Measuring Earth with GPS, Unit 2: Earthquakes

Additional Assessment Questions

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*Below are additional summative assessment questions, beyond those in the three activities.*

# Alt Text: Two graphs with a horizontal axis labeled “Year”. The numbers across the bottom of the horizontal axis begin at the left side with 2006 and increase by increments of 1 until the label 2018 at the far right. The top diagram has the vertical axis labeled “North (mm)” and begins at the bottom at 0mm and has 50mm increments until a maximum of 200. The bottom diagram has the vertical axis labeled “East (mm)” and begins at the bottom at 0mm and has 50mm increments until a maximum of 200mm. The data are dots on the graph labeled in the legend as “Daily position” and a line that tends to be in the middle of the dots labeled in the legend as “30-day average”. For the top graph, the line begins on the far left at 2006 at 2mm and has a general upward trend across the graph, ending in 2018 at 138mm. For the bottom graph, the line begins on the far left at 2006 at 2mm and has a general upward trend across the graph, ending in 2018 at 179mm. Example #1: Assess Parts 1, 3 (Module Goal 1; Unit Learning Outcomes 1)

Write detailed, step-by-step directions telling someone how to calculate the total horizontal speed and the direction of movement of the station. You do not need to actually calculate it.

Figure 1. Horizontal GPS data from station PABH in Washington from the beginning of January 2006 to the end of December 2017.

# Example #2: Assess Parts 1, 3 (Module Goals 1, 2; Unit Learning Outcomes 1, 2, 3, 4)

Alt Text: USGC 
Two graphs with a horizontal axis labeled “Year”. The numbers across the bottom of the horizontal axis begin at the left side with 2006 and increase by increments of 1 until the label 2018 at the far right. The top diagram has the vertical axis labeled “North (mm)” and begins at the bottom at 0mm and has 50 mm increments until a maximum of 350mm.  The bottom diagram has the vertical axis labeled “East (mm)” and begins at the top at 0mm and has 50 mm increments until a maximum of -350mm. The data are dots on the graph labeled in the legend as “Daily position” and a line that tends to be in the middle of the dots labeled in the legend as “30-day average”. 
For the top graph, the line begins on the far left at 2006 at 3mm. It initially goes upward to 105mm, but at ¼ the way to 2011 mark, it vertically drops to about 88mm. It then immediately begins to rise, generally trending upward across the graph, and ending in 2018 at 261mm.
For the bottom graph, the line begins on the far left at 2006 at -3mm and has a general downward trend across the graph, ending in 2018 at -284mm.

Alt Text: P607 
Two graphs with a horizontal axis labeled “Year”. The numbers across the bottom of the horizontal axis begin at the left side with 2006 and increase by increments of 1 until the label 2018 at the far right. The top diagram has the vertical axis labeled “North (mm)” and begins at the bottom at 0mm and has 50mm increments until a maximum of 350mm.  The bottom diagram has the vertical axis labeled “East (mm)” and begins at the top at 0mm and has 100 mm increments until a maximum of -350mm. The data are dots on the graph labeled in the legend as “Daily position” and a line that tends to be in the middle of the dots labeled in the legend as “30-day average”. 
For the top graph, the line begins on the far left at 2006 at 9mm. It initially goes upward to 25mm, but at ¼ the way to 2011 mark, it vertically drops about 13mm. It then slowly, and generally trends upward across the graph, ending in 2018 at 38mm.
For the bottom graph, the line begins on the far left at 2006 at -6mm, and has a general downward trend across the graph, ending in 2018 at -67mm.

Alt Text: P480 
Two graphs with a horizontal axis labeled “Year”. The numbers across the bottom of the horizontal axis begin at the left side with 2006 and increase by increments of 1 until the label 2018 at the far right. The top diagram has the vertical axis labeled “North (mm)” and begins at the bottom at 0mm and has 50 mm increments until a maximum of 350mm.  The bottom diagram has the vertical axis labeled “East (mm)” and begins at the top at 0mm and has 100 mm increments until a maximum of -350. The data are dots on the graph labeled in the legend as “Daily position” and a line that tends to be in the middle of the dots labeled in the legend as “30-day average”. 
For the top graph, the line begins on the far left at 2006 at 2mm and has a general upward trend across the graph, ending in 2018 at 298mm.
For the bottom graph, the line begins on the far left at 2006 at -2mm and has a general downward trend across the graph, ending in 2018 at -331mm.



Figure 1. Horizontal GPS data from stations USGC and P607 in Southern California from the beginning of January 2006 to the end of December 2017.

This area of Southern California needs a new hospital. Would you recommend building a hospital between P480 and USGC or between USGC and P607? Formulate an argument to support your recommendation. Write a letter with your recommendation to avoid earthquake hazards, using the GPS data to support your argument. You will need to explain to your friend how GPS station motion can play a role in learning about earthquakes.

Be sure to include the following points in your letter to receive full credit:

• You include a clear statement about your recommendation for location.

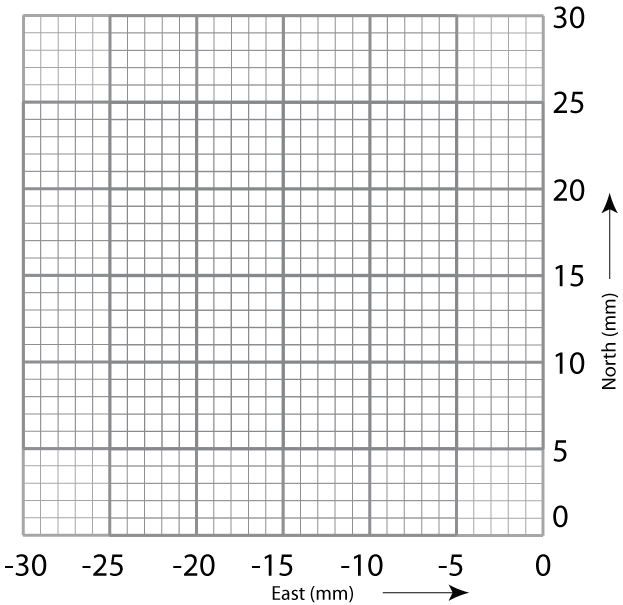
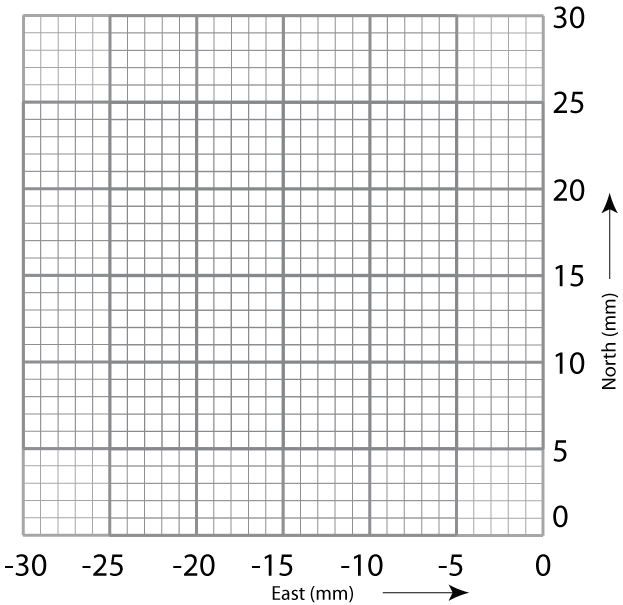
• You use words to describe the data supporting your argument.

• You use numerical rates (numbers plus units) to support your argument. Correctly include what the rate measures.

• You explain the link between GPS motion and plate motion.

• You explain the link between GPS motion and earthquakes.

The following may be useful to you:



total rate = **√** (north–south rate)2 + (east–west rate)2

# Example #3: Assess Parts 1, 3 (Module Goals 1, 2; Unit Learning Outcomes 1, 2, 3)

Alt Text: Two graphs with a horizontal axis labeled “Year”. The numbers across the bottom of the horizontal axis begin at the left side with 2006 and increase by increments of 1 until the label 2018 at the far right. The top diagram has the vertical axis labeled “North (mm)” and begins at the bottom at 0mm and has 50 mm increments until a maximum of 350mm.  The bottom diagram has the vertical axis labeled “East (mm)” and begins at the top at 0mm and has 50 mm increments until a maximum of -350mm. The data are dots on the graph labeled in the legend as “Daily position” and a line that tends to be in the middle of the dots labeled in the legend as “30-day average”. The data begins in mid-2007 mark. 
For the top graph, the line begins on the far left at ½ the way to the 2008 mark at 3mm. It initially goes upward reaching 68mm at ¼ the way to 2011 mark. It drops to about 44mm halfway the way to 2011 mark. It then begins its general upward trend across the graph, ending in 2018 at 217mm.
For the bottom graph, the line begins on the far left at 2006 at -1.5mm. It has a general downward trend across the graph with an abrupt drop from -66mm to -89mm between ¼ and ⅓ the way to the 2011mark, and ending in 2018 at -281mm. 


Figure 1. Horizontal GPS data from station P481 in California near the Mexico border from the beginning of January 2006 to the end of December 2018.

Use the graph showing ground motion as measured by GPS over time to answer the following questions.

What is the approximate long-term rate of change in the north–south direction? (Part 3; Module Goal 1; Unit Learning Outcome 1)

a. 25 mm

b. 225 mm

c. 25 mm/year

d. 40 mm/year

What is the most likely explanation that the GPS station is moving? (Part 3; Module Goal 1; Unit Learning Outcome 2)

a. There are constant, small earthquakes near the GPS station.

b. The tectonic plate the GPS station is on is moving.

c. The GPS station was installed on a slowly moving landslide.

What happened in 2010? (Part 3; Module Goal 1; Unit Learning Outcome 2)

a. There was an earthquake.

b. There was a large rainstorm leading to a flood.

c. The entire North American Tectonic Plate shifted.

What is the correct reasoning for a recommendation for building roads based on this GPS data in California? (Part 3; Module Goal 1, 2; Unit Learning Outcomes 1, 2, 3)

a. Avoid building roads near the GPS station because the ground the station is on is moving, so there is likely to be an earthquake there.

b. Avoid building roads near the GPS station because the ground the station is on has moved far enough during earthquakes that roads will no longer connect.

c. You cannot make recommendations based on this single GPS station because you need to know how nearby stations are moving.