Tsunami
What controls the speed of a tsunami wave?

Remind pupils of the disastrous tsunami wave of 26th December 2004 in the Indian Ocean. Some pupils may actually have experienced a tsunami, or may have been affected by experiences of relatives.

Ask pupils to say what things might affect the speed at which a tsunami travels. (*The main factor is the depth of water across which the wave travels).*

Set up a long tank made of any suitable material, preferably transparent. (The 1m length of house guttering shown in the background of the picture will work, although it is really rather too shallow). Add, say, 10 mm of water to the tank and colour it with food dye or ink. Raise one end of the tank onto a block about 50mm high and let the water settle down. Then drop the end of the tank sharply off the block onto the bench. Time how long it takes for the wave to reach the other end of the tank. Unless the tank is very long, a more accurate result may be obtained by timing about 5 reflections of the wave off the ends of the tank, and dividing by the number of reflections. Several sets of readings should be taken and the averaged result calculated.

Ask the pupils whether the wave will travel faster or more slowly if the water is deeper. (*It travels faster).*

Double the depth of water (e.g. to 20mm) and repeat the activity as above.

Show the effects of a sloping beach by adding a 'beach' modelled in clay to one end of the tank. Ask pupils to observe how the wave rapidly engulfs the 'beach', but slaps relatively harmlessly against the vertical wall at the other end of the tank. (It might not be harmless in real life though!)

Timing the flow of a tsunami in a plastic tank (*Photo: P. Kennett*)

A tsunami strikes - the 2004 tsunami strikes the coast of Thailand at Ao Nang. Photo by David Rydevi: skylark292@gmail.com *This image has been (or is hereby) released into the public domain by its creator, David Rydevik. This applies worldwide.*

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The back up

Title: Tsunami

Subtitle: What controls the speed of a tsunami wave?

Topic: Investigating the relationship between the depth of water in a tank and the velocity of a water wave generated by lifting and then dropping one end of the tank.

Age range of pupils: 10 – 18 years

Time needed to complete activity: 20 mins

Pupil learning outcomes: Pupils can:

- describe how waves are transmitted across water;
- explain that waves travel faster in deeper water than in shallow water;
- understand the role of friction in slowing the wave;
- explain the dangers of being on a beach when a tsunami strikes.

Context: The topic provides a graphic link between the theory of wave motion and a potentially lethal natural phenomenon. It could be taught in both science and geography lessons.

Following up the activity:

- Pupils could calculate the speed of the wave for various water depths and plot a graph of speed against water depth (*It is a non-linear relationship).*
- Pupils can model different coastal configurations in clay to investigate the impact of an arriving tsunami.
- Use a search engine, e.g. Google, to find many video clips and images of the Boxing Day tsunami of 2004. A websearch can be carried out for other tsunami simulations; also for proposals to establish tsunami-warning systems.

Underlying principles:

- Tsunamis are triggered by major events such as earthquakes, submarine landslides or volcanic explosions.

- Such events generate several types of waves – some travel through the Earth as body waves, but others travel round the Earth's surface and are known as surface waves. Tsunamis are a type of surface wave.
- When a tsunami arrives in shallowing water, the base of the wave is slowed down by friction. The wave crest overtakes the base and may then pile up to form a 'wall of water', which crashes down on the beach.
- Other tsunamis are less dramatic but still result in a dangerously rapid rise in water level up the beach.
- The Indian Ocean tsunami of 2004 travelled at speeds of several hundred kilometres per hour.

Thinking skill development:

- understanding an emerging pattern of water depth versus speed (construction)
- reasoning behind the answers (metacognition)
- applying the findings to real situations (bridging)

Resource list:

- flat-bottomed tank, ideally transparent, e.g. a fish tank, cut-down water carrier or length of gutter.
- water (coloured if possible)
- block about 50mm high, to give the tank a slope
- stop clock, or watch with seconds hand
- ruler or tape measure
- clay

Useful links:

Try the Earthlearningidea activity 'A tsunami through the window – what would you see, what would you feel?'

An 11 year old English girl, on holiday in Phuket, Thailand in 2004 recognised, from a recent geography lesson at her school, that the 'frothy sea' was a sign of an approaching tsunami. She raised the alarm and saved many lives. Her story is told on the BBC News website: http://news.bbc.co.uk/1/hi/uk/4229392.stm

Source: Earth Science Education Unit (2005) *Sensing the Earth: teaching Key Stage 4 Physics.*