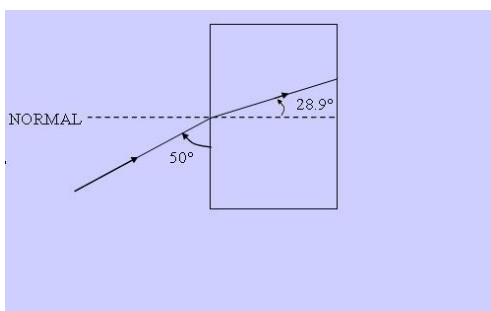# Higher Refraction of Light Questions

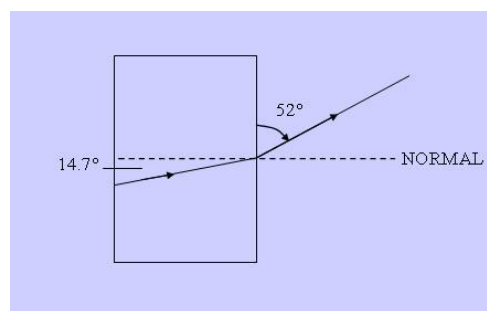| Medium	Refractive Index
Air	1.00
Water	1.33
Crown Glass	1.50
Diamond	2.42

This table can be used for any of the 15 questions that follow.

1. Identify the **unknown mediums** in the diagrams **a)** and **b)** by **calculation**.
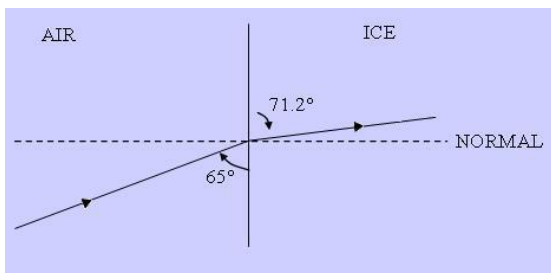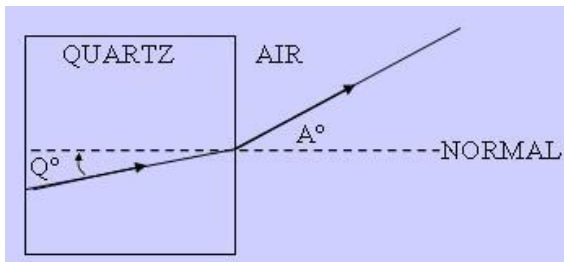
a)

b)

2. Monochromatic light of **wavelength 650nm** is passed from Air into Ice as shown in the diagram below.

   Calculate or find the following from the information given:

a) **Refractive index** of Ice.

b) **Wavelength** of the red light in Ice in **nm**.

c) **Speed** of red light in Ice.

d) **Frequency** of red light in Ice.

e) How does the **frequency** of red light **compare** in Air and in Ice?

3.

The table below shows the readings taken in a refraction of light experiment with light travelling from Quartz into Air.

| Angle Q (°)	10	19	27	34	39
Angle A (°)	15	30	45	60	75

a) State the equation linking angles Q° and A°.

b) Calculate **(n ± Absolute Uncertainty)** for Quartz.

4. Calculate the **critical angle** for the following substances:

a) Water.

b) Crown Glass.

c) Diamond.

5. a) **Calculate the critical angle for Glycerol** which has a refractive index of **1.47**.
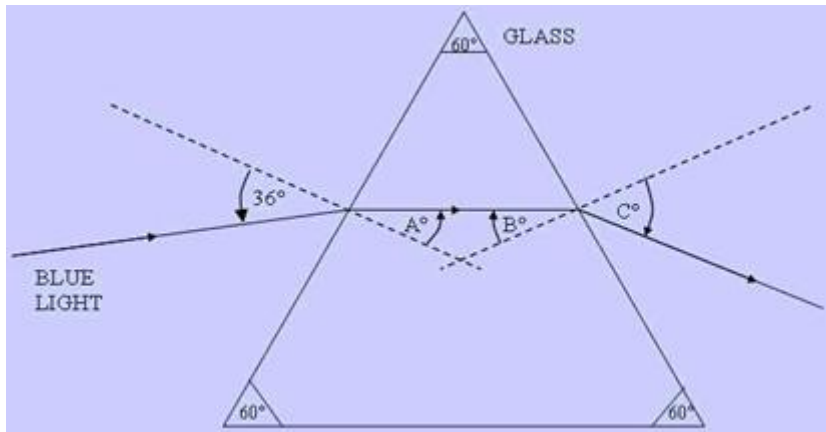
b) **Complete the following diagrams** showing the paths of the rays of light between the Glycerol to Air interface.
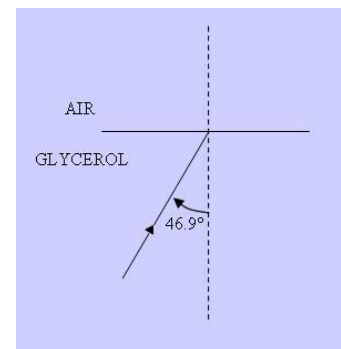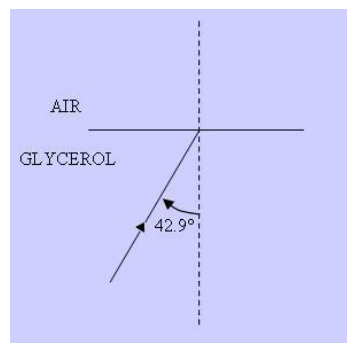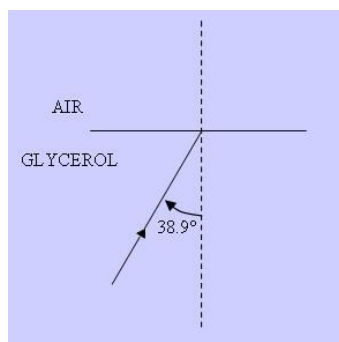
All of the angles should be added to the diagrams by calculation or otherwise!!!

6. Blue light of refractive index 1.54 in glass is shone into the triangular glass prism below.
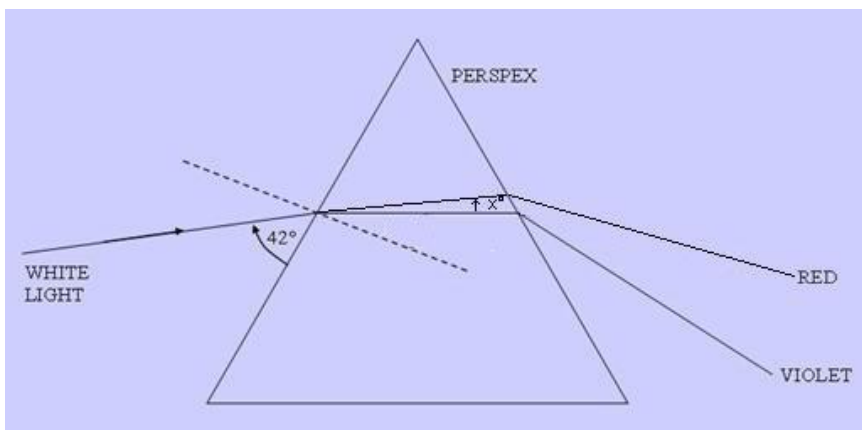
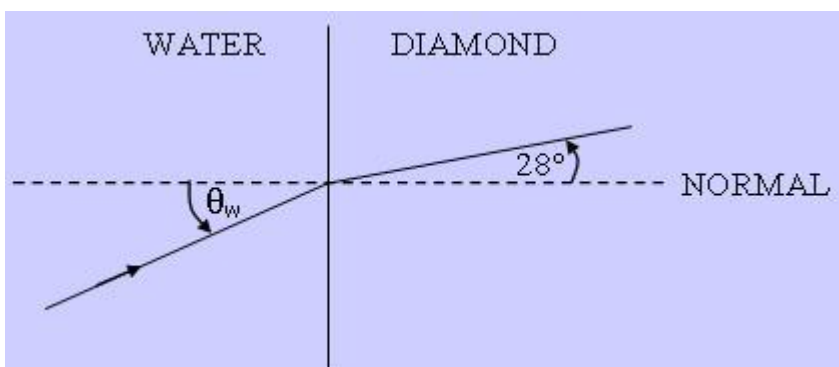**Calculate or find** the unknown angles **A, B and C**.

7. The refractive index of **red** light in Perspex is **1.52 and 1.54 for violet** light.
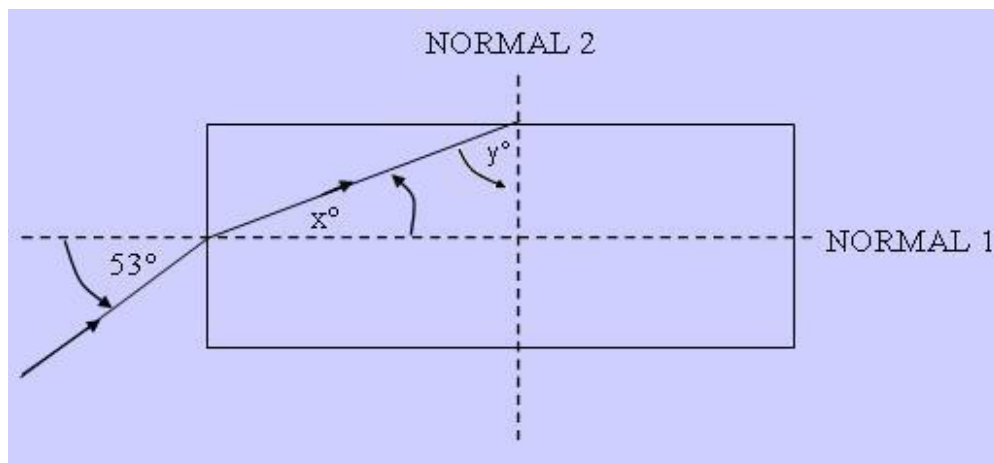
Calculate or find:

a) **Speed of red light** in Perspex.
b) **Speed of violet light** in Perspex.
c) **Angle X°** shown in the diagram below.

**8.** Calculate the **angle θ_w** in the diagram below.

9. A light beam strikes the edge of a rectangular block of Perspex of **refractive index 1.51** as shown below.

Calculate or find:

a) i) Angle **X°**.

  ii) Angle **Y°**.

  iii) **Critical angle** of the Perspex.

b) **Explain what happens** to the beam of light at Normal 2.

**10. Blue light** of wavelength **430 nm** passes from Air to Crown Glass and then into Water as shown below.
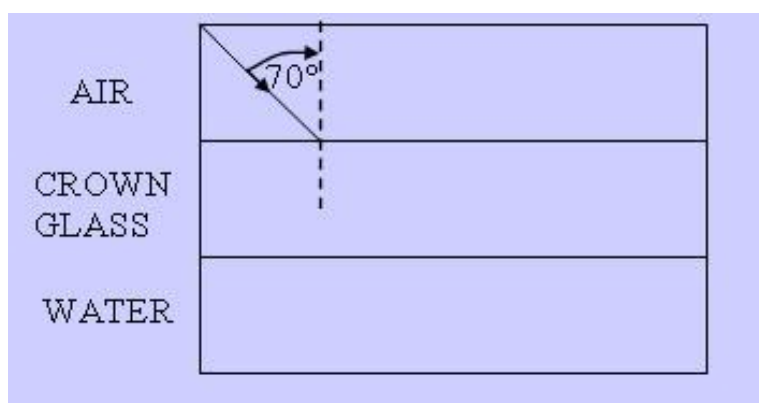
a) **Complete the path of the ray of light** when passing from Air through to Water, calculating and **displaying all** of the **relevant angles**.

b) Calculate **the speed of light** in **Water** and in **Crown Glass**.

c) Calculate the **wavelength of the light** in **Water** and in **Crown Glass**.

11.

A beam of monochromatic light of frequency $4 \cdot 85 \times 10^{14}$ Hz passes from air into liquid paraffin. In liquid paraffin the light has a speed of $2 \cdot 10 \times 10^8$ m s^{-1}.

(a) Calculate the refractive index of the liquid paraffin.

(b) What is the frequency of the light when it is in the liquid paraffin?

12. The following graph shows how refractive index depends on the type of material and the wavelength in air of the light used.
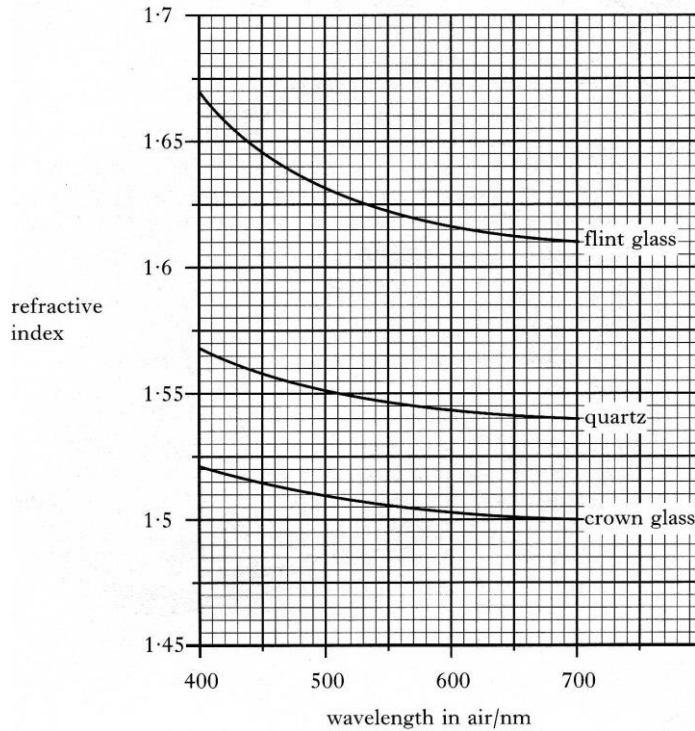
A ray of light of wavelength 510 nm in air passes into a block of quartz.

 (i) Calculate the wavelength of this light in the quartz.

 (ii) Explain what happens to the value of the critical angle in quartz as the wavelength of visible light increases.

(iii) A ray of white light enters a triangular prism made of crown glass, producing a visible spectrum on a screen, as shown below.
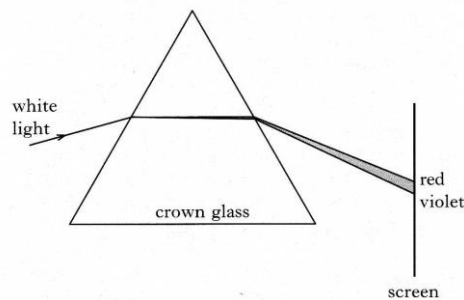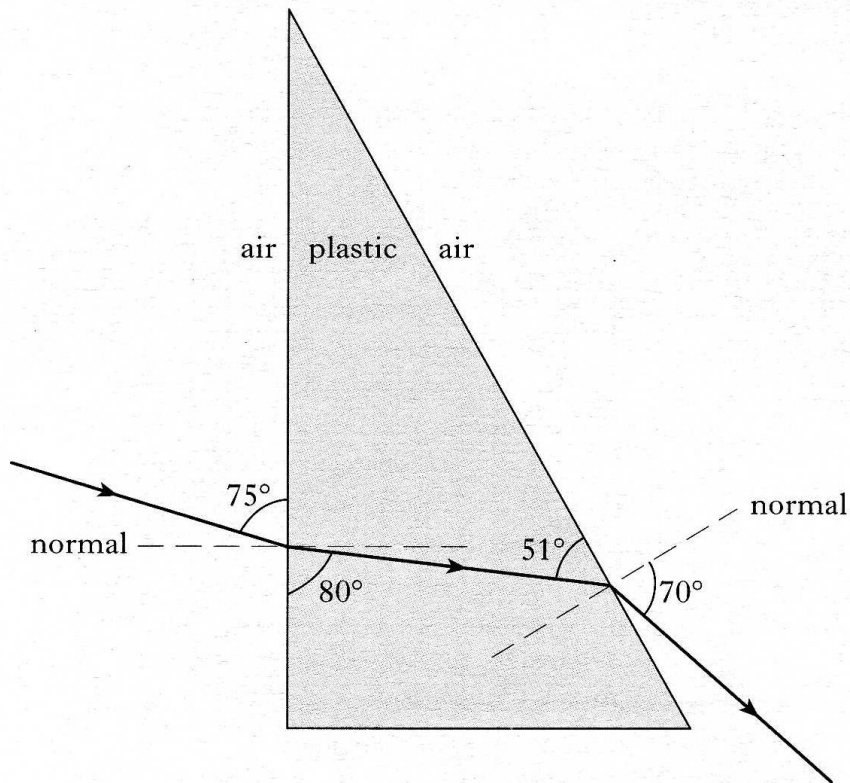

The crown glass prism is now replaced by a similar prism made from flint glass.

Describe how the visible spectrum on the screen will be different from before.

13.

(a) The diagram below shows the refraction of a ray of red light as it passes through a plastic prism.

Calculate the refractive index of the plastic for this red light.

(b) The refractive index of a glass block is found to be 1·44 when red light is used.

(i) What is the value of the critical angle for this red light in the glass?

(ii) The diagram shows the paths of two rays of this red light, PO and QO, in the glass block.
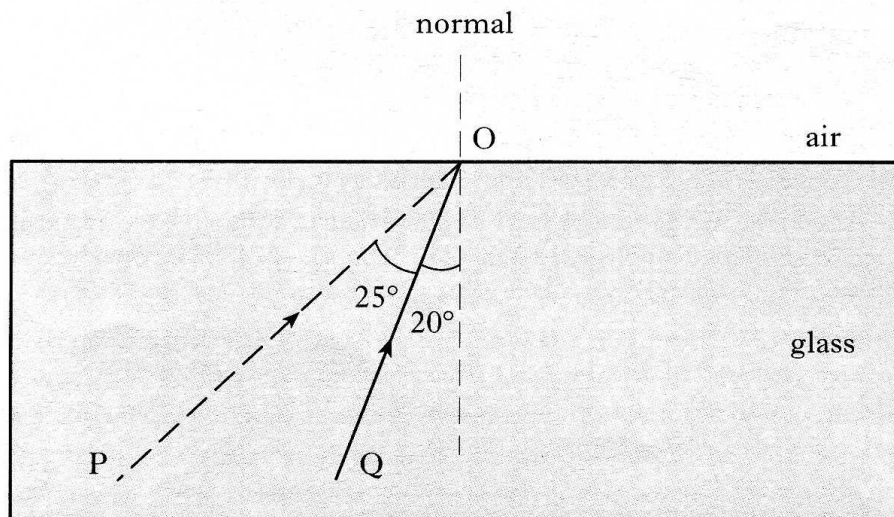
When rays PO and QO strike the glass-air boundary, **three** further rays of light are observed.

Copy and complete the diagram to show **all five** rays.

Clearly indicate which of the three rays came from P and which came from Q.

The values of all angles should be shown on the diagram.

14.

A laser beam is used to investigate the refraction of light from water into air.

A waterproof laser is placed within a tank of water and the laser beam is directed towards the water surface as shown below.
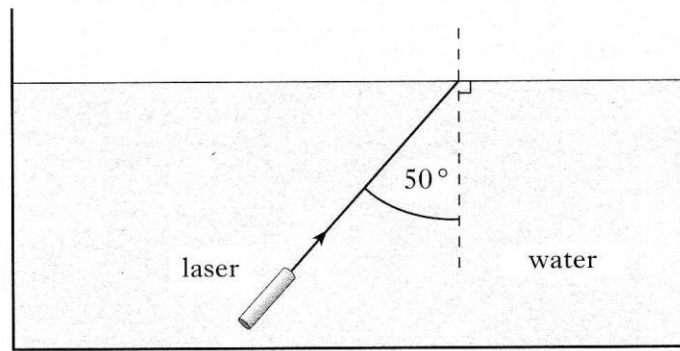
(a) The water in the tank has a refractive index of 1·33. Describe what will happen to the ray of light at the water surface. You must justify your answer by calculation.

(b) The water in the tank is replaced by another liquid. The position of the laser is altered so that the laser beam follows the path shown in the diagram below. The angle θ_1, and the angle θ_2, as shown in the diagram, are measured.
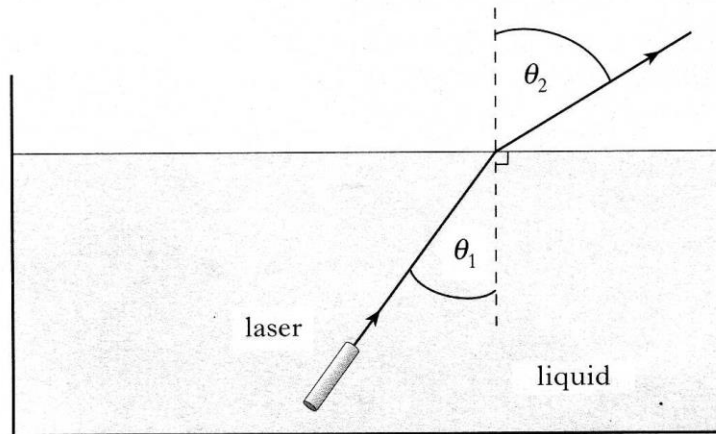
The measurements are repeated for different values of θ_1 and the corresponding values of θ_2. The values of $\sin \theta_1$ and $\sin \theta_2$ are used to plot the graph shown below.
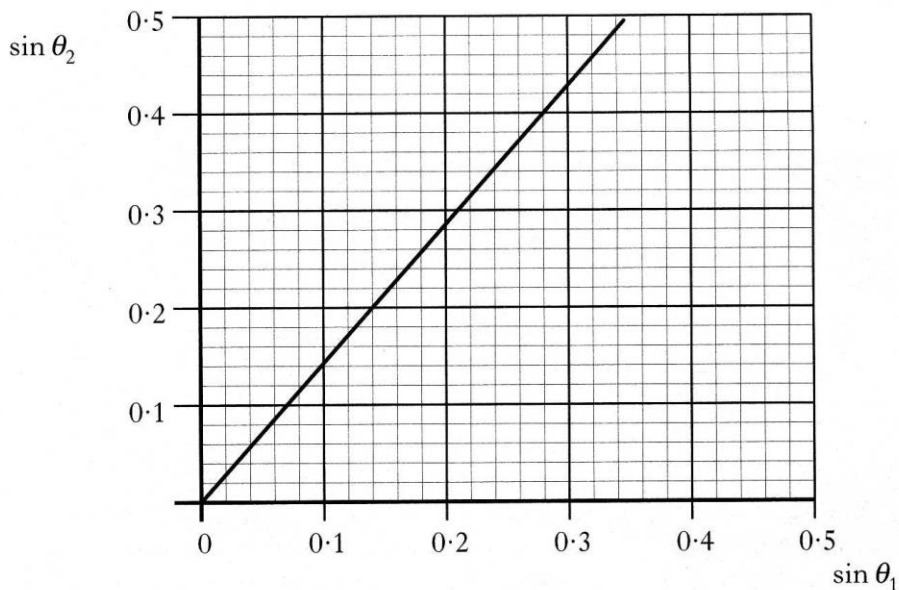
Use information from the graph to calculate the refractive index of the liquid.

(c) Light from the laser has a wavelength of 670×10^{-9}m in air. What is the wavelength of the laser light when passing through a liquid which has a refractive index of 1·47?

15.

A decorative lamp has a transparent liquid in the space above a bulb. Light from the bulb passes through rotating coloured filters giving red or blue light in the liquid.

(a) A ray of red light is incident on the liquid surface as shown.
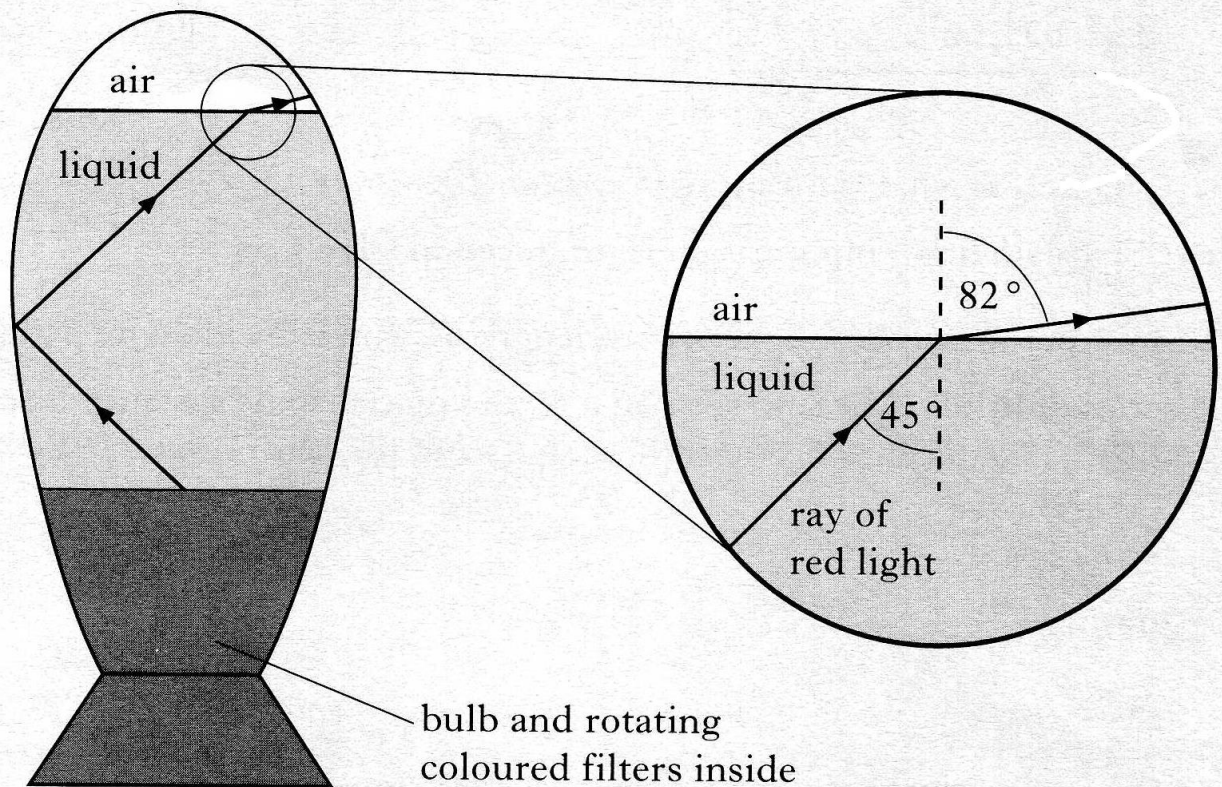
(i) Calculate the refractive index of the liquid for the red light.

(ii) A ray of blue light is incident on the liquid surface at the same angle as the ray of red light.

The refractive index of the liquid for blue light is greater than that for red light. Is the angle of refraction greater than, equal to or less than 82° for the blue light?

You must explain your answer.

(b) A similar lamp contains a liquid which has a refractive index of 1·44 for red light. A ray of red light in the liquid is incident on the surface at an angle of 45° as before.

Sketch a diagram to show the path of this ray after it is incident on the liquid surface.

Mark on your diagram the values of all appropriate angles.

All relevant calculations must be shown.