Chapter 14. Wave

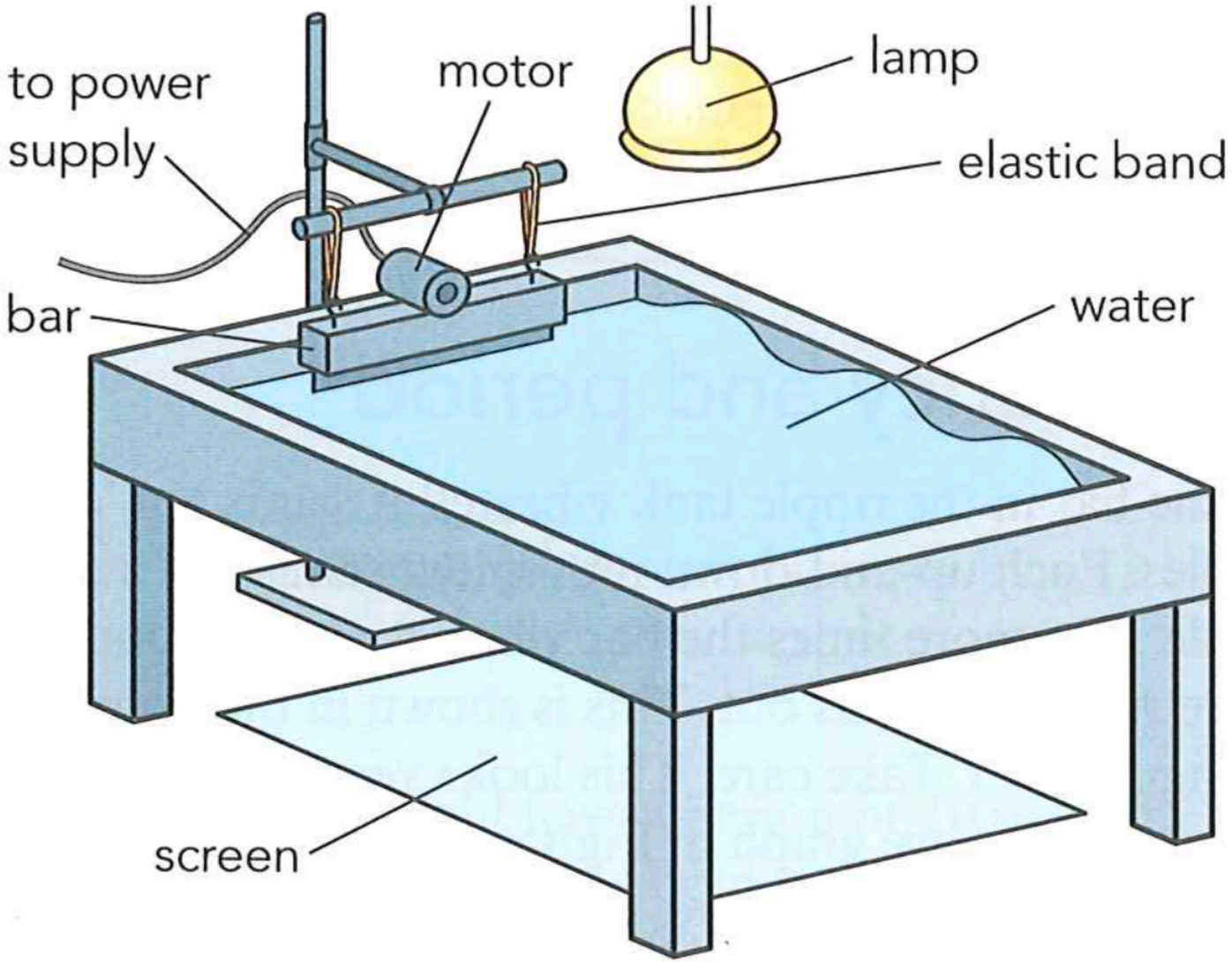
New word:

parallel perpendicular/at right angle medium vacuum
crest/peak trough/valley undisturbed point/equilibrium
amplitude period frequency wavelength wavefront propagation
transverse longitudinal compression rarefaction
reflection refraction diffraction
normal
angle of incidence
angle of reflection
angle of refraction

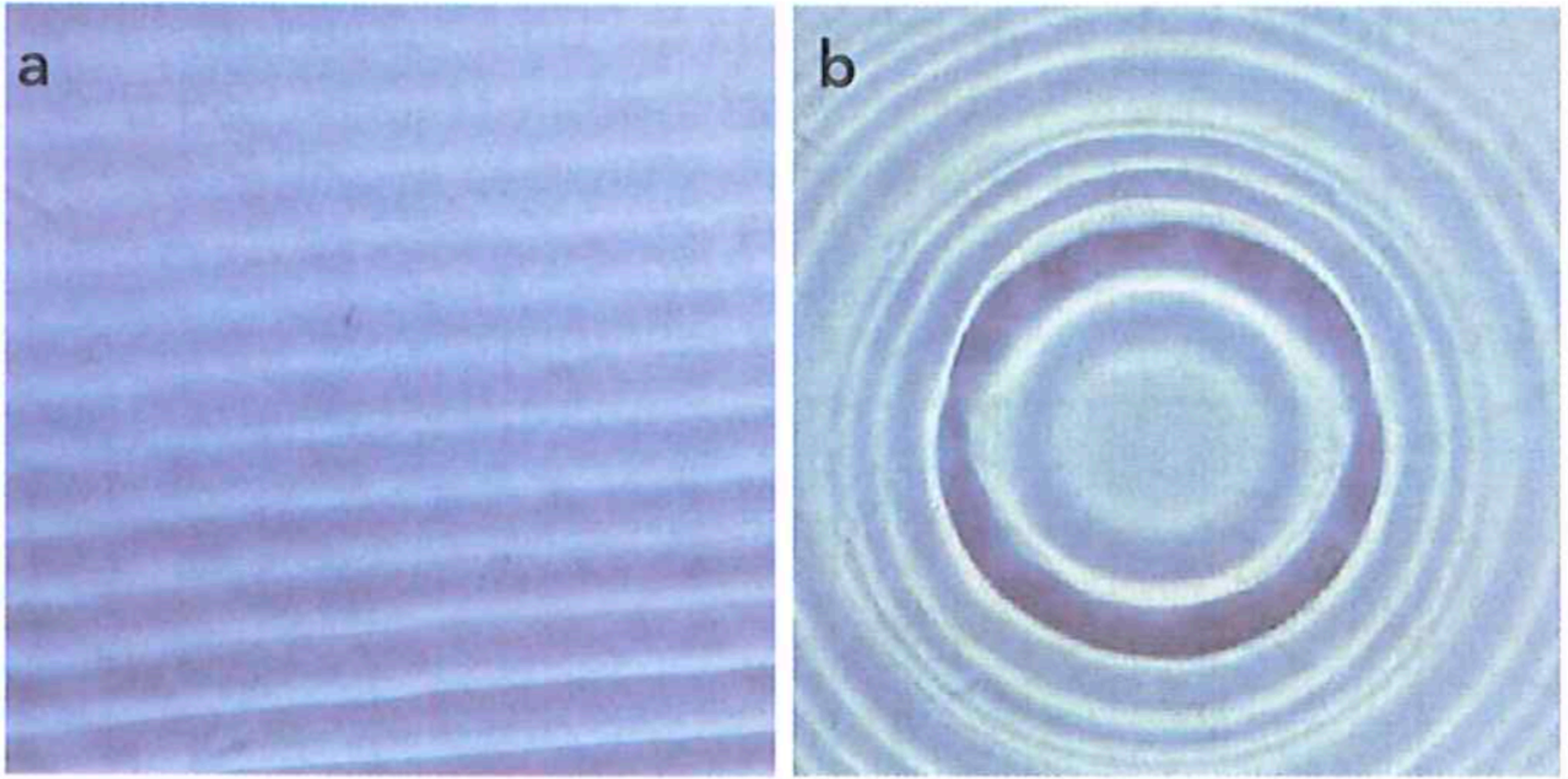
What are Waves

- Why does the water start to move?
- How is a wave formed?

What are Waves



What are Waves



Wave is a way of transferring energy

What are Waves

What are Waves

What are Waves

"Water waves leave the place where they are created, but the water itself does not leave, just like the wind stirring up a wave of wheat in the field. We see the waves of wheat rolling toward the field, but the wheat itself remains in its original place."

Leonardo da Vinci

What are Waves

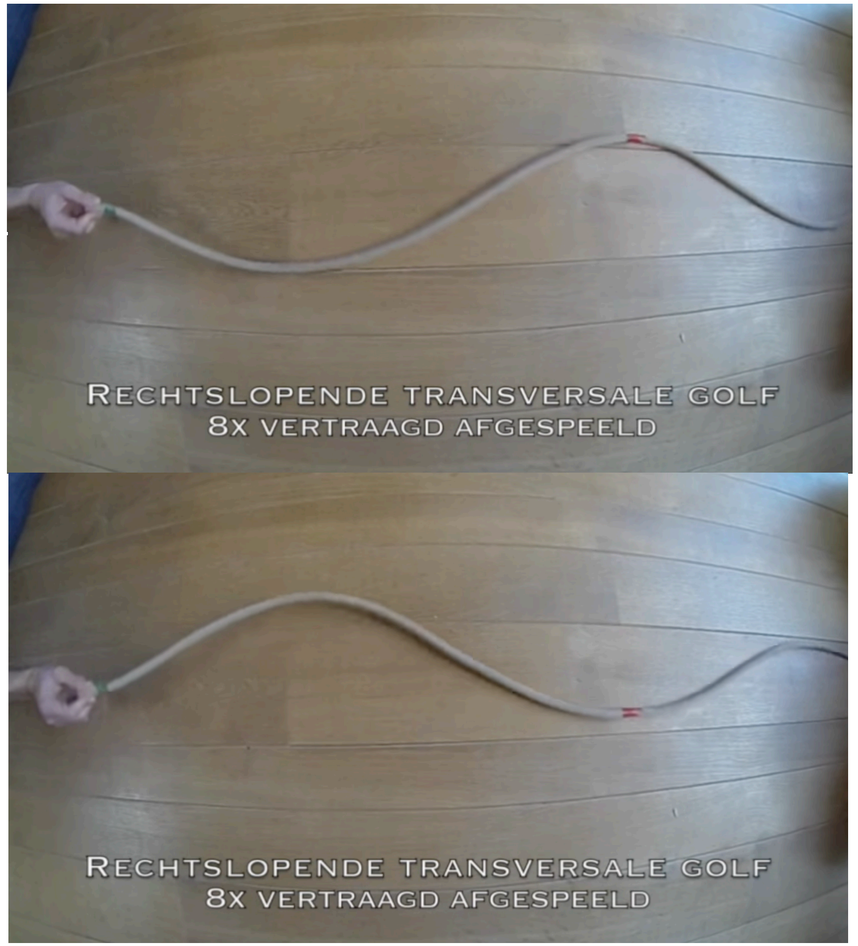
What are Waves

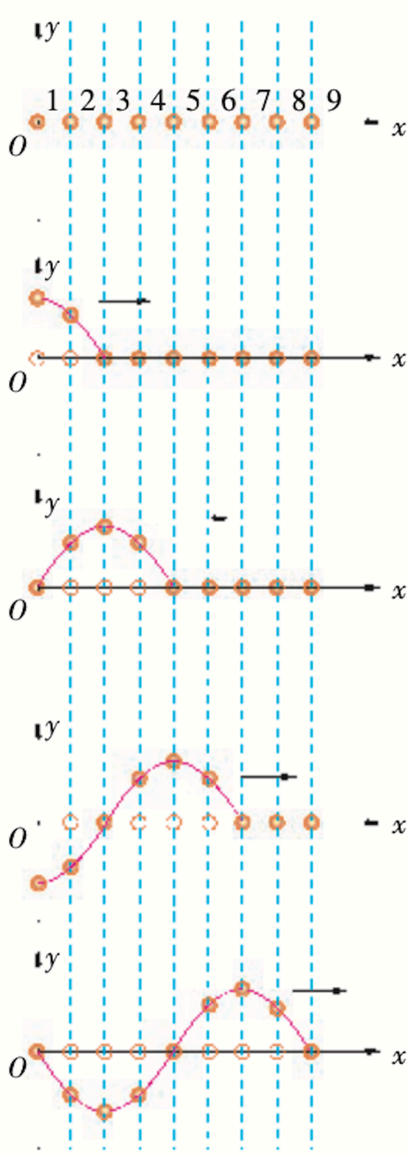
Wave is a way of transferring energy

without transferring matter.

wave is moving but matter is not

Making Waves

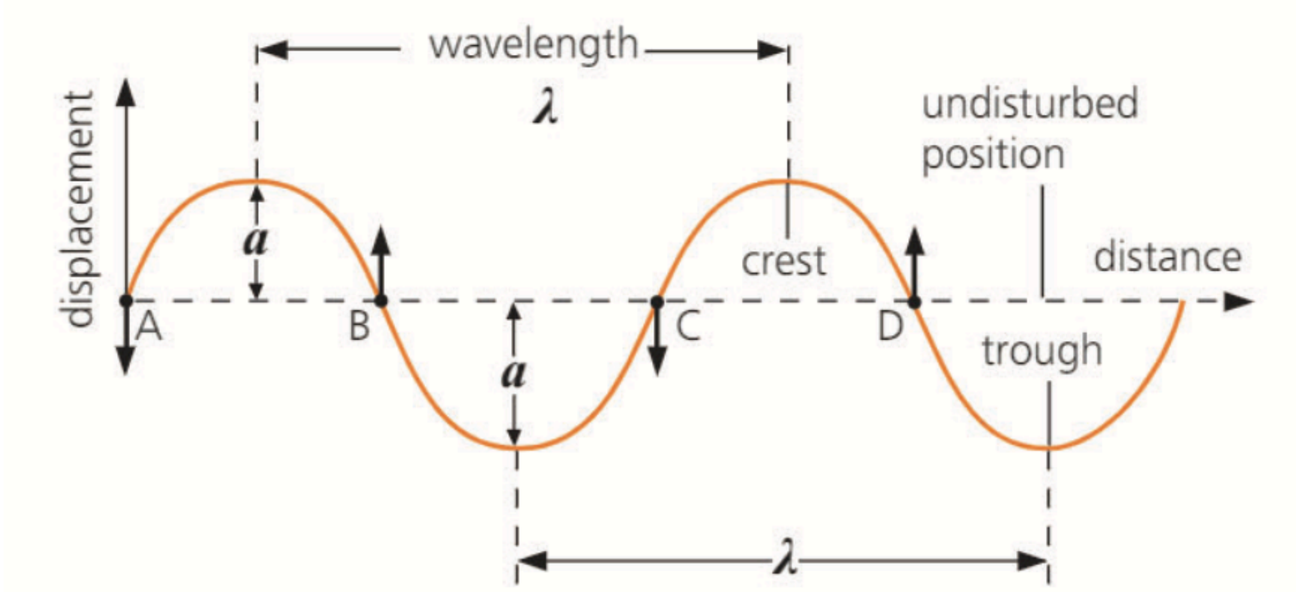


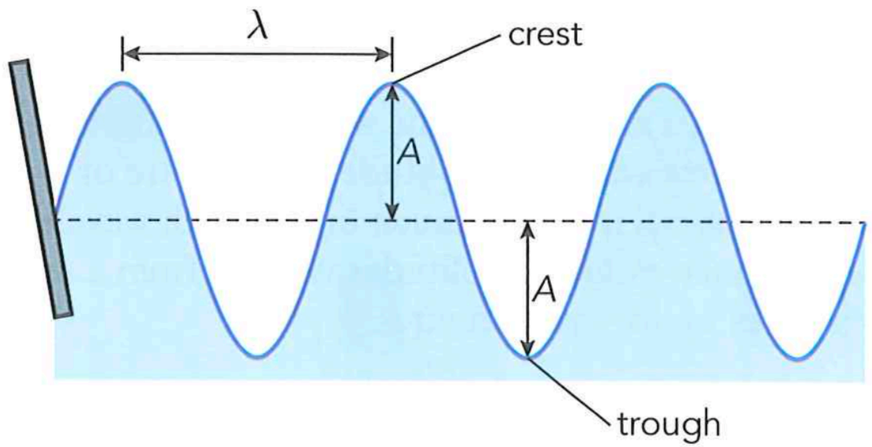


Wave Quantities

How do we describe waves in physics? What physical quantities do we use?

1. Displacement-distance graph(波形图)





Wave at a particular **time** moves up and downs at different **positions**

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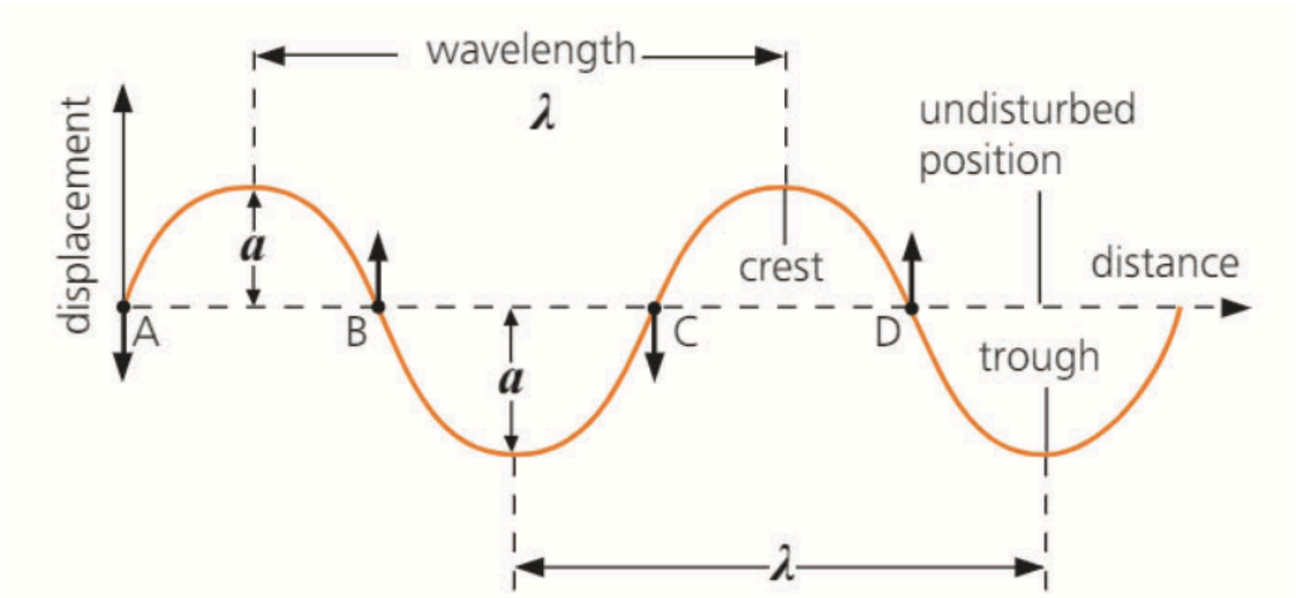


Wave at a particular **time** moves up and downs at different **positions**

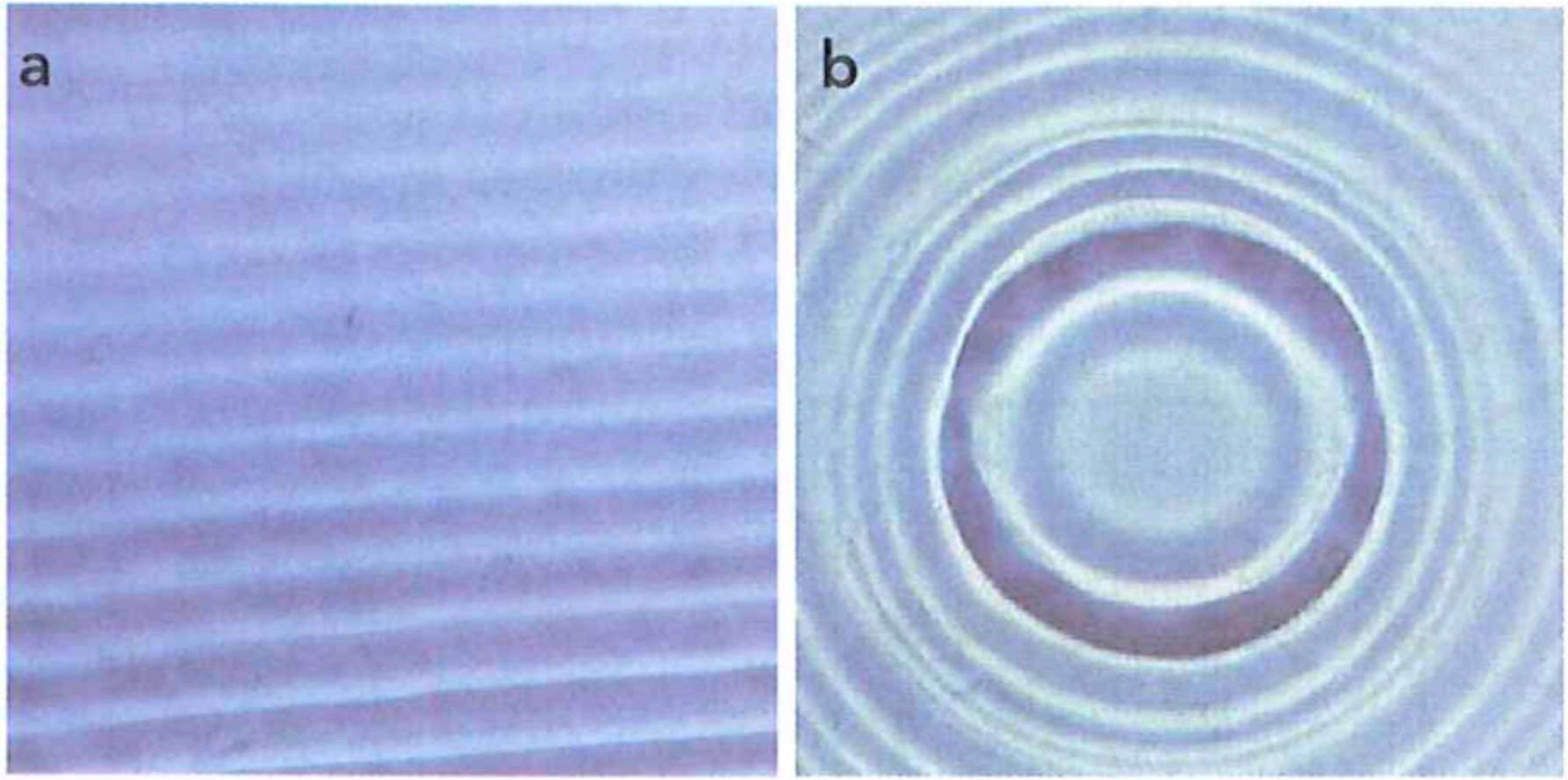
Phase: points with the same displacement and same velocity

Wavelength : the distance from one **crest** to the next/ btw any two points which are in same phase; unit: m

Amplitude A: the height of the crest/the depth of a trough; unit: m

Wavefront: the set of all points having the same *phase*; e.g. all crest forms wavefront

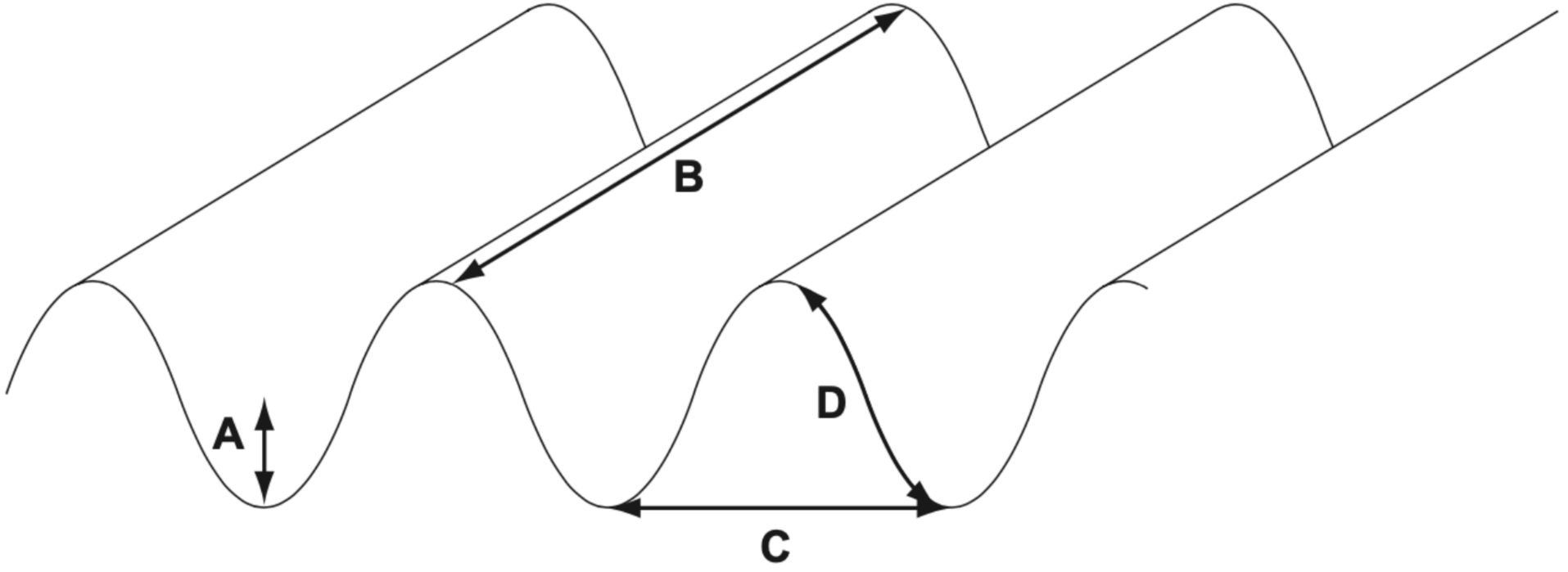
Wavefront



Exercise

The diagram shows a water wave in a ripple tank.

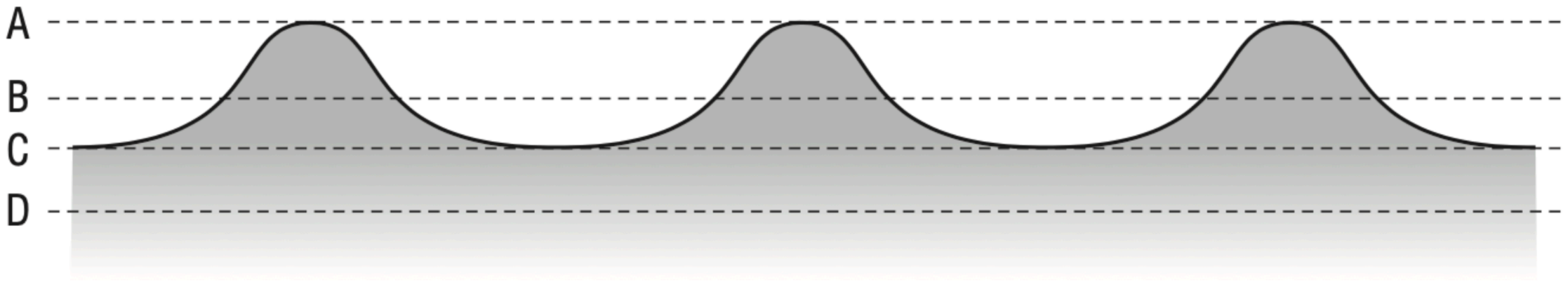
Which line represents a wavefront?



Exercise

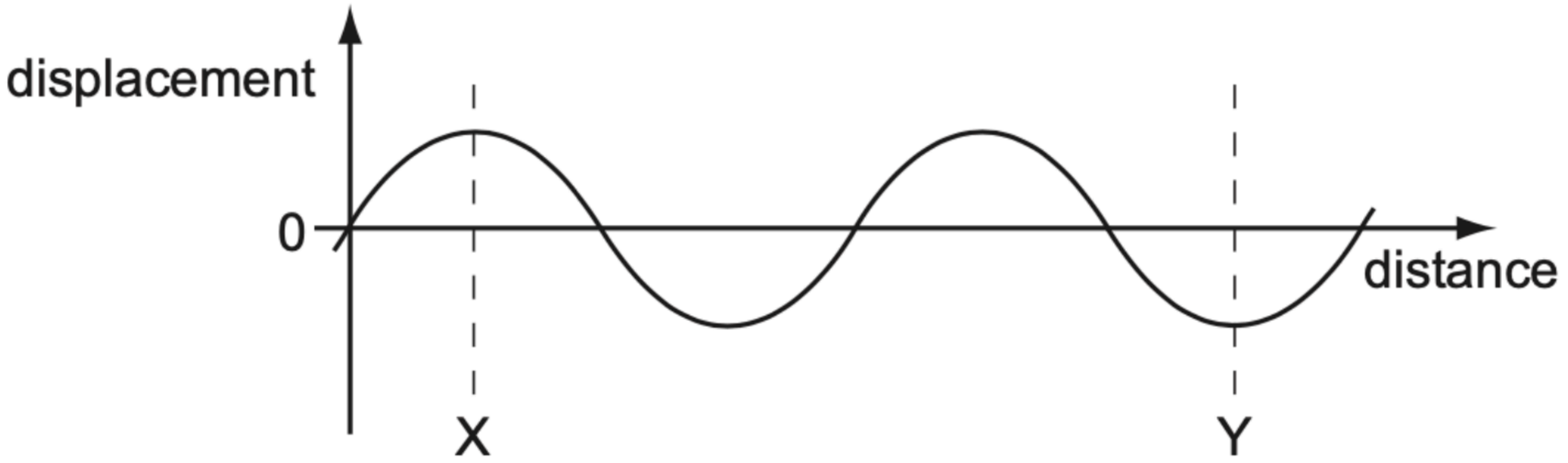
The diagram shows a section through a series of waves on water.

Which dotted line shows the position of the still water surface after the waves have passed?



Exercise

The diagram shows a wave.

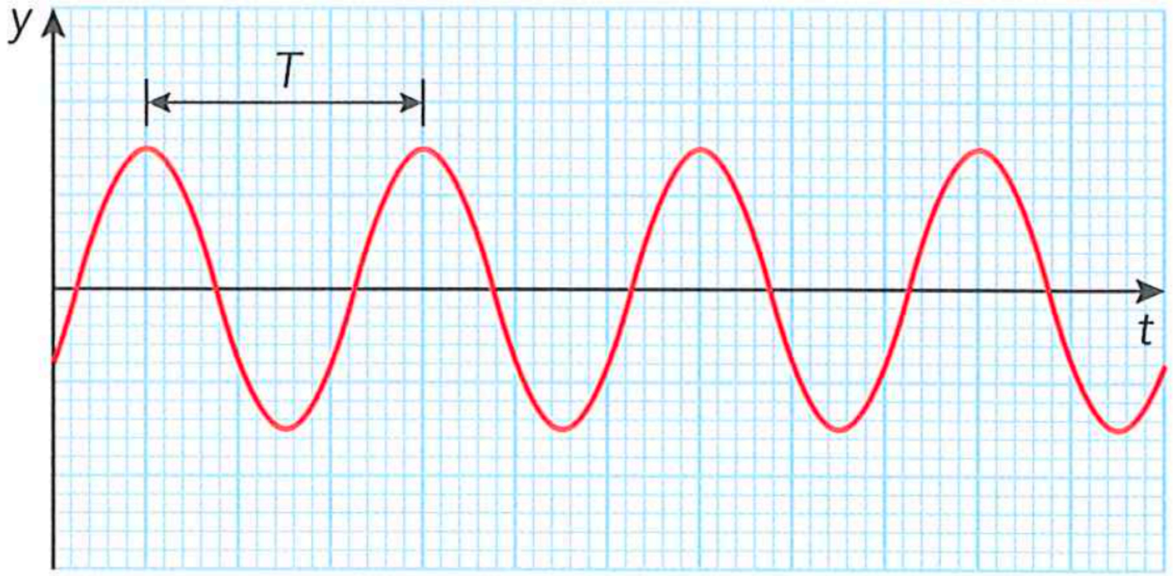


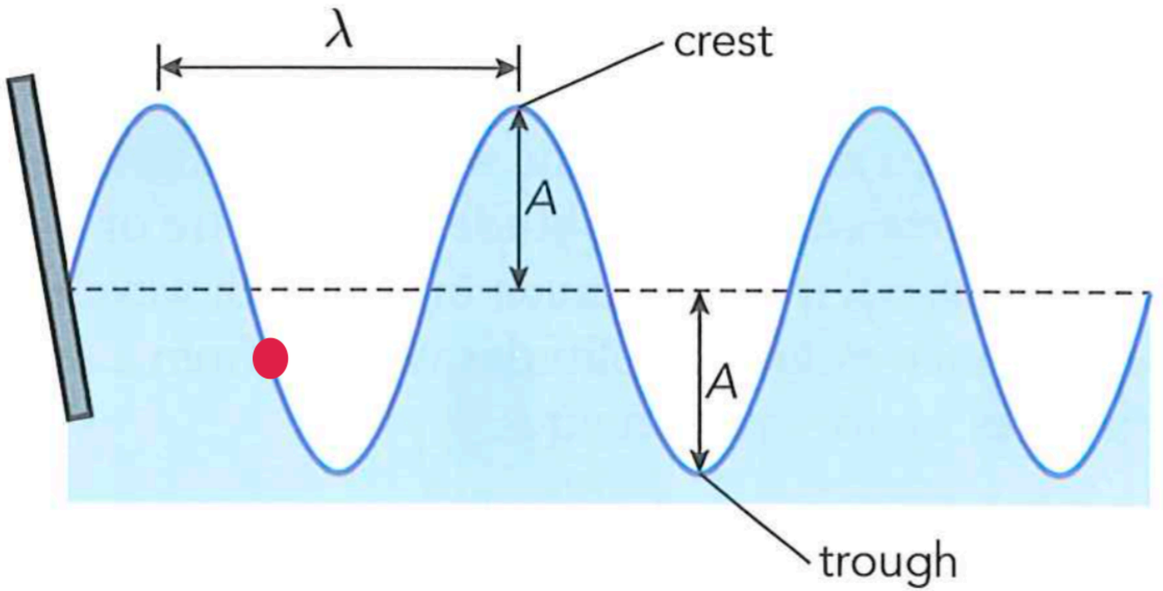
How many wavelengths are there between X and Y?

A $\frac{2}{3}$ **B** 1 **C** $1\frac{1}{2}$ **D** 3

Wave Properties

2. displacement-time graph（振动图）

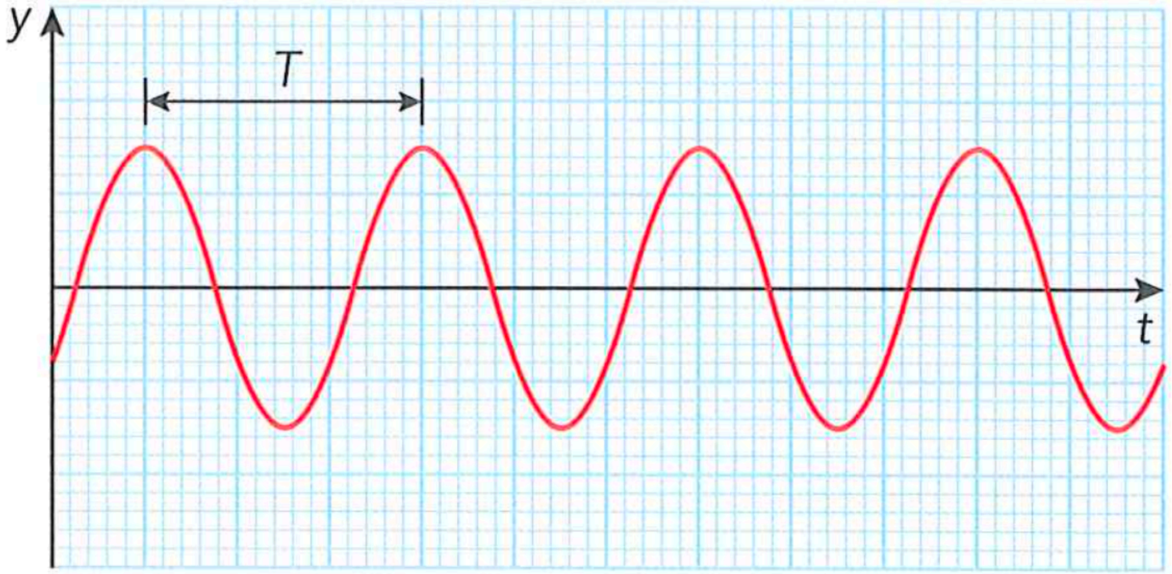




Wave at **a particular point** moves up and down as time passes

Wave Properties

2. displacement- time graph（振动图）



Wave at **a particular point** moves up and down as time passes

Period T: the time taken for one complete wave to pass a point; time taken for one point completes one oscillation.

unit: s

Frequency f: number of waves send out per second; number of oscillations completed per second. unit: Hz

$$T = \frac{1}{f}$$

Wave Speed

Wave speed: the speed at which wave travels

E.g. the speed of the crest of a ripple traveling over the surface of the water

Unit: m/s

Equations: $v = \frac{\lambda}{T}$ $\lambda = vT = \frac{v}{f}$ $f = \frac{1}{T}$ $v = \lambda f$

Sound wave through air: $v = 330 m/s$

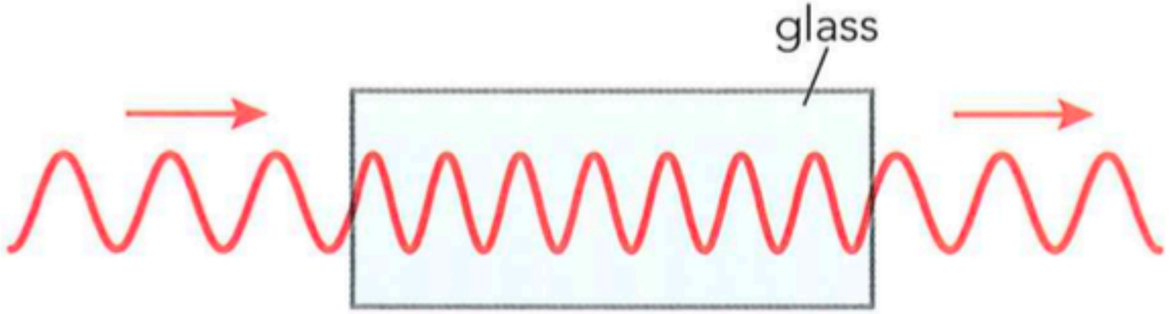
Light wave through air: $v \approx 3.0 \times 10^8 m/s$

Wave Speed

Waves travel in different materials will have different speed.

light in vacuum: c in water: 75%c in glass: 67%c

sound in air < sound in steel



Frequency unchanged; $v = \lambda f$

$\left(\lambda = \frac{v}{f} \right)$

$v \uparrow \Rightarrow \lambda \uparrow$

Exercise

Which is the best description of the speed of a water wave?

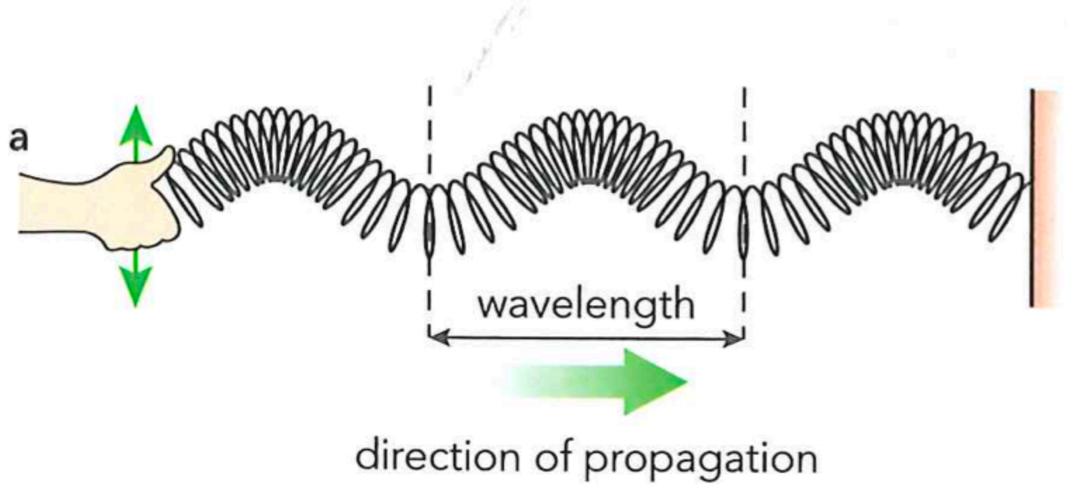
A the distance between one wave crest and the next

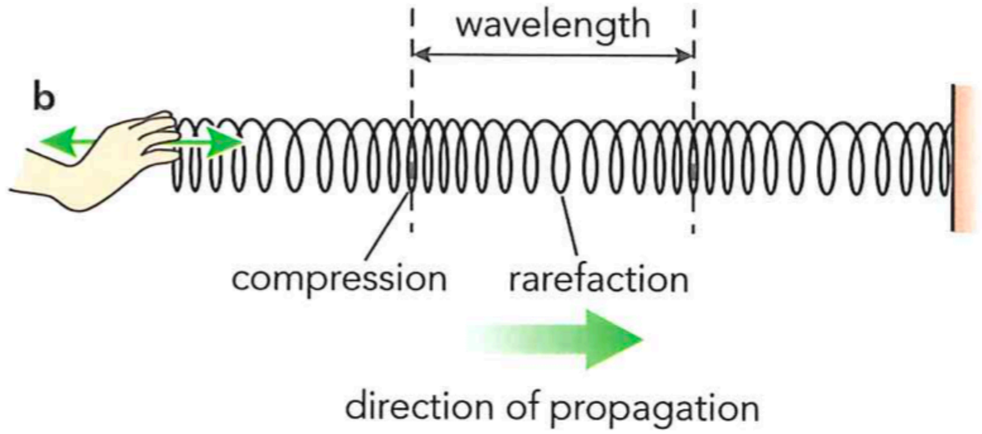
B the distance between the crest of a wave and a trough

C the distance that a particle of water moves up and down in one second

D the distance that a wavefront moves along the surface in one second

Transverse and longitudinal waves



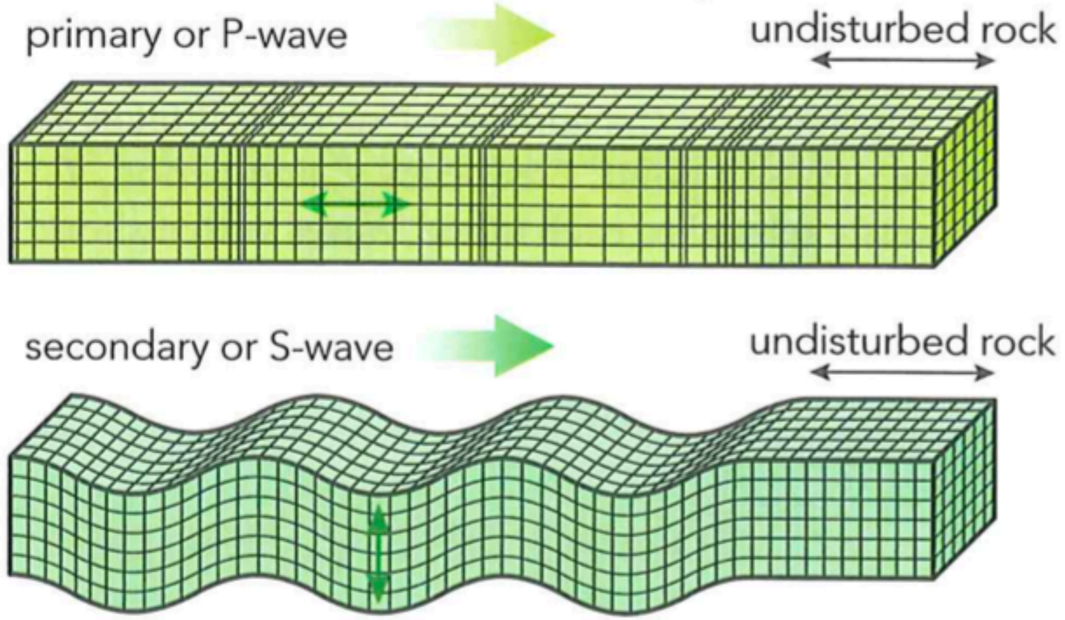


1. Transverse wave: the particles vibrate perpendicular to the direction of propagation/travel of the wave.
Longitudinal wave:the particles vibrate parallel to the direction of propagation/travel of the wave.

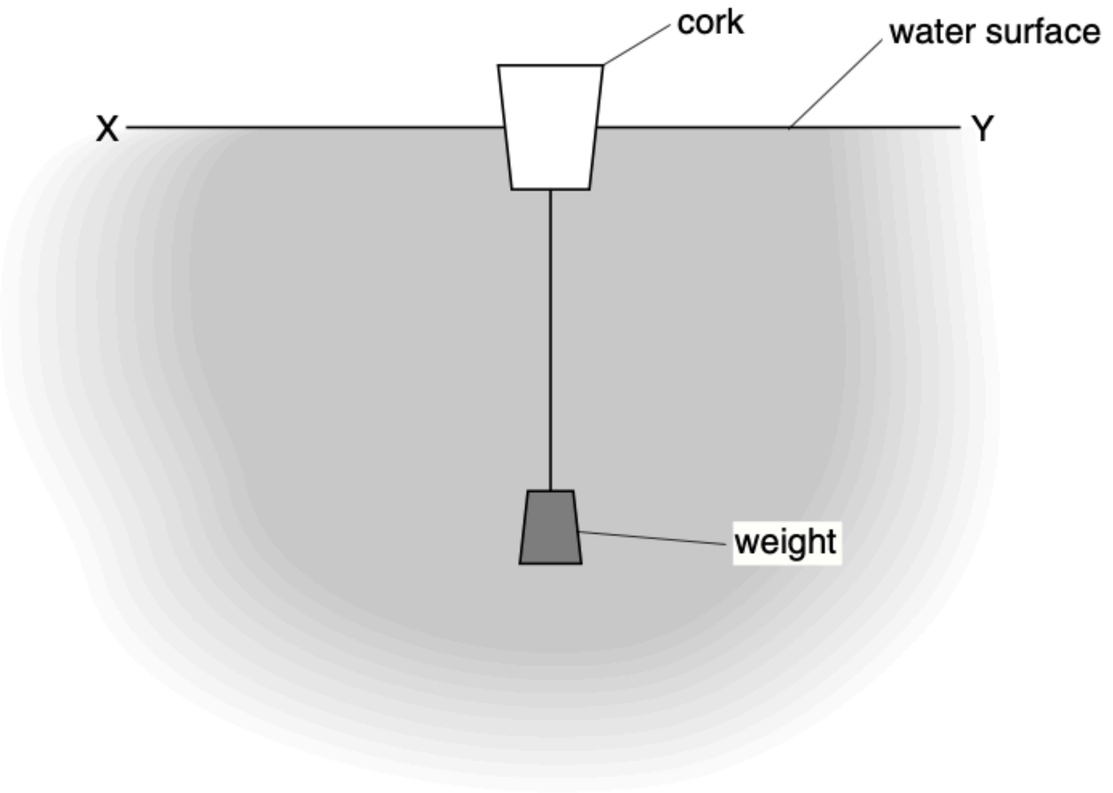
2. Transverse wave have crests and troughs; longitudinal wave have compressions and rarefactions

Transverse and longitudinal waves

Transverse waves	Longitudinal waves
ripples on water	sound
light and all other electromagnetic waves	primary seismic waves (P-waves)
secondary seismic waves (S-waves)	



The diagram shows a cork with a weight attached so that the cork floats upright.



Transverse waves travel across the water from X to Y.

Which way do the waves make the cork move?

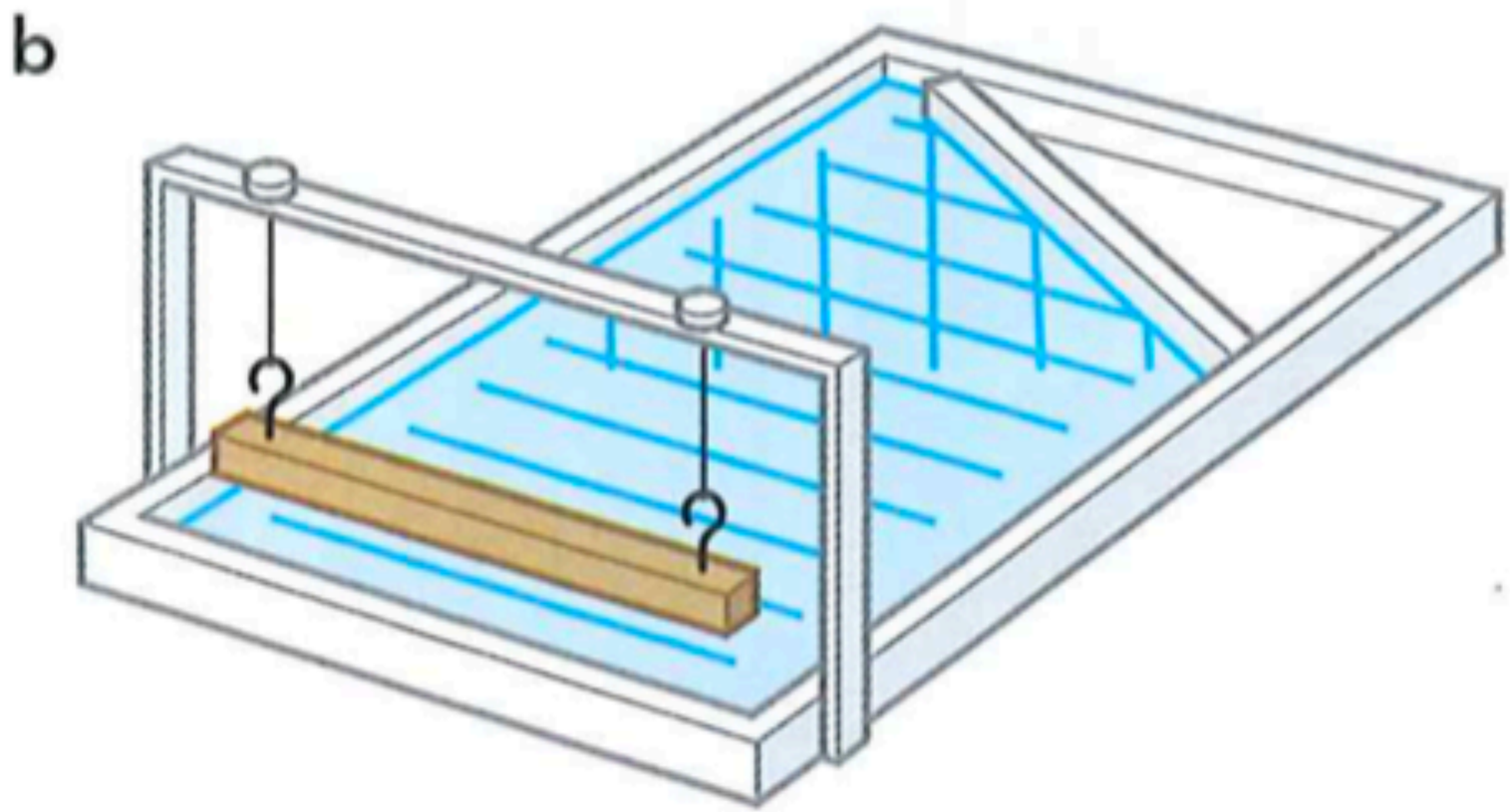
A $\rightarrow\leftarrow$ right and left

B $\uparrow\downarrow$ up and down

C $\rightarrow$ only to the right

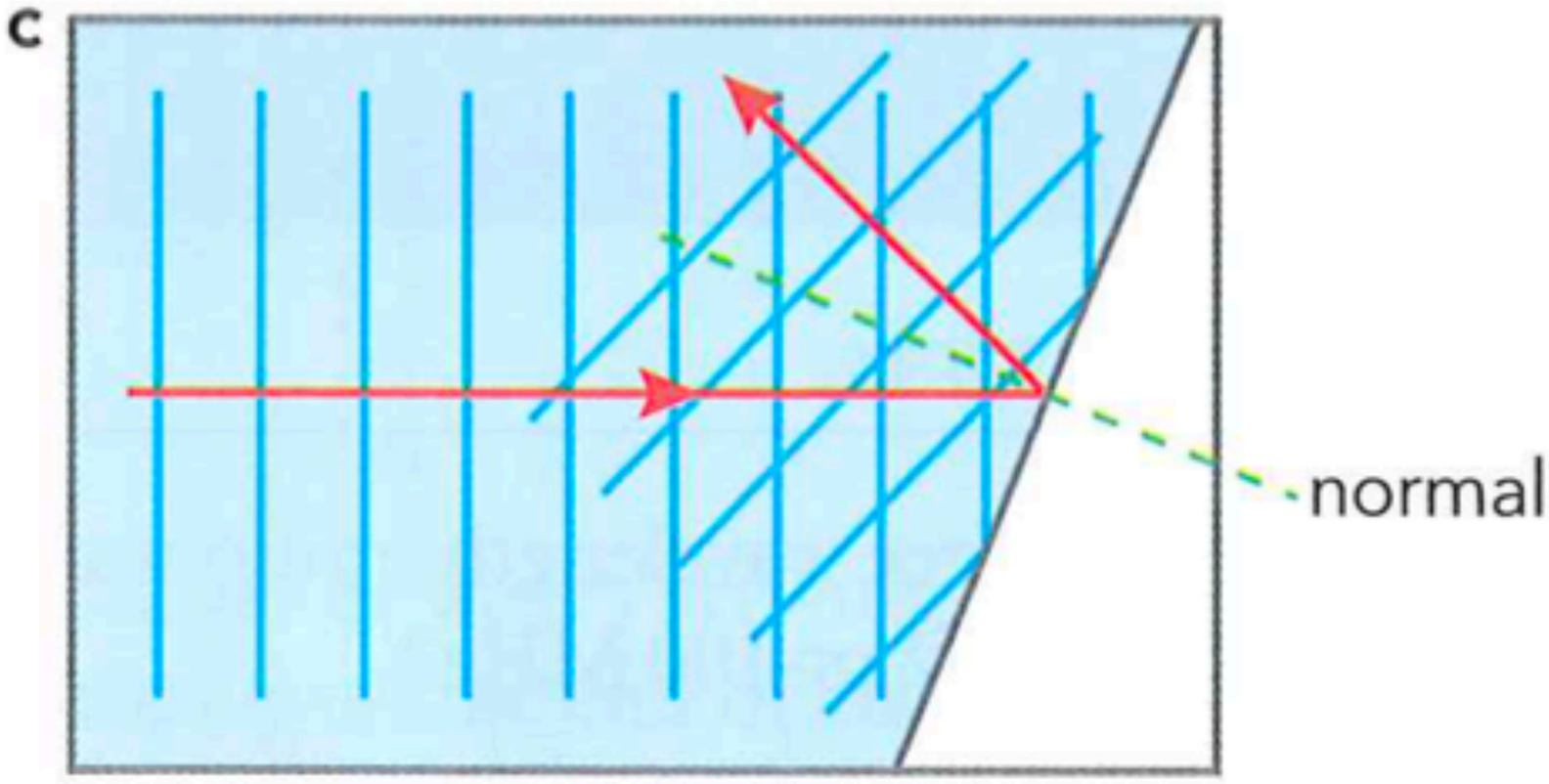
D $\leftarrow$ only to the left

Wave Phenomena: Reflection



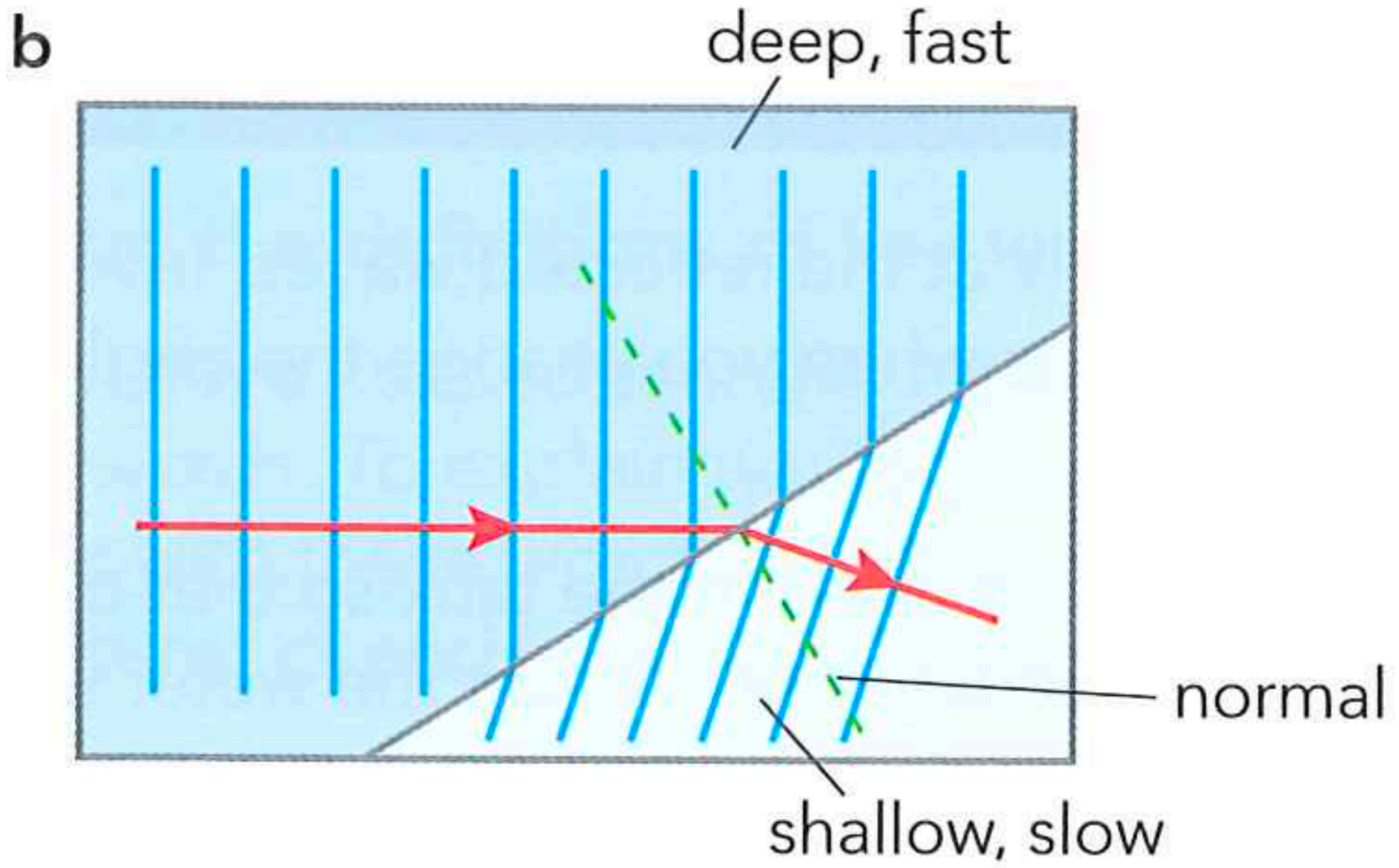
Wave Phenomena: Reflection

$$\theta_i = \theta_r$$



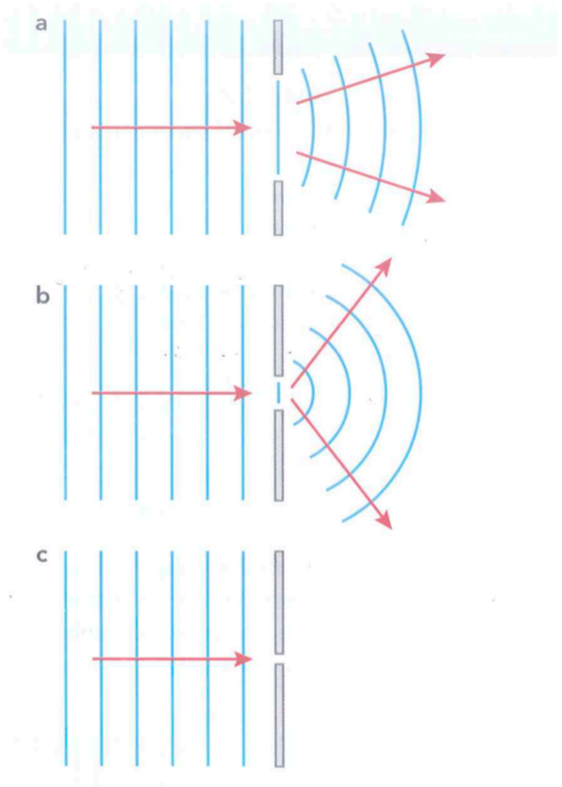
Wave Phenomena: Refraction

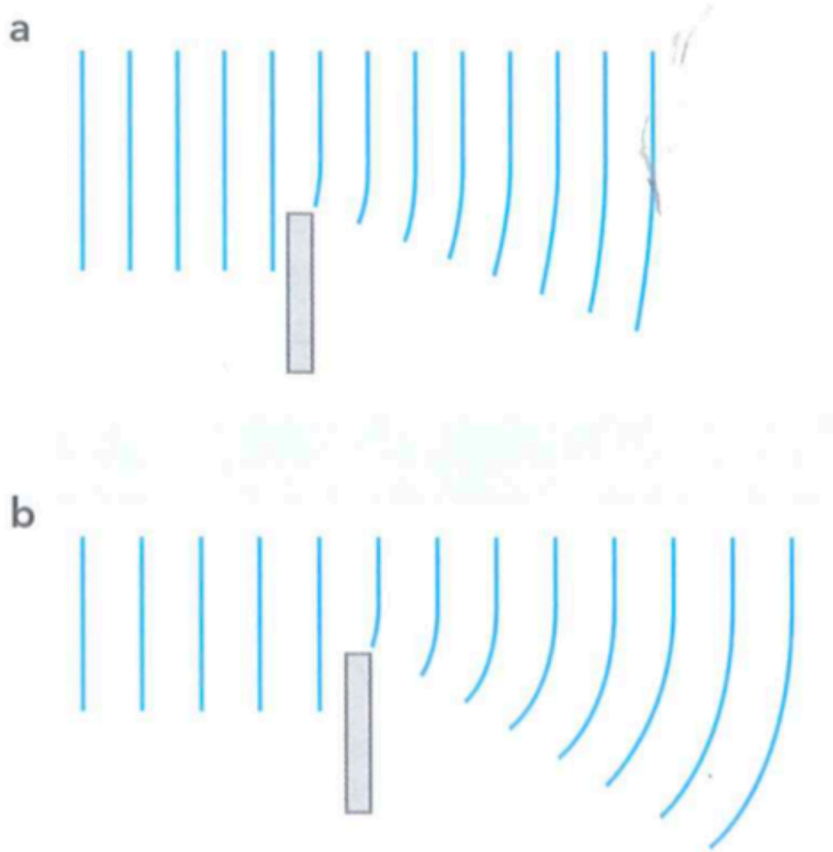
Wave travel at different speed in different medium



Wave Properties: Diffraction

Diffraction: a wave spreads out when it travels through a gap or past the edge of an object.





Diffraction effect is **greatest** when the **size of the gap or the object** equals to the **wavelength**.

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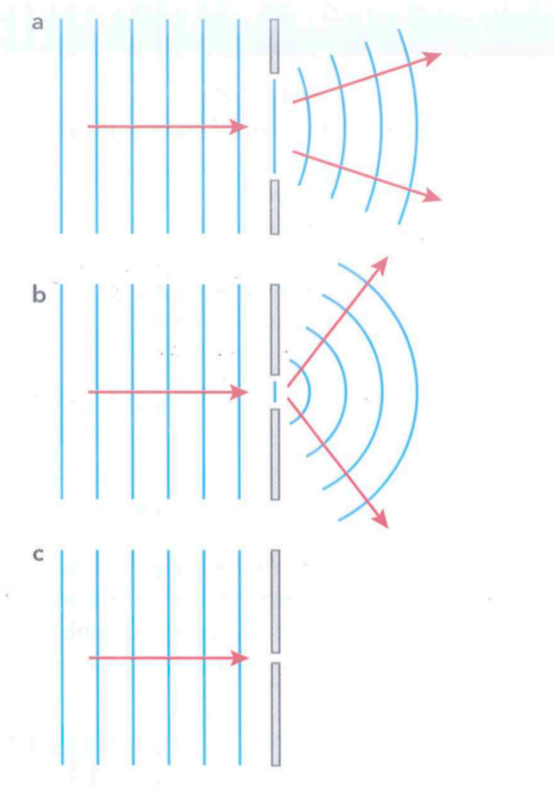

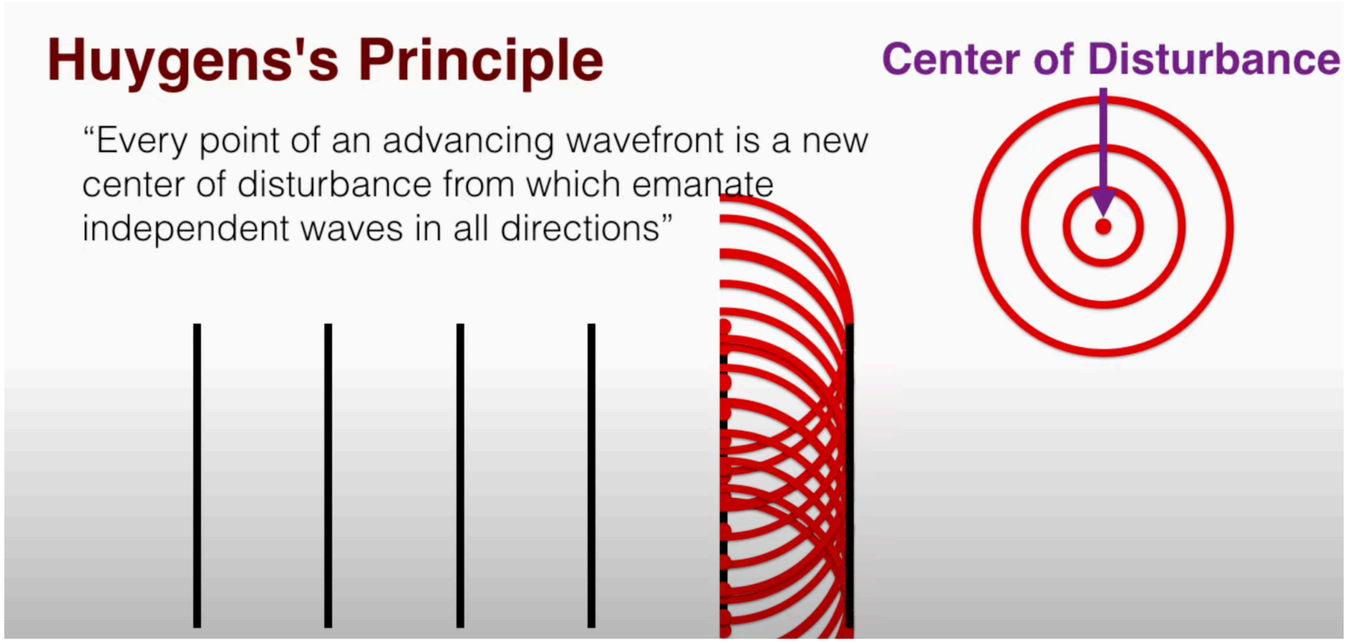

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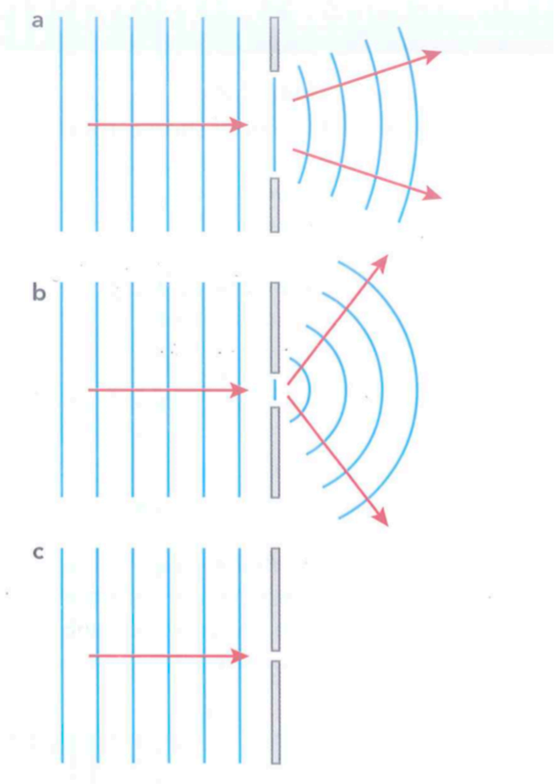

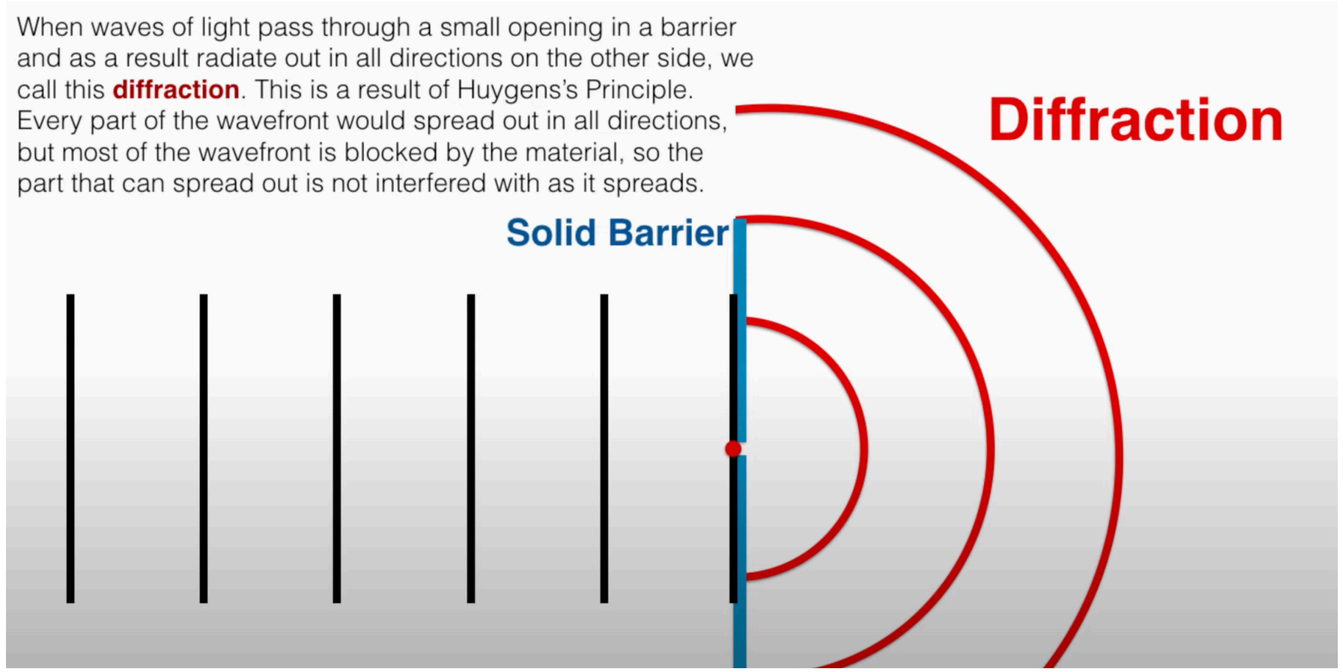

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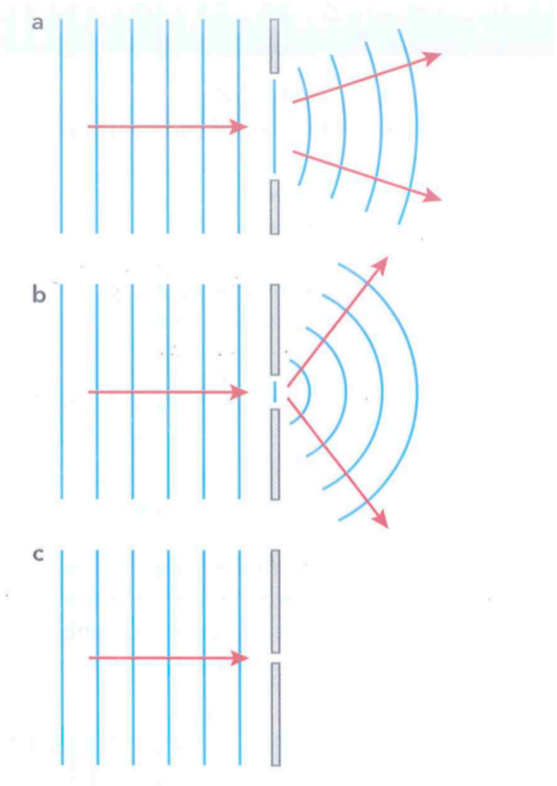
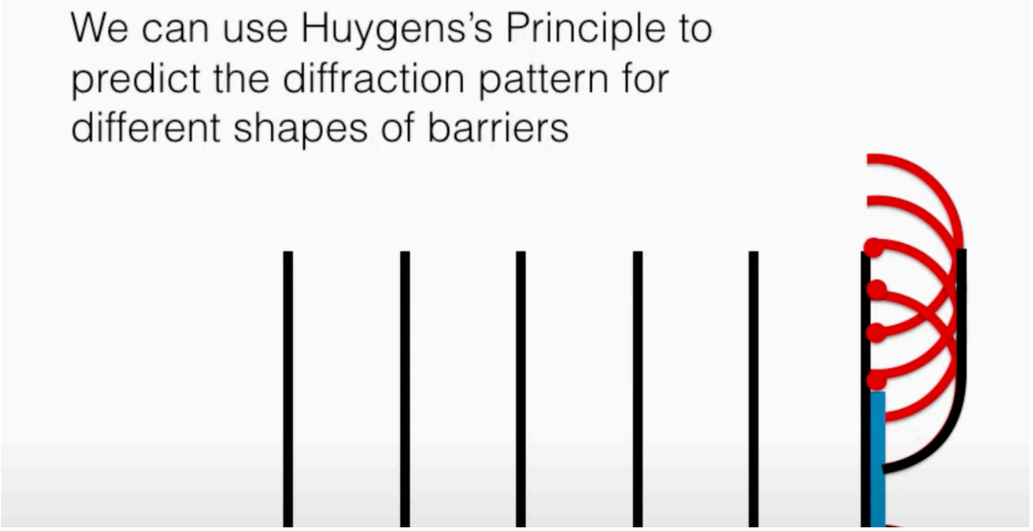
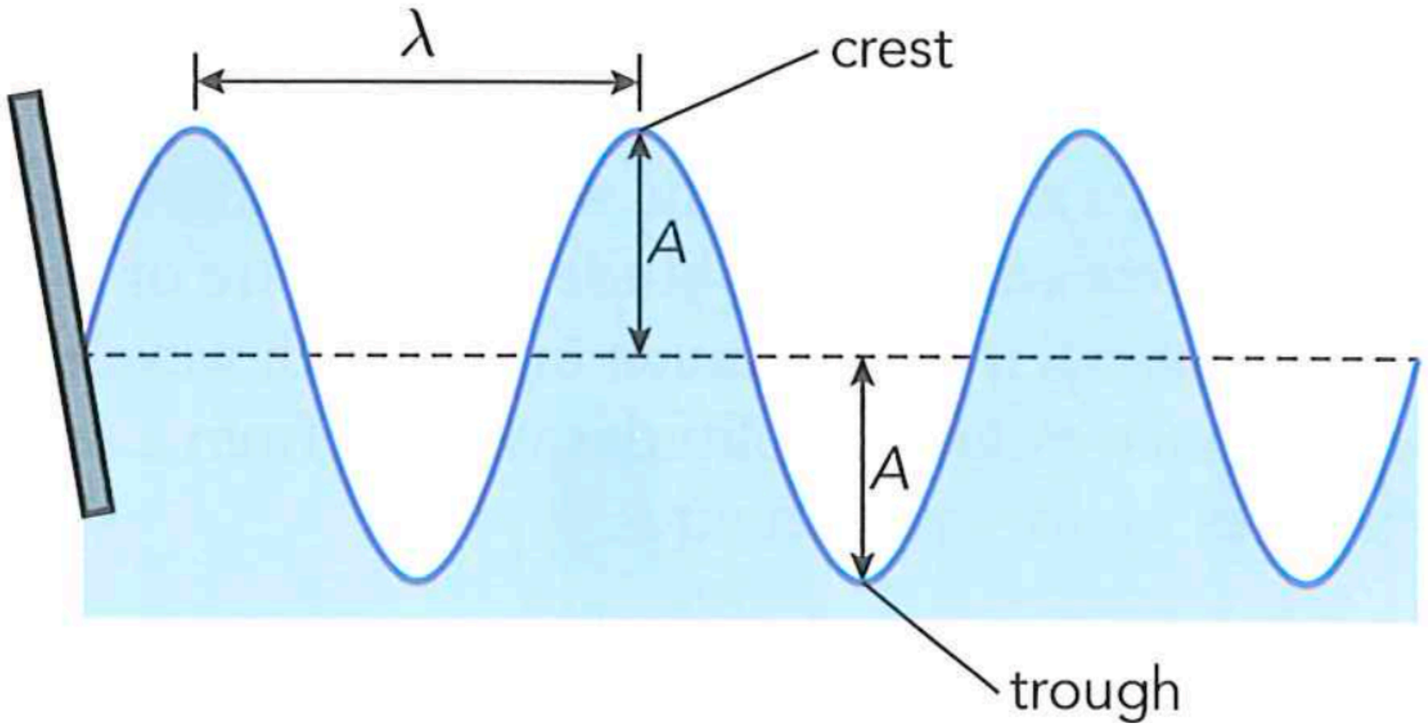




What are Waves



Wave in physics is a **model**:

In physics, we extend the **idea of a wave** to describe many other phenomena, including **light, sound**, etc. We do this by imagining an **idealized** wave.