Higher
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Past Paper questions
2000 - 2010
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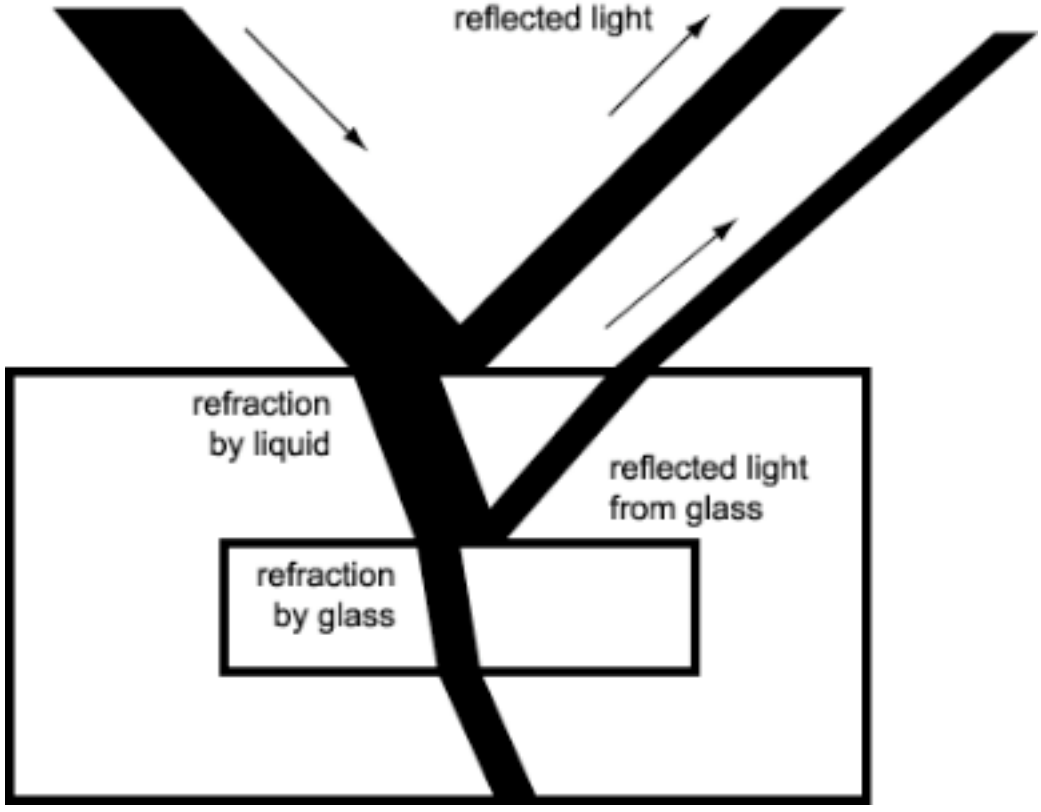
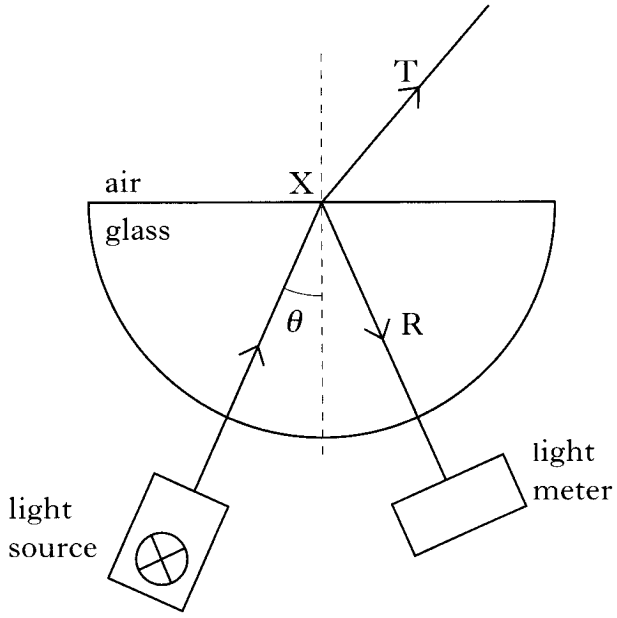
3.2 Refraction



2000 Q27

A student is investigating the effect that a semicircular glass block has on a ray of monochromatic light. She observes that at point X the incident ray splits into two rays:

T - a transmitted ray
R - a reflected ray.



The student uses a light meter to measure the intensity of ray R as angle θ is changed.

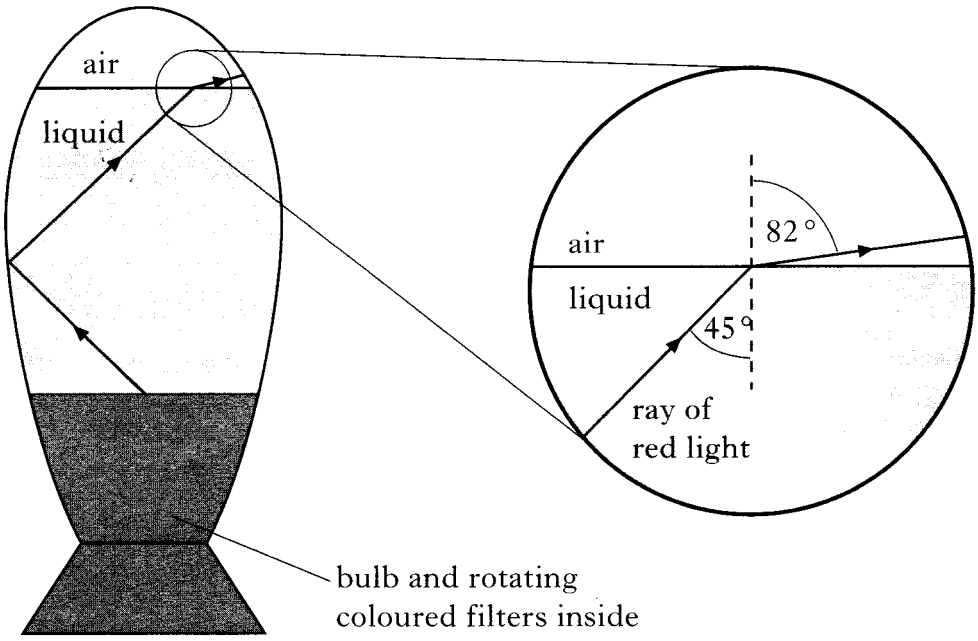
(a) State what is meant by the intensity of a radiation.

(b) Explain why, as angle θ is changed, it is important to keep the light meter at a constant distance from point X for each measurement of intensity.

2004 Q27.

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.

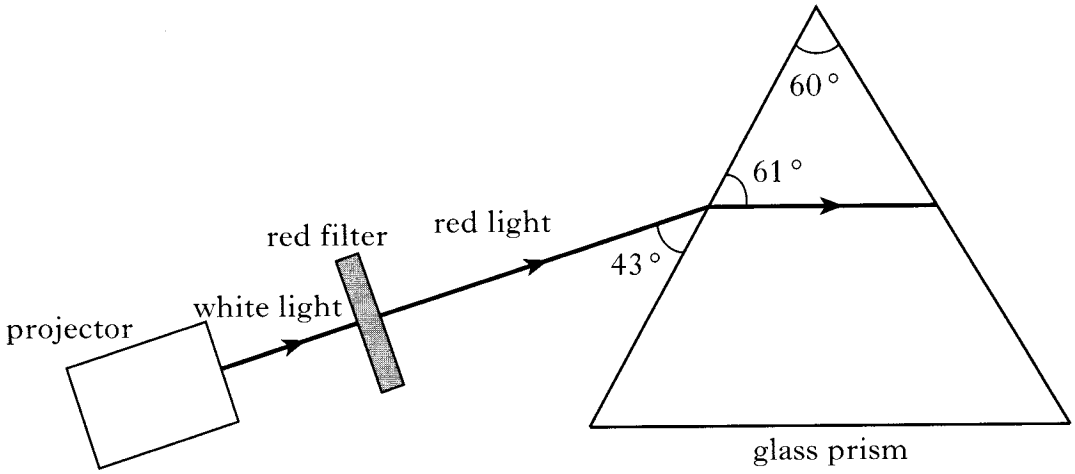
(ii) A ray of blue light is incident on the liquid surface at the same angle as the ray of red light.
The refractive index of the liquid for blue light is greater than that for red light. Is the angle of refraction greater than, equal to or less than 82° for the blue light?
You must explain your answer.

(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.

2005 Q28.

A physics student investigates what happens when monochromatic light passes through a glass prism or a grating.

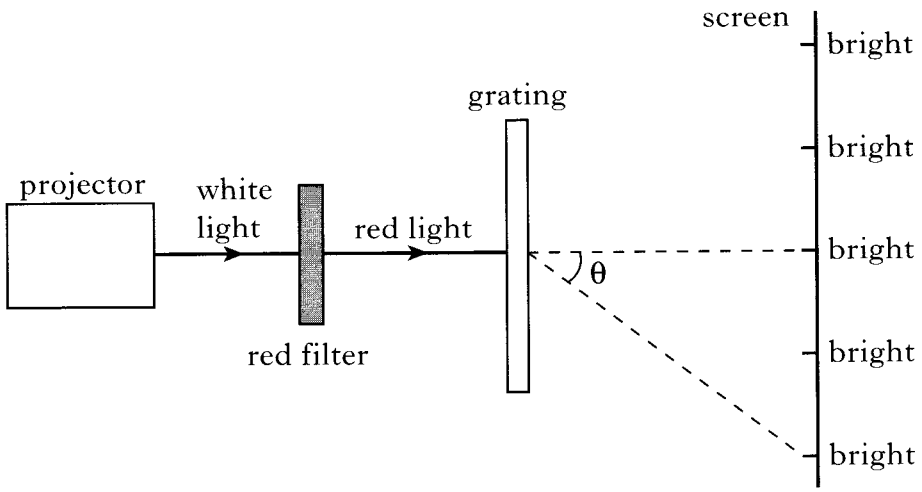
(a) The apparatus for the first experiment is shown below.



(i) Calculate the refractive index of the glass for the red light.

(ii) Sketch a diagram which shows the ray of red light before, during and after passing through the prism. Mark on your diagram the values of all relevant angles.

(b) The apparatus for the second experiment is shown below.



A pattern of bright and dark fringes is observed on the screen.

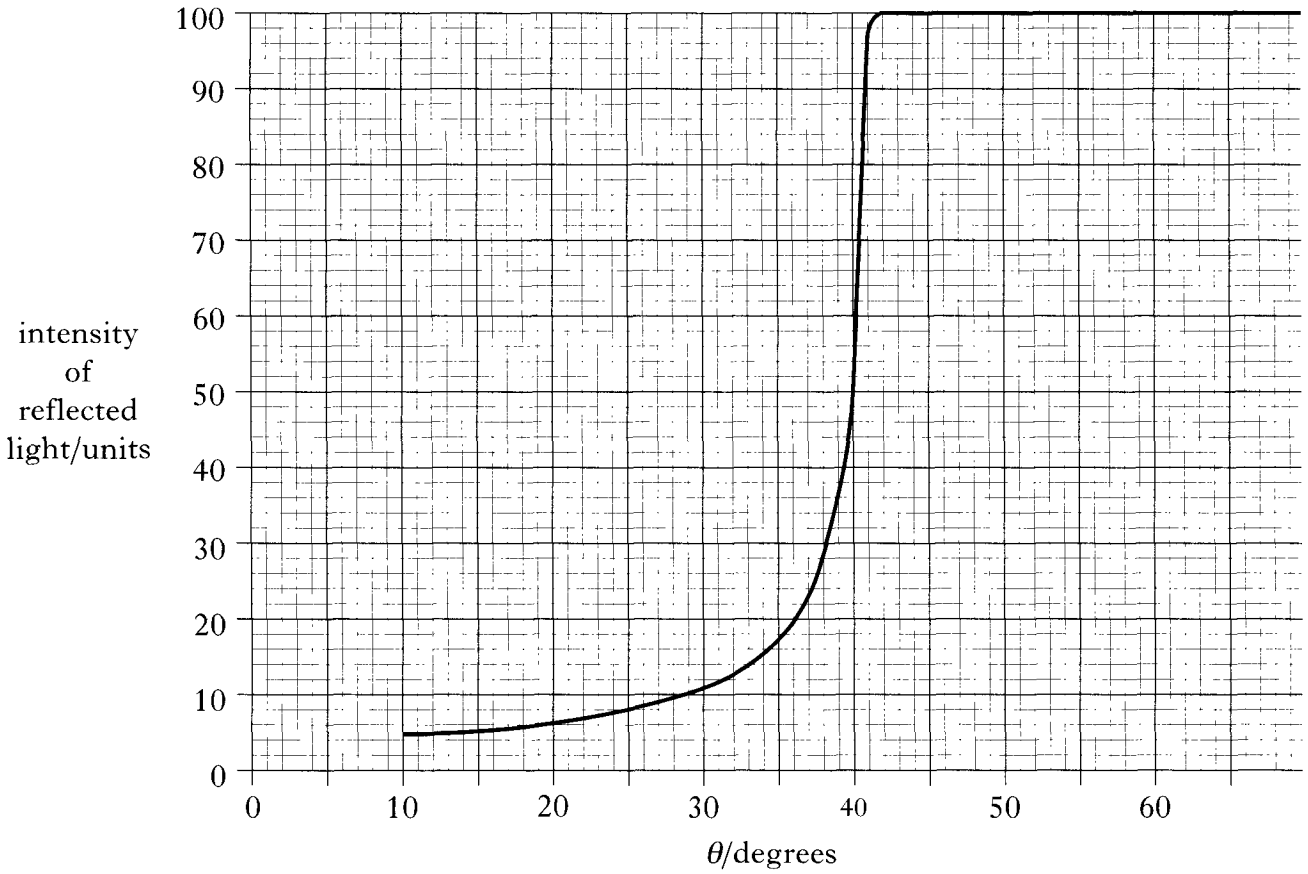
The grating has 300 lines per millimetre and the wavelength of the red light is 650 nm.

(i) Explain how the bright fringes are produced.

(ii) Calculate the angle θ of the second order maximum.

(iii) The red filter is replaced by a blue filter.
Describe the effect of this change on the pattern observed.
Justify your answer.

(c) The graph below is obtained from the student's results.

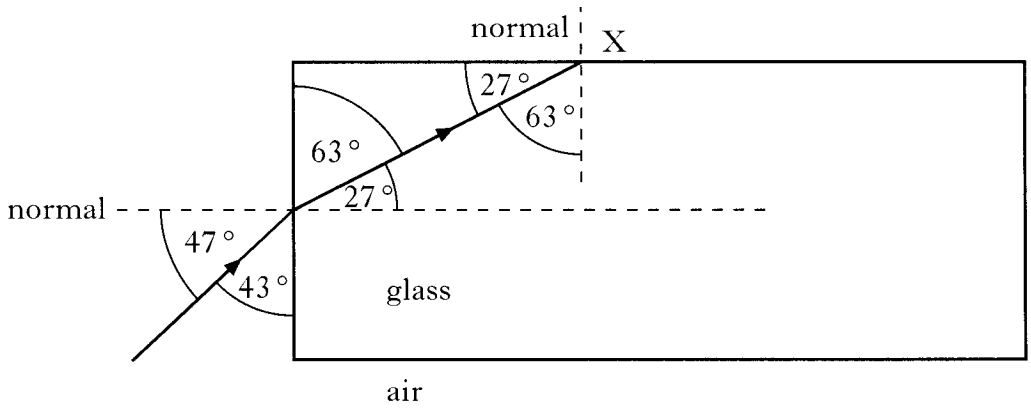


(i) What is the value of the critical angle in the glass for this light?
(ii) Calculate the refractive index of the glass for this light.
(iii) As the angle θ is increased, what happens to the intensity of ray T?

2001 Q27

(a) Light of wavelength 486 X 10-9 m is viewed using a grating with a slit spacing of 2.16 X 10-6 m. Calculate the angle between the central maximum and the second order maximum.

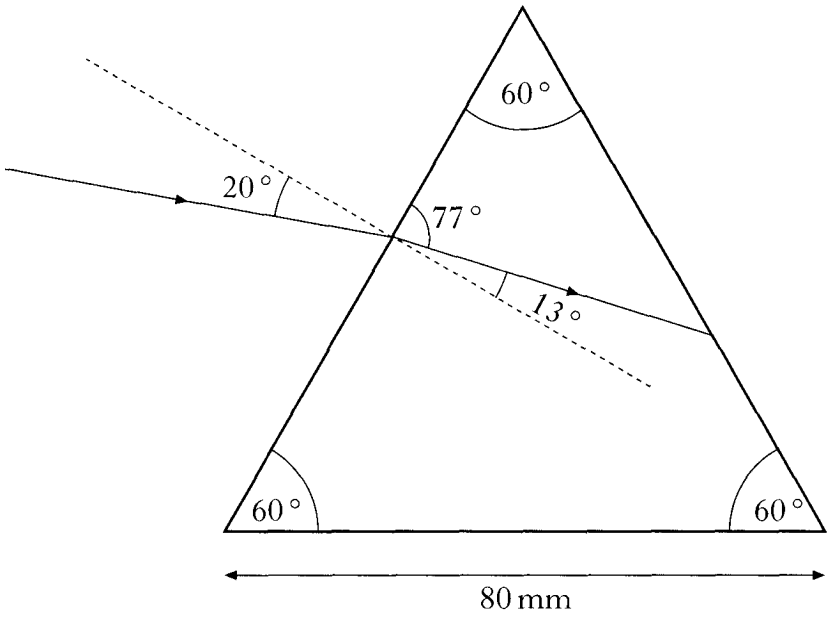
(b) A ray of monochromatic light passes from air into a block of glass as shown.



(i) Using information from the diagram, show that the refractive index of the glass for this light is 1.61.
(ii) Show by calculation whether the ray is totally internally reflected at point X.

2002 Q27

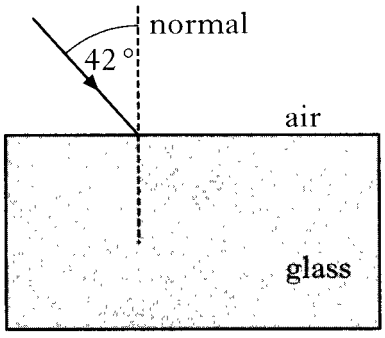
A ray of red light is directed at a glass prism of side 80 mm as shown in the diagram below.



(a) Using information from this diagram, show that the refractive index of the glass for this red light is 1.52.
(b) What is meant by the term critical angle?
(c) Calculate the critical angle for the red light in the prism.
(d) Sketch a diagram showing the path of the ray of red light until after it leaves the prism. Mark on your diagram the values of all relevant angles.

2003 Q27 (b)

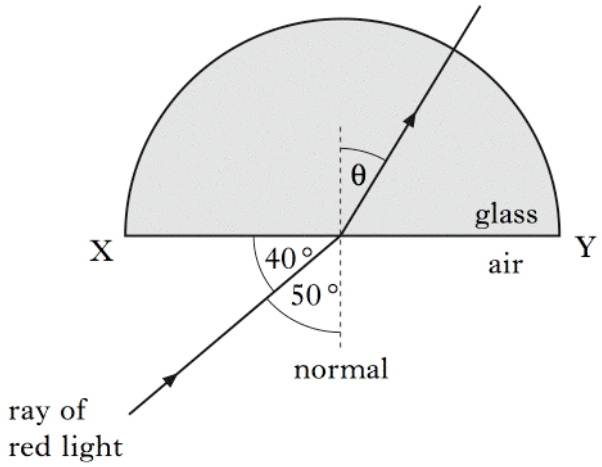
(b) A laser produces light of frequency 4.74×10^{14} Hz in air.
A ray of light from this laser is directed into a block of glass as shown below.



The refractive index of the glass for this light is 1.60.
(i) What is the value of the frequency of the light in the block of glass?
(ii) Calculate the wavelength of the light in the glass.

2007 Q29.

A ray of red light is incident on a semicircular block of glass at the mid point of XY as shown.



The refractive index of the block is 1.50 for this red light.

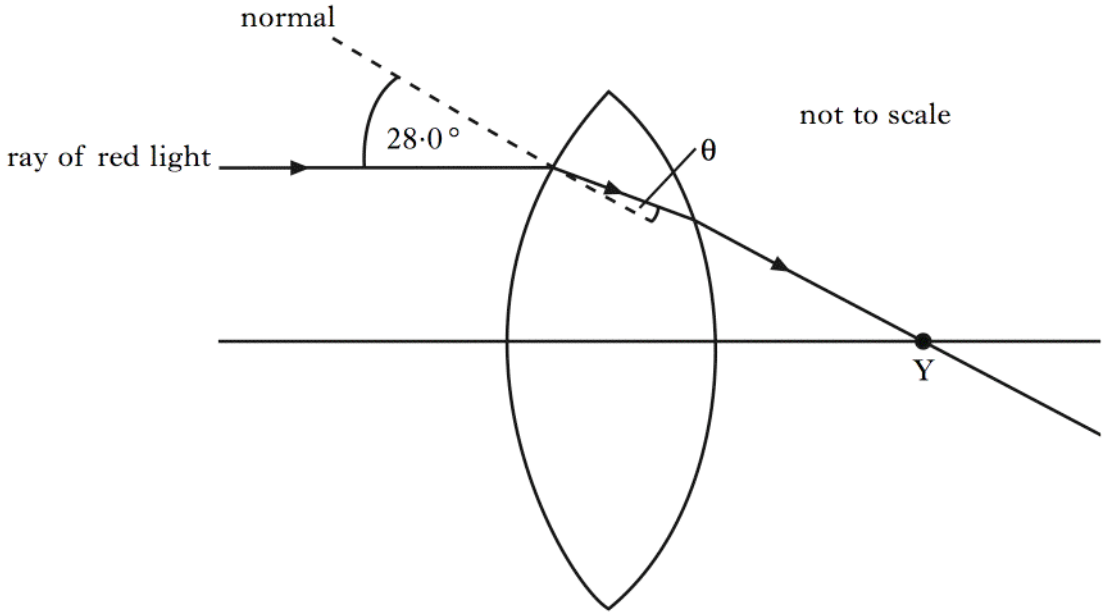
(a) Calculate angle θ shown on the diagram.

(b) The wavelength of the red light **in the glass** is 420 nm.
Calculate the wavelength of the light in air.

(c) The ray of red light is replaced by a ray of blue light incident at the same angle. The blue light enters the block at the same point. Explain why the path taken by the blue light in the block is different to that taken by the red light.

2008 Q27.

(a) A ray of red light of frequency 4.80×10^{14} Hz is incident on a glass lens as shown.

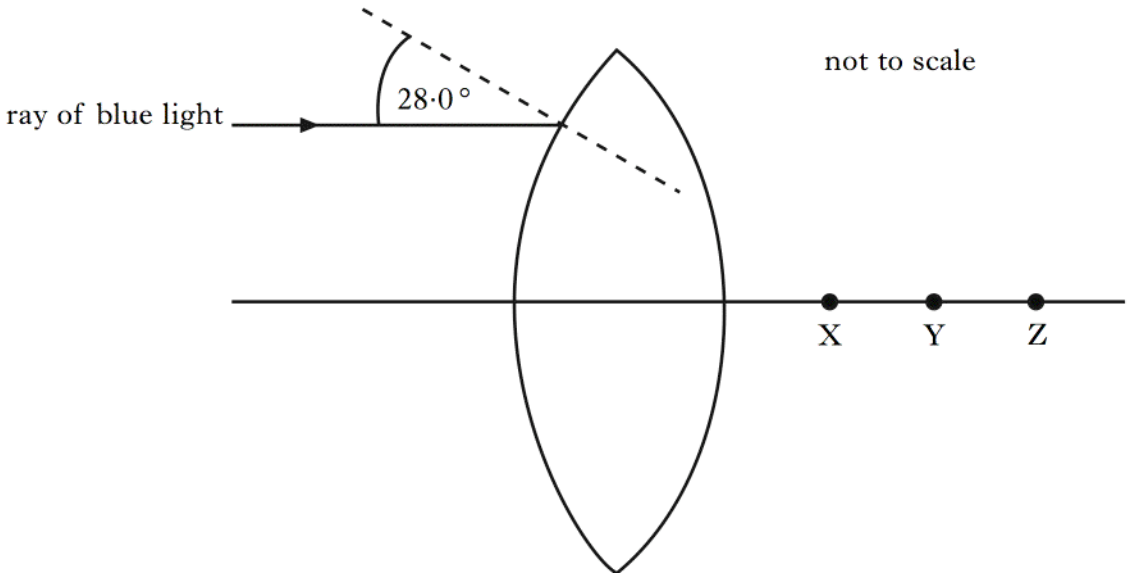


The ray passes through point Y after leaving the lens.
The refractive index of the glass is 1.61 for this red light.

(i) Calculate the value of the angle θ shown in the diagram.

(ii) Calculate the wavelength of this light inside the lens.

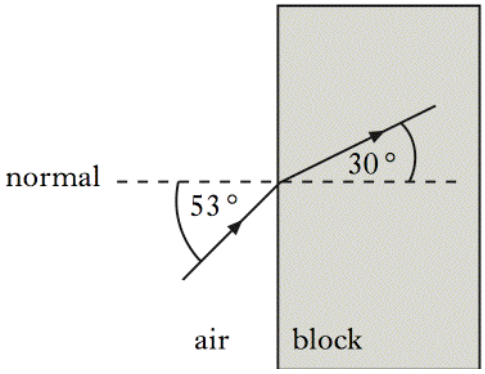
(b) The ray of red light is now replaced by a ray of blue light.
The ray is incident on the lens at the same point as in part (a).



Through which point, X, Y or Z, will this ray pass after leaving the lens?
You must justify your answer.

2009 Q28.

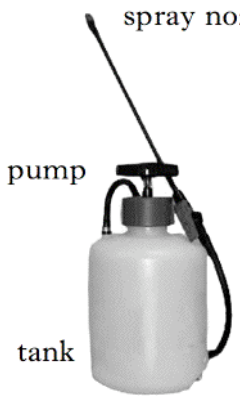
(b) Another source of light has a frequency of 4.6×10^{14} Hz in air.
A ray of this light is directed into a block of transparent material as shown.



Calculate the wavelength of the light in the block.

2010 Q28.

A garden spray consists of a tank, a pump and a spray nozzle.



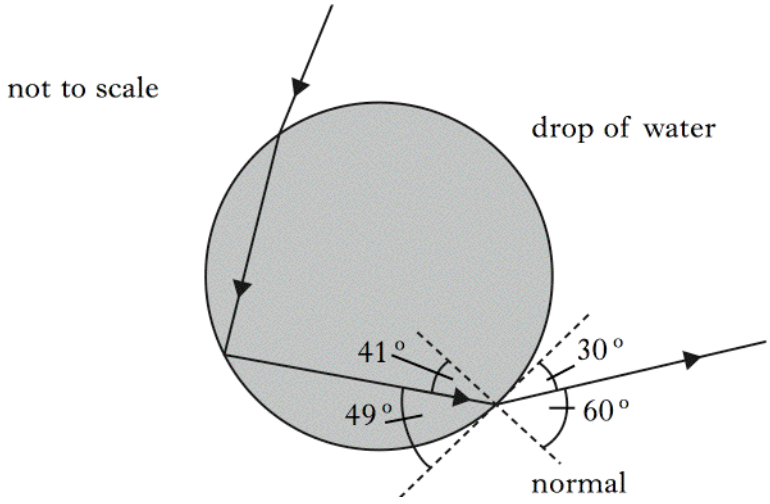
The tank is partially filled with water. The pump is then used to increase the pressure of the air above the water.

(a) The volume of the compressed air in the tank is 1.60×10^{-3} m^3.
The surface area of the water is 3.00×10^{-2} m^2.
The pressure of the air in the tank is 4.60×10^5 Pa.

(i) Calculate the force on the surface of the water.

(ii) The spray nozzle is operated and water is pushed out until the pressure of the air in the tank is 1.00×10^5 Pa.
Calculate the volume of water expelled.

(b) The gardener observes a spectrum when sunlight illuminates the drops of water in the spray.
This is because each drop of water is acting as a prism.
The diagram shows the path taken by light of wavelength 650 nm through a drop of water.



(i) What happens to the frequency of this light when it enters the drop of water?

(ii) Using information from the diagram, calculate the refractive index of the water for this wavelength of light.

(iii) Calculate the critical angle for this wavelength of light in the water.

(iv) Light of shorter wavelength also passes through the drop of water.
Will the critical angle for this light be less than, equal to, or greater than that for light of wavelength 650 nm?
Justify your answer.