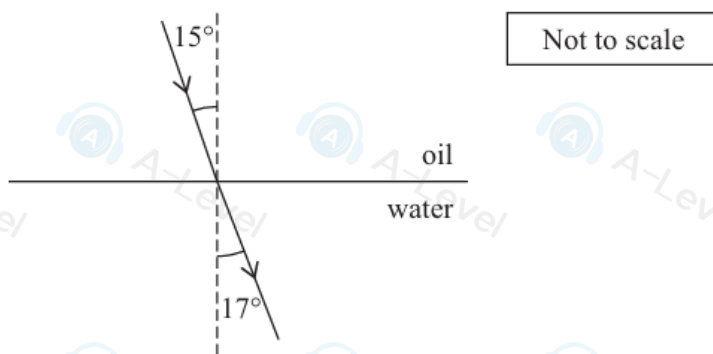


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- 3 The diagram shows a ray of light incident at a boundary between oil and water. The refractive index of water is 1.33



Which of the following expressions gives the refractive index of the oil?

- A $\frac{\sin 17^\circ}{1.33 \sin 15^\circ}$
- B $\frac{1.33 \sin 17^\circ}{\sin 15^\circ}$
- C $\frac{\sin 15^\circ}{1.33 \sin 17^\circ}$
- D $\frac{1.33 \sin 15^\circ}{\sin 17^\circ}$

- 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)

- 1: The refractive index of vegetable oil is 1.47

Which of the following is the speed of light, in ms^{-1} , in vegetable oil?

- A 1.59×10^8
- B 2.04×10^8
- C 3.00×10^8
- D 4.41×10^8

(Total for Question 1 = 1 mark)

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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)

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)

10 Sound waves travel through air and pass into a concrete wall. The energy of the sound wave transmitted into the concrete wall is much less than the energy of the sound wave in air.

Which of the following wave properties is the reason for this?

- A absorption
- B diffraction
- C reflection
- D refraction

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS



- 9 An ultrasound pulse-echo technique is used to produce an image by reflection from many boundaries.

If the transmitted pulse is too long, the image produced is of poor quality.

This could be because the

- A energy of the pulse is too high.
- B frequency of the ultrasound is too high.
- C time between consecutive transmitted pulses is too short.
- D wavelength of the ultrasound is too long.

(Total for Question 9 = 1 mark)

- 8 A ray of light travels through glass, towards a boundary between glass and air. The critical angle for this boundary is 42° .

Which row of the table is correct?

	Angle of incidence	What happens at the boundary?
<input type="checkbox"/> A	40°	All of the light is refracted
<input type="checkbox"/> B	40°	All of the light is reflected
<input type="checkbox"/> C	45°	All of the light is refracted
<input type="checkbox"/> D	45°	All of the light is reflected

(Total for Question 8 = 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.

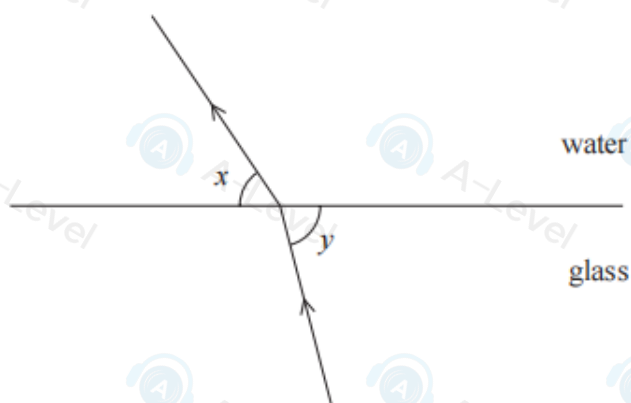
speed of sound = 340 m s^{-1}

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)

7 The diagram shows a ray of light passing from glass to water.



Which of the following is a correct expression for the refractive index for light passing from glass to water?

- A $\frac{\sin x}{\sin y}$
- B $\frac{\sin y}{\sin x}$
- C $\frac{\sin (90^\circ - x)}{\sin (90^\circ - y)}$
- D $\frac{\sin (90^\circ - y)}{\sin (90^\circ - x)}$

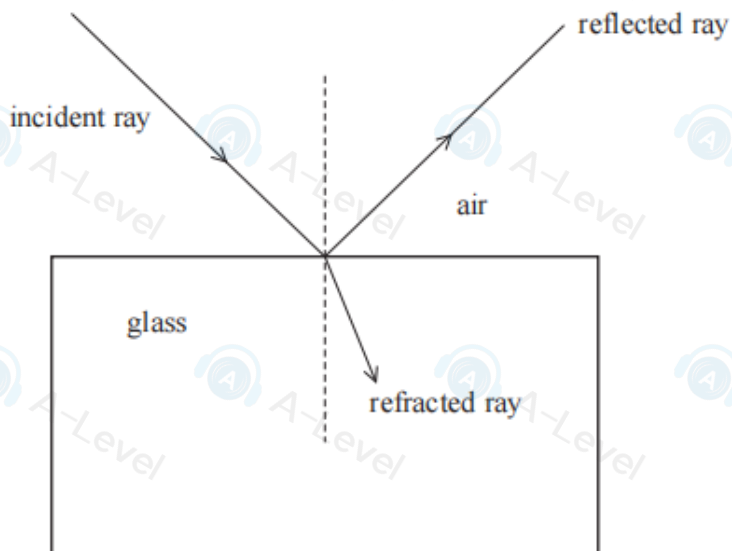
(Total for Question 7 = 1 mark)

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18 When an incident ray of light meets a boundary between air and glass, some of the light is reflected and some is refracted, as shown.



The reflected light is partially plane polarised.

(a) State what is meant by plane polarised.

(2)

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(b) Deduce whether the refracted ray is unpolarised or partially plane polarised.

(2)

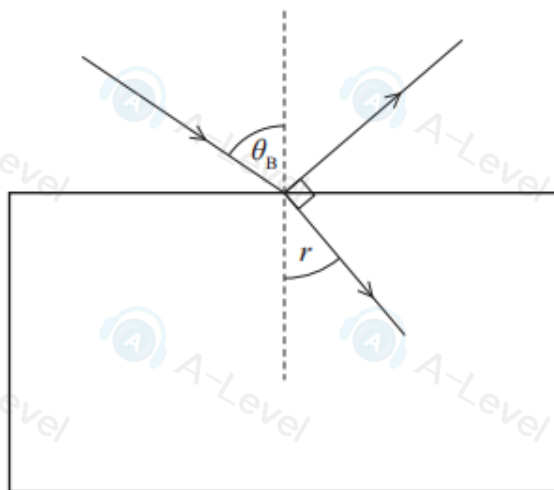
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- (c) At the Brewster angle θ_B , the reflected light is completely plane polarised. This occurs when the reflected ray and the refracted ray are at right angles to each other, so $\theta_B + r = 90^\circ$



- (i) Show that $\tan \theta_B = \frac{n_g}{n_a}$
 n_a = refractive index of air
 n_g = refractive index of glass

(3)

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(ii) Calculate θ_B for light passing from air into glass.

refractive index of air = 1.00

refractive index of glass = 1.50

(2)

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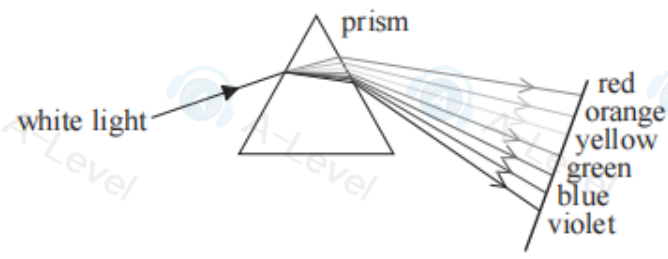
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$\theta_B =$

(iii) Different colours of visible light are refracted as they pass through a prism as shown.



A student suggests that the Brewster angle for violet light would be smaller than that for red light, as violet is refracted more than red.

Criticise this suggestion.

(2)

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(Total for Question 18 = 11 marks)

- 17 The photograph shows a new design of car that can travel with minimal operation from the driver compared to a conventional car.



The new car contains systems to detect other vehicles. One system uses a pulse-echo technique with laser light and another system uses the Doppler effect with microwaves.

- (a) One of these new cars travels behind a truck. Both vehicles are travelling at the same speed.

Pulses of laser light are transmitted from the new car and the time taken for each reflected pulse to return is measured.

The time between a pulse being transmitted and returning is measured to be 2.6×10^{-7} s.

Calculate the distance between the new car and the truck.

(3)

Distance =



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(b) The speed of the truck decreases.

(i) Explain how the new car uses the Doppler effect with microwaves to detect that the speed of the truck has decreased. (3)

(ii) The new car automatically applies the brakes when it detects that the speed of the truck has decreased.

Explain why the introduction of the new car may reduce road traffic accidents. (3)

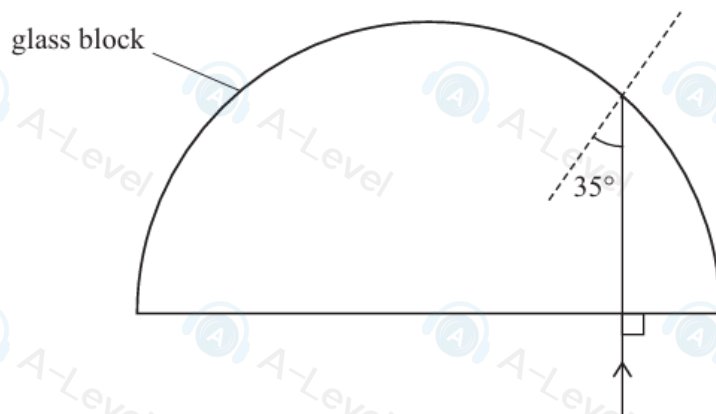
(Total for Question 17 = 9 marks)



P 5 1 6 3 4 A 0 2 1 2 8

14 A student used a semicircular glass block to investigate the refraction of light.

He directed a ray of light onto the glass block, as shown.



(a) State why the ray of light does not refract as it enters the glass block.

(1)

(b) The glass has a refractive index of 1.5

(i) The ray of light is refracted at the curved surface of the block.

Calculate the angle of refraction.

(2)

Angle of refraction =

