



# Distance and midpoint

from the Esri GeoInquiries™ collection for Mathematics

Target audience – Geometry learners

Time required – 15 minutes

**Activity** Site a water tower shared by two towns at the midpoint and determine the costs involved using the Pythagorean theorem.

**Math Standards** **CCSS: Math.Content.8.G.B.8.** Apply the Pythagorean theorem to find the distance between two points in a coordinate system.

**Learning Outcomes**

- Students will demonstrate how to find the midpoint between two points in a coordinate plane.
- Students will demonstrate how to find the distance between two points in a coordinate plane.

Map URL: <http://esriurl.com/mathGeoInquiry6>

## Engage

### Can you estimate the midpoint?

- Read aloud: “Greensburg and Kinsley have agreed to share the cost of a new water tower to be used by residents of both towns. However, each town has chosen different types of pipes, with different costs, to carry water from the tower to each town. Since each will pay for their respective pipes separately, the tower should be as close to halfway between each town as possible.”
- Click the URL above to launch the map.
- Find Greensburg and Kinsley on the map.
- Where do you think a water tower should be located? *[Have one or more students provide this information.]*
- Click the link in the upper right, Modify Map.
- Click the Edit button and place a marker at one or more guess locations on the map.
- Select a marker and click the map to indicate the location.

## Explore

### Can you calculate the precise water tower location?

- With the Details pane visible, click the Show Contents Of Map button.
- Select the Coordinate Grid layer check box to turn on the layer.
- ? What is the size of each square on the grid? *[Click the grid to discover 1 km<sup>2</sup>.]*
- Read the grid to determine the coordinates for Greensburg and for Kinsley. *[(37.6, 8.5) & (27.2, 45.3) resp.]*
- ? What should be the midpoint for a water tower, based on these coordinates? *[Midpoint at (32.4, 26.9)]*
- ? Were the original guesses close to this calculated midpoint?

## Explain

### Can you calculate the cost of each pipe?

- Read aloud: “Kinsley decided to install water mains made of concrete while Greensburg voted to use PVC pipe. Concrete costs \$94,080 per kilometer and PVC costs \$60,160 per kilometer.”
- Apply the Pythagorean theorem to find the distance between each town and the tower site. *[19.12 km]*
- Use these distances to find the difference in costs between Greensburg and Kinsley. *[\$1,798,809.60 - \$1,150,259.20 = \$648,550.40]*
- ? Why do you think the towns chose different types of pipe?

## Elaborate/Extend

### Which water source should be used?

- Turn on the Windhorst Farm layer.
- The farm location and a water access point on the Arkansas River will be visible.
- To irrigate its 470 acres, the Windhorst Farm wants to draw water either from the proposed water tower or from the access point on the Arkansas River.
- Find the grid coordinates for the farm and the river access point. *[(23.8, 22.8) and (20.5, 31.1) respectively]*
- Apply the Pythagorean theorem to determine which water source that the Windhorst Farm should choose. *[Tower distance: 9.5 km; river access point distance: 8.9 km]*

## Evaluate

### Find the flight distance to the hospital

- An emergency medical helicopter needed to fly from Greensburg to the Windhorst Farm.
- ? what is the shortest distance that it would need to fly if you assume the hospital is in the center of Greensburg? *[19.9 km]*

## TURN A MAP LAYER ON AND OFF

- Make sure that the Details pane is selected, and click Show Map Contents.
- To show individual map layers, select the check boxes next to the layer names.
- Hint: If a map layer name is light gray, zoom in or out on the map until the layer name is black. The layer can now be turned on.

## ADD MAP NOTES

- Click Add and from the drop-down list, choose Add Map Note.
- Type a name, select a template from the drop-down list, and click Create.
- In the Add Features pane, choose a symbol and click in the map to place it.
- In the pop-up window, add your desired information.

## Next Steps

**DID YOU KNOW?** ArcGIS Online is a mapping platform freely available to public, private, and home schools. A school subscription provides additional security, privacy, and content features. Learn more about ArcGIS Online and how to get a school subscription at <http://www.esri.com/schools>.

**THEN TRY THIS...**

- While using an ArcGIS Online organizational school account, add the Population layer from Living Atlas.
- Use Summarize Data and click Summarize Within to find the population bounded by the grid area.

## TEXT REFERENCES

This GIS map has been cross-referenced to material in sections of chapters from these high school texts.

- *Geometry by Holt, Rinehart & Winston — Chapter 1*
- *Geometry by Houghton Mifflin — Chapter 8*
- *Geometry by Moise & Downs — Chapter 13*