (1)

|  |  |
| --- | --- |
| 5.8 units | Diagram showing two points in a 3-dimensional coordinate system and the calculation of the distance between them. |

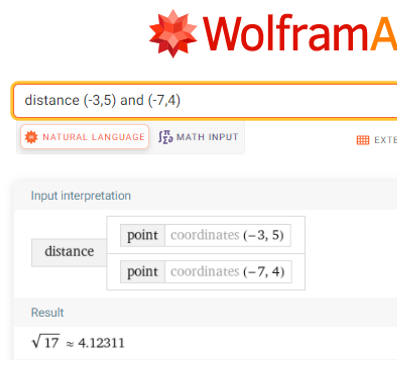
The distance between the two points and is units.

## USING TECHNOLOGY

We can use technology to find the distance between points.

Go to www.wolframalpha.com.

To find the distance between the two points and enter distance and in the entry field. Wolframalpha tells you what it thinks you entered, then tells you its answer. In this case, 2311.



## THE EQUATION OF A CIRCLE AND A SPHERE

We can use the distance formulas to get equations of circles and spheres.

The center-radius form of a circle with center at the point and radius is

|  |  |
| --- | --- |
|  | Diagram showing use of distance formula to get equation of a circle with a point and radius. |

The center-radius form of a sphere with center at the point and radius is

|  |  |
| --- | --- |
|  | Diagram showing use of distance formula to get equation of a sphere with a point and radius. |

To write the equation of a circle that has as its center the point and radius 8,

Example (2)

we use the center-radius form with and .

To write the equation of a sphere that has as its center the point and radius

Example (3)

8, we use the center-radius form with

and .

## EXAMPLES

1. Find the distance between the two points and . Round to one decimal place.

ANS: units

1. Find distance between the two points and . Round to one decimal place.

ANS: units

1. Write the equation of a circle that has as its center the point and radius 1.

ANS:

4.Write the equation of a sphere that has as its center the point and radius 4.

ANS:

## NOTE TO INSTRUCTOR

Consider deriving the formula for the distance between two points. Let the two points be and Draw the two points and use the Pythagorean Theorem.

|  |  |
| --- | --- |
| By the Pythagorean Theorem,  Take square roots to get | Diagram of two points in a 2-dimensional coordinate system and use of Pythagorean Theorem to derive formula for the distance between those two points. |

The equation of a circle comes from the distance formula by using one of the points, say as the center and the other point, say as a general point on the circle. A circle is defined as a closed plane curve consisting of all points at a given distance from a point within the curve. Use the distance formula replacing with and with and with

Consider working through these problems as examples.

1. Find the distance between the two points and . Round to one decimal place.

ANS: units

1. Find the distance between the two points and . Round to one decimal place.

ANS: units

1. Write the equation of a circle that has as its center the point and radius 2.

ANS:

1. Write the equation of a sphere that has as its center the point and radius 3.

ANS:

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