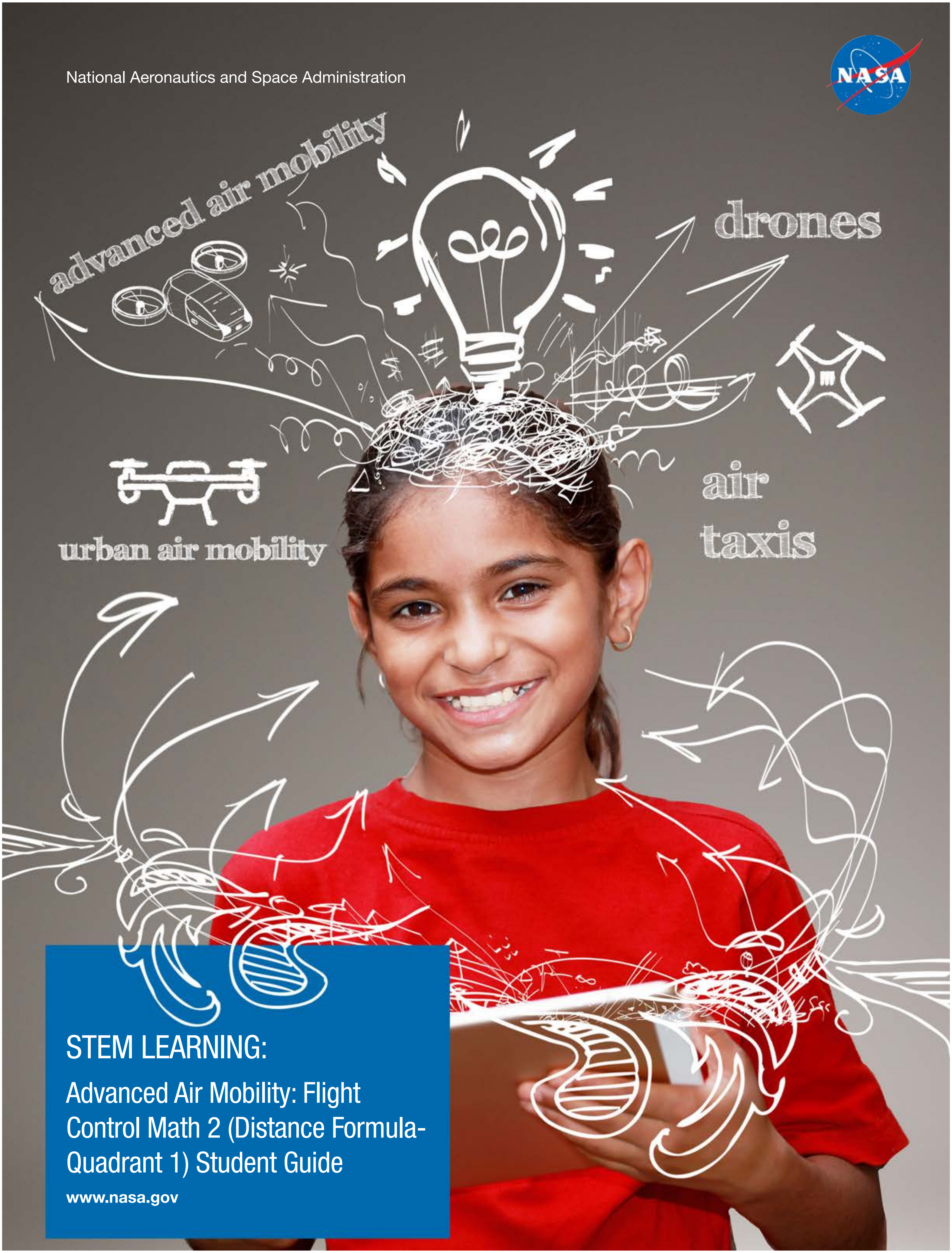
National Aeronautics and Space Administration



STEM LEARNING:

Advanced Air Mobility: Flight Control Math 2 (Distance Formula-Quadrant 1) Student Guide

www.nasa.gov

PACKAGE DELIVERY DRONES

NASA is leading the nation to quickly open a new era in air travel called Advanced Air Mobility, or AAM. The vision of AAM is that of a safe, automated, accessible, and affordable air transportation system for passengers and cargo in both urban and rural locations.

Package delivery drones are small Unmanned Aerial Vehicles, or UAVs, that carry a package from a distribution point to its final destination. These drones fly autonomously, meaning that they are controlled by a computer while flying.

This method of package delivery is more efficient than traditional ground-based transportation methods. Delivery drones avoid traffic, travel shorter distances, and don't require a driver. Eventually, drones will be able to deliver more than just packages. Imagine being able to save lives by quickly delivering urgent medical supplies to remote locations!

Package delivery drones transport packages to their final destination. Credit: Wikimedia Commons

DISTANCE FORMULA

The distance formula can be used to determine the distance between two points on a graph.

Distance between two points: *P_1 (x_1, y_1) and P_2 (x_2, y_2)*

$$distance = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

Example: Determine the distance between a point at (5, 6) and a point at (22, 4) where each point on the graph represents 1 kilometer.

$$distance = \sqrt{(22-5)^2 + (4-6)^2}$$

$$distance = \sqrt{17^2 + (-2)^2}$$

$$distance = \sqrt{289 + 4}$$

$$distance = \sqrt{293}$$

$$distance = 17.1 \text{ squares}$$

Convert to km: $(17.1)(0.5) = 8.6\text{ km}$

STUDENT ACTIVITY

In this activity, you are the assistant distribution manager for an online retailer. Your job is to coordinate the "last mile delivery," which means the delivery of packages from distribution centers to their final destination.

Today you are to review the delivery system in Dallas, Texas where your company has two distribution centers. You work in the company's headquarters, so you will be evaluating the system using this as the reference point (the origin for your graph).

Part 1: Getting the Coordinates

To determine the distances between points on a map, a graph has been placed over the map. In figure 2, the two package distribution centers and five customers' houses have been plotted on the graph.

The origin (0, 0) is the company's headquarters and is indicated on the graph.

Determine the coordinates of each location and enter them below:

Location	Coordinate (x)	Coordinate (y)
Package Distribution Center 1		
Package Distribution Center 2		
Anthony		
Barbara		
Clive		
Deidre		
Ekani		

Part 2: Using the Distance Formula

Your delivery drones cannot fly too far because of their batteries. So, it is very important that you schedule deliveries to come from the distribution center closest to the final destination. Your system determined that Barbara and Deirdre are closest to Package Distribution Center 1, while Anthony and Ekani are closest to Package Distribution Center 2.

Note: Don't forget to convert your answers into kilometers (km) (1 square = 0.5 km).

1. What is the distance from Package Distribution Center 1 to Barbara's house?

2. What is the distance from Package Distribution Center 1 to Deirdre's house?

3. What is the distance from Package Distribution Center 2 to Anthony's house?

4. What is the distance from Package Distribution Center 2 to Ekani's house?

5. Your boss calls and asks which distribution center is closest to Clive's house. You need to figure out the answer and call her back. Make sure you have mathematical calculations to use as evidence to support your claim.

6. A new customer calls to see if it's possible to have your drone delivered to his house. The coordinates of his house are (35, 21). Plot this on the graph.

   a. If your drone is capable of traveling 25 km (round trip), would it be capable of delivering to this location from Package Delivery Center 1? (Keep in mind that the drone must fly back to the delivery center as well.) Support your answer with your calculations.

   b. If your drone is capable of traveling 25 km (round trip), would it be capable of delivering to this location from Package Delivery Center 2? (Keep in mind that the drone must fly back to the delivery center as well.) Support your answer with your calculations.

7. Keeping in mind that the maximum range of the drone is 25 km, would it be possible to leave Package Delivery Center 1, fly to Barbara's house, then fly to Deirdre's house, and finally return to Package Delivery Center 1? Support your answer with your calculations.

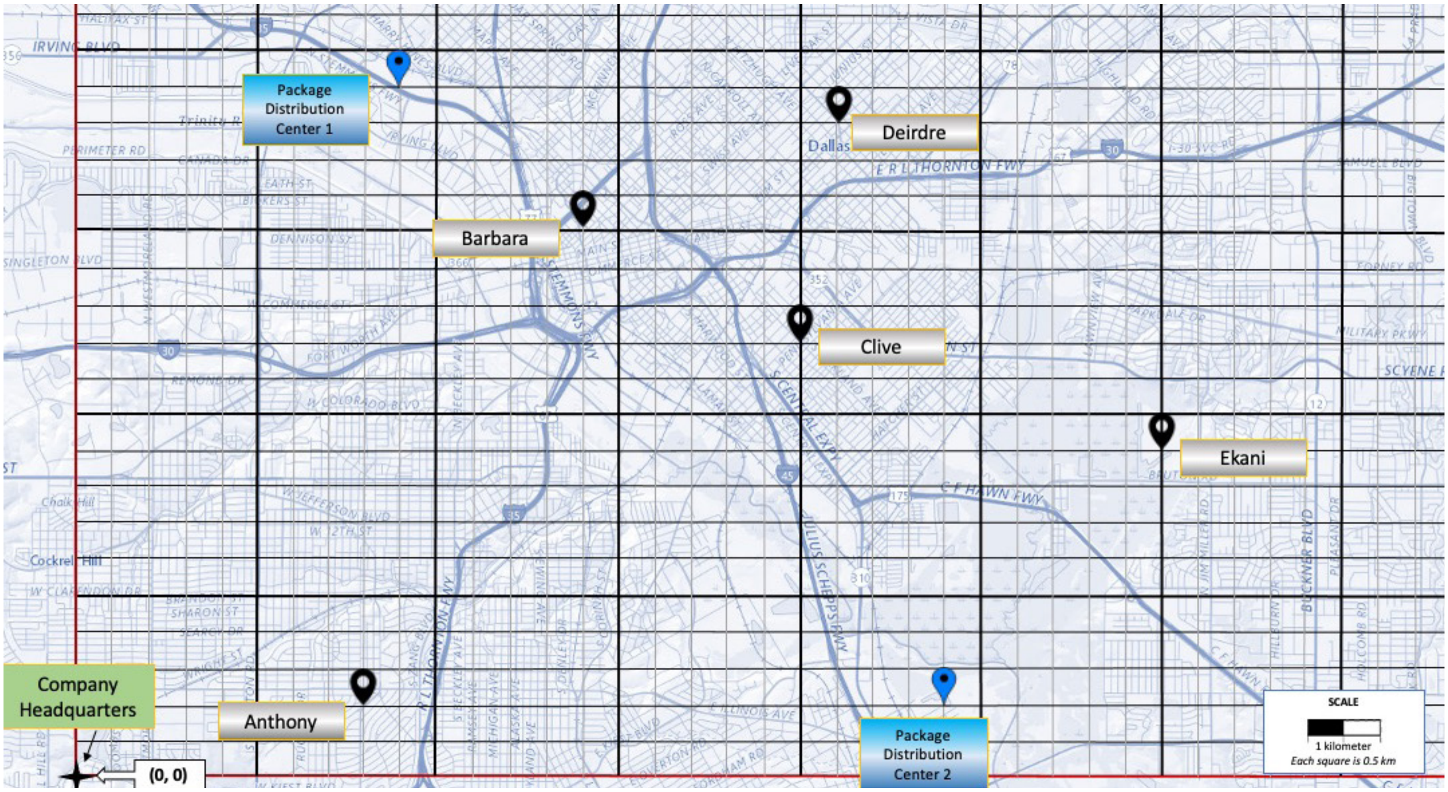


Figure 2. Map with key locations marked. Credit: USGS

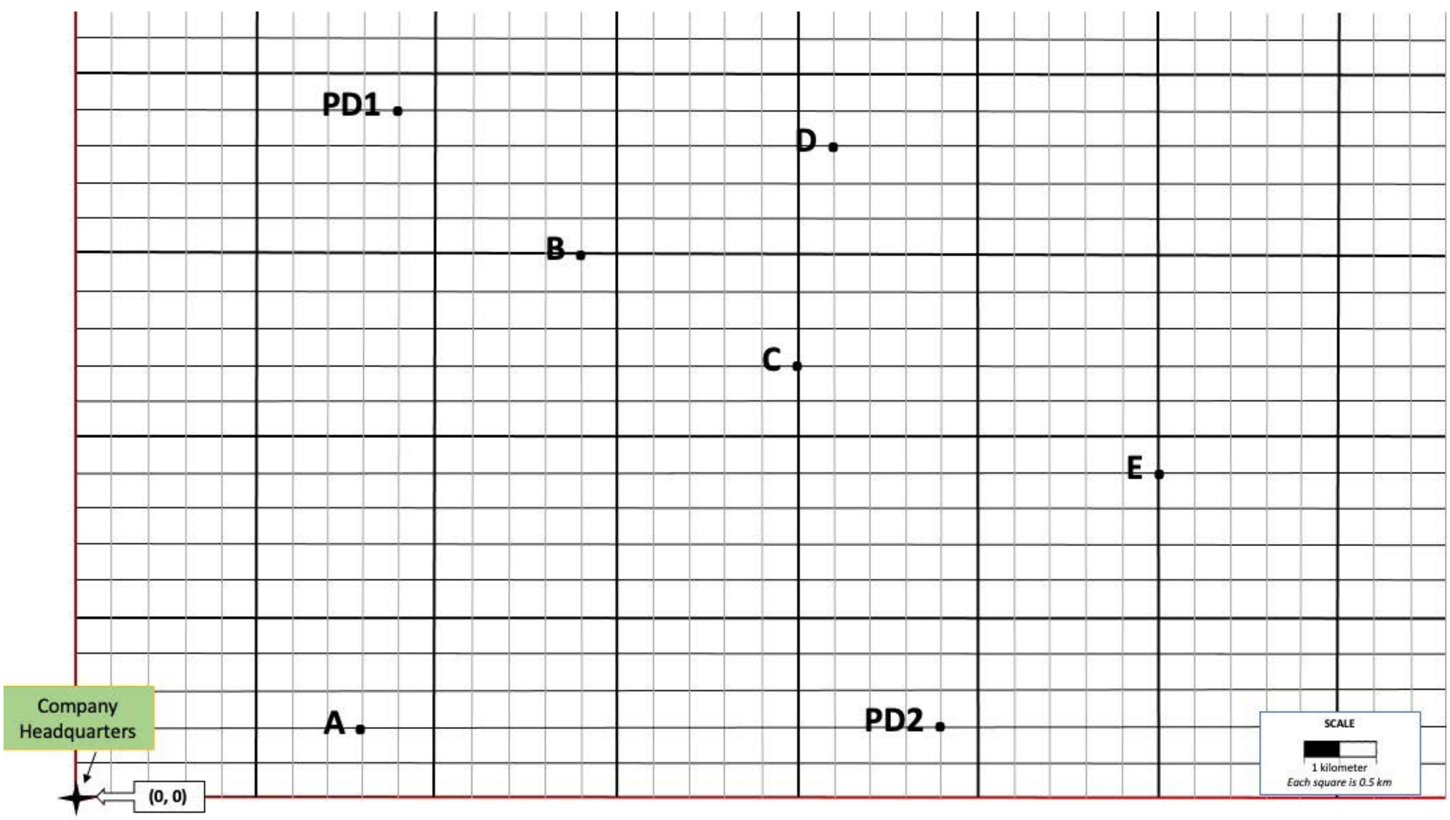


Figure 3. Graph with key points plotted and labeled.

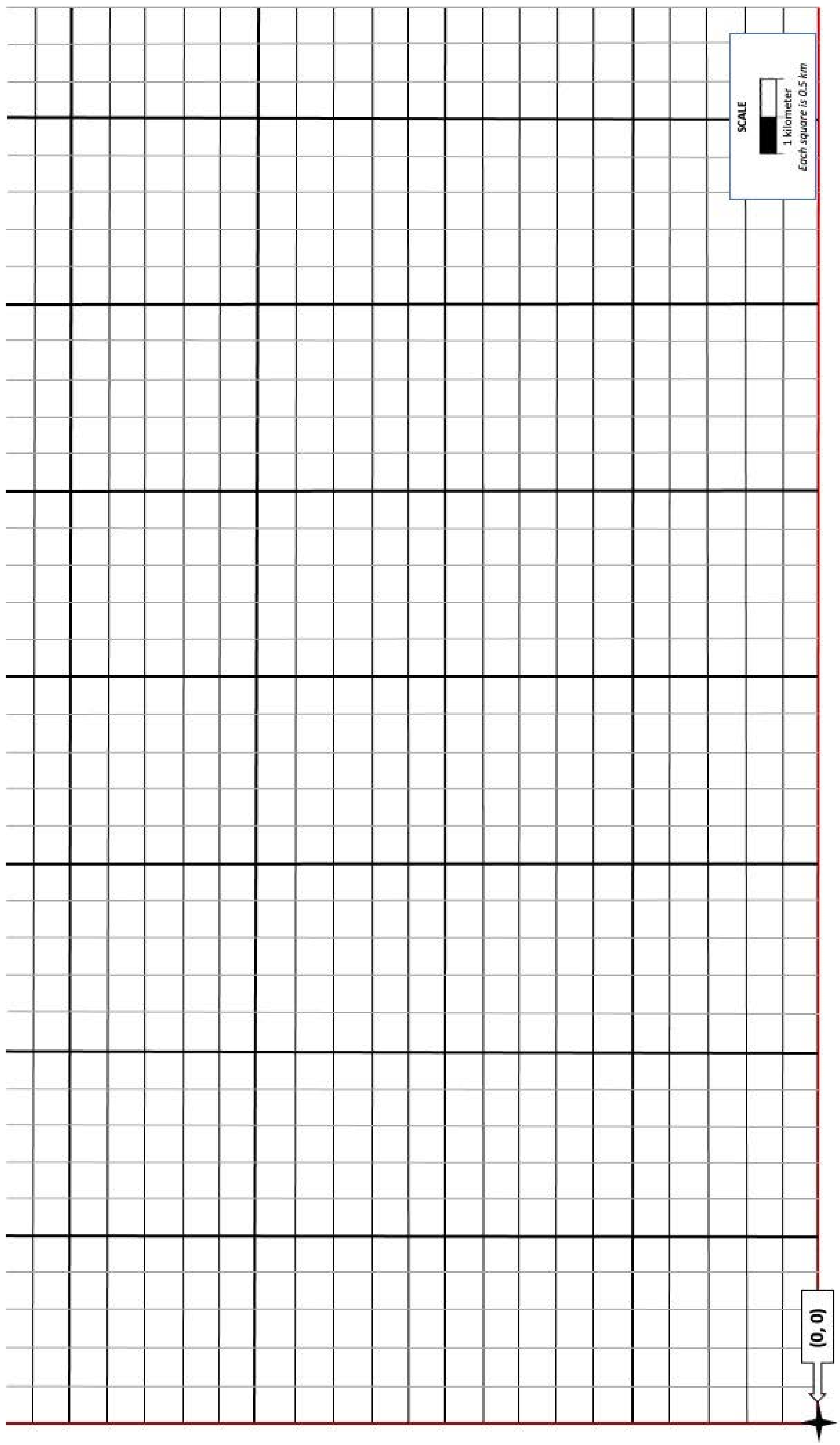


Figure 4. Printable blank graph.

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