



Reading GPS Time Series Plots Worksheet

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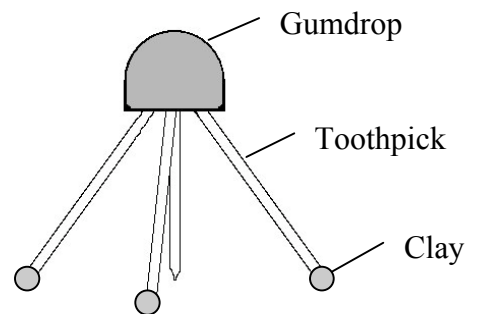
The Global Positioning System, *GPS*, is used to study the Earth, how tectonic plates move and how the Earth's tectonic plates deform. *GPS* monuments are attached the ground and measure how the earth moves. While the *GPS* units in a car measure movement in miles per hour, high-precision *GPS* units used for scientific studies measure how fast or slow the Earth's plate move and can measure **a few millimeters in a year**. Even millimeters can be important because slow moving rock can cause big earthquakes.

Part 1) Build a gum-drop model of a *GPS* monument and pinpointing location with *GPS*.

Materials: 1 gum drop = *GPS* Receiver ; 4 toothpicks (3 legs, one center post) = Monument braces ; 3 small Playdoh feet = *Cement* ; $\frac{1}{4}$ sheet transparency = 'see-through' crust

Procedure:

1. Insert 3 toothpicks diagonally into the gumdrop (the *GPS* receiver). The toothpicks will act as the legs (braces to hold the monument steady).
2. Insert a slightly shorter toothpick sticking straight down from the middle of the gumdrop. The tip of this toothpick should be just barely above the surface. This will be the 'place marker'.
3. Put very small pieces of clay on the bottom of the legs (not the place marker). The clay will act as a cement to hold the *GPS* station in place. In reality the legs of a *GPS* station are cemented deep into the ground so that if the ground moves, so does the *GPS* station.



Pinpointing location with *GPS*

1. What do the tops of the stands (not the stand itself) represent?
2. What does the length of string represent?
3. How many satellites are needed to pinpoint the location of a spot on the Earth?

4. Why wouldn't one or two satellites work? Can you draw a diagram to show this?
5. Draw the setup of the demonstration in the space to the right.



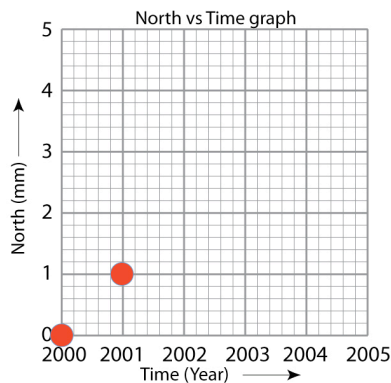
Part 2) Measuring movement of a high-precision GPS station

Similar to a car GPS unit, high-precision GPS data is collected as coordinates such as latitude, longitude, and elevation. To make analysis easier to do, scientists convert the data into 4 parts: north, east and vertical elevation, as well as time.

The data in the table show how far GPS Monument A has moved each year. The first column shows the Time in Years. The next three columns show how far the monument moved each year in the North-South, East-West, and the vertical directions. We will make four graphs to study this data.

GPS Monument A			
Time (Year)	North (mm)	East (mm)	Height (mm)
2000	0	0	0
2001	1	1	0
2002	2	2	0
2003	3	3	0
2004	4	4	0
2005	5	5	0

1. Make a **North vs Time (year)** graph by placing a dot on the graph paper marking each year. On your graph paper, each block represents 1mm.



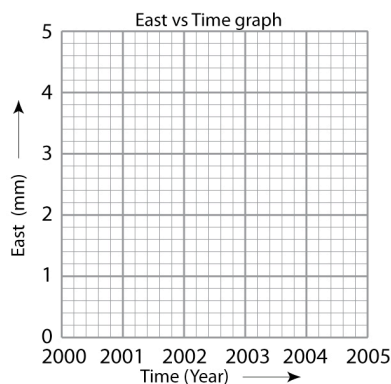
The locations of the monument for the years 2000 and 2001 have been plotted for you.

What direction is GPS Monument A moving? North or South?

What direction would the monument be moving if the North position *decreased* from 5 to 0 from year 2000 to 2005?

Your answer (North or South)?: _____

2. Now make an **East vs Time (year)** graph showing how GPS Monument A moved every year.



What direction is GPS monument A moving? East or West?

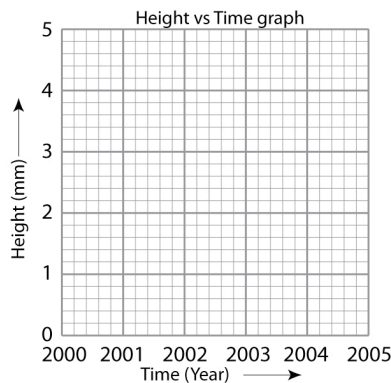
What direction would the monument be moving if the East positions *decreased* from 5 mm to 0 mm from years 2000 to 2005?

Your answer (North or South)?: _____

GPS Monument A

Time (Year)	North (mm)	East (mm)	Height (mm)
2000	0	0	0
2001	1	1	0
2002	2	2	0
2003	3	3	0
2004	4	4	0
2005	5	5	0

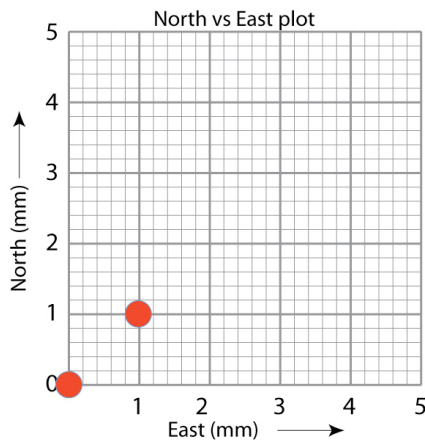
3. And finally make a **Height vs Time (year)** graph showing how GPS Monument A moved every year.



Describe the motion of the monument in the vertical direction. Is GPS Monument A moving in the vertical direction?

Your answer: _____

4. Now let's plot the North and East positions together on the map grid; North is on the y-axis, East is on the X-axis; the positions from years 2000 and 2001 have been plotted.



- **Plot** the locations of the GPS monument for years 2002 through 2005.
- **Draw** an arrow with the tail at the first point and the arrowhead at the last data point.
- Move your gum-drop GPS monument from its starting position (2000) to the end position (2005).

According to your map, what direction is your GPS monument moving?

Your answer: _____

Part 3) What direction is GPS monument B moving?

The data in the table show how far Station B has moved each year. The first column shows the Time in Years.

GPS Monument B		
Date	North (mm)	East (mm)
2000	0	0
2001	-1	-2
2002	-2	-4
2003	-3	-6
2004	-4	-8
2005	-5	-10

Focus on the data for the **North** data

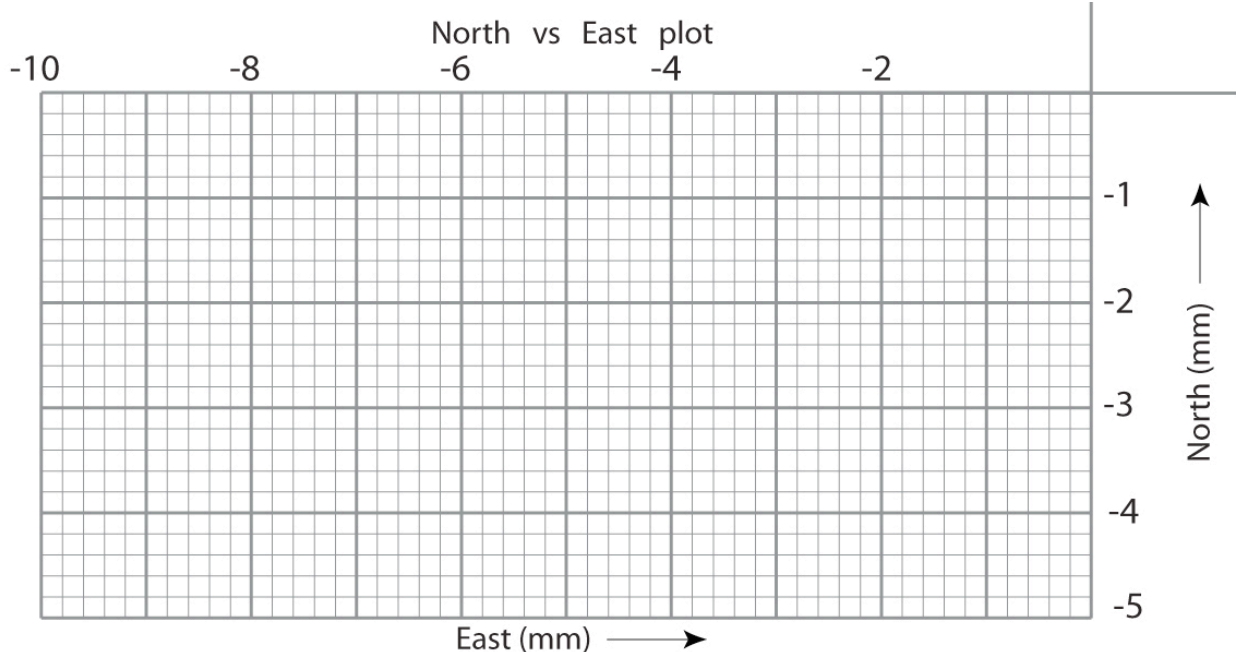
- Is Monument B moving in a more positive or negative direction?
- What direction is GPS Monument B moving? North or South?

Your answer: _____

Now, focus on the data for the **East** data

- Is Monument B moving in a more positive or negative direction?
- What direction is GPS Monument B moving? East or West?

Your answer: _____

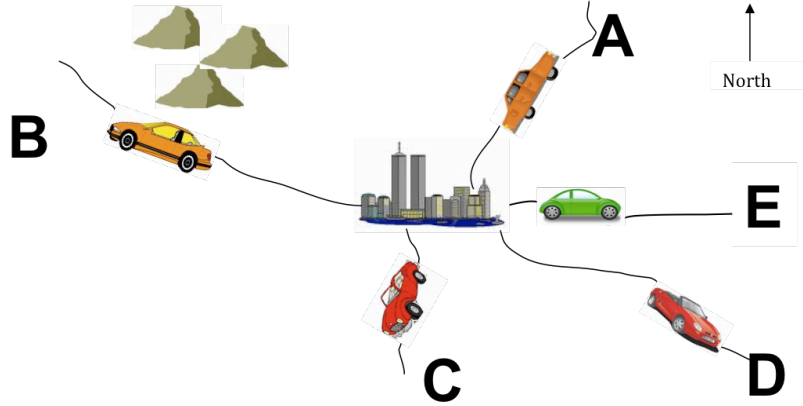


- **Plot** the North and East together on the map grid; the positions from years 1999 and 2000 have been plotted for you. Plot the location for 2001, 2002, 2003, and 2004.
- **Draw** an arrow with the tail at the first point and the arrowhead at the last data point.
- **Move** your gum-drop GPS monument from its starting position (1999) to the end position (2004).

According to your map, what direction is your GPS monument moving?

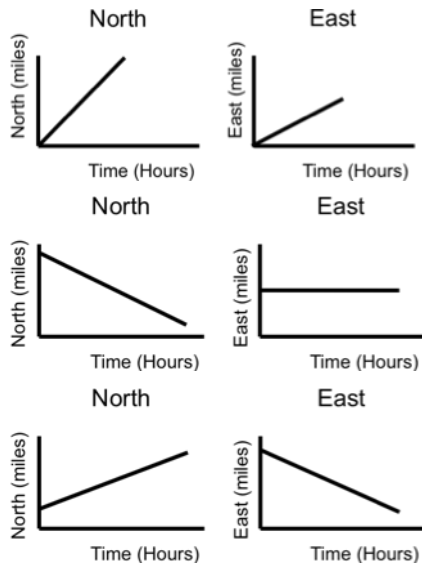
Your answer: _____

Part 4: Test your knowledge



1. Look at the graphed data below and **describe the direction** each set of graph indicates.
2. Identify the letter of the car (on the map) that most closely matches the direction of the graphs. The first example has been done for you. Refer to the previous pages for help.

Direction	CAR LETTER
<u>north-northeast</u>	<u>Car A</u>



For the two cars remaining, identify the car letter and direction

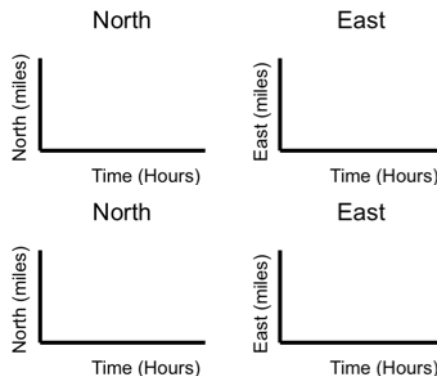
Car letter _____

Is moving in direction: _____

Car letter _____

Is moving in direction: _____

Draw the North and East graphs that match the car's direction



Good job! Now you can look at scientific GPS plots and figure out the direction our Earth's tectonic plates are moving!