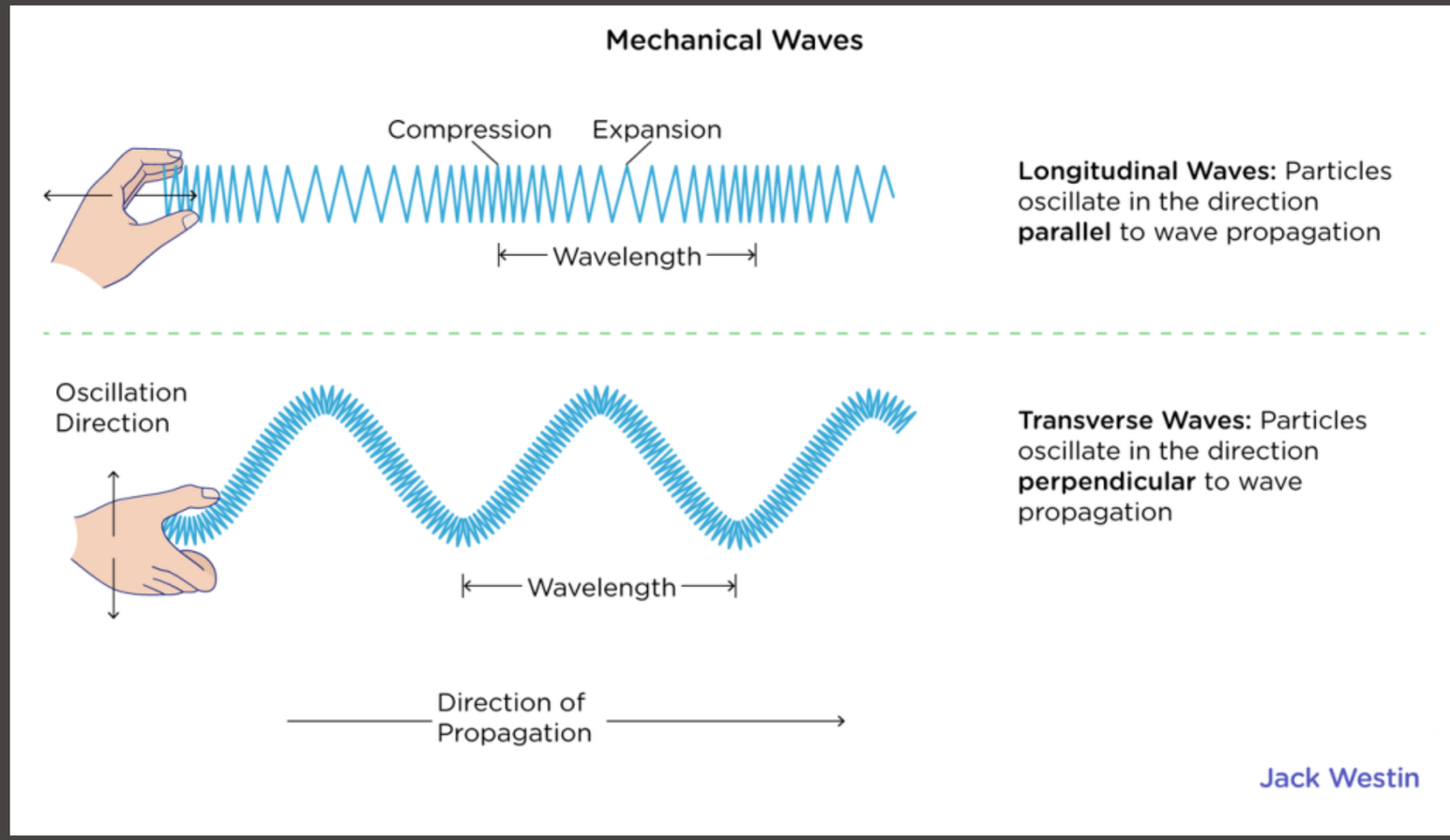
Waves and Sounds

This tree frog from Asia uses the large, inflatable sac under its throat to amplify the sound of its voice. Only the males can do this, and their calls can travel ten times further than sounds from other frogs. The sound itself is generated when air from the sac is blown past two stretched membranes in the bottom the frog’s mouth, making them vibrate.

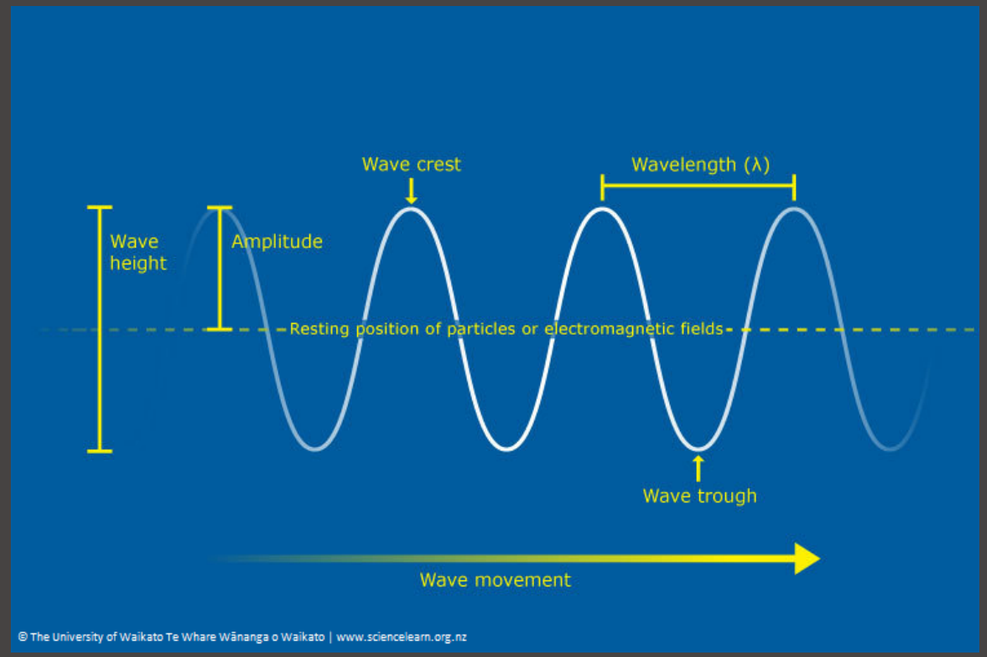
Transverse and longitudinal waves

- Moving the end coil of the spring backwards and forwards produce a wave effect.
- The waves are bunched-up sections of coils with stretched-out sections in between.
- The waves are called longitudinal waves.
- When the end coil of the spring is moved sideways, it pulls the next coil sideways a friction of a second later.
- In this way, the sideways motion is passed from coil to coil.
- The waves are called transverse waves.



Describing waves

- Some of the terms to describe waves:
  - Speed — The speed of the waves is measured in meters per second (m/s)
  - Frequency — This is the number of waves passing any point per second. The SI unit of frequency is the hertz (Hz). For example, if the hand on a rope makes four oscillations per second, then four waves pass any point per second, and the frequency is 4 Hz.
  - Wavelength — This is the distance between any point on a wave and the equivalent point on the next.
  - Amplitude — This is the maximum distance a point moves from its rest position when a wave passes.



The wave equation

- The speed, frequency, and wavelength of any set of waves are linked by this equation:

  speed = frequency * wavelength

- In symbols: $v = f\lambda$ (λ = Greek letter lambda)
- Where speed is in m/s, frequency in Hz, and wavelength in m.

speed = frequency * wavelength

Practice

- The waves in A below are travelling across water.

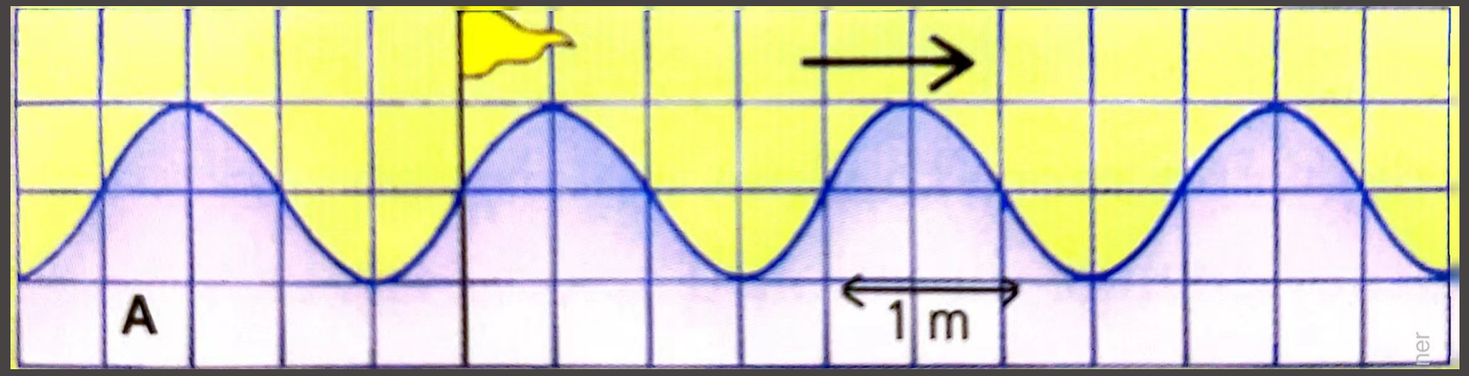
a. Are the waves transverse or longitudinal?

b. What is the wavelength of the waves?

c. What is the amplitude of the waves?

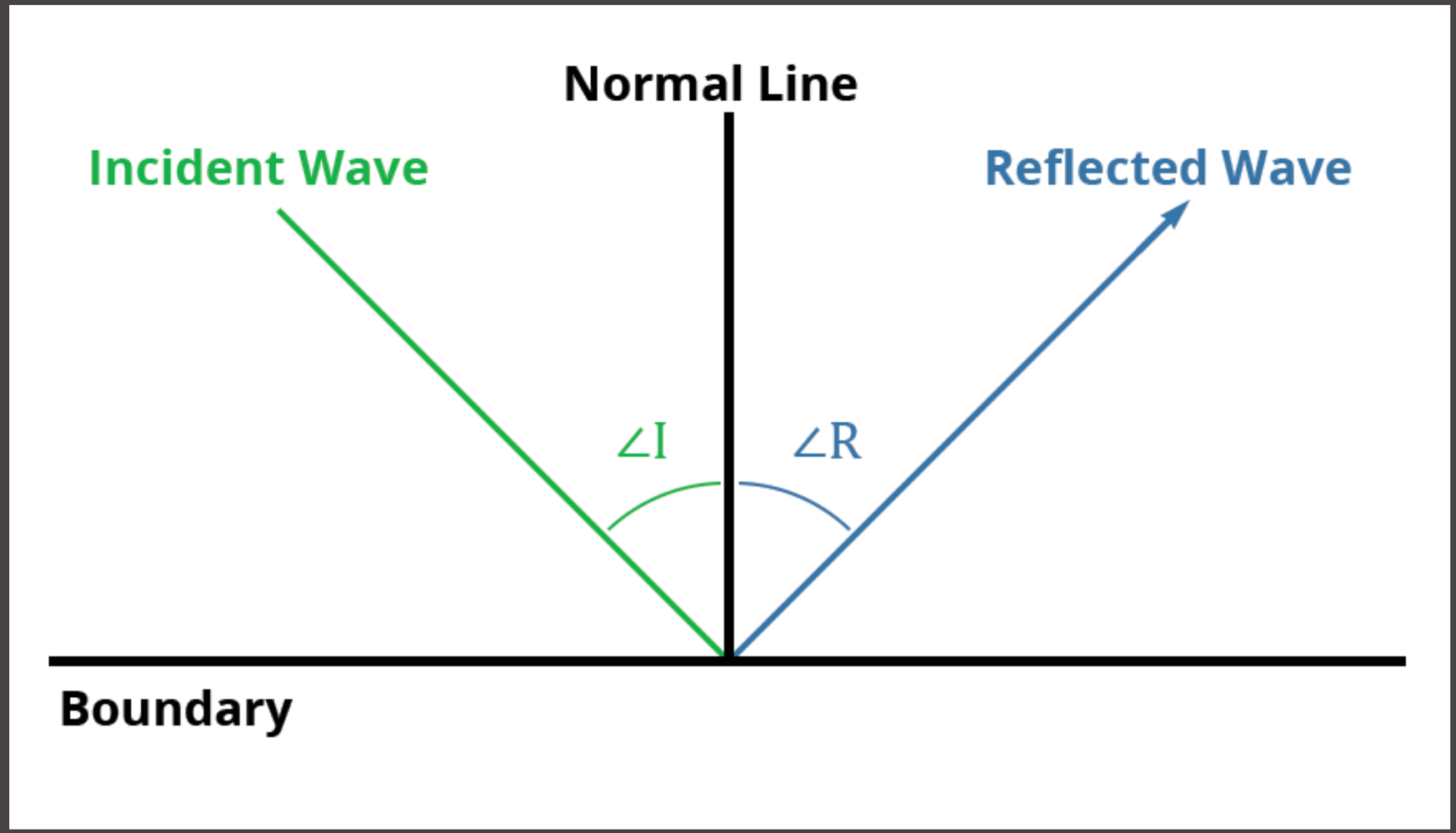
d. If two waves pass the flag every second, what is the frequency?

e. Use the wave equation to calculate the speed of the waves in A.



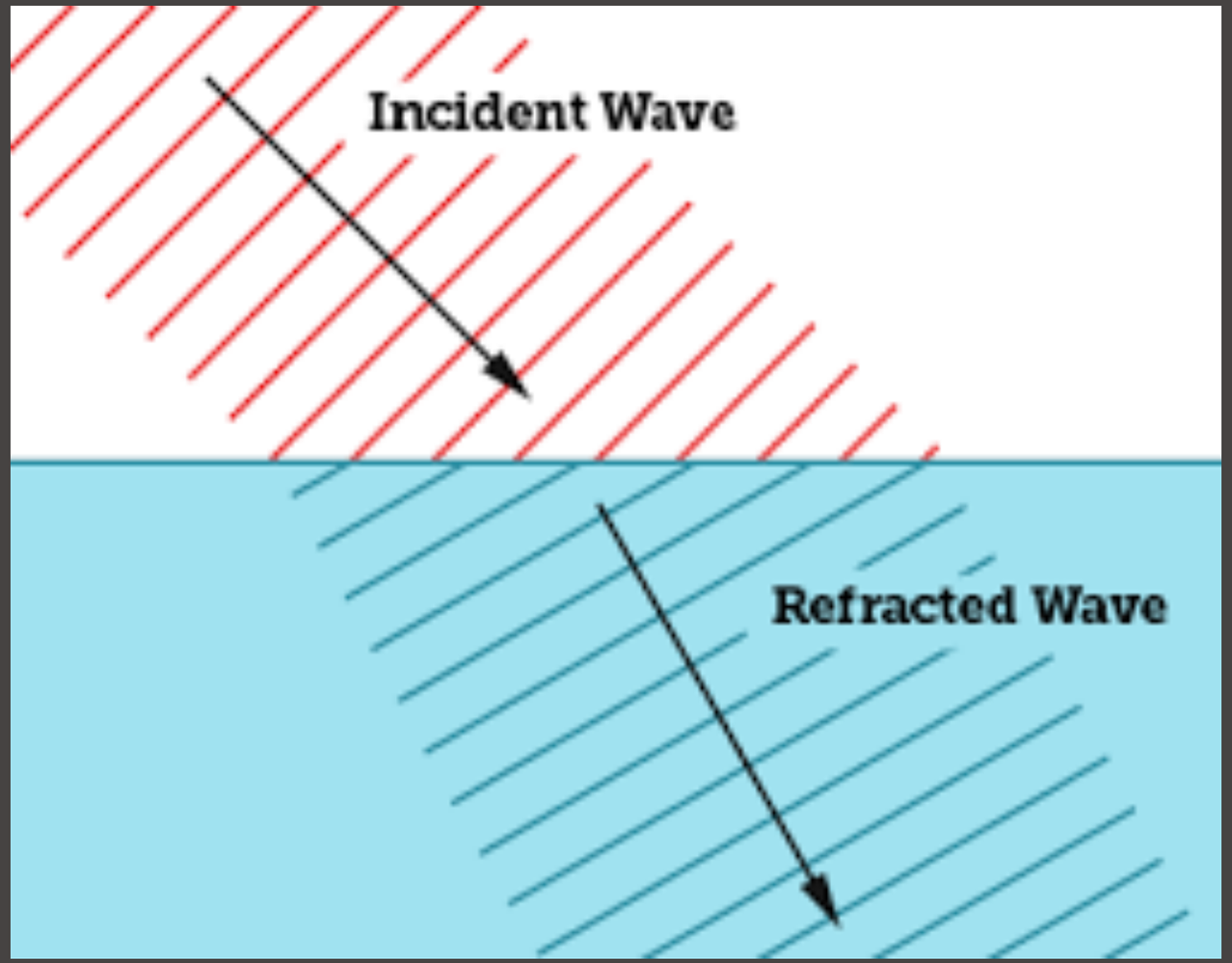
Wave effects — Reflection

- A vertical surface is put in the path of the waves. The waves are reflected from the surface at the same angle as they strike it.



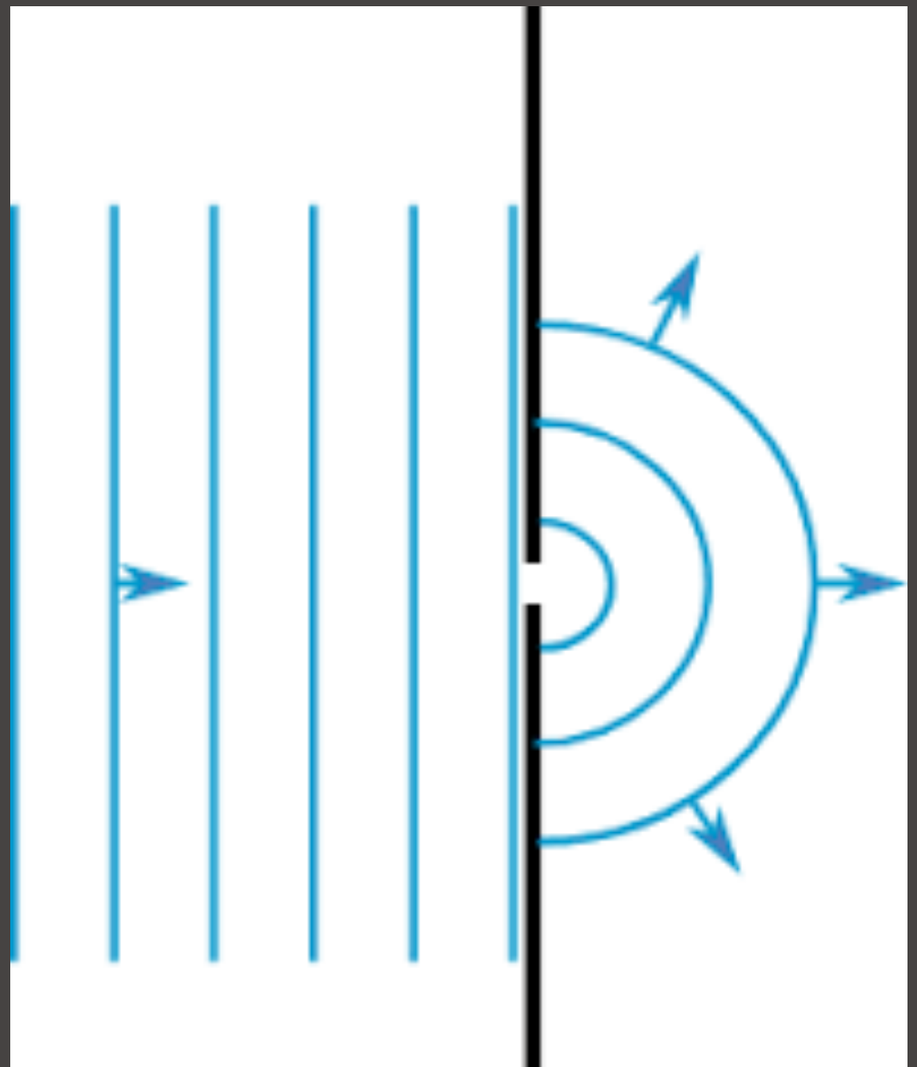
Wave effects — Refraction

- A flat piece of plastic makes the water more shallow, which shows the waves down. When the waves slow, they change direction. The effect is called refraction.



Wave effects — Diffraction

- The waves bend round the sides of an obstacle, or spread out as they pass through a gap. The effect is called diffraction.



Sound waves

- Sound waves are caused by vibrations.
- Sound waves are longitudinal waves.
- Sound waves need a material to travel through.
- Sound waves can travel through solids, liquids, and gases.
- Sound waves can be reflected and refracted.
- Sound waves can be diffracted.
- Please give an example which demonstrates each of the following:
  - Sound can travel through a gas.
  - Sound can travel through a liquid.
  - Sound can travel through a solid.

Speed of sound

- In the air, the speed of sound is about 330 meters per second (m/s), or 760 mph.
- That is slower than Concorde but about four times faster than a racing car.
- The speed of sound depends on the temperature of the air.
- The speed of sound does not depend on the pressure of the air.
- The speed of sound is different through different materials.

Characteristics of sound waves

- Sound waves are caused by vibrations.
- The number of oscillations per second is called the frequency. It is measured in hertz (Hz).
- Different frequencies sound different to the ear.
- You hear high frequencies as high notes: musicians say that they have a high pitch.
- You hear low frequencies as low notes: they have a low pitch.
- Octaves are musical scales based on pitch.

Note	Frequency	Note	Frequency
C3	130.81	C4	261.63
D3	146.83	D4	293.66
E3	164.81	E4	329.63
F3	174.61	F4	349.23
G3	196	G4	392
A3	220	A4	440
B3	246.93	B4	493.88