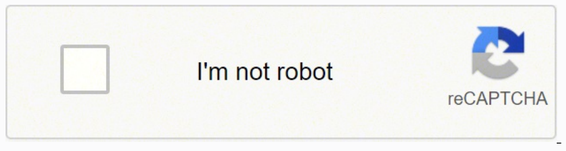


Open

Locating the epicentre of an earthquake worksheet

Earthquake Quiz

1. What is true about the crust of the Earth?
   - O a The crust is one big plate.
   - O b There are about 20 plates that all move slowly.
   - O c The crust is broken into thousands of small pieces.

2. What are earthquakes caused by?
   - O a Plates crushing together, pulling apart, or side sweeping each other .
   - O b Accidental explosions by people.
   - O c A monster in the Earth.

3. What is the epicenter?
   - O a The duration of the earthquake.
   - O b The region where the earthquake is felt.
   - O c The location where the earthquake begins.

4. Can scientist predict when an earthquake happens?
   - O a Yes
   - O b No

5. Tsunamis are big waves that are caused by:
   - O a The wind.
   - O b An earthquake or volcano explosion on land.
   - O c An underwater earthquake or volcano explosion.

6. What do you do when you lie in bed and an earthquake happens?
   - O a You stay in bed and protect your head with a pillow.
   - O b You run outside.
   - O c You run to one of your parents.

If you are not in bed, you drop to the ground and crawl under a desk or near a wall!!!

7. Earthquake are measured by:
   - O a a thermometer
   - O b a seismogram
   - O c a seismograph

Answers are found on the next page

How is an Earthquake's Epicenter Located?

- **Three seismograph stations are needed to locate the epicenter of an earthquake**
- **A circle where the radius equals the distance to the epicenter is drawn**
- **The intersection of the circles locates the epicenter**

Earth Science Regents
Locating an Epicenter

Name_____

Period _____

Introduction:

As you have learned in class, earthquakes are vibrations caused by large releases of energy. These energy releases can occur as a result of fault movements, asteroid impacts, volcanic eruptions, and movements of magma, as well as by explosions. As a result, vibrations can begin both in and on the Earth's crust. The energy released radiates away from the point of origin, the **focus**. Commonly, when describing the *location* of an earthquake, scientists and the media often talk about the earthquake's **epicenter,** the point on the Earth's surface directly above the focus.

Earthquake energy can be recorded on a **seismograph**, producing a **seismogram**. Seismographs can "pick up" several types of energy **waves**, which travel through the Earth, and radiate in all directions from the focus. Two of these waves are used to locate earthquake epicenters:

- **"P"-waves** or **longitudinal waves:** "P" stands for primary. These waves travel fastest and arrive at seismographs first. They are compressional ("push-pull") waves.
- **"S"-waves** or **transverse waves:** "S" stands for secondary. These waves travel more slowly and arrive at seismographs *after* P-waves. They are perpendicular ("side-to-side") waves.

As you may recall, we use travel time graphs (Page 11 ESRT's) to show how long it takes each type of seismic wave to travel a distance, measured on Earth's surface. The difference between the *S*-wave arrival time and the *P*-wave arrival time corresponds to the distance of the seismograph from the focus of the earthquake. However, these waves can arrive at a seismograph from ***any direction!*** Thus, one seismograph is not enough to determine the epicenter of an earthquake. A second seismogram, recorded in a different location, can narrow down the possible location to some degree, but at least three seismograms are required in order to accurately plot the epicenter.

In this lab, you will use seismograms from three locations to determine the epicenter of an earthquake. You will use the *P*- and *S*-wave arrival time difference to determine distance to epicenter, then use a compass to record the distance radius measured by each station. Remember, accuracy is important- take care to make accurate measurements!

Materials:

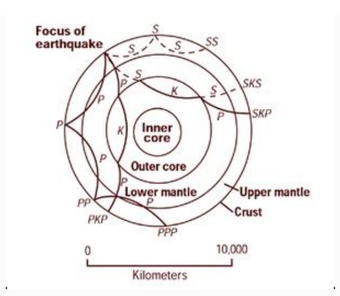
- 3 seismograms from the same earthquake
- Safe drawing compass
- *P*- and *S*-wave travel time curve
- Map for plotting the earthquake epicenter
- Straight edge

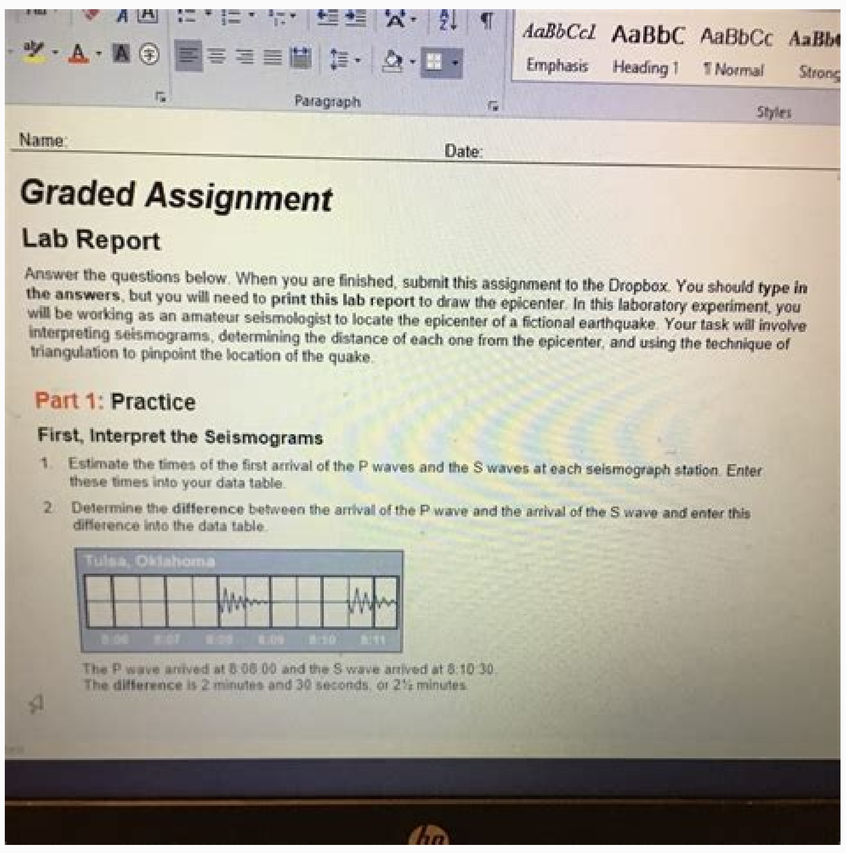
Procedure:

1. Examine Figure 1, which shows seismograms of an earthquake recorded at three different locations. Note that the first set of zigzags at each city indicate the arrival of P-waves, and the second set of zigzags indicate the arrival of S-waves. In order to determine the time of arrival for each P- and S-wave, move your finger in a straight line down to the **time axis** beneath the wave.

2. Estimate to the nearest ten seconds, the times of the first arrival of the P-waves and S-waves at each station in Figure 1. Then, subtract the S minus P:

	First P arrival	First S arrival	S-P
San Jose, Costa Rica			
New York, NY			
San Francisco, CA			





If the epicenter of the earthquake is 215 kilometers away, that equals 2.15 centimeters on the map. Do not use the elevators, even if they are working. All maps are different. Earthquake safety should not be a big concern when traveling, but in the unlikely event that an earthquake does occur, it doesn't hurt to know what to do during and have a plan. If you're in your hotel room, stay there. Especially if you are traveling to a region known for frequent earthquakes like California, Japan, or New Zealand, you may experience small tremors. Finding the Distance to the Epicenter Use the time difference between the arrival of the P and S waves to estimate the distance from the earthquake to the station. Most earthquake-related casualties result from collapsing walls, flying glass, and falling objects. Shout only as a last resort. Find 23 millimeters on the right side of the chart and mark that point. In this case, the first P and S waves are 24 seconds apart. Measure the amplitude of the strongest wave. How Do We Measure Earthquake Magnitude? If the worst happens and you are trapped under the debris of the earthquake, remember these safety tips: Tap on a pipe or wall so rescuers can locate you. If you're in bed when the earthquake strikes, stay there. If you are in a restaurant, get under the table. Find the point for 24 seconds on the left side of the chart of simplified S and P travel time curves and mark that point. (From Bolt, 1978.) Measure the distance between the first P wave and the first S wave. Stay away from glass, windows, outside doors and walls, and anything that could fall, such as lighting fixtures, or furniture. The amplitude is the height (on paper) of the strongest wave. Hold on to something until the shaking stops. Stay inside until shaking stops and it is safe to go outside. Stay off the phone unless it's an emergency. Place a ruler (or straight edge) on the chart between the points you marked for the distance to the epicenter and the amplitude. While earthquake locations are normally done with a computer that can quickly determine the paths of seismic waves through the Earth to many seismic stations, you can get a good estimate of an earthquake location using a map, a ruler, a pencil, and a compass for drawing circles on the map. The biggest potential dangers are ground movement, cracks opening up in the road, and distracted drivers. The point where your ruler crosses the middle line on the chart marks the magnitude (strength) of the earthquake. In this case, the triangle of space created when a bookshelf, wall, or part of a ceiling falls against a large piece of furniture is your best chance of not getting crushed. Instead, move towards the most open space you can find in the moment.Move away from buildings, streetlights, and utility wires.Once in the open, stay there until the shaking stops. On this seismogram, the amplitude is 23 millimeters. This is where the compass, the map, and the other seismograph records come in. Use a whistle if one is available. All of the circles should overlap. Hold on and protect your head with a pillow. Here are examples of a seismograms from different places in North America that recorded the same earthquake. Under a sturdy desk or in an inside corner of your room is the safest place to be, even if you're on the 40th floor. The epicenter of the earthquake is somewhere on the edge of that circle. There may be aftershocks. There are usually aftershocks, and sometimes they may be worse than the original earthquake. Don't light any candles unless you've ruled out gas leaks.Watch out for shifted items when opening cupboards, especially those containing glass or heavy items.Get dressed and put on sturdy shoes before you start cleaning up or go outside.If you have internet or cell access, post your status to social media so that your friends and family know you're ok, or send a text. Use a doorway for shelter only if it is in close proximity to you and if you know it is a strongly supported, load-bearing doorway. If you are on a quieter road, pull over to the side of the road and stop as quickly as safety permits and stay in the vehicle.Avoid stopping near or under buildings, trees, overpasses, and utility wires.Slow down and put on your turn signal to get to the side of the road.Proceed cautiously once the earthquake has stopped. It should look something like a piece of a ruler. Assuming you are in a region where buildings have been retrofitted for earthquakes, like California, the biggest danger will be from debris and you should follow the following tips: Stay where you are. If you are not sure that the building has been built for earthquakes, you should lie down next to a large and heavy piece of furniture like a bed, sofa, or desk. Just because the earthquake is over, that doesn't mean you're in the clear. All the same, you should memorize the basic earthquake safety tips according to the Federal Emergency Management Agency (FEMA). Figure out how long the distance to the epicenter (in centimeters) is on your map. The greatest danger exists directly outside buildings, at exits, and alongside exterior walls. Shouting can cause you to inhale dangerous amounts of dust.Do not light a match.Do not move about or kick up dust.Cover your mouth with a handkerchief or clothing. If you are worried about earthquakes, there are a few things you can pack and keep on you or in your car, which will be of great use in an emergency. A crank radio or battery-operated radioA small flashlightTravel snacksWater Thanks for letting us know! This earthquake had a magnitude of 5.0. Finding the Epicenter You have just figured out how far your seismograph is from the epicenter and how strong the earthquake was, but you still don't know exactly where the earthquake occurred. Many of the 120 fatalities from the 1933 Long Beach earthquake occurred when people ran outside only to be killed by falling debris from collapsing walls. To figure out just where that earthquake happened, you need recordings from seismic stations in other places. If you are under a heavy light fixture or window, move to the nearest safe place like under a desk or in the corner. If there's a heavy bookcase next to a match-stick desk, don't get under the desk. Research has shown that most injuries occur when people inside buildings attempt to move to a different location inside the building or try to leave. The point where all of the circles overlap is the approximate epicenter of the earthquake. Using your compass, draw a circle with a radius equal to the number you came up with in Step #2 (the radius is the distance from the center of a circle to its edge). The center of the circle will be the location of your seismograph. An earthquake while you're driving feels like there's something wrong with your car. On your map, one centimeter could be equal to 100 kilometers or something like that. The point where the three circles intersect is the epicenter of the earthquake. This technique is called "trilateration." (Image from IRIS.) Check the scale on your map. They may come within minutes, hours, or days later, and can be weaker or stronger than the original quake.If you're near the coast after a major quake, pay attention to tsunami warnings and move inland and to higher ground immediately.Follow local media for emergency broadcasts.Check for gas leaks or exposed wires and turn off gas or fuse box if necessary. Do the same thing for the distance to the epicenter that the other seismograms recorded (with the location of those seismographs at the center of their circles). If you are in your car during an earthquake, do the following: Don't stop in the middle of the freeway if traffic is still moving around you. Be aware that the electricity may go out or the sprinkler systems or fire alarms may turn on. If you are outdoors when the earthquake starts, do not seek shelter inside. According to the chart, this earthquake's epicenter was 215 kilometers away. Distances from the stations to the earthquake are estimated from the difference between P and S wave arrival times: Illustrative example seismograms from IRIS. If there's nothing around you to get under, cover your face and head with your arms and crouch in the corner of the building. For example, say your map has a scale where one centimeter is equal to 100 kilometers. Following the first tremor, keep these safety tips in mind: Be prepared for aftershocks. Brace yourself on the side with the hinges to avoid the door swinging at you. Avoid roads, bridges, or ramps that might have been damaged by the earthquake. Drop to the ground and take cover by getting underneath a sturdy table or another piece of furniture. Ground movement during an earthquake is seldom the direct cause of death or injury.

2014-2-6 · Thinking Outside the Box: A Misguided Idea The truth behind the universal, but flawed, catchphrase for creativity. Posted February 6, 2014

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