1 **(a)** **(i)** A ray of light passes through a length of curved optical fibre.

Draw a diagram showing the fibre and the path of the ray of light.

[1]

(ii) Describe one use of optical fibres in medicine. You may draw a diagram.

.....

.....

.....

.....

.....

.....

..... [3]

(b) Draw a straight line from each wave on the left to the most appropriate speed.

	90 m / s (9×10)
light in air	6000 m / s (6×10^3)
	100 000 m / s (1×10^5)
microwaves in a vacuum	
	1 000 000 m / s (1×10^6)
sound in steel	300 000 000 m / s (3×10^8)
	60 000 000 000 m / s (6×10^{10})

[3]

(c) The refractive index of a block of glass is 1.5.

Use your value for the speed of light from **(b)** to calculate the speed of light in this block.

speed = ... [2]

[Total: 9]

2 **(a)** Explain what is meant by

(i) *total internal reflection*,

.....

.....[1]

(ii) *critical angle*.

.....

.....[1]

(b) Fig. 7.1 shows a ray of light, travelling in air, incident on a glass prism.

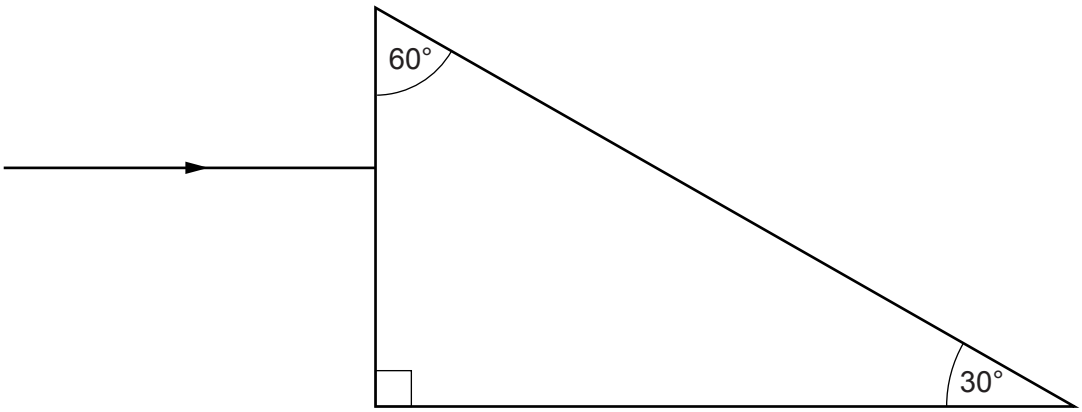

Fig. 7.1

(i) The speed of light in air is 3.0×10^8 m/s. Its speed in the glass is 2.0×10^8 m/s.

Calculate the refractive index of the glass.

refractive index = ...[2]

(ii) Show that the critical angle for the glass-air boundary is 42°.

[1]

(iii) On Fig. 7.1, draw carefully, without calculation, the continuation of the ray through the prism and into the air. [3]

[Total: 8]

3 **(a)** Fig. 7.1 represents an object O placed in front of a converging lens.

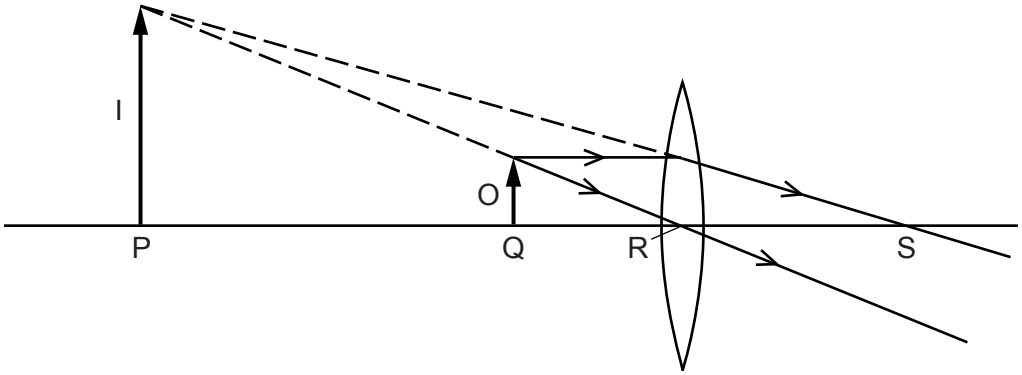

Fig. 7.1

(i) State a full description of the image I.

..... [2]

(ii) Using the letters on Fig. 7.1, identify the focal length of the lens.

..... [1]

(iii) On Fig. 7.1, draw an eye suitably placed to view the image I. [1]

(b) Fig. 7.2 shows an object O placed to the left of a converging lens. A principal focus of the lens is at the position marked F.

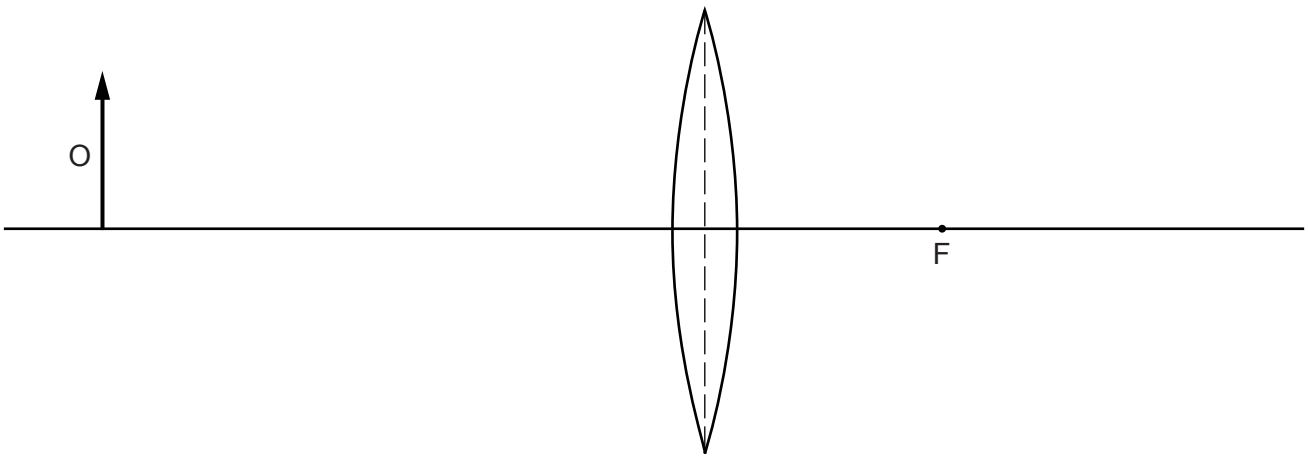

Fig. 7.2

(i) On Fig. 7.2, draw two rays to locate the image of object O. Draw the image.

(ii) On Fig. 7.2, draw one other ray from the upper tip of O to the image.

[4]

[Total: 8]

4 The refractive index n of glass in air is 1.5.

(a) **(i)** State the equation that relates the speed of light in air v_a, the speed of light in glass v_g and n.

.....[1]

(ii) The speed of light in air is 3.0×10^8 m/s.

Calculate the speed of light in glass.

speed = ...[1]

(b) Light travelling in glass strikes the edge of the glass. Fig. 6.1 shows a ray of light at an angle of 41° to the normal.

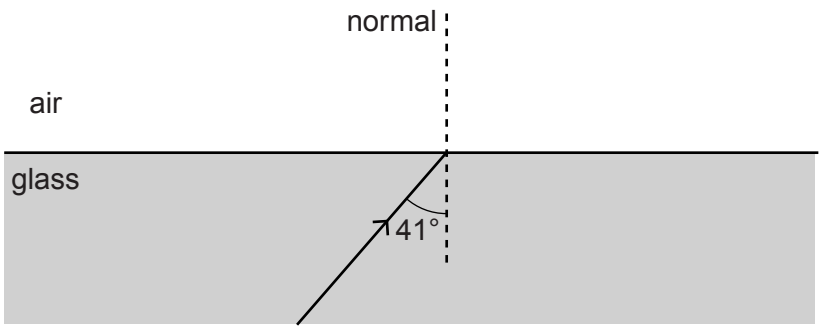

Fig. 6.1

(i) The light passes from the glass into the air.

Calculate the angle that the ray makes with the normal in the air.

angle = ...[2]

(ii) State what happens to light that strikes the edge of the glass at an angle to the normal much larger than 41°.

.....[1]

(c) Describe one example of how optical fibres are used in medicine.

.....

.....

.....

.....[2]

[Total: 7]

5 A glass, converging lens is used as a magnifying glass to observe a red ant.

(a) Fig. 6.1 shows the lens, the principal axis, and the two principal focuses F_1 and F_2.

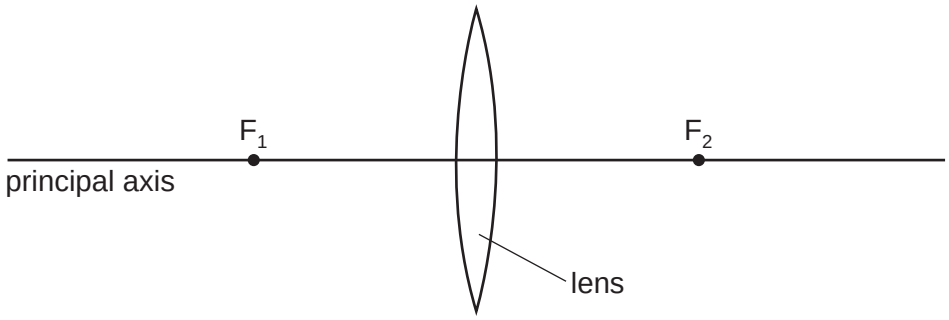

Fig. 6.1

(i) **1.** On Fig. 6.1, mark a point on the principal axis, labelled A, to indicate a suitable position for the ant.

2. On Fig. 6.1, mark a point on the principal axis, labelled E, to indicate a suitable position for the observer's eye.

[1]

(ii) Tick **one** of the boxes to indicate where, on the principal axis, the image of the ant is located.

- ☐ to the left of F_1
- ☐ between F_1 and the lens
- ☐ within the lens
- ☐ between the lens and F_2
- ☐ to the right of F_2

[1]

(iii) Underline **two** words in the list that describe the image produced by the magnifying glass.

diminished **inverted** **real** **upright** **virtual**

[2]

(b) **(i)** The red light from the ant passes into the lens.

As the light enters the lens, state what happens to

1. its wavelength,

.....[1]

2. its frequency.

.....[1]

(ii) State how the wavelength of violet light in air differs from the wavelength of red light in air.

.....[1]

[Total: 7]

6 **(a)** Fig. 7.1 shows a convex lens being used to produce an image of an object.

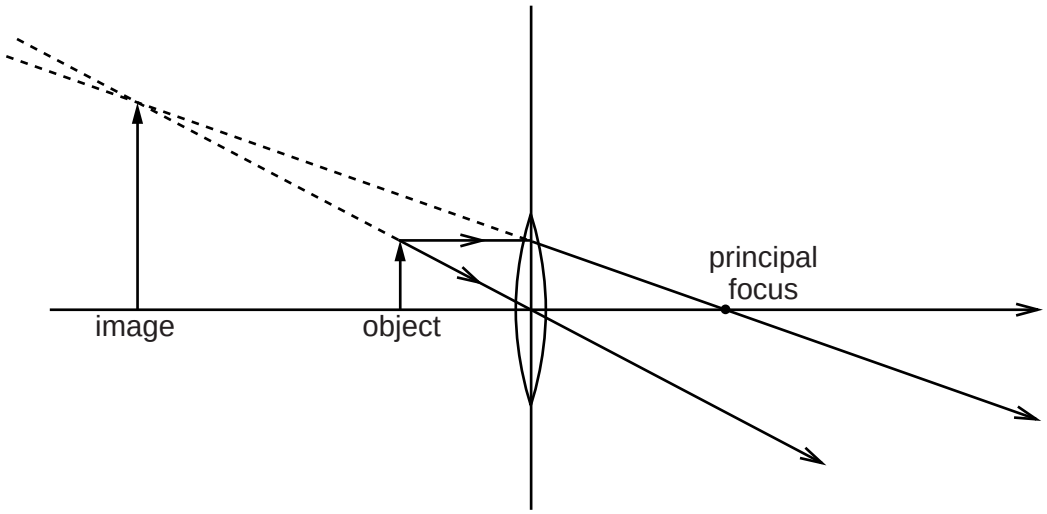

Fig. 7.1

(i) Place **three** ticks in the table that describe this image.

can only be formed on a screen	
diminished	
enlarged	
inverted	
real	
same size	
upright	
virtual	

[3]

(ii) On Fig. 7.1, mark a letter E to indicate a possible position for an eye to be placed to observe this image. [1]

(iii) State an application in which a convex lens is used in this way.

.....[1]

(b) In the space below, draw a ray diagram to locate the image of an object of height 1.0 cm placed 5.0 cm from a convex lens of focal length 2.0 cm. Draw your diagram full size. You are advised to locate the lens roughly in the centre of the space. Label the image.

[3]

[Total: 8]