What is a tsunami?

Tsunami is the Japanese name given to large waves that sometimes devastated the shores and ports of Japan. A tsunami is a wave in the ocean but it is very different to normal waves.

Tsunamis have very long wavelengths. Crest to crest they measure between 10 and 500 km and they travel through the ocean at more than 700 km/h. Sometimes there appears to be just one wave but often there are multiple waves travelling a few minutes apart.

Wave height [amplitude] may not appear to be great in the open ocean (and often goes unnoticed) but unlike normal waves the tsunami is moving the entire water column, all the way to the sea floor! The water depth therefore has a major influence on the behaviour and appearance of the wave. In addition because of the wavelength, the first sign of the arrival of a tsunami may actually be the sea level falling and bays appearing to empty.

In deep open water the wave is almost impossible to see although modern instruments can detect it. However, as the wave approaches shore and the water shallows it slows down. The wave rapidly bunches up as the faster rear sections catch up with the slower front sections resulting in the wave growing in height the closer it gets to shore. This effect is enhanced if the near-shore sea bed provides a long gradual shallowing. Many tsunamis are barely distinguishable from normal sea waves but some turn into monsters rising 30 metres above the shore line! The damage along a shore line may vary because of the influence the local shape of the sea floor has on wave behaviour.

Bays and harbours that are funnel shaped also suffer more from a tsunami because they concentrate the effects. Damage in these areas is further increased by the sloshing backwards and forwards of the water, just like in a bathtub!

What causes a tsunami?

Unfortunately tsunamis have been given numerous names in the past that are misleading. Even the word tsunami meaning ‘harbour wave’ is misleading!

All tsunami are caused by the sudden displacement of large volumes of water. All are the result of violent events with enough power to displace large volumes very rapidly. However, tsunami may be caused by events that are not local to the tsunami site. Because the waves have been generated by huge releases of energy and they travel so effectively through the deep ocean some tsunami are caused by events that literally happen on the other side of the world.

The usual causes of a tsunami are:

- an earthquake
  - most tsunamis are caused by submarine earthquakes but not all submarine earthquakes cause tsunamis. Movement on the fault must have a vertical component that generates sufficient displacement to set a tsunami running

- a landslide
  - underwater landslides or coastal landslides that fall into the ocean can displace enough water to create a tsunami. Sometimes the landslides are caused by earthquakes.

- a volcanic eruption or explosion
  - submarine explosions, caldera collapse and massive pyroclastic flows can all cause sufficient displacement of water to generate a tsunami.

- impact by a meteorite
  - large meteorites have a high probability of landing in the ocean and causing a tsunami given that about two thirds of the surface of the Earth is covered by water.
Tsunami scenarios

1. In November 2004 a magnitude 7.3 earthquake occurred 10km below the surface south west of West Cape on the South Island of New Zealand. Tsunamis were not reported for New Zealand or Australia. Did this earthquake cause a large vertical displacement on the sea floor? Explain your answer.

2. If an earthquake just off shore of West Cape on the South Island of New Zealand were to generate a tsunami it would impact on both New Zealand and Australia. Using a map of the region and assuming a travel time of 950 km/hour how long would the tsunami take to arrive at Hobart? How long would it take the same wave to reach Sydney?

3. Examine a map of New Zealand. Would residents of the coastal city of Christchurch, New Zealand, be affected by this tsunami? Explain your reasoning.

4. Examine a map of Victoria. Assuming this tsunami has the potential to have a run up height of 20 metres, would residents of coastal villages east of Wilsons Promontory be affected by this tsunami? Explain your reasoning?

5. Examine the map below. Tsunamis are known to be caused by earthquakes and other events off shore of Chile and elsewhere around the pacific. Is the east coast of Australia threatened by tsunamis generated off shore of Chile? Explain your answer.

6. If the Big Island of Hawaii has 15 hours to prepare for a tsunami to arrive from Chile how fast is it travelling?