Year 12 Science: Tsunami, landslides and linked hazards

Name: _____ Date: _____

Try these without your notes first, then check the answer key.

Practice

1. What makes a tsunami different from a wind wave?

2. Find the speed of a tsunami where the ocean is 1000 m deep, in m/s.

3. What happens to a tsunami's wavelength as it moves into shallow water?

4. Why do strike-slip earthquakes seldom cause large tsunami?

5. Give two ways heavy rain makes a landslide more likely.

Exam-style question: a Kermadec tsunami

A magnitude 8.1 megathrust earthquake ruptures the Kermadec subduction zone, north-east of New Zealand, and tsunami warnings are issued around the Pacific.

6. Describe a tsunami wave, referring to the water column.

7. Explain how this earthquake generates a tsunami, including the energy changes.

8. Suppose the ocean between the source and a coast 1000 km away is 4000 m deep on average. Calculate how long the tsunami takes to arrive, in hours.

9. Explain the changes in speed, wavelength and amplitude as the tsunami approaches New Zealand's coast.

Fix the mistake

10. Correct this statement: "A tsunami is a giant wind wave that is tall out at sea."

11. Correct this statement: "The tsunami speeds up as it reaches the shore, which is why it is so powerful."

12. Correct this statement: "Every big earthquake under the sea makes a big tsunami."

13. Correct this statement: "Rain causes landslides by washing the soil away."

Answer key (for parents and tutors)

1. What makes a tsunami different from a wind wave?
   A tsunami moves the whole water column, from sea floor to surface; a wind wave moves only the surface water.
2. Find the speed of a tsunami where the ocean is 1000 m deep, in m/s.
   $v = \sqrt{(9.8 \times 1000)} = \sqrt{9800} = 99$ m/s.
3. What happens to a tsunami's wavelength as it moves into shallow water?
   It gets shorter, because the front slows and the waves bunch up.
4. Why do strike-slip earthquakes seldom cause large tsunami?
   They move the sea floor sideways, with little vertical movement, so little water is displaced.
5. Give two ways heavy rain makes a landslide more likely.
   It adds weight to the slope, and the water pressure pushes grains apart and cuts friction.
6. Describe a tsunami wave, referring to the water column.
   A tsunami is a series of waves in which the whole water column, from sea floor to surface, is displaced by a sudden disturbance (Achieved).
7. Explain how this earthquake generates a tsunami, including the energy changes.
   Achieved: the sea floor is lifted and pushes the water up. Merit: the locked upper plate is bent down and stores elastic energy; when the fault slips it springs up, lifting the water column, which gains gravitational potential energy. Excellence: gravity pulls the raised water back down, and its gravitational potential energy becomes kinetic energy of waves spreading out in all directions; the larger the area and height of the uplift, the more water is displaced and the larger the tsunami.
8. Suppose the ocean between the source and a coast 1000 km away is 4000 m deep on average. Calculate how long the tsunami takes to arrive, in hours.
   $v = \sqrt{(9.8 \times 4000)} = 198$ m/s; $t = 1\,000\,000 \div 198 = 5050$ s; $5050 \div 3600 = 1.4$ hours (Merit for the working with units).
9. Explain the changes in speed, wavelength and amplitude as the tsunami approaches New Zealand's coast.
   Achieved: it slows down and gets taller. Merit: friction with the shallowing sea floor slows the wave, so the wavelength shortens and the amplitude increases. Excellence: in deep water it travels at hundreds of km/h with little energy loss, which is why warnings go Pacific-wide; near the coast the front slows first, the back catches up, the wavelength shortens, and the same energy in a shorter, slower wave makes it much taller, so it floods far inland.
10. Correct this statement: "A tsunami is a giant wind wave that is tall out at sea."
    It is made by moving the whole water column, and in the deep ocean it is usually less than a metre high.
11. Correct this statement: "The tsunami speeds up as it reaches the shore, which is why it is so powerful."
    It slows down in shallow water; it grows taller because the waves bunch up and the energy is squeezed into a shorter wave.
12. Correct this statement: "Every big earthquake under the sea makes a big tsunami."
    A tsunami needs vertical movement of the sea floor; strike-slip quakes move sideways and seldom make large tsunami.
13. Correct this statement: "Rain causes landslides by washing the soil away."
    Rain adds weight and its water pressure pushes grains apart, cutting friction until the driving force wins.