Year 13 Science: Ocean heat, tides, waves and El Niño

Name: _____ Date: _____

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

Practice

1. A swell has a period of 10 s in deep water. Find its speed.

2. Find its wavelength in deep water.

3. Find its speed in water 5.0 m deep.

4. A wave's height grows from 1.0 m to 2.0 m. By what factor does its energy increase?

5. High tide at Tauranga is at 3:40 am. About when is the next high tide?

6. During an El Niño, which way does warm surface water move, and what happens to upwelling off Peru?

Exam-style question: El Niño and a Hawke's Bay farm

NIWA has announced that an El Niño is developing. A Hawke's Bay sheep farmer wants to know what it might mean for the coming summer.

7. Describe what happens to the trade winds and the warm water of the equatorial Pacific during an El Niño.

8. Explain how these changes affect the Walker circulation and rainfall across the Pacific.

9. Explain why Hawke's Bay is more likely to be dry during an El Niño summer.

10. Explain why the farmer should treat the El Niño as a raised risk, not a certainty.

Fix the mistake

11. Correct this statement: "Waves carry water across the ocean to the beach."

12. Correct this statement: "El Niño means the trade winds get stronger."

13. Correct this statement: "Doubling a wave's height doubles its energy."

14. Correct this statement: "Spring tides happen only in spring."

Answer key (for parents and tutors)

1. A swell has a period of 10 s in deep water. Find its speed.
   $v = gT \div 2\pi = 9.8 \times 10 \div 6.283 = 15.6\ m\ s^{-1}$.
2. Find its wavelength in deep water.
   $\lambda = vT = 15.6 \times 10 = 156\ m$.
3. Find its speed in water 5.0 m deep.
   $v = \sqrt{(9.8 \times 5.0)} = \sqrt{49} = 7.0\ m\ s^{-1}$.
4. A wave's height grows from 1.0 m to 2.0 m. By what factor does its energy increase?
   Energy $\propto$ height^2, so $2.0^2 \div 1.0^2 = 4$ times.
5. High tide at Tauranga is at 3:40 am. About when is the next high tide?
   Add about 12 h 25 min: about 4:05 pm.
6. During an El Niño, which way does warm surface water move, and what happens to upwelling off Peru?
   It moves east, back across the Pacific, and upwelling of cold, nutrient-rich water off Peru weakens.
7. Describe what happens to the trade winds and the warm water of the equatorial Pacific during an El Niño.
   The trade winds weaken or reverse, and the warm water piled up in the western Pacific spreads back east towards South America (Achieved).
8. Explain how these changes affect the Walker circulation and rainfall across the Pacific.
   With warm water in the central and eastern Pacific, rising air and heavy rain shift east, so Indonesia and northern Australia become drier and Peru wetter; the Walker loop weakens, which weakens the trades further, a positive feedback (Merit).
9. Explain why Hawke's Bay is more likely to be dry during an El Niño summer.
   El Niño brings more frequent south-westerly winds over New Zealand. Air reaching Hawke's Bay from the south-west has crossed the ranges and dropped its moisture on the western side, then descends and warms on the eastern side (a rain shadow and föhn effect), so the east is drier and windier, increasing drought risk (Merit for wind direction linked to rain shadow).
10. Explain why the farmer should treat the El Niño as a raised risk, not a certainty.
    ENSO explains less than a quarter of the variation in New Zealand's seasonal climate; the Southern Annular Mode, local weather systems and sea temperatures around New Zealand also matter, so some El Niño summers are not dry in Hawke's Bay (Excellence links the Pacific changes to New Zealand's winds and weighs the uncertainty).
11. Correct this statement: "Waves carry water across the ocean to the beach."
    Water particles move in circles and stay roughly in place; waves transfer energy.
12. Correct this statement: "El Niño means the trade winds get stronger."
    The trades weaken in an El Niño; they strengthen in a La Niña.
13. Correct this statement: "Doubling a wave's height doubles its energy."
    Energy is proportional to height squared, so doubling the height gives four times the energy.
14. Correct this statement: "Spring tides happen only in spring."
    Spring tides come twice a month, at new and full Moon, when the Sun and Moon line up.