4.0 Student Activity: Grass Fire

Overview: Students use the Pythagorean Theorem to investigate the distance between two points on a coordinate plane and develop a formula for finding distance.

Objective: **Mathematics TEKS**
(6.7) The student is expected to locate and name points on a coordinate plane using ordered pairs or non-negative rational numbers.
(7.3.B) The student is expected to estimate and find solutions to application problems involving proportional relationships such as similarity, scaling, unit costs, and related measurement units.
(7.7.A, 8.7.D) The student is expected to locate and name points on a coordinate plane using ordered pairs of integers (rational numbers).
(8.7.C) The student is expected to use pictures or models to demonstrate the Pythagorean Theorem.
(6.13.B, 7.15.B, 8.16.B) The student is expected to validate his/her conclusions using mathematical properties and relationships
Mathematics TAKS Grades 6 – 8
Objective 2: The student will demonstrate an understanding of patterns, relationships, and algebraic reasoning. (7.3B)
Objective 3: The student will demonstrate an understanding of geometry and spatial reasoning. (6.7, 7.7A, 8.7C, 8.7D)
Objective 6: The student will demonstrate an understanding of the mathematical processes and tools used in problem solving. (6.13.B, 7.15.B, 8.16.B)

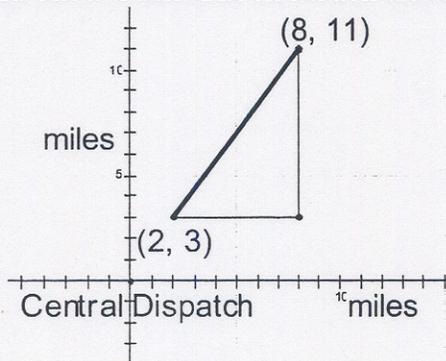**Terms:** horizontal distance, vertical distance, Pythagorean Theorem, variables, formula

Materials: Grass Fire Activity Sheet

Procedures: *Have the students work in groups of two or three.*

As written, this is an 8th grade activity. Sixth and seventh graders cannot answer question 4 because they have not yet learned Pythagorean's Theorem. To modify the activity for 6th and 7th graders, do not give students the picture below the question. Instead have them plot the given points on centimeter grid paper. On a transparency, model the right triangle shown on the activity sheet for students. Have students draw that right triangle on their grid paper and answer questions 1-3. Students can answer question 4 by measuring the distance between the station and fire with a ruler and using the scale factor of 1cm=1mile. Sixth graders should stop here. Seventh graders should continue with question 5.

Student Activity: Grass Fire

A surveillance helicopter reported a grass fire to the central dispatch. The dispatcher located the fire on a gridded map and determined the fire is 8 miles due east and 11 miles due north from the central dispatch. The dispatcher it coordinates (8,11). The dispatcher determines that the fire station located at coordinates (2,3) is closest to the fire and calls that station to send out a truck. The fire truck travels in a direct route with no obstacles.

1. **What are the coordinates of the right angle vertex of the triangle on the previous page?**
    The coordinates of the right triangle vertex are (8, 3).

2. **What is the horizontal distance between the station and the fire?**
    The horizontal distance from (8,11) to (2,3) is calculated by subtracting the x-coordinates.

    $$|8\text{-}2| = 6$$

3. **What is the vertical distance between the station and the fire?**
    The vertical distance from (8,11) to (2,3) is calculated by subtracting the y-coordinates.

    $$|11 - 3| = 8$$

4. **Use the Pythagorean Theorem to determine the actual distance from the station to the fire.**

$$\text{Distance}^2 = 6^2 + 8^2$$
$$\text{Distance}^2 = 36 + 64$$
$$\text{Distance}^2 = 100$$
$$\text{Distance} = 10$$

Notice: $\text{distance} = \sqrt{((\textit{difference in x's})^2 + (\textit{difference in y's})^2)}$

5. **How long will it take the fire truck to get to the fire if its average speed is 50 mph?**

$$D = rt$$
$$10 = 50 \cdot t$$
$$t = \frac{1}{5} \text{hour} = 12 \text{ minutes}$$

Extension: *The dispatcher needs a formula to find the distance between any two points on his map. Using variables (a,b) to represent the location of the fire station and (c,d) to represent the location of the fire, write a formula he could use.*

The formula can be written $D = \sqrt{(a-c)^2 + (b-d)^2}$.

- *Ask: Does it matter if you use a – c or c – a? No, the difference will be squared so it will come out the same either way.*

- *Ask: Can the formula be applied to special cases like (2,3) and (2,7) or (3,9) and (8,9) where the two points are on the same vertical line or horizontal line? Yes. For example in the case of the two points (2,3) and (2,7) the calculation would be*

$$D = \sqrt{(2-2)^2 + (7-3)^2}$$
$$D = \sqrt{0^2 + 4^2}$$
$$D = \sqrt{16}$$
$$D = 4$$

The difference between x values (horizontal distance) or the difference between y values (vertical distance) may equal zero and the formula will still produce the distance between the points.

Summary: *The distance formula is derived from the Pythagorean Theorem and can be used to find the distance between any two points.*

Student Activity: Grass Fire

A surveillance helicopter reported a grass fire to the central dispatch. The dispatcher located the fire on a gridded map and determined the fire is 8 miles due east and 11 miles due north from the central dispatch. The dispatcher assigns it coordinates (8,11). The dispatcher determines that the fire station located at coordinates (2,3) is closest to the fire and calls that station to send out a truck. The fire truck travels in a direct route with no obstacles.
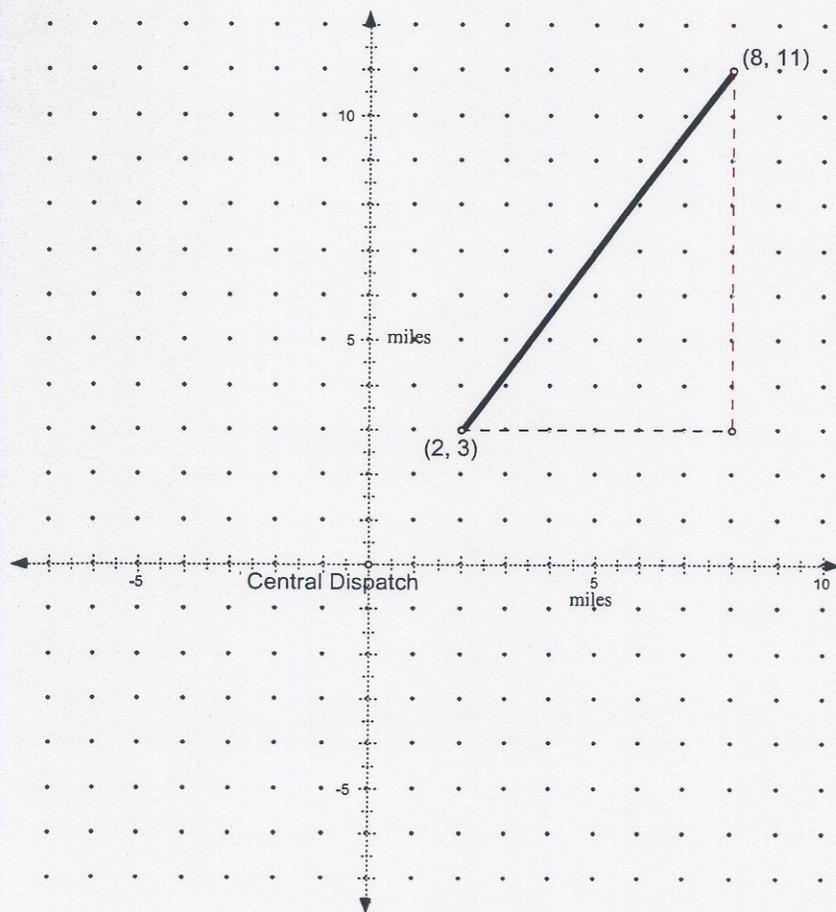
1. What are the coordinates of the right angle vertex of the triangle on the previous page?

2. What is the horizontal distance between the station and the fire?

3. What is the vertical distance between the station and the fire?

4. Use the Pythagorean Theorem to determine the actual distance from the station to the fire?

5. How long will it take the fire truck to get to the fire if its average speed is 50 mph?