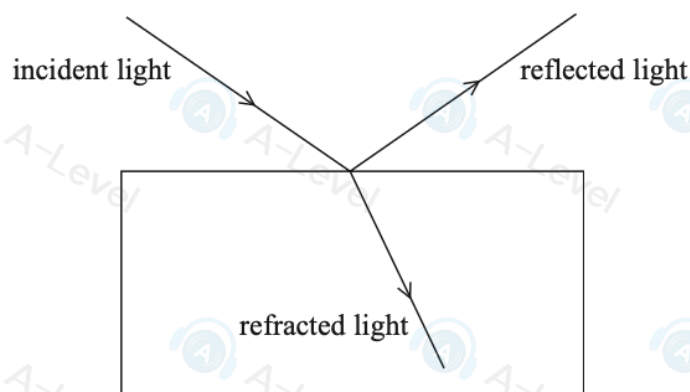


- 3 Monochromatic light is incident on a rectangular glass block. Some of the light is reflected and some of the light is refracted, as shown.



Which of the following properties does **not** decrease when the light is refracted?

- ☐ A frequency
- ☐ B intensity
- ☐ C speed
- ☐ D wavelength

(Total for Question 3 = 1 mark)

- 3 Which of the following would increase the detail in an ultrasound scan?

- ☐ A increasing the duration of the pulses
- ☐ B increasing the frequency of the ultrasound
- ☐ C increasing the intensity of the ultrasound
- ☐ D increasing the wavelength of the ultrasound

(Total for Question 3 = 1 mark)

- 9 Light travels through air and enters a glass block.

Which of the following quantities does **not** change as the light enters the glass block?

- ☐ A amplitude
- ☐ B frequency
- ☐ C velocity
- ☐ D wavelength

(Total for Question 9 = 1 mark)

- 2 The distance between an approaching aircraft and an airport can be determined using the pulse-echo technique with radio waves.

The time between the pulse of radio waves being emitted and the reflected pulse being received is  $t$  and the velocity of radio waves in air is  $c$ .

Which of the following expressions can be used to determine the distance of the aircraft from the airport?

☐ A  $2 \times c \times t$

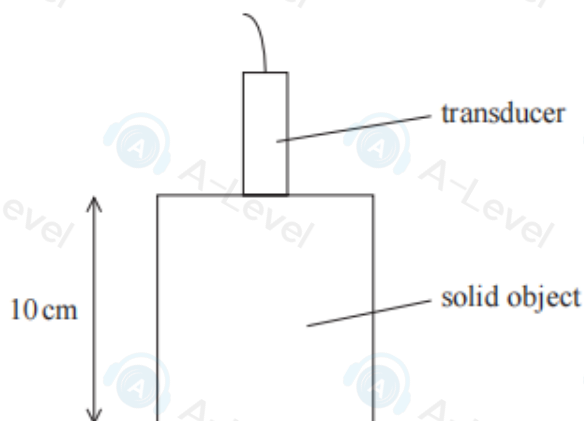
☐ B  $\frac{c \times t}{2}$

☐ C  $\frac{c}{2 \times t}$

☐ D  $c \times t$

(Total for Question 2 = 1 mark)

- 7 An ultrasound transducer is placed on the surface of a solid object as shown.



A pulse of ultrasound is transmitted into the object. The pulse is received at the transducer  $50 \mu\text{s}$  after it is emitted.

Which of the following can be used to calculate the speed of sound in this object?

☐ A  $\frac{0.10}{50 \times 10^{-6}}$

☐ B  $\frac{0.10}{25 \times 10^{-6}}$

☐ C  $\frac{0.10}{100 \times 10^{-6}}$

☐ D  $\frac{0.20}{25 \times 10^{-6}}$

(Total for Question 7 = 1 mark)

- 6 A bat is an animal that locates objects using a pulse-echo technique. A bat emits a pulse of sound waves that travel to an object. The bat detects the reflected pulse 4 ms later.

speed of sound =  $340 \text{ m s}^{-1}$

Which of the following expressions gives the distance, in metres, between the bat and the object?

☐ A  $2 \times 340 \times 4 \times 10^{-3}$

☐ B  $\frac{340}{2 \times 4 \times 10^{-3}}$

☐ C  $340 \times 4 \times 10^{-3}$

☐ D  $\frac{340 \times 4 \times 10^{-3}}{2}$

(Total for Question 6 = 1 mark)

- 1: The refractive index of vegetable oil is 1.47

Which of the following is the speed of light, in  $\text{m s}^{-1}$ , in vegetable oil?

☐ A  $1.59 \times 10^8$

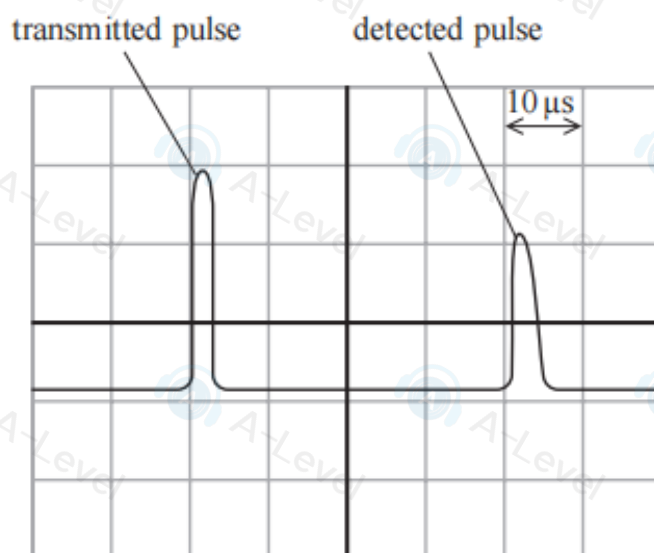
☐ B  $2.04 \times 10^8$

☐ C  $3.00 \times 10^8$

☐ D  $4.41 \times 10^8$

(Total for Question 1 = 1 mark)

8 The oscilloscope screen below shows the transmitted and detected pulses.



The speed of ultrasound in the first material is  $v$ .  
Each division on the oscilloscope screen represents  $10 \mu\text{s}$ .

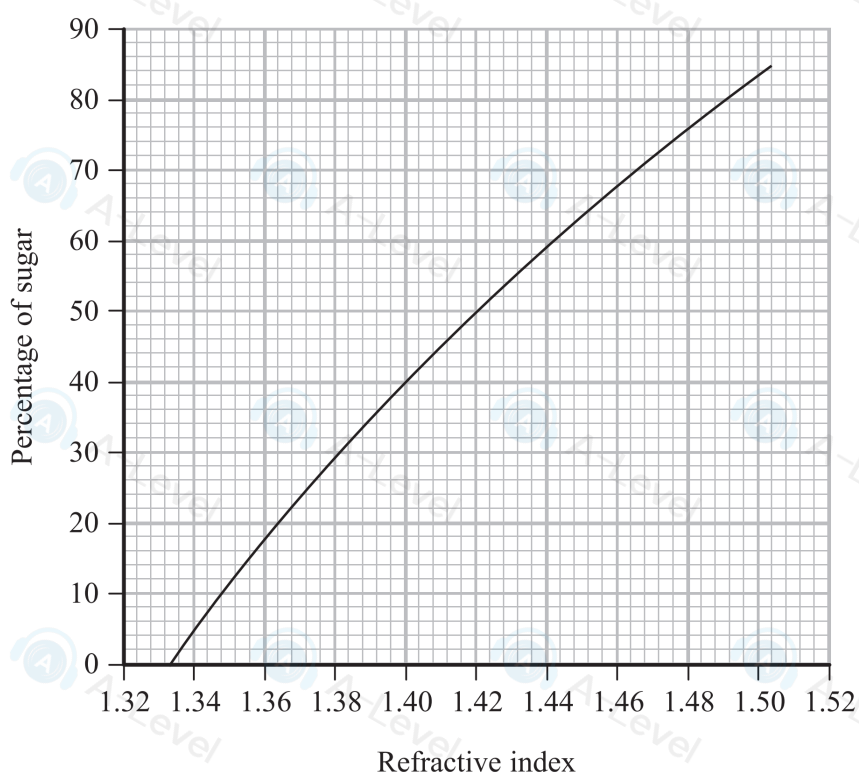
What is the approximate thickness of the first material?

- ☐ A  $(20 \times 10^{-6}) v$
- ☐ B  $(25 \times 10^{-6}) v$
- ☐ C  $(40 \times 10^{-6}) v$
- ☐ D  $(80 \times 10^{-6}) v$

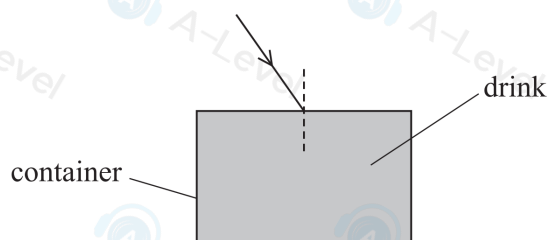
(Total for Question 8 = 1 mark)

17 The refractive index of a drink can be used to determine the percentage of sugar in the drink.

The graph shows how the refractive index of a drink varies with the percentage of sugar in the drink.



- (a) The drink is poured into a container with thin Perspex walls. A laser is used to shine a ray of light through the drink. The diagram shows the arrangement viewed from above.



- (i) Explain how the percentage of sugar in the drink affects the path of the ray as it enters the drink.

(2)



- (ii) The angle of incidence and the angle of refraction of the light ray as it passes into the drink are measured.

Determine the percentage of sugar in the drink. You can ignore the effect of the light ray passing through the Perspex. (3)

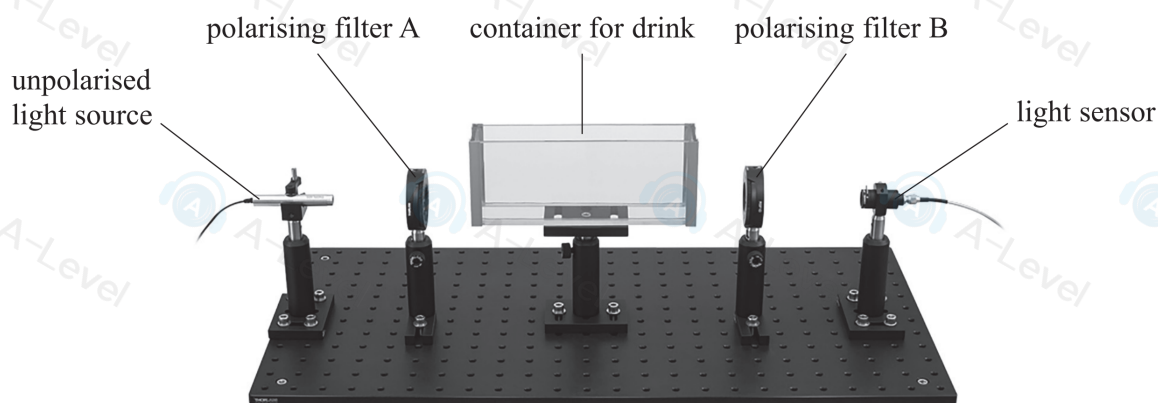
angle of incidence =  $40^\circ$

angle of refraction =  $26^\circ$

Percentage of sugar = .....



- (b) An alternative method to determine the percentage of sugar in a drink is shown.  
As polarised light passes through the drink, the plane of polarisation rotates by an amount dependent on the percentage of sugar in the drink.



- (i) Explain what is meant by the plane of polarisation.

(2)

- (ii) Initially there is no drink in the container and the polarising filters are aligned so that no light is detected by the light sensor.

Explain how the alignment of the two polarising filters, A and B, ensures that no light is detected.

(2)



- (iii) The polarising filters are kept in alignment so no light is detected. Then the container is filled with drink and light is detected.

Explain why the intensity of the light detected is less than the intensity of the light transmitted by polarising filter A.

(2)

- (iv) Explain how the angle through which the plane of polarisation has been rotated can be determined using this apparatus.

(3)

(Total for Question 17 = 14 marks)



16 The speed of sound in sea water varies with depth as shown in diagram A.

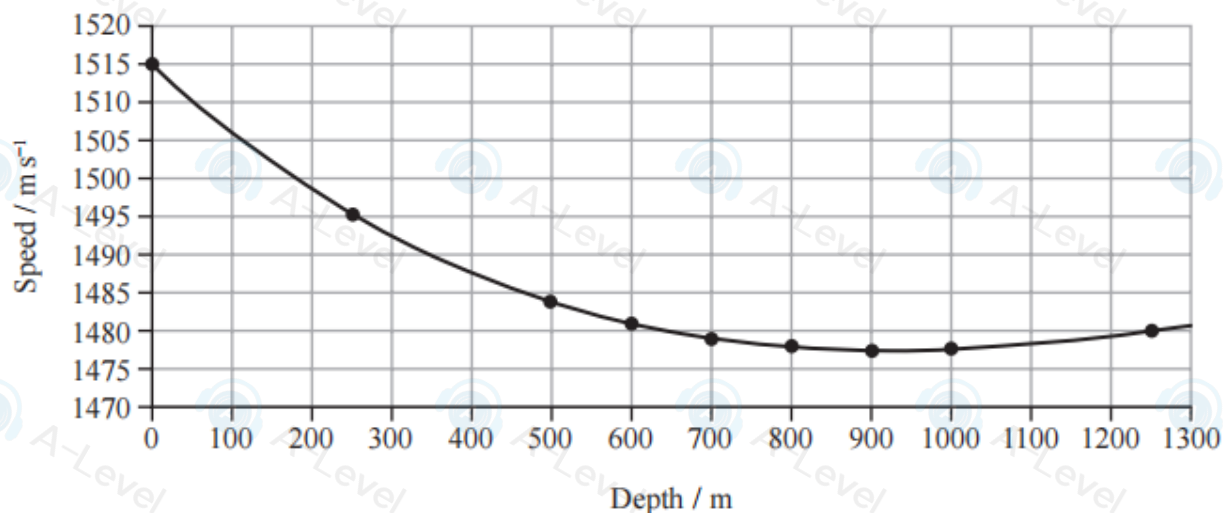


Diagram A

Sound produced at a depth of 900 m initially travels towards the water surface. As the sound approaches a depth of 700 m it changes direction and follows the path shown to the point P in diagram B.

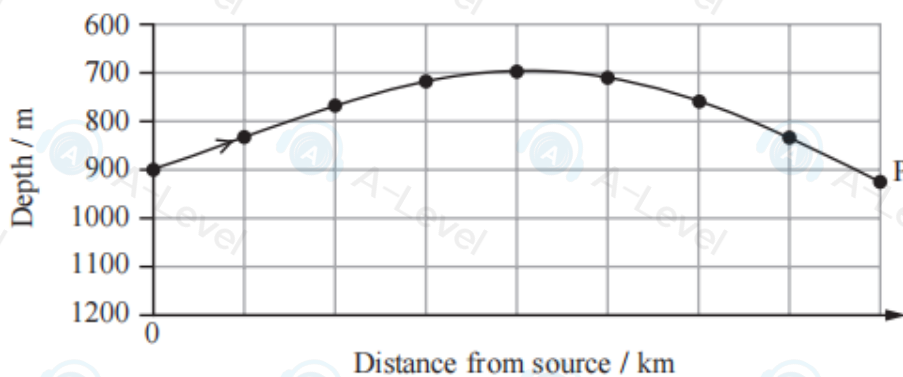


Diagram B

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

- (a) Explain why the sound follows the path shown in diagram B.

Your answer should refer to refraction and diagram A.

(5)

- (b) Sound that travels in a straight line from the source to point P takes longer to arrive than sound that travels along the path shown in diagram B.

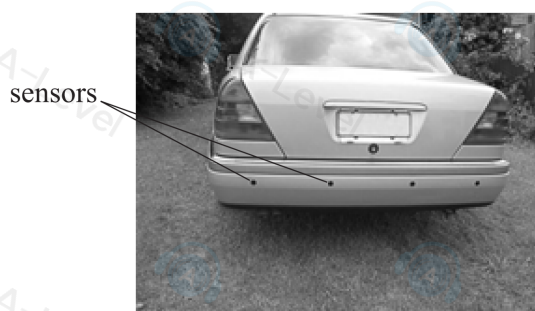
Suggest why.

(2)

- (c) Suggest two factors that might cause the speed of sound to vary with the depth of the sea.

(2)

12 Sensors can be fitted to the rear bumper of a car to help the driver reverse the car safely.



The sensors emit ultrasound pulses. Pulses that hit an object behind the car are reflected back to the sensors. The time taken for the reflected pulse to return is measured so that the distance to the object can be determined.

(a) State why it is necessary to emit the ultrasound in pulses.

(1)

(b) A car manufacturer claims that the sensors are able to detect objects from a distance of 0.10 m from the car.

Calculate the maximum duration of each pulse.

speed of sound in air =  $340 \text{ m s}^{-1}$

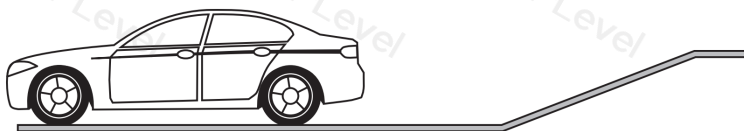
(3)

Maximum duration = .....



- (c) (i) Suggest why the sensors may not help the driver when reversing towards an ascending ramp.

(1)



- (ii) Suggest why the sensors may not help the driver when reversing towards a thin post.

(1)

(Total for Question 12 = 6 marks)



P 4 8 4 2 4 A 0 9 2 4

- 11 Some animals use a pulse-echo technique to collect information about their surroundings.

Describe how this technique provides information about the surroundings.

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(Total for Question 11 = 3 marks)