Unit One

Chapters 3 and 4

Emission, Propagation and Reception of sound

Prepared and presented by: Mr. Mohamad Seif

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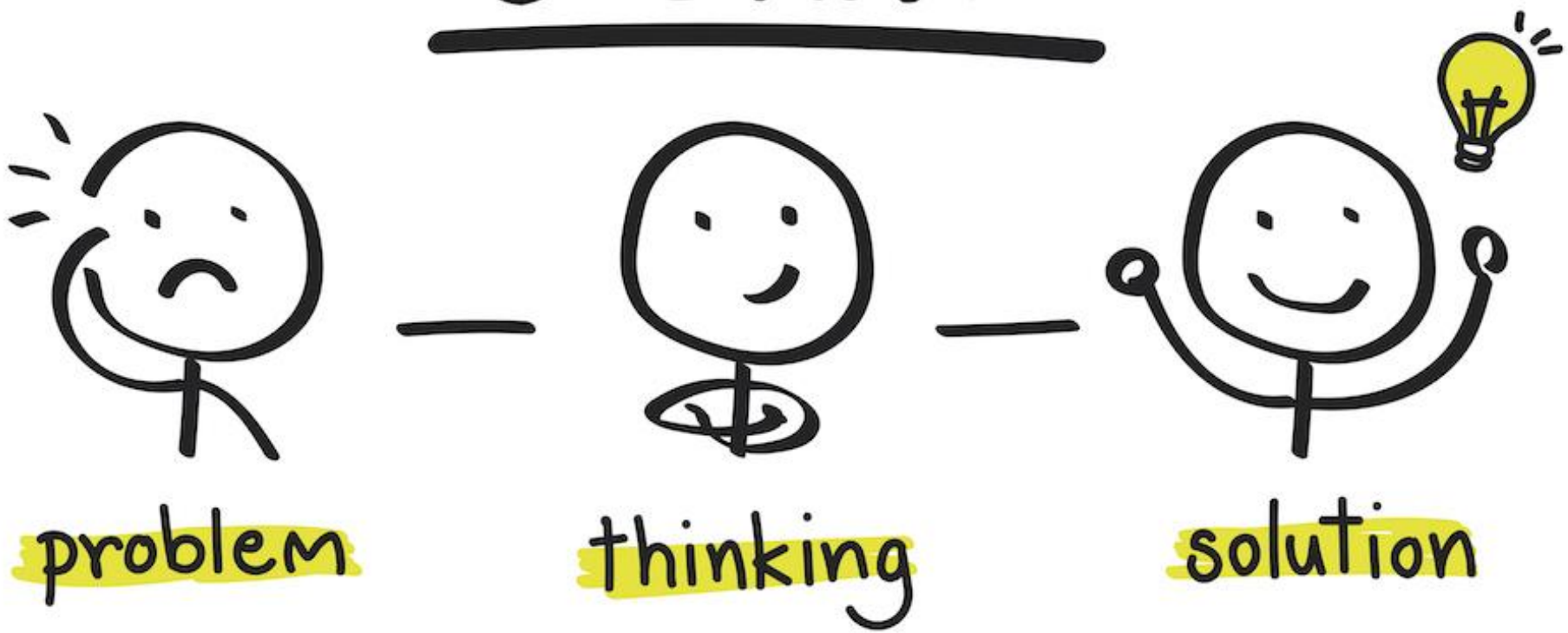
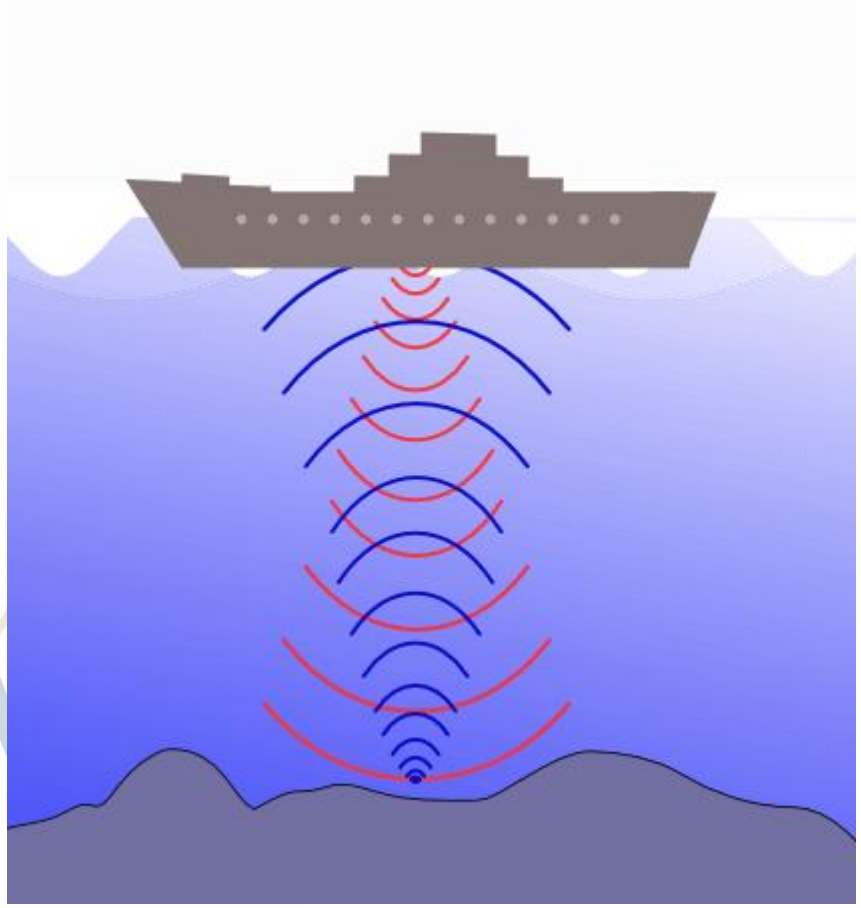
PROBLEM SOLVING



Exercise 1

The adjacent figure shows the use of sonar equipment to measure the depth of the sea.

The speed of ultra sound in sea water 1500 m/s.



1)What is the advantage of using ultra sound in sonar?

2)Give the name of the phenomenon of sound wave applied in sonar equipment.

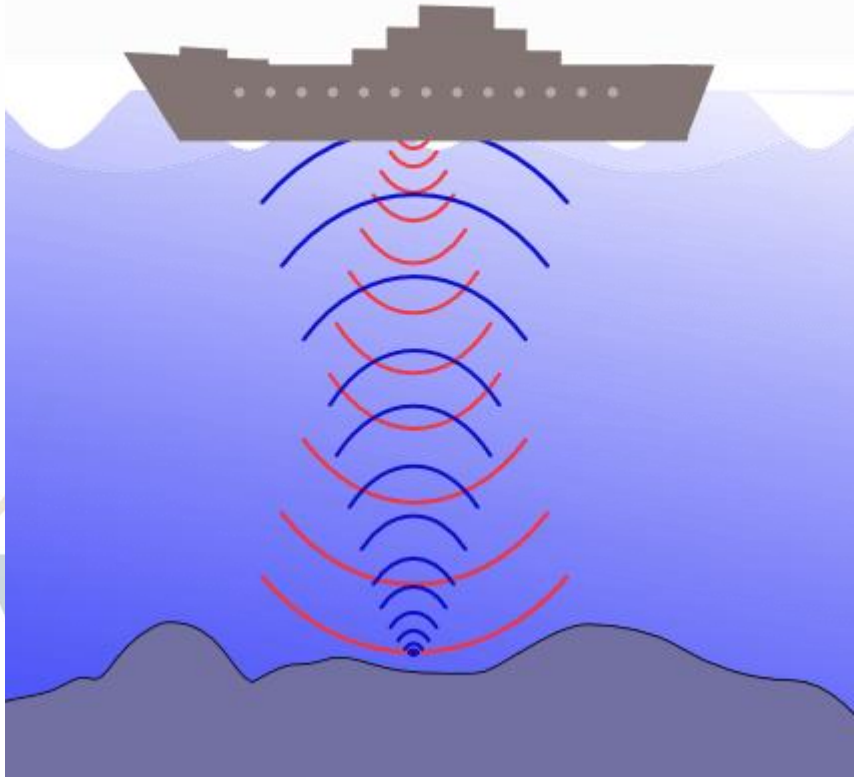
3)Why is the speed of sound greater in water than in air?

Exercise 1

4) Sound waves with frequency of 50000 Hz are used to determine the depth of the sea.

a) What is the wavelength of the sound wave in sea water?

b) If the time interval between the instant the soundwave is sent to the instant the echo is received is 1.5s, what is the depth of the sea?



Exercise 1

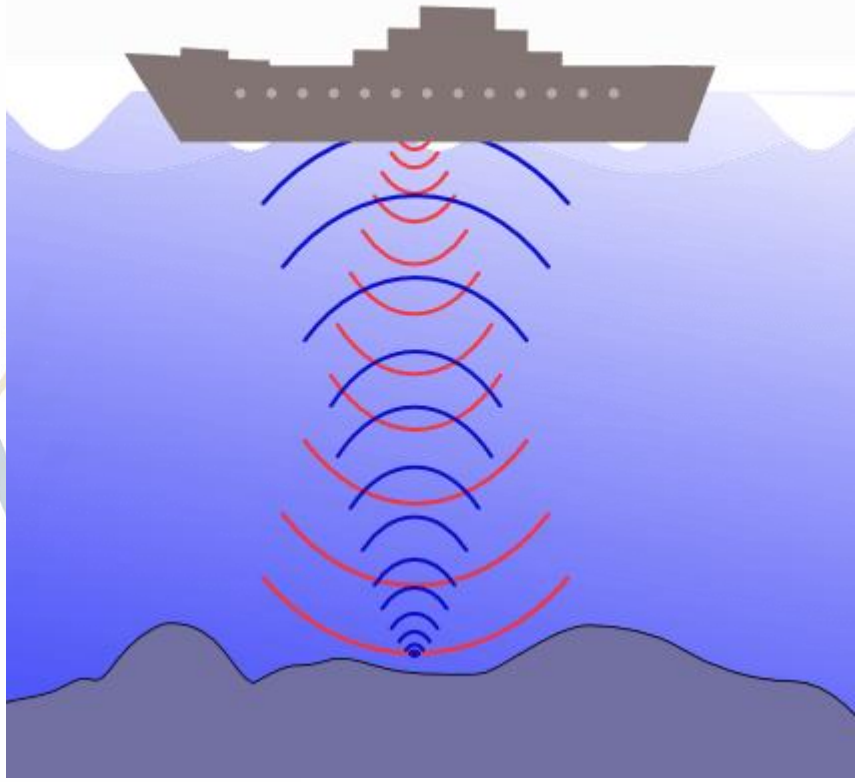
1)What is the advantage of using ultra sound in sonar?

Ultrasound is much less absorbed in sea water

Ultrasound is more directional in water than audible sound.

2) Give the name of the phenomenon of sound wave applied in sonar equipment.

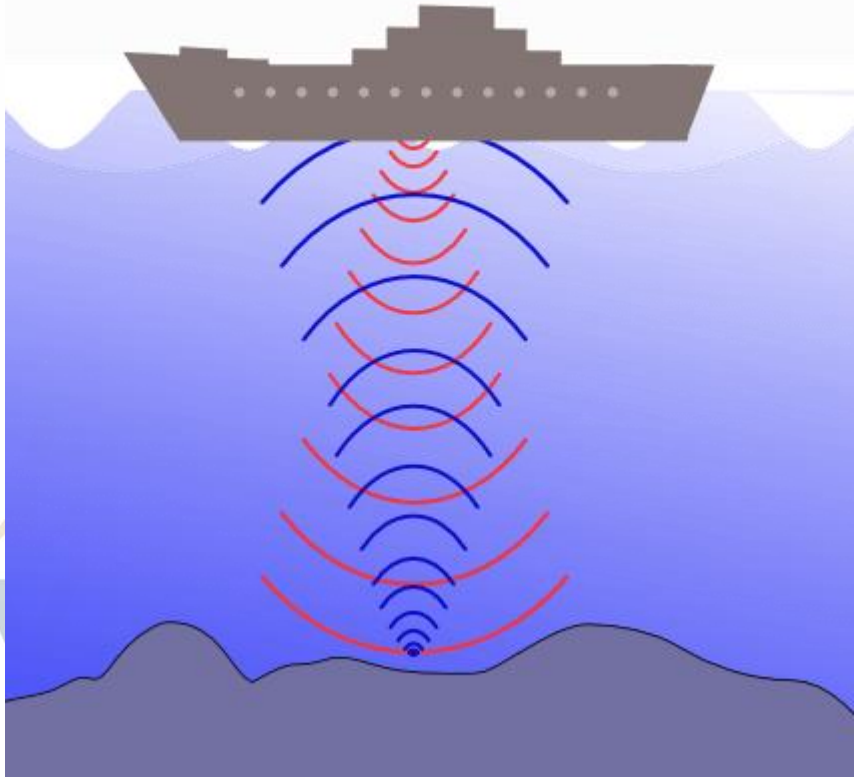
The phenomenon is Reflection of sound.



Exercise 1

3)Why is the speed of sound greater in water than in air?

The particles in water is closer together than in air, so sound can be transmitted more easily.



4)Sound waves with frequency of 50000 Hz are used to determine the depth of the sea.

a)What is the wavelength of the sound wave in sea water?

$$\lambda = \frac{v}{f} = \frac{1500}{50000} \Rightarrow \lambda = 0.03m$$

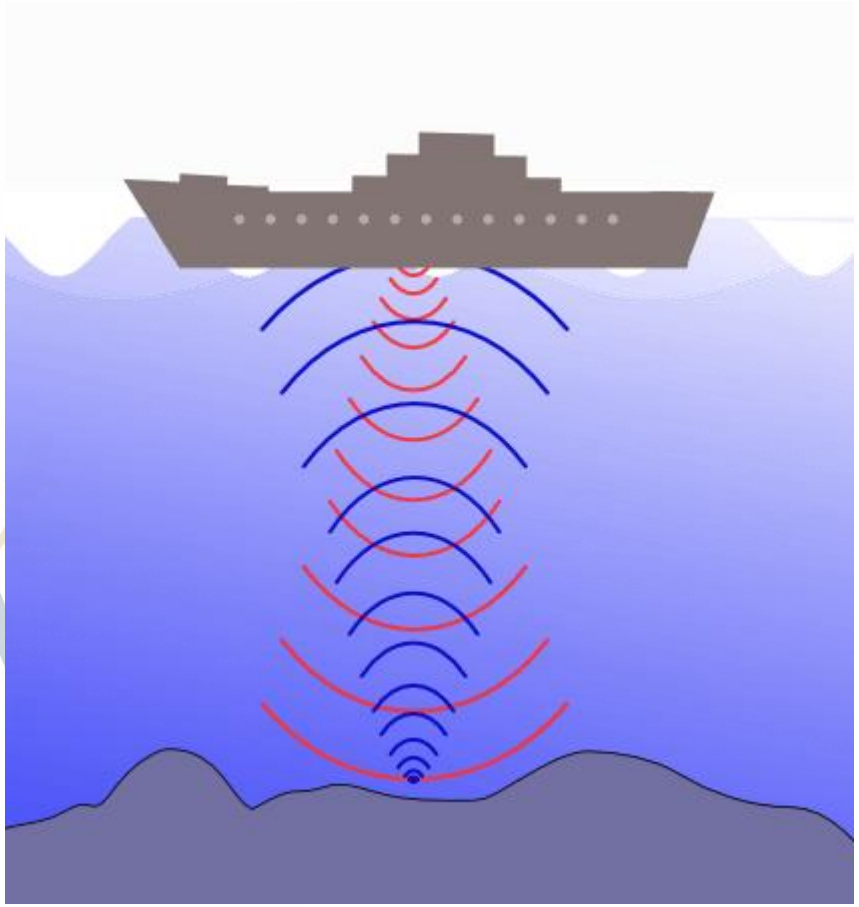
Exercise 1

b) If the time interval between the instant the soundwave is sent to the instant the echo is received is 1.5s, what is the depth of the sea?

$$d = \frac{v\Delta t}{2} = \frac{1500 \times 1.5}{2}$$

$$d = 1125m$$

The depth of the sea is 1125m



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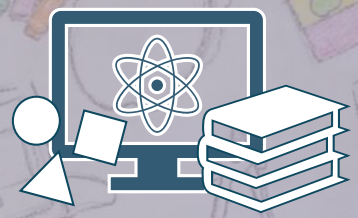

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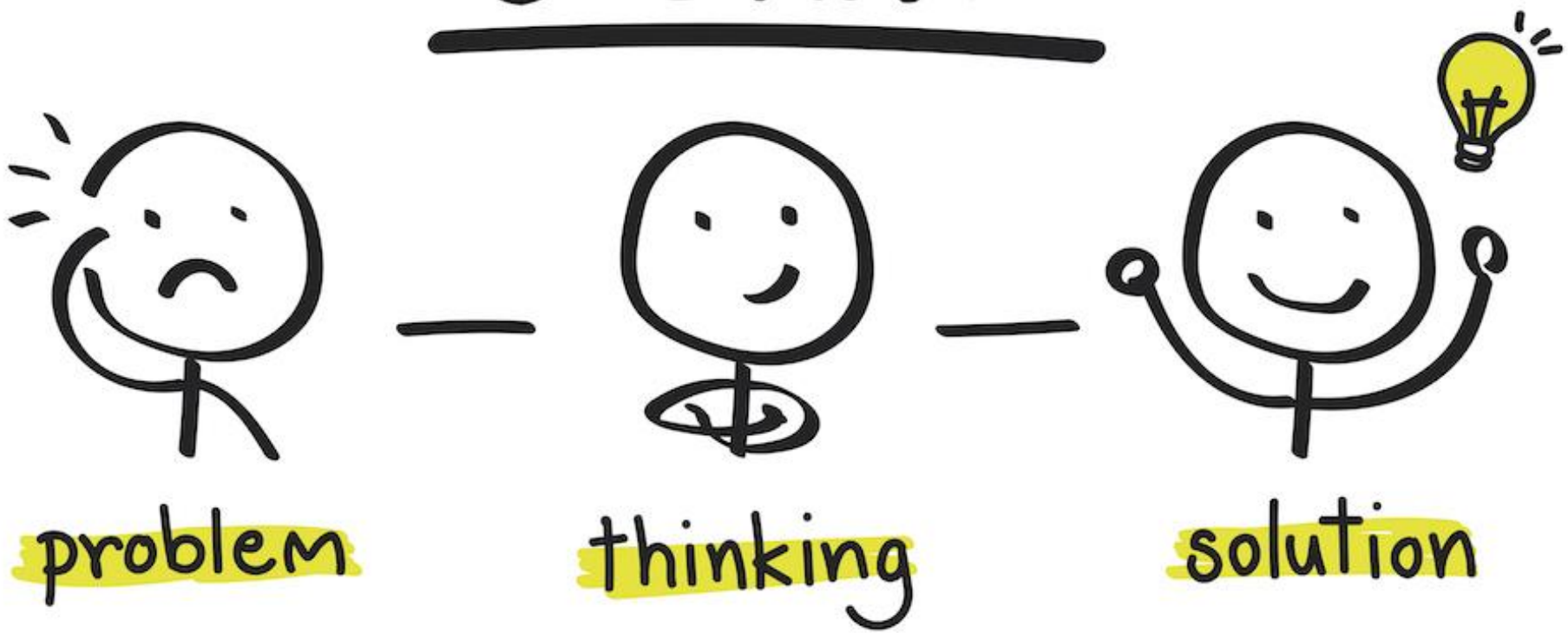


Exercise 2 sound wave

A dolphin moves a distance x in water towards an obstacle at a speed of 15 m/s.

At 2m from the obstacle, it emits an ultrasound signal towards the obstacle. The speed of ultrasound in water is 1500 m/s.

1)Are ultrasounds audible to the human ear? Justify.

2)Name two applications that use ultrasounds.

3)Determine the distance x covered by the dolphin.

4)Determine the time needed by the dolphin to receive the echo.

5)If the response time of the dolphin is 0.1s, can it avoid the obstacle? Justify.

Exercise 2 sound wave

$v = 15\ m/s;\ d = 2m$; speed of ultrasound in water is 1500 m/s.

1)Are ultrasounds audible to the human ear? Justify.

Ultrasound is not audible, because audible sound range is $20Hz < f_{audible} < 20,000Hz$, and the frequency of ultrasound is above 20,000Hz

2) Name two applications that use ultrasounds.

Ultrasound is used for Echography and supersonic cleaners

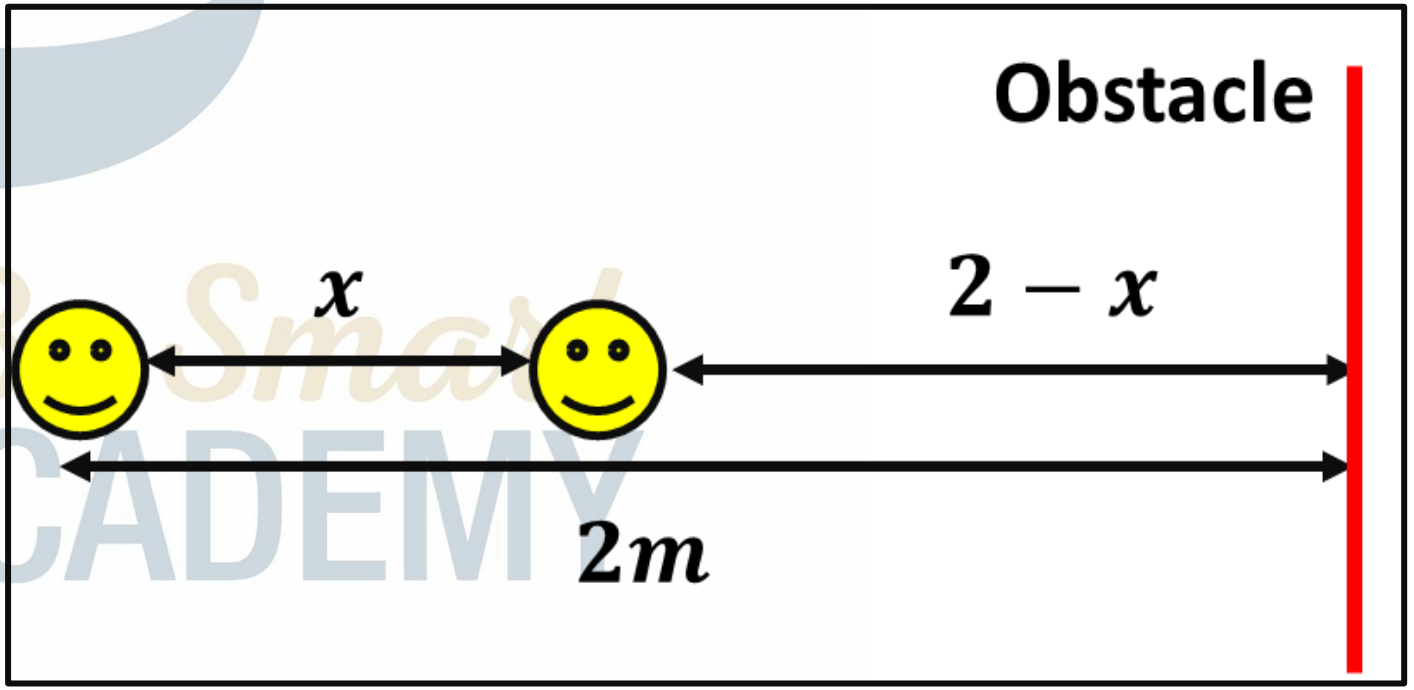
Exercise 2 sound wave

$v = 15\ m/s;\ d = 2m$; speed of ultrasound in water is 1500 m/s.

3)Determine the distance x covered by the dolphin.

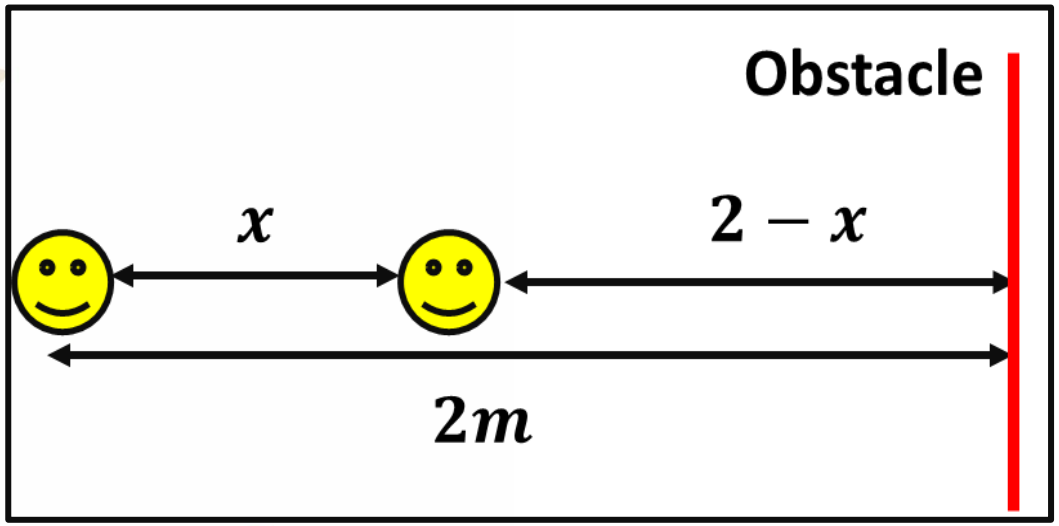
The distance covered by the dolphin during a time interval Δt is $d_1 = x$.

The distance traveled by ultrasound during the same time interval Δt is $d_2 = 2 + 2 - x = 4 - x$.



Exercise 2 sound wave

$v = 15\ m/s;\ d = 2m$; speed of ultrasound in water is 1500 m/s.



$$\Delta t = \Delta t$$

$$\frac{x}{v_{dolphin}} = \frac{4-x}{v_{sound}}$$

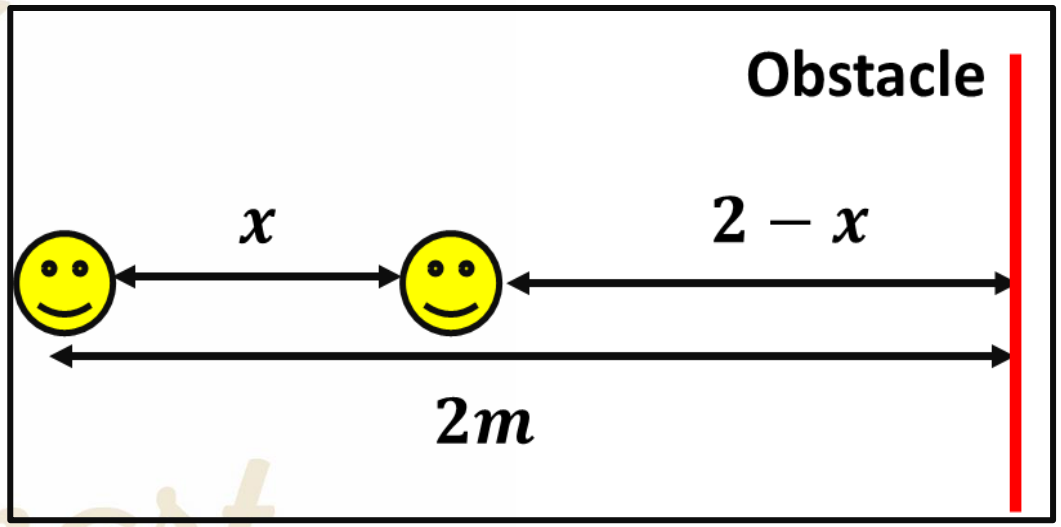
$$\frac{x}{15} = \frac{4-x}{1500} \Rightarrow 1500x = 60 - 15x$$

$$1515x = 60 \Rightarrow x = \frac{60}{1515} \Rightarrow x = 0.039m$$

Exercise 2 sound wave

4) Determine the time needed by the dolphin to receive the echo.

$$d = \frac{v\Delta t}{2}$$

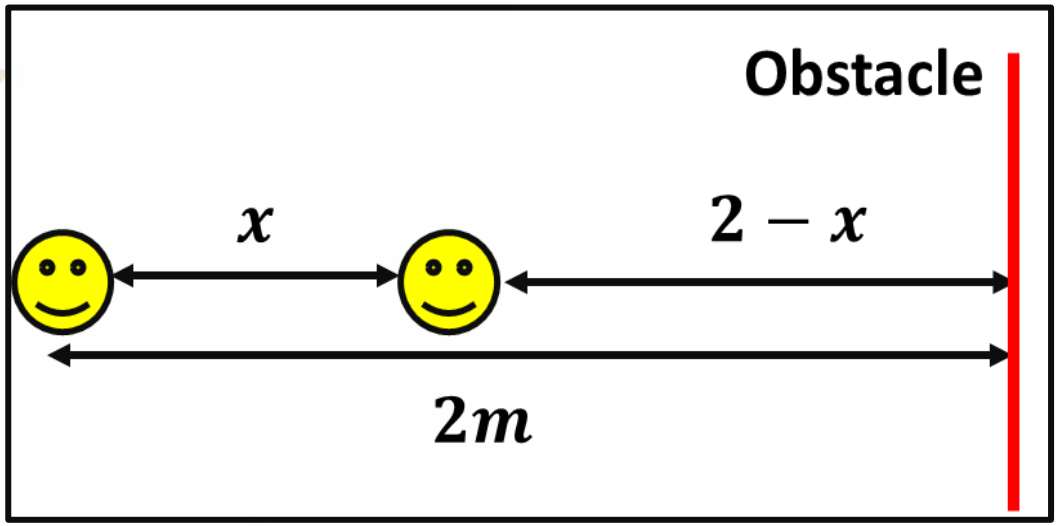


$$\Delta t = \frac{2d}{v} = \frac{2 \times 2}{1500}$$

$$\Delta t = 0.0026s$$

Exercise 2 sound wave

5) If the response time of the dolphin is 0.1s, can it avoid the obstacle? Justify.

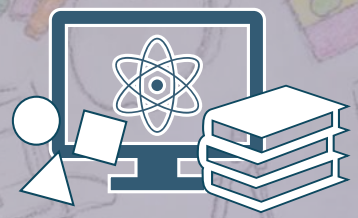


The remaining distance between the dolphin and the obstacle is: $2 - x = 2 - 0.039 = 1.961m$

The time needed by the dolphin to reach the obstacle is

$$t = \frac{d}{v} = \frac{1.961}{15} = 0.1309s$$

$$t_{response} < t_{dolphin}$$

Then the dolphin avoids the obstacle

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