**Tsunami Activity**

**Boxing Day Tsunami, Indonesia** (If you’re interested, you can look up how “Boxing Day” got its name which has nothing to do with the sport of boxing).

**Purpose:** to understand the scope of tsunamis including their travel time across an ocean and to understand what type of plate boundary most often causes tsunamis especially large tsunamis

**Knowledge gained:**

* Understand how much warning time people might have if they live along a coast.
* Review how the Mercalli scale is different than the Richter scale and what it means for the Mercalli scale to measure intensity rather than magnitude.
* Gain an understanding of the rate and direction of plate movement near Indonesia.
* Learn about the history of movement and hazards associated with the megathrust fault in Indonesia.
1. A magnitude 9.1 occurred at 00:58:53 UTC (Universal Time), December 26, 2004 near Sumatra, Indonesia (3.3°N 96°E). Plot the earthquake location on the following map with a small star. Next, go to the world map with plates outlined in red in Chapter 2 of your textbook. On the map below, draw the plate boundary near Indonesia. Include the symbol for this type of plate boundary.

1. Let’s review Chapter 2. Along which type of plate boundary did this earthquake occur?
2. Based on your previous answer, sketch a cross-section showing the tectonic relationship of the India and Burma plates. Label the Sunda Trench, lithosphere and asthenosphere. Draw and label the rising magma and volcanoes, too. Chapter 2 (and/or the chapter slides in D2L) will be of help in drawing this type of plate boundary.
3. Now go to the USGS website on this earthquake. <https://earthquake.usgs.gov/earthquakes/eventpage/official20041226005853450_30>

Click on the interactive map. Then, click the key on the right side.

1. What was the highest number on the Mercalli Scale for this earthquake? (Hint: you can click on the colored blobs on the map). Please provide your answer in a Roman numeral since the Mercalli scale uses Roman numerals and not regular numbers.
2. Please go to your textbook and give a description of what happens at this intensity on the Mercalli Scale. (The Richter and Mercalli Scales do not use the same numbering system).
3. What was the extent (distance) to which the earthquake was felt at this intensity? You’ll need a piece of scratch paper. Put the straight edge next to the area to measure on your screen. Carefully, mark each end with a light pencil mark (trying not to touch your computer screen with your writing utensil). Then, bring your scratch paper to the scale at bottom and determine the length in kilometers. Be sure to include units of km in your answer. (The actual rupture length of the fault was even longer and the greatest length in recorded history at 1500 km, which is longer than the state of California! In other words, an area the length of California moved in this earthquake.)
4. Now go back to this USGS website and click on **Regional Information**. <https://earthquake.usgs.gov/earthquakes/eventpage/official20041226005853450_30#executive>
5. Please click on the **Map of Tectonic Summary Region**. You may also wish to view [this website](https://sideshow.jpl.nasa.gov/post/series.html) that has vectors showing plate movement globally. The vectors show direction. While, you can use this website to calculate speed it will be easier to determine speed from the Map of Tectonic Summary. What is the speed *and* direction of the Indo-Australian Plate? (You can use the Map of Tectonic Summary Region to answer this two-part question).
6. Click on <https://earthquake.usgs.gov/earthquakes/eventpage/official20041226005853450_30/region-info> and scroll down in the reading in the USGS website. Provide a brief history of the history of megathrust earthquakes prior to 2004.
7. This tectonic region has also produced of the deadliest volcanic eruptions in history. What is the name of this famous volcano? What year was the major eruption? How many people lost their lives in this eruption?
8. The headline of the Arizona Daily Sun for Tuesday, Dec. 28, 2004 reads “Tidal Destruction” and mentions the “killer tidal wave.” What is incorrect about these statements?
9. The speed of a tsunami in the ocean is described by the following equation:

C = √ (g X D) = the square root of g times D (be sure to multiple gravity by depth *first* before taking the square root)

 C = velocity in m/s (meters per second)

 g = gravity = 9.8 m/s2

 D = ocean depth in meters

If the average ocean depth is 4000 m, calculate C in m/s. (SHOW YOUR MATH and include units).

* To do this, first multiply gravity, which is 9.8 m/s2 by 4000 meters. Next, take the square root of your answer.
* If you’re using your phone calculator, try turning your phone sideways so the scientific calculator appears. From here, calculators vary. So there might be a key that looks like “xy”. The “x” is the answer you just calculated and “y” (the power) is ½ or 0.5. To make sure you’re doing this correctly, let’s do an example. The square root of 9 is 3. So try typing in 9 and see if you can get the answer of 3 by typing 0.5 as the power.
* Let’s try another example. Let’s say you were asked to calculate the speed of a tsunami at 100 meters of depth.

√(9.8 m/s2 x 100 m) = √(980 m2/s2) = (980 m2/s2)^0.5 = **31.3 m/s**

1. Next, convert your answer from the previous question to km/hr. Show your math and include units.

Example: 31.3 m/s x 3600 sec/hr ÷ 1000 m/km = 112.7 km/hr

1000 meters = 1 kilometer

3600 seconds = 1 hour

1. This speed is comparable to that of a
	1. car
	2. freight train
	3. bicycle
	4. jet airliner
	5. a baby crawling
2. According to our textbook, over 230,000 died. According to the map in the “Lack of Warning and Education Costs Lives” case study at the end of the chapter, how long did the tsunami take to reach nearest shoreline in Sumatra, Indonesia? Include units in your answer.
3. How long did the first wave take to reach Sri Lanka? You can use the map in the case study. Include units in your answer.
4. Do you think your answer in in the previous question would have been adequate to notify the public in Sri Lanka? Briefly explain.
5. Why did so many people lose their lives around the Indian Ocean?
6. According to the “Lack of Warning and Education Costs Lives” case study would a warning system been enough time to save the lives of those living in Sumatra? Why or why not?