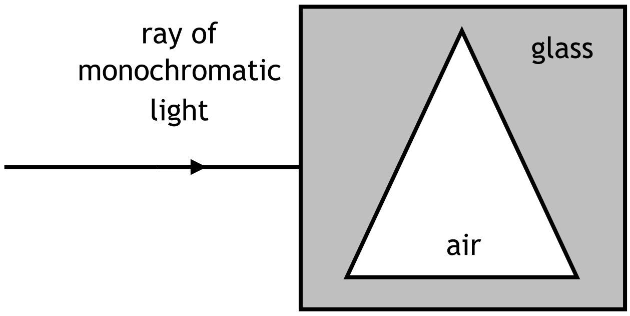
Homework 6: Refraction of Light

1. Light of frequency $6{\cdot}0 \times 10^{14}$ Hz passes from air into glass. The refractive index of the glass is 1·5 and the speed of light in air is $3{\cdot}00 \times 10^{8}$ ms^{-1}.

   The wavelength of this light in the **glass** is

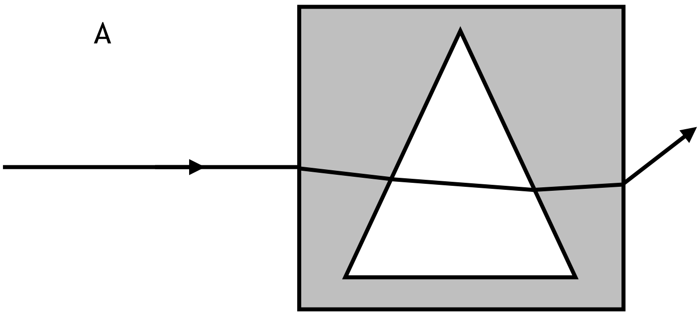
   A $5{\cdot}0 \times 10^{-9}$ m
   B $3{\cdot}3 \times 10^{-7}$ m
   C $5{\cdot}0 \times 10^{-7}$ m
   D $7{\cdot}5 \times 10^{-7}$ m
   E $1{\cdot}8 \times 10^{23}$ m

2. A ray of monochromatic light is directed at right angles into a rectangular glass block as shown below. The centre of the block has a hollow **air-filled** prism shape.



   Identify the diagram that correctly shows the path followed by the ray of light as it passes through the block.

A



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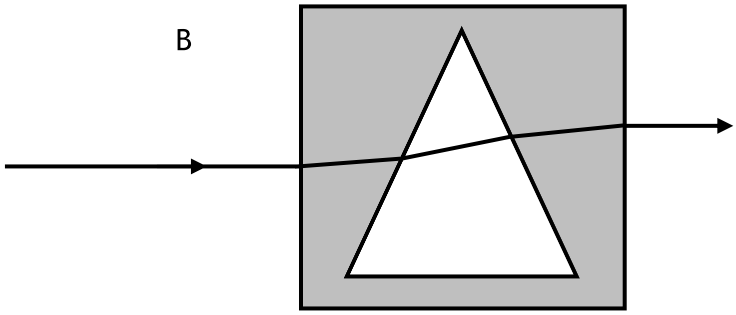

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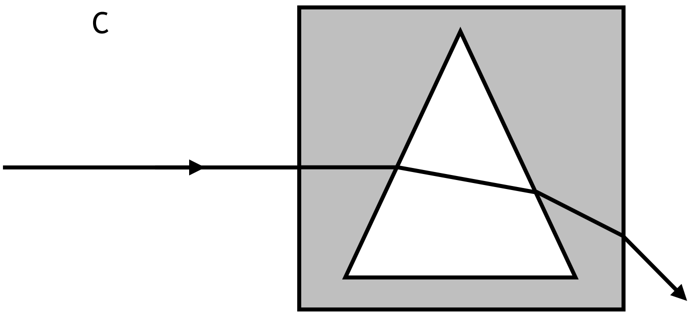
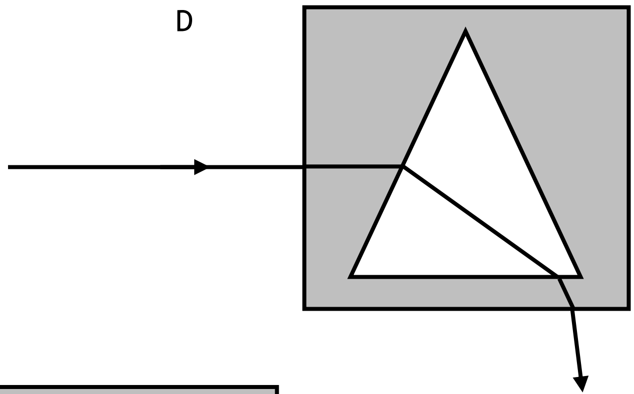
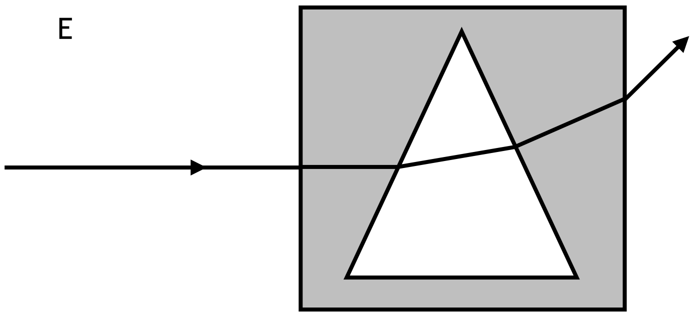


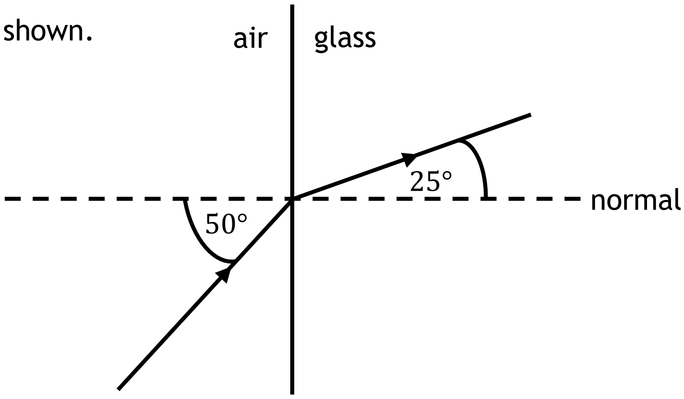
D



E



3. A ray of red light travels from air into glass as shown.



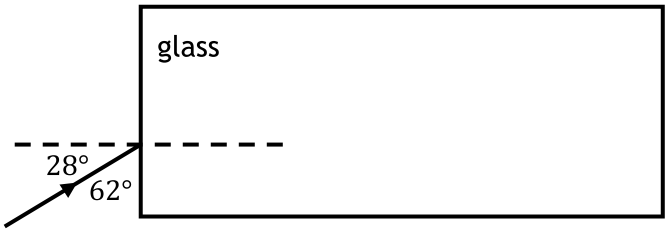
The critical angle for the glass is

A 33·5°
B 41·1°
C 45·0°
D 45·2°
E 65·0°

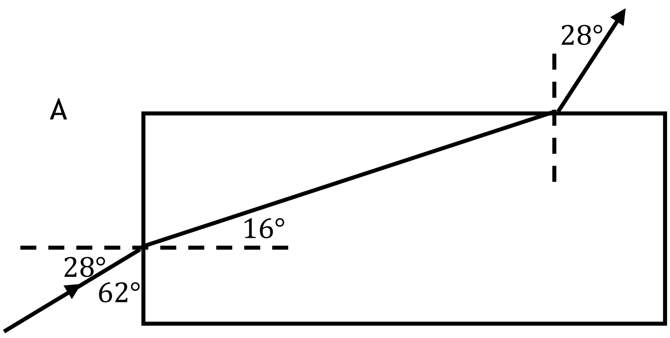
4. A ray of red light travels from perspex into air. Identify the row in the table that shows what happens to the speed and the frequency of the light on entering the air.

	Speed	*Frequency*
A	increases	increases
B	decreases	remains the same
C	remains the same	increases
D	increases	remains the same
E	decreases	decreases

5. A ray of monochromatic light, travelling in air, strikes the side of a rectangular block of glass of refractive index 1·7, as shown.
Identify the diagram that correctly shows the subsequent path of the ray of light.



A



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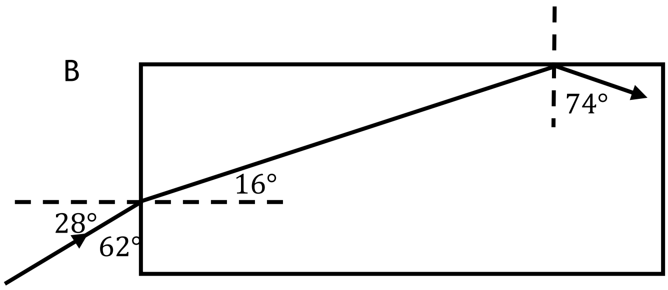

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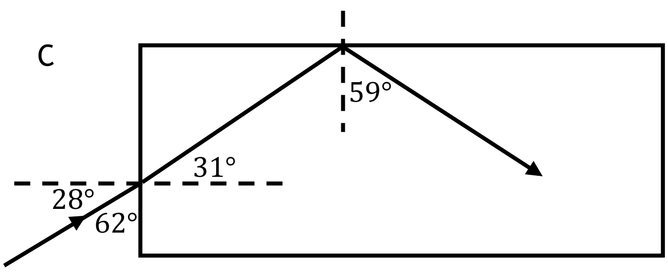

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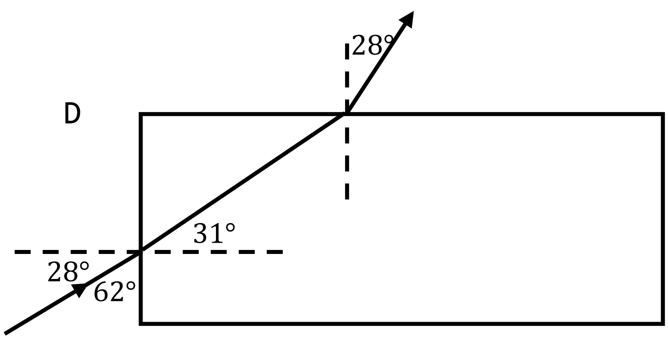

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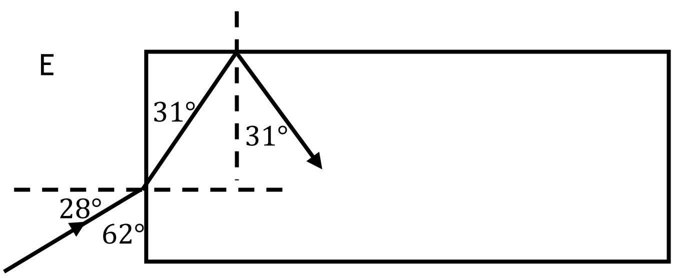


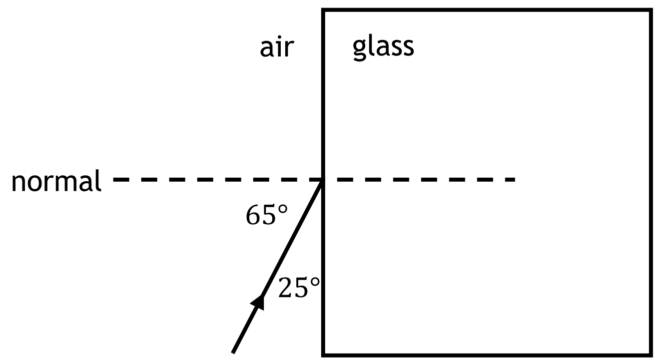
6. A ray of light passes from air into water.
A student makes the following statements about the light.

I The speed of the light in water is less than the speed of the light in air.
II The frequency of the light in water is less than the frequency of the light in air.
III The wavelength of the light in water is less than the wavelength of the light in air.

Which of the statements is/are correct?

A I only
B II only
C III only
D I and III only
E I, II and III

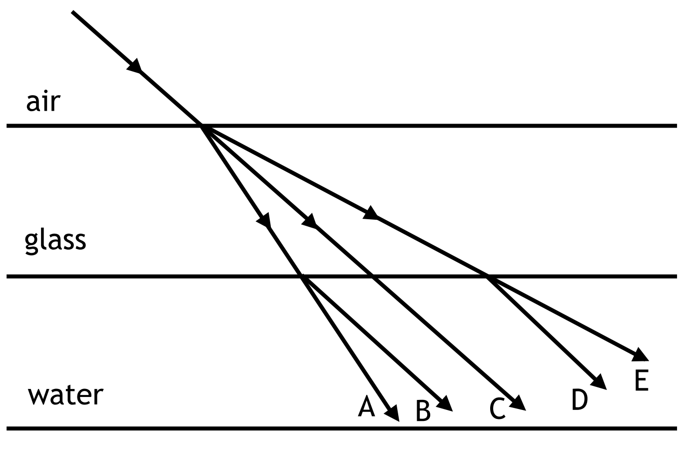
7. A ray of monochromatic light of frequency $6 \cdot 0 \times 10^{14}$ Hz is incident upon a block of glass of refractive index 1·5, as shown.



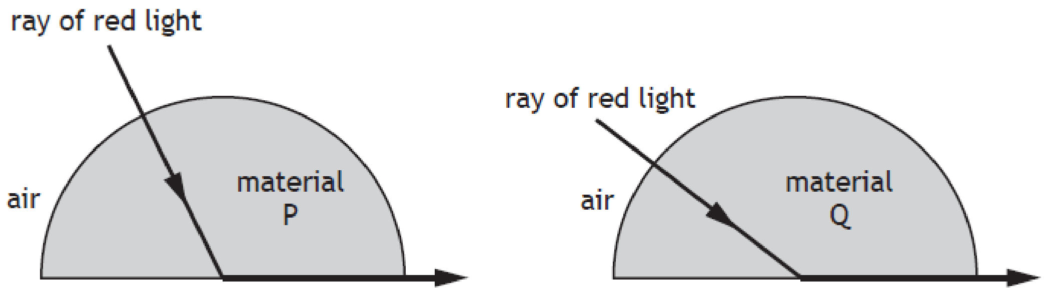
Identify the row in the following table that gives the angle of refraction and the frequency of light in the block of glass.

	Angle of refraction in glass	*Frequency in glass (Hz)*
A	37°	$6 \cdot 0 \times 10^{14}$
B	37°	$4 \cdot 0 \times 10^{14}$
C	16°	$6 \cdot 0 \times 10^{14}$
D	16°	$4 \cdot 0 \times 10^{14}$
E	37°	$9 \cdot 0 \times 10^{14}$

8. A ray of monochromatic light passes from air into glass and then into water as shown in the diagram.
Identify the correct path of the ray of light.



9. Red light is used to investigate the critical angle of two materials P and Q.



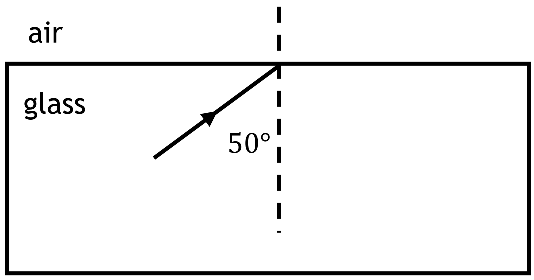
A student makes the following statements.

I Material P has a higher refractive index than material Q.
II The wavelength of red light is longer inside material P than inside material Q.
III The red light travels at the same speed inside materials P and Q.

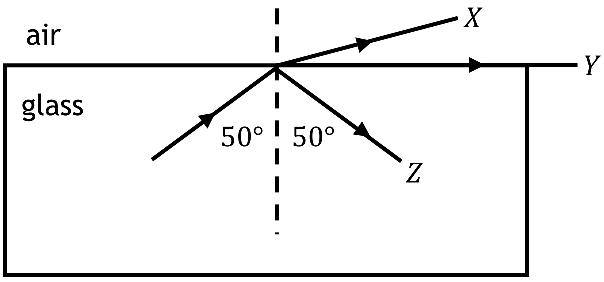
Which of the statements is/are correct?

A I only
B II only
C III only
D I and II only
E I, II and III

10. A ray of light travelling through glass approaches air, as shown.

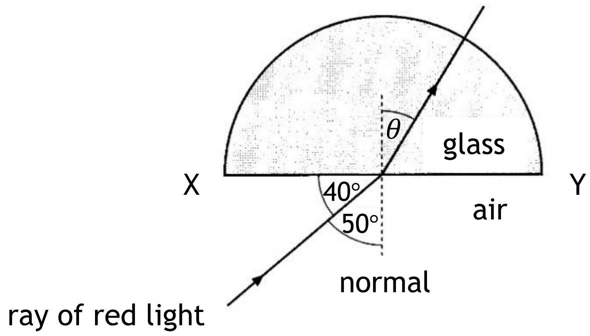


The refractive index of the glass is 1·5.
Identify which of the following paths will the ray follow.



A X only
B Y only
C Z only
D X and Z only
E Y and Z only

11. A ray of red light is incident on a semi-circular block of glass at the midpoint of XY as shown.



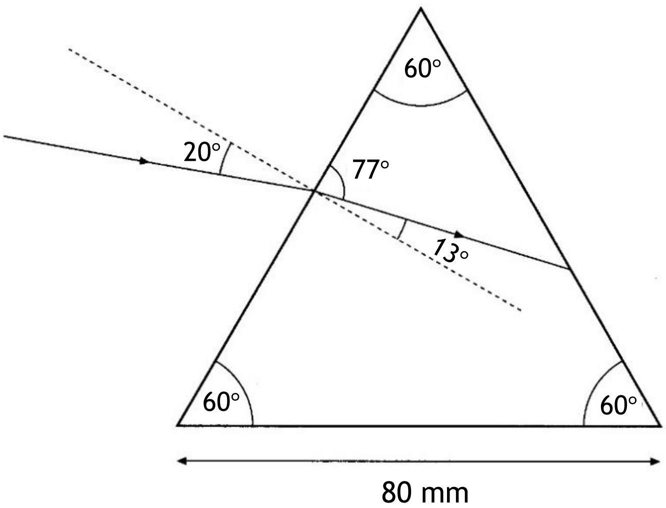
The refractive index of the block is 1·50 for this red light.

(a) Calculate the 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.

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



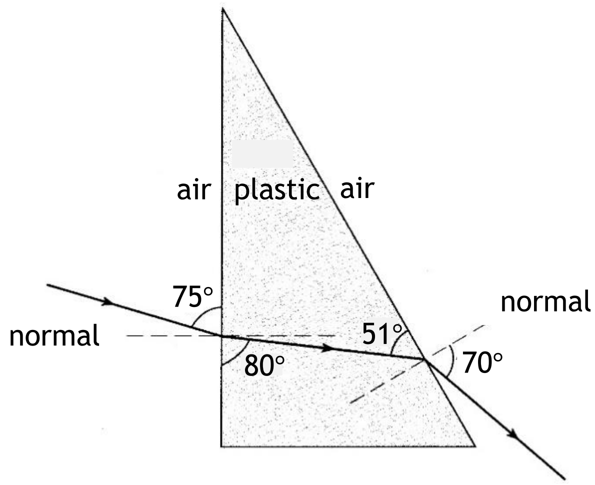
(a) Using information from this diagram, show that the refractive index of the glass for this red light is 1·52.

(b) State 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 it leaves the prism.
Mark on your diagram the values of all relevant angles.

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

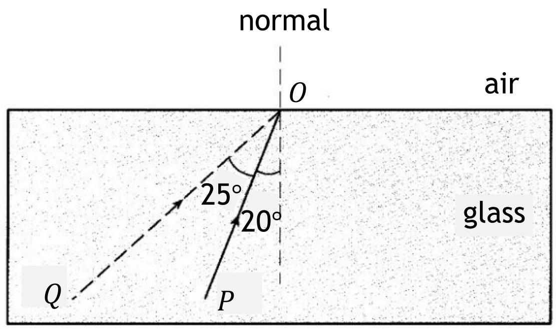


(a) Calculate the refractive index of the plastic for this red light.

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

(i) Calculate 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.

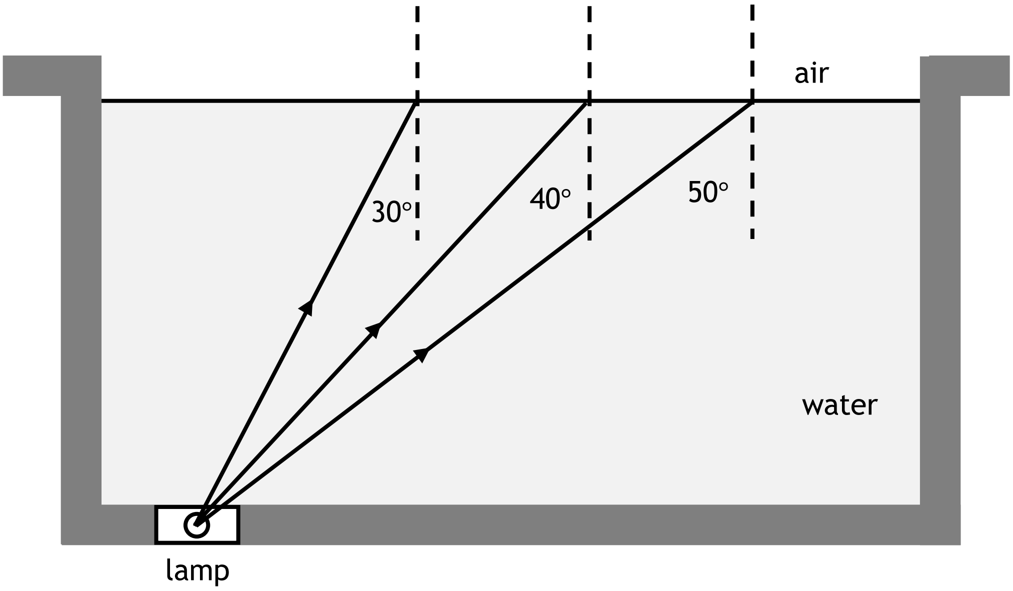


When rays PO and QO strike the glass-air boundary, **three** further rays of light are observed.

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 swimming pool is illuminated by a lamp built into the bottom of the pool.



Three rays of light from the same point in the lamp are incident on the water-air boundary with angles of incidence of 30°, 40° and 50°, as shown above.

The refractive index of the water in the pool is 1·33.

(a) Draw a diagram to show clearly what happens to each ray at the boundary. Indicate on your diagram the sizes of appropriate angles.
All necessary calculations must be shown.

(b) An observer stands at the side of the pool and looks into the water.
Explain, with the aid of a diagram, why the image of the lamp appears to be at a shallower depth than the actual depth of the bottom of the pool.