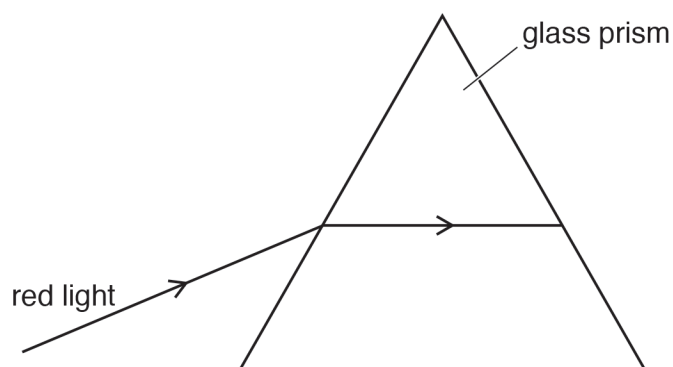**1** Show that the refractive index of glass with a critical angle of 45° is 1.41.

[2]

[Total: 2]

2 The diagram shows a ray of red light incident on one side of a glass prism in air.

For red light, the refractive index of glass is n_R.

(a) The angle of incidence is 53° and the angle of refraction in the glass is 30°.

(i) Calculate n_R.

n_R = ... [2]

(ii) On the diagram, sketch a line to indicate the path of the red light when it emerges from the glass prism. Label this path R. [1]

(b) For violet light, the refractive index n_V of glass is slightly larger than n_R.

A ray of violet light is incident on the prism along the same path as the ray of red light.

On the diagram, sketch a line to indicate the path of the violet light in the prism and when it emerges into the air. Label this path V.

[1]

[Total: 4]

3 Light passes from a beaker of water into air.

(a) State the speed of light in air.

.... [1]

(b) The refractive index of water is 1.3.

Calculate the speed of light in water.

speed of light in water = ... [3]
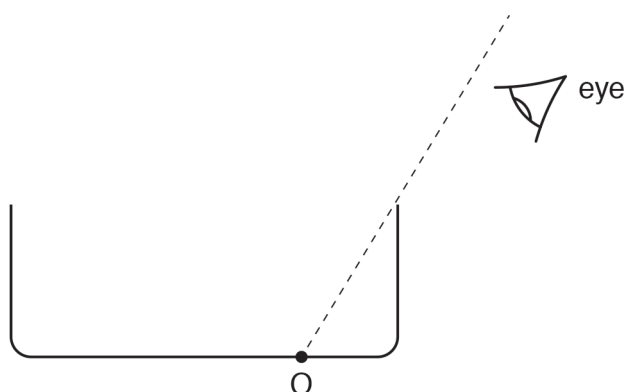
[Total: 4]

4 Explain why the quantity *refractive index* does not have a unit.

....

.... [1]

[Total: 1]

5 The diagram shows an empty container and an observer's eye. There is a small coin at position O. The observer is unable to see the coin.

The observer and the coin stay in the same position and the container is filled with water. The observer can now see the coin.

(a) Explain why the coin can be seen by the observer.

....

.... [2]

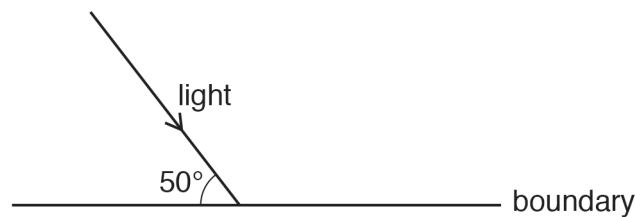**(b)** State the name of the wave process which occurs as the light passes from the water into the air.

.... [1]

(c) Explain why the image of the coin is a virtual image.

.... [1]

[Total: 4]

6 The diagram shows light approaching a boundary between two materials at speed *v*. The speed of the light after crossing the boundary is 1.3 *v*.

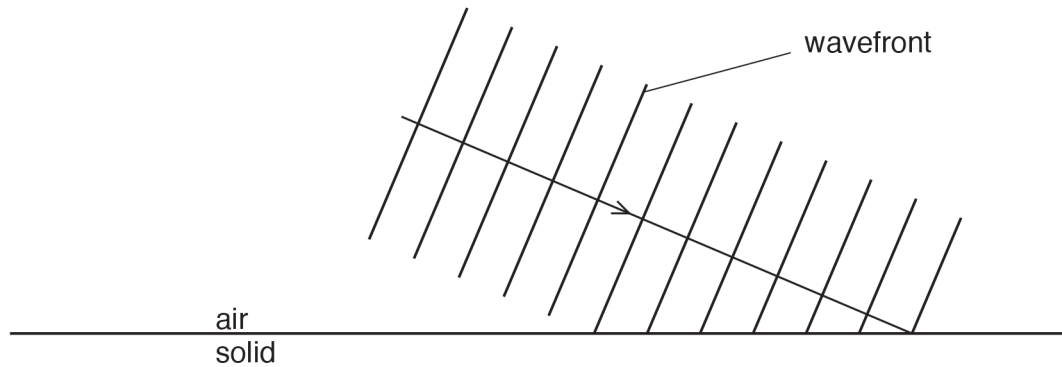**(a)** Determine the angle of incidence.

angle of incidence = ... [1]

(b) Calculate the angle of refraction.

angle of refraction = ... [3]

[Total: 4]

7 Green light of frequency 5.7×10^{14} Hz is travelling in air at a speed of 3.0×10^8 m/s. The light is incident on the surface of a transparent solid.

The diagram shows the wavefronts and the direction of travel of the light in the air.

The light travels more slowly in the transparent solid.

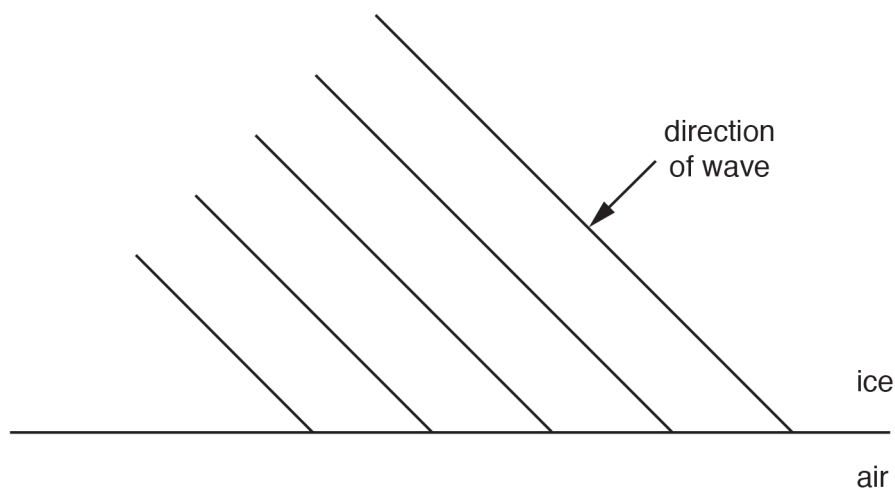The refractive index of the transparent solid is 1.3.

The light is incident on the surface of the solid at an angle of incidence of 67°.

Calculate the angle of refraction of the light in the solid.

angle of refraction = ... [2]

[Total: 2]

8   The diagram shows parallel wavefronts of a light wave in ice. The wavefronts are incident on a boundary with air.

The speed of the light wave in air is 3.0×10^8 m/s. The refractive index of the ice is 1.3.

Calculate the speed of the light wave in the ice.

speed = ... [2]

[Total: 2]

9   The critical angle for a type of glass is 42°.

Diagram A and diagram B show two prisms ABC and PQR made of this type of glass. A ray of monochromatic red light passes into each of the prisms.
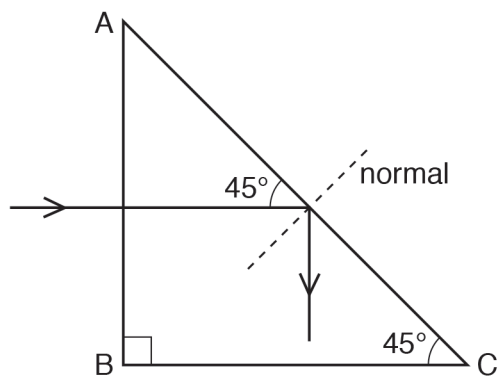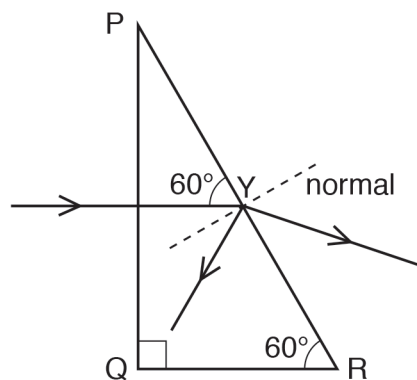

Diagram A   **Diagram B**

(a) Describe and explain what happens to the ray of light in diagram A as it strikes side AC of the prism.

....

....

.... [2]

(b) Describe and explain what happens to the ray of light in diagram B as it strikes the glass at point Y.

....

....

....

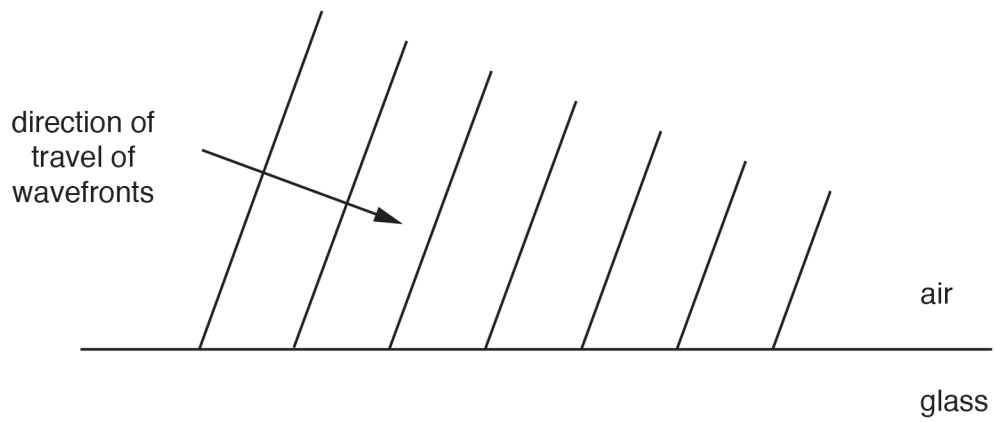... [3]

[Total: 5]

10 A wave, in air, is incident on a glass block. The diagram shows the wavefronts at the air-glass boundary. The arrow shows the direction of travel of the wavefronts.
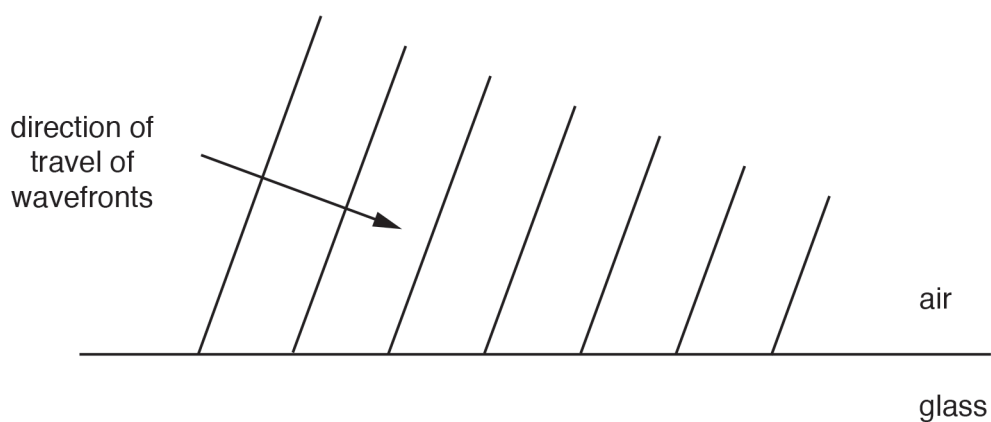
direction of travel of wavefronts

air

glass

The wave undergoes refraction at the air-glass boundary.

On the diagram draw the wavefronts of the refracted wave.

[3]

[Total: 3]

11 A wave, in air, is incident on a glass block. The diagram shows the wavefronts at the air-glass boundary. The arrow shows the direction of travel of the wavefronts.
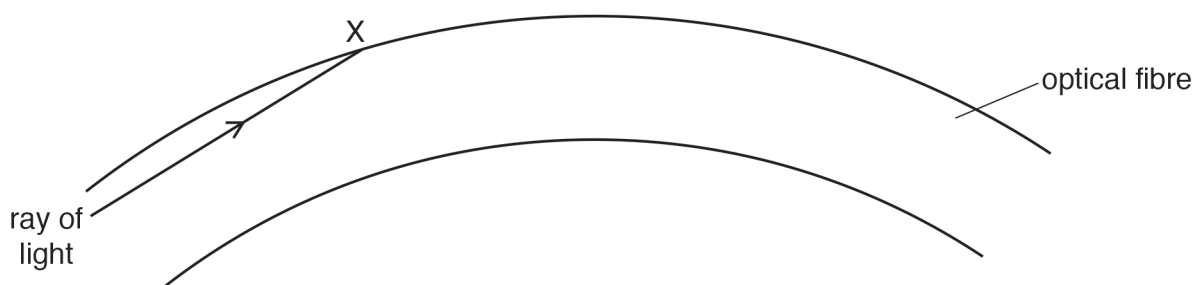
direction of
travel of
wavefronts

air

glass

The wave undergoes reflection at the air-glass boundary.

On the diagram draw the wavefronts of the reflected wave.

[3]

[Total: 3]

12 The diagram shows a section of an optical fibre in air. A ray of light is incident on the fibre wall at X.

X

optical fibre

ray of
light

(a) On the diagram, continue the path of the ray of light up to the end of the fibre. [1]

(b) The refractive index of the material of the fibre is 1.46. Calculate the critical angle of the material of the fibre.
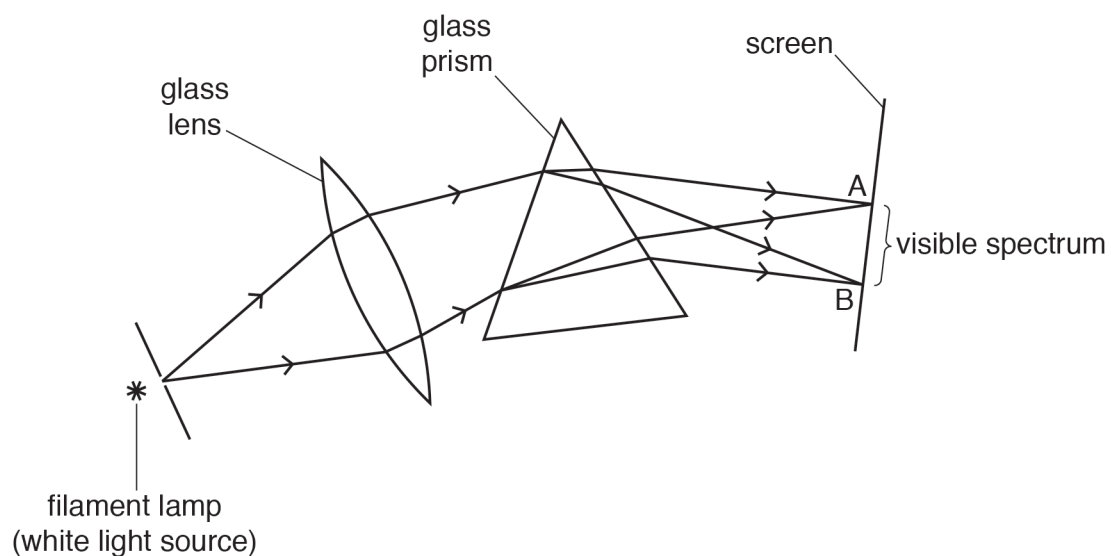
critical angle = ... [2]

(c) State **two** uses of optical fibres.

1 ....

2 .... [2]

[Total: 5]

13 The diagram shows a visible spectrum focused on a screen by passing light from a source of white light through a lens and a prism.

(a) State the name of the process that separates the colours in white light.

.... [1]

(b) State the colour of the light on the screen at:

point A ....

point B. .... [1]

(c) State the property of the glass of the prism that causes white light to be split into the different colours of the spectrum.

.... [1]

[Total: 3]

14 The speed of light in a block of glass is 1.9×10^8 m/s.

Calculate the refractive index of the glass.

refractive index = ... [2]

[Total: 2]

15 The speed of a light wave in air is 3.00×10^8 m/s. The refractive index of water is 1.33.

Calculate the speed of the light wave in water.

speed = ... [2]

[Total: 2]

16 A source emits visible light.

The diagram shows a ray of red light from the source incident on the face XY of a glass prism at point S.
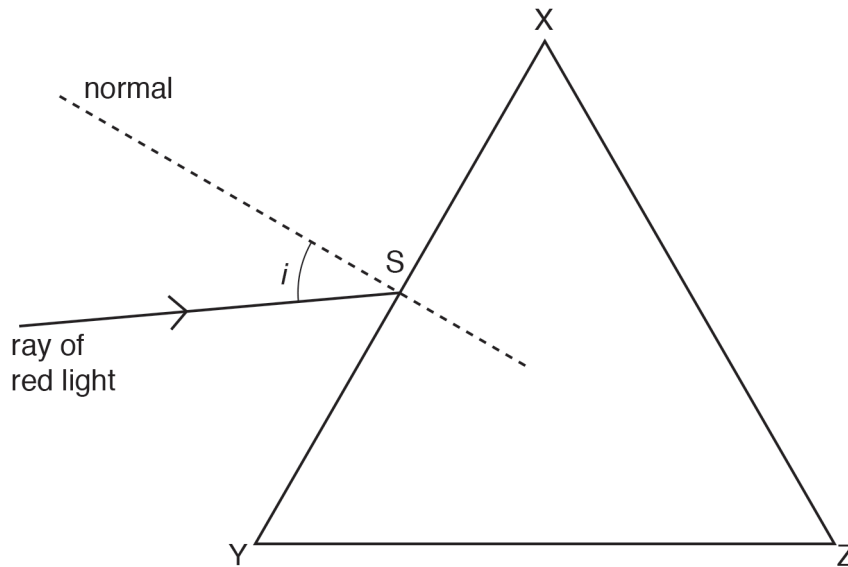
The angle of incidence *i* of the ray is 35 °. The refractive index of the glass for red light is 1.5.

(a) Calculate the angle of refraction in the glass at S.

angle of refraction = ... [2]

(b) On the diagram, draw the refracted ray at face XY and the ray emerging from face XZ of the prism. Label this ray R. [2]

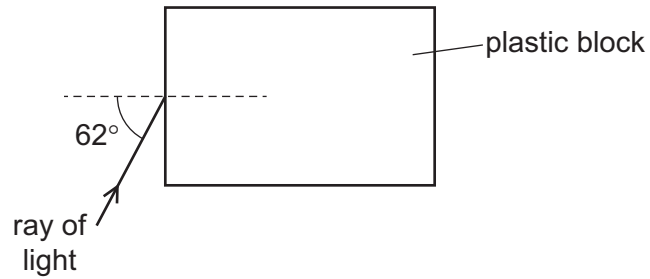**(c)** A ray of blue light follows the same path as the ray of red light incident on the face XY.

On the diagram, draw the path of this ray in the prism and emerging from the prism.

Label this ray B. [2]

[Total: 6]

17 Light travelling in air enters a plastic block at an angle of incidence of 62°.

The plastic has a refractive index of 1.48.

What is the angle of refraction?

A   18°   B   28°   C   37°   D   42°

[1]

[Total: 1]

18 The speed of light in air is 3.0×10^8 m / s.
The speed of light in a transparent liquid is 2.0×10^8 m / s.

A ray of light is incident on the surface of the liquid at an angle of incidence of 40°.

(a) Calculate the refractive index of the liquid.

refractive index = ... [2]

(b) Calculate the angle of refraction in the liquid.

angle of refraction = ... [2]

[Total: 4]