Date: _____

Your Name: _____

New England Common Assessment Program

Released Science Inquiry Task

Encounter with an Active Volcano

2016

Grade 11

Science

Directions:

You will be reading a story and analyzing the data provided to answer a set of questions. Read the story and questions thoroughly and explain all of your answers. You may include labeled drawings or diagrams to help you answer the questions.

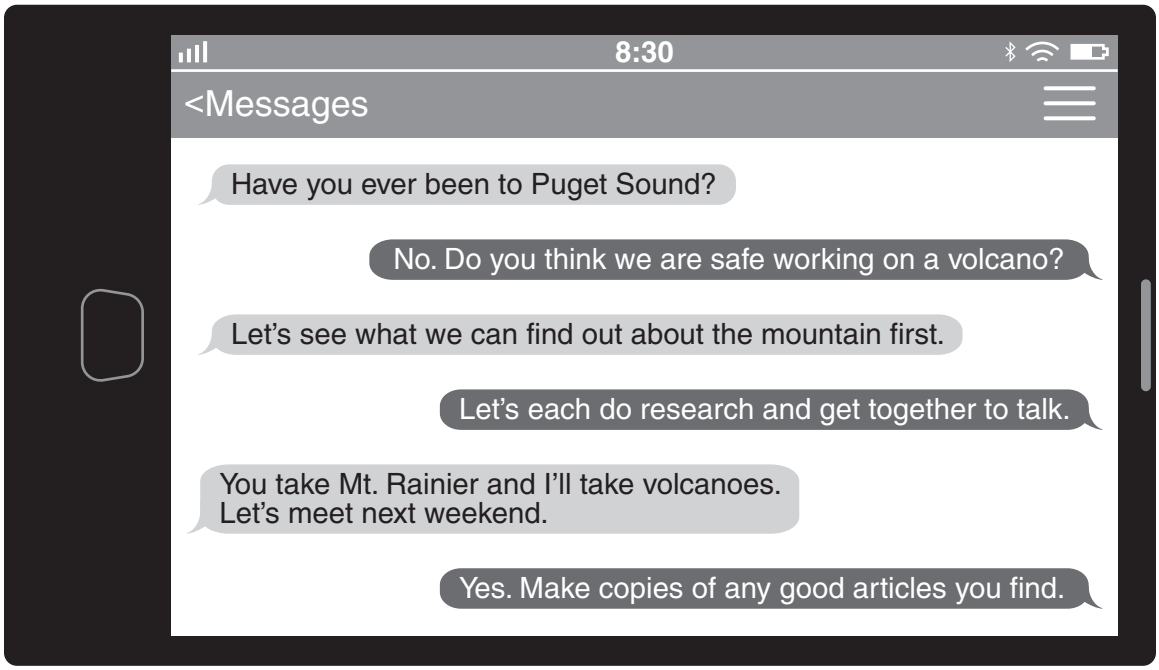
This Word Bank provides definitions for words used in this task. You may refer back to this page throughout the session.

Word Bank

Elevation	the height above sea level
Frequency	the rate at which something occurs or is repeated over a particular period of time
Hazard	a danger or risk
Intern	a student or trainee who works, sometimes without pay, to gain career experience
Nonviolent eruption	nonexplosive volcanic activity
Plume	a rising or expanding body of gas and ash particles
Seismic	relating to earthquakes or other vibrations within Earth's interior
Shallow earthquake	an earthquake originating within 60 kilometers beneath Earth's surface

Encounter with an Active Volcano

Patrick and Julia, two high school friends from New England, have been accepted as summer interns to work as tour guides in Mt. Rainier National Park in the state of Washington. They will be leading tours of Mt. Rainier, an active volcano that has not erupted for over 100 years. They will stay in different houses in the town of Puyallup, which is located on Puget Sound, near Seattle, Washington. The two friends made the following texts to each other about their upcoming adventure.



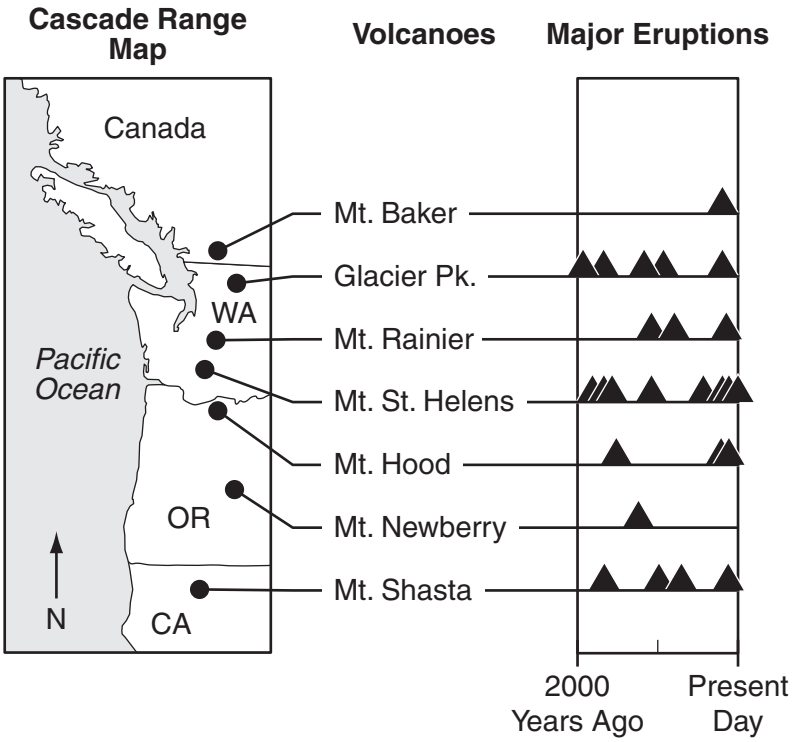
The following weekend, Patrick and Julia met and shared information. They were both amazed that they would be working on an active volcano with a peak that is covered with more than 20 glaciers. The two friends learned that Puyallup was about 40 kilometers northwest and 4000 meters lower in elevation than Mt. Rainier.

Julia found information that classified Mt. Rainier as a dangerous volcano even though the last recorded eruptions of the mountain were during 1894 and 1895. Those eruptions were small and concentrated at the summit.

Patrick collected information about Mt. St. Helens, a volcano 56 kilometers southwest of Mt. Rainier and where a violent eruption occurred in 1980. Since that time, Mt. St. Helens has had nonviolent eruptions from 2004 to 2008 that added lava to the volcano's crater. More than 100 shallow earthquakes per day signaled underground magma movement in early 2004. However, the 2004–2008 eruptions happened slowly, so they posed no danger to anyone outside the volcano's crater.

Some of the articles that Patrick read indicated that many geologists see similarities between the volcanic activities of Mt. St. Helens and Mt. Rainier. The two students learned that both volcanoes are part of a system of volcanoes called the Cascade Mountain Range. Julia found a diagram showing some of the volcanic mountains in the Cascade Range. Diagram 1 shows the information she found.

Diagram 1: Some Cascade Range Eruptions during the Last 2000 Years



The data in the articles and the diagram helped Patrick and Julia develop this question they could investigate to help them determine their safety during their summer in Puyallup, Washington.

Research Question:

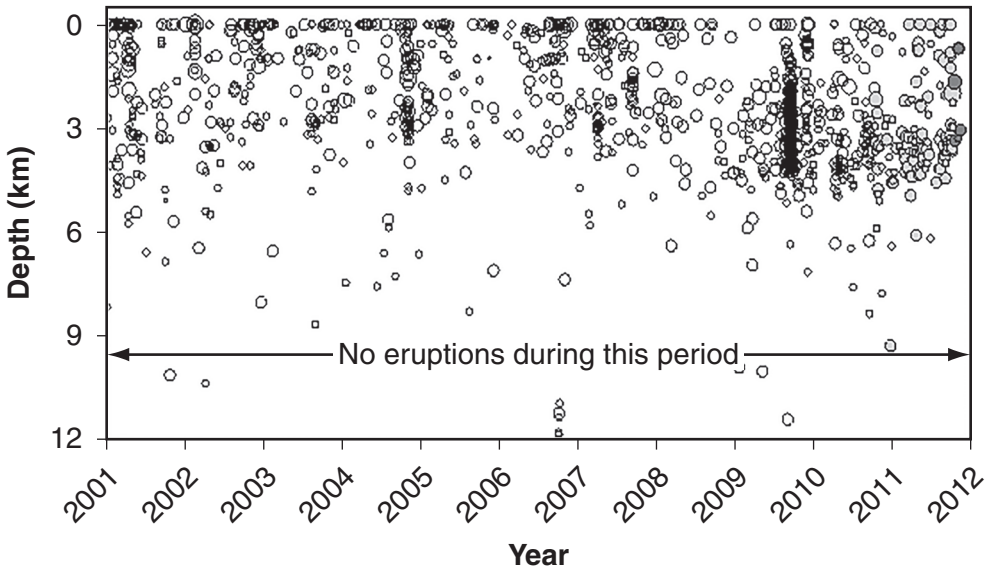
How does geological evidence from past volcanic eruptions support predictions about future eruptions?

The results of scientists' seismic monitoring of both Mt. St. Helens and Mt. Rainier provided Patrick and Julia with data about the depth and frequency of earthquakes beneath both volcanoes. They decided that they could compare data about Mt. Rainier to data from both the 1980 and 2004–2008 eruptions of Mt. St. Helens to predict the likelihood that Mt. Ranier will have a violent eruption during the summer.

The two students found historical earthquake (seismic) data for both mountains. They learned that most earthquakes that occur directly within a volcano are caused by the movement of magma beneath the volcano. Some continuous earthquake activity is common in a volcanic region. However, the depth and frequency of earthquakes often increase at the time of an eruption.

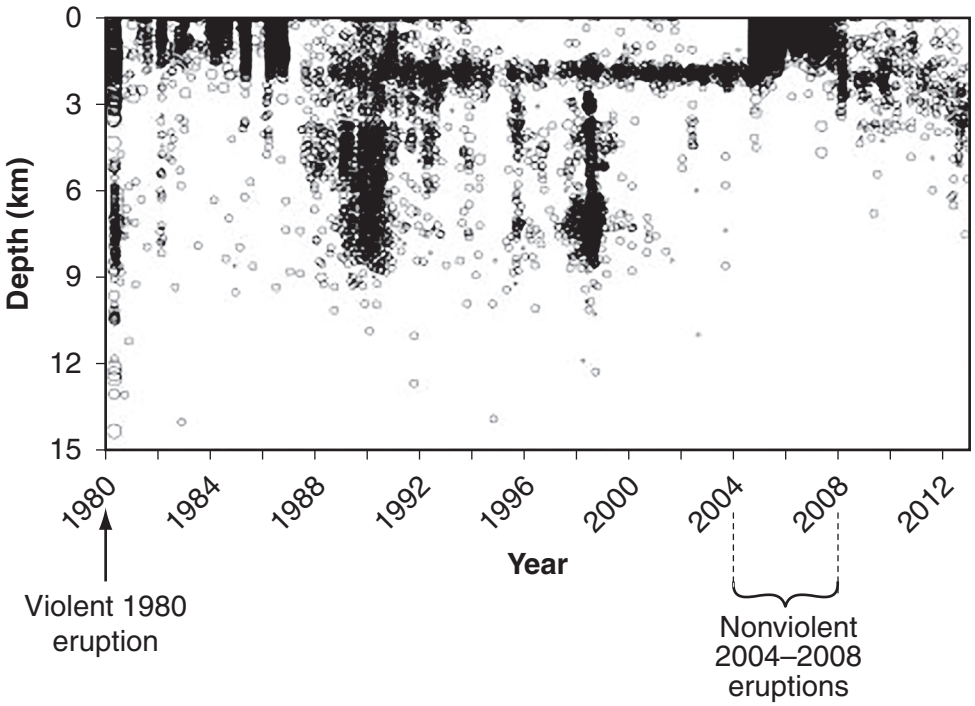
Graphs 1 and 2 show the data about earthquake activity that Patrick and Julia found for both mountains. Each circle represents an earthquake event. Darker areas indicate greater frequency of earthquake activity.

Graph 1: Mt. Rainier Earthquake Activity 2001–2012



Adapted from U.S. Geological Survey.

Graph 2: Mt. St. Helens Earthquake Activity 1980–2012



Adapted from U.S. Geological Survey.

Patrick and Julia compared the data about eruption and earthquake activity in Diagram 1 and Graphs 1 and 2 to predict the likelihood of a violent Mt. Rainier eruption during their stay. Julia predicted that Mt. Rainier was likely to have a violent eruption very soon, maybe before the end of the summer.

Patrick wondered if the scales of the data in Graphs 1 and 2 gave Julia enough information to make her prediction.

Answer questions 1 and 2 on page 1 in your Student Answer Booklet.

1. Identify **two** reasons the scales used for the data in Graphs 1 and 2 (depth and years) are or are not appropriate for Julia's prediction. Explain why the scales are or are not appropriate.

Patrick studied all the data and disagreed with Julia's prediction. Patrick claimed that no violent eruption will occur this year on Mt. Rainier.

2. Identify how the evidence from Graphs 1 and 2 supports Patrick's claim that no violent eruption will occur this year on Mt. Rainier. Explain your answer.

"What if Mt. Rainier does erupt? Does that really pose a danger to us?" Julia wondered.

"The earthquake data do not tell us about that," said Patrick. "If Mt. Rainier erupts, what will the impact be on this area?"

"Maybe data from past volcanic eruptions could help answer that question," said Julia.

Julia and Patrick both thought that data about past volcanic eruptions might help them evaluate the impact of a Mt. Rainier eruption. Patrick said he had found plenty of data about the effects of past volcanic eruptions when other Cascade Range volcanoes erupted. The data is described below.

Cascade Range Volcanic Data

- the approximate years of major and minor eruptions,
- the approximate amounts of volcanic material added to and removed from the mountains by the eruptions, and
- the extent of the area covered by materials deposited from the eruptions.

Patrick and Julia thought that this additional Cascade Range volcanic data could help them make a prediction about the possible impact associated with a Mt. Rainier eruption.

Answer question 3 on page 2 in your Student Answer Booklet.

❸ Identify which of the Cascade Range volcanic data would **best** support a prediction about the possible impact of a violent Mt. Rainier eruption to the area. Explain how the data would help make a prediction.

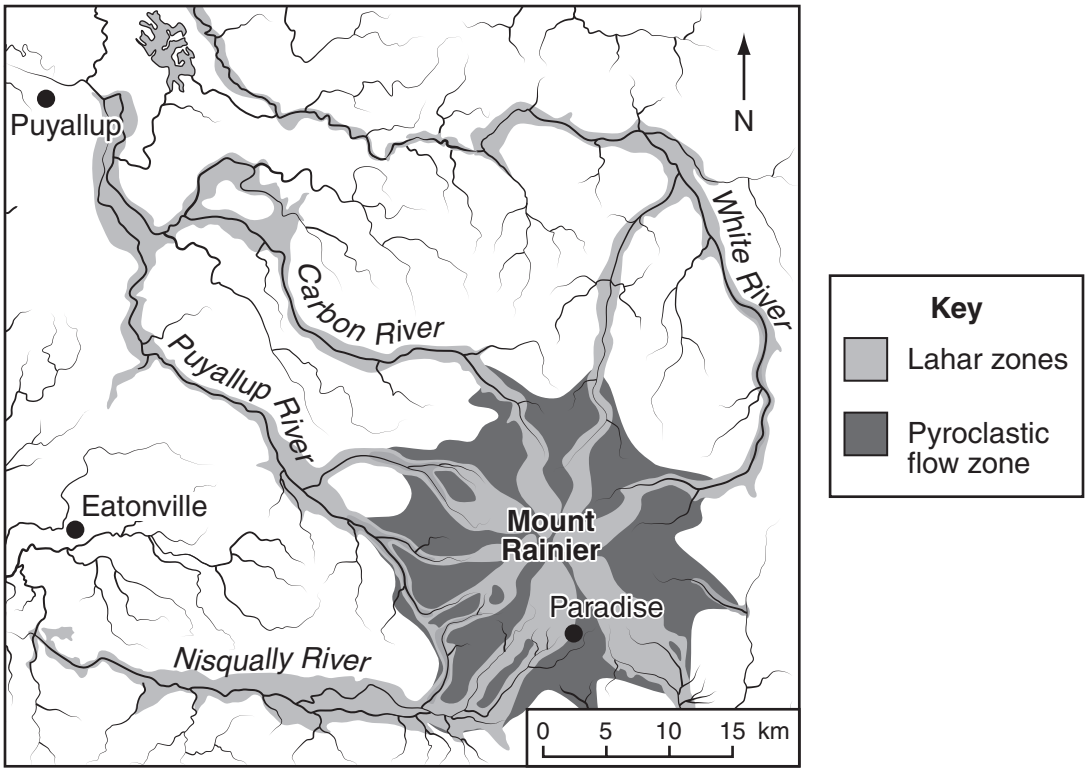
Patrick and Julia learned that lava flow was not the only destructive effect of an eruption so Julia was curious about what different types of hazards occurred during past violent eruptions of Mt. Rainier. She thought that knowing this information might help them determine the hazards posed by a future violent eruption of Mt. Rainier.

Patrick found two articles that described the hazards violent volcanic eruptions pose. According to the articles, the two risks that seemed the most significant based on past violent eruptions of Cascade Range volcanoes were lahars and pyroclastic flows. The article described these hazards in this way:

- lahars—mixtures of water and rock fragments that flow downstream from the volcano through river valleys
  - move faster than humans can run
  - tens of meters deep
  - hundreds of meters wide
- pyroclastic flows—mixtures of rock fragments and gases
  - high-density and extremely hot
  - move away from the volcano blast area at high speeds

Julia found this map that shows the areas affected by lahars and pyroclastic flows based on geologic evidence from past violent Mt. Rainier eruptions.

Map 1: Historical Extent of Mt. Rainier Lahars and Pyroclastic Flows



Adapted from sources shown at http://www.mmdtkw.org/ALRIVes0917aRainierRiskMap.jpg.

Answer question 4 on page 2 in your Student Answer Booklet.

4 Suppose a violent volcanic eruption happened on Mt. Rainier. Based on the data in Map 1, identify the level of risk (high, moderate, or low) from lahars and pyroclastic flows in **two** of the following towns in Washington:

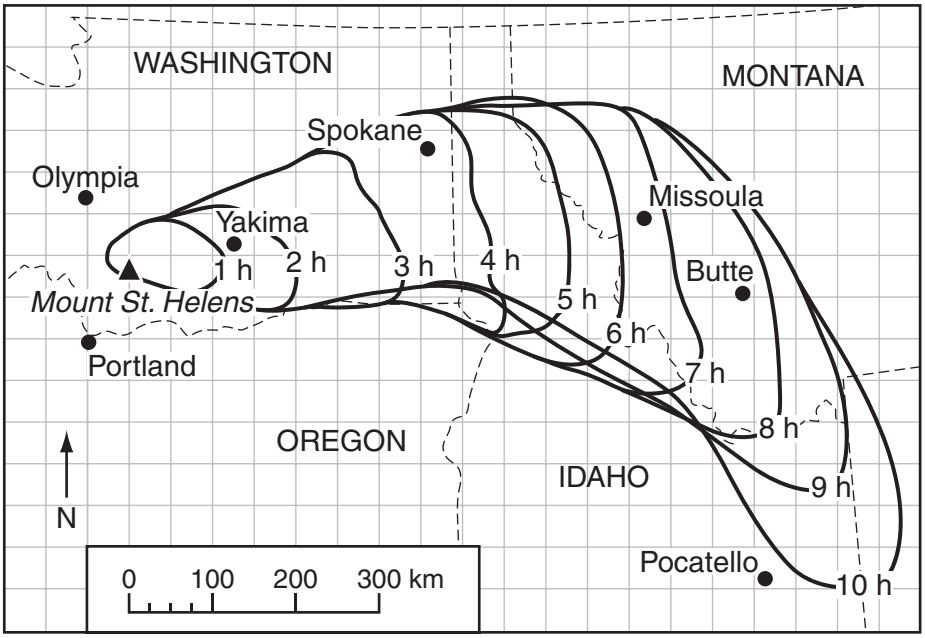
- Eatonville
- Puyallup
- Paradise

For each of the two locations you chose, use the data from Map 1 to justify the levels of risk you identified for **each** hazard.

GO ON

Patrick found information about ash deposited in places far away from Mt. St. Helens after the 1980 eruption. He and Julia wondered if ash from a violent Mt. Rainier eruption might be deposited in Puyallup. Julia found a map that showed the path followed by ash released into the air from the Mt. St. Helens volcano on May 18, 1980, over the first 10 hours. The ash plume traveled quickly over a wide area, as shown in Map 2 below.

Map 2: Mount St. Helens Ash Plume Path over 10 Hours
May 18, 1980



Data adapted from Topinka, USGSICVO, 1999, Modified from: Sama–Wojcicki, et.al., 1981, IN: USGS Professional Paper 1250

Answer question 5 on page 3 in your Student Answer Booklet.

5 Create a line graph of the maximum distance the plume travelled from Mt. St. Helens each hour based on data from Map 2. Be sure to include all the required elements of a graph.

Answer question 6 on page 4 in your Student Answer Booklet.

6 Identify the independent and dependent variables of the investigation that produced the data shown on Map 2 and your graph. Based on the map data, explain the relationship between these two variables.

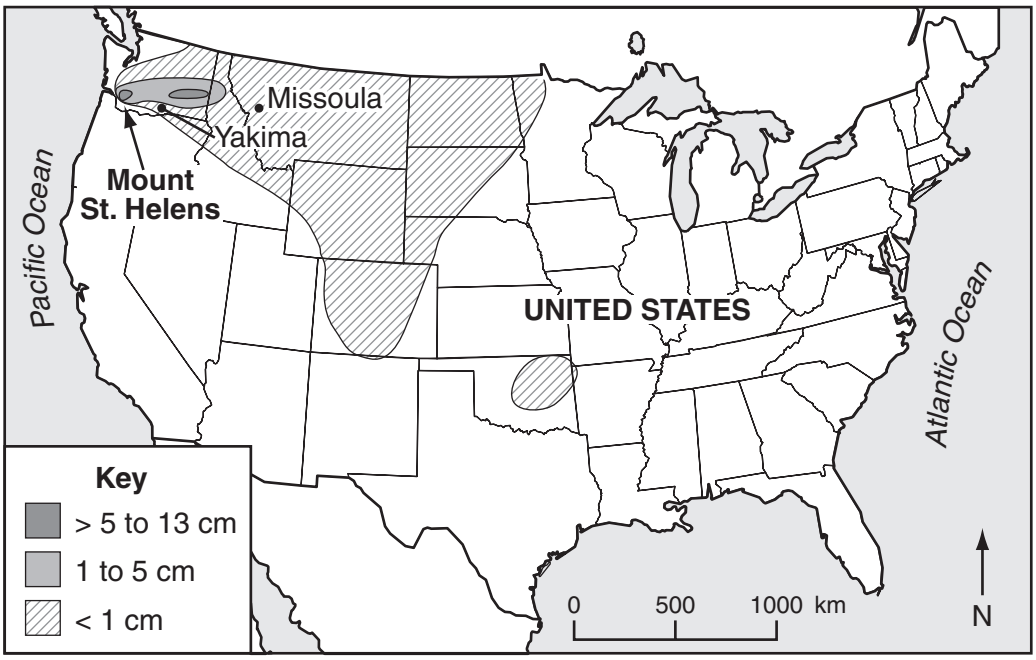
Patrick and Julia studied Map 2. They both wondered how this large area of gas and ash in the air affected people on the ground.

"I wonder how much of the ash fell to the ground," Patrick said.

"Let's see if we can find a map that shows that information," Julia suggested.

By searching on the Internet, Patrick and Julia found a map of ash deposits they could compare to Map 2. Map 3 shows the depth of ash deposits from the 1980 Mt. St. Helens eruption.

Map 3: Depth of Ash Deposits from 1980 Mount St. Helens Eruption



Patrick wondered if environmental conditions may have affected the data shown on Maps 2 and 3. Julia looked up the weather archives for May 18, 1980, at Missoula, Montana. She found the weather data shown in Table 1 below.

Table 1: Weather at Missoula, Montana May 18, 1980

Time (P.M.)	Temperature (°C)	Relative Humidity (%)	Pressure (kPa)	Wind Direction	Wind Speed (kph)
2:00	20	50	102.6	SSE	9.3
3:00	22	34	101.7	NNE	5.6
4:00	22	33	101.2	NNW	5.6
5:00	22	35	101.2	S	7.4

GO ON

Answer question 7 on page 4 in your Student Answer Booklet.

❼ Based on the weather data in Table 1, identify **two** possible environmental variables that may have affected the data shown in Maps 2 and 3. Describe how each variable may have affected the observations shown on Maps 2 and 3.

Julia and Patrick decided that the seismic and volcanic data would help them make a reasonable conclusion about all the risks from a violent volcanic eruption of Mt. Rainier during their stay.

Answer question 8 on page 5 in your Student Answer Booklet.

❽ Based on all the data Julia and Patrick gathered, make a conclusion about the risk to Patrick and Julia in Puyallup if Mt. Rainier erupts. Identify the possible hazards when a violent eruption does happen. Explain how the data support your conclusion.

STOP