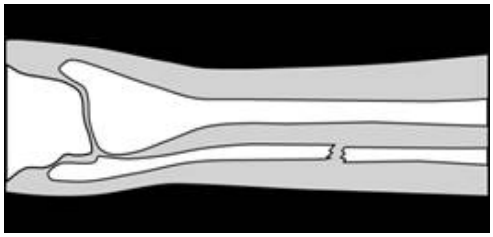
Q1. Both X-ray machines and CT scanners are used to produce images of the body.

(a) The diagram shows an X-ray photograph of a broken leg.



Before switching on the X-ray machine, the radiographer goes behind a screen.

Explain why the radiographer does this.

.....

.....

.....

.....

.....

.....

.....

(3)

(b) The following is an extract from a newspaper article.

> **X-rays cause 700 new cancers each year in the U.K.**
>
> Each year there are about 125 000 new cancer cases in the UK, of which, about 700 may be due to the use of X-rays to diagnose illness.

The article was reporting on a scientific research project first published in a medical journal.

What evidence would the scientists have collected to come to the conclusion that X-rays can cause cancer?

.....

.....

.....

.....

.....

(2)

(c) Explain the advantage of a CT scan compared to an X-ray.

.....

.....

.....

.....

.....

(2)
(Total 7 marks)

Q2. The figure below shows an X-ray image of a human skull.

Stockdevil/iStock/Thinkstock

(a) Use the correct answers from the box to complete the sentence.

absorbs	**ionises**	**reflects**	**transmits**

When X-rays enter the human body, soft tissue ..... X-rays and bone ..... X-rays.

(2)

(b) Complete the following sentence.

The X-rays affect photographic film in the same way that ..... does.

(1)

(c) The table below shows the total dose of X-rays received by the human body when different parts are X-rayed.

Part of body X-rayed	Dose of X-rays received by human body in arbitrary units
Head	3
Chest	4
Pelvis	60

Calculate the number of head X-rays that are equal in dose to one pelvis X-ray.

.....

.....

.....

Number of head X-rays = ...

(2)

(d) Which **one** of the following is another use of X-rays?

Tick (✓) **one** box.

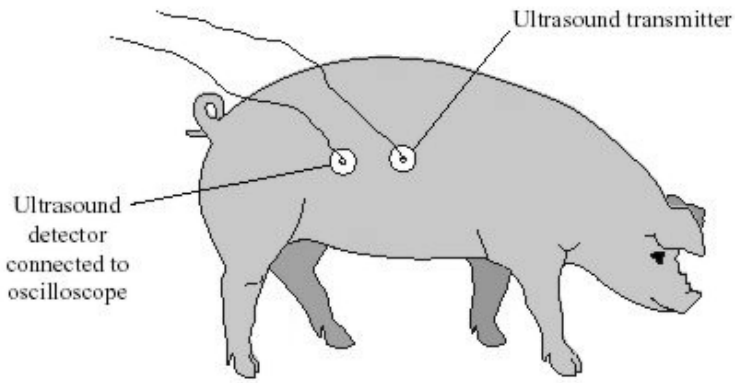
Cleaning stained teeth ☐

Killing cancer cells ☐

Scanning of unborn babies ☐

(1)
(Total 6 marks)

Q3. Pigs have a layer of fat in their skin. Underneath the fat is a layer of muscle. Ultrasonic waves are used to measure the thickness of the layer of fat. An ultrasound transmitter and detector are attached to the skin of the pig.



(a) Explain why ultrasound can be used to measure the thickness of the layer of fat.

.....

.....

.....

.....

(2)

(b) The oscilloscope does not measure distance directly.

(i) What does the oscilloscope measure in this case?

.....

.....

(1)

(ii) What other information is needed to calculate the thickness of the layer of fat in a pig?

.....

.....

(1)

(Total 4 marks)

Q4. (a) Human eyes and digital cameras both have parts with the same function.

Complete the missing parts in the table below.

Details of part	**Part of eye**	**Part of digital camera**
Refracts light to produce an image	Cornea and lens	Lens
Images are focused here	Retina	.....
Variable opening where light enters	.....	Aperture

(2)

(b) Long sight is a defect of the human eye.

State **two** causes of long sight.

1 .....

.....

2 .....

.....

(2)

(c) Long sight can be corrected by wearing spectacles with converging (convex) lenses.

A lens in these spectacles has a power of +3.2 dioptres.

Calculate the focal length of this lens.

Use the correct equation from the Physics Equations Sheet.

.....

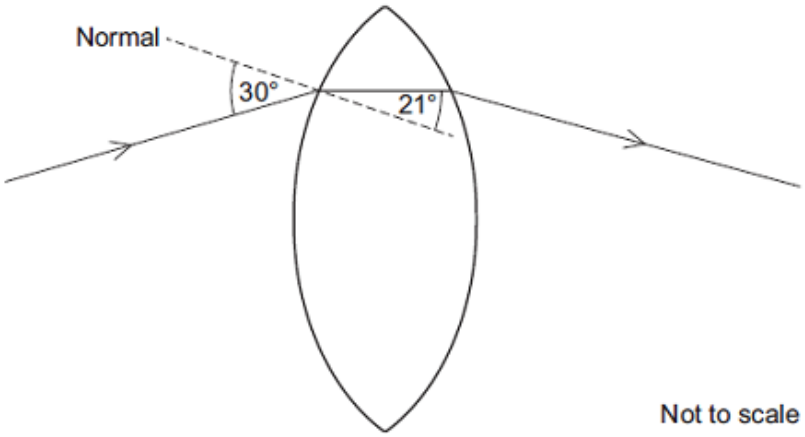
.....

.....

Focal length = ... metres

(2)

(d) The figure below shows a ray of light passing through a converging (convex) lens.



(i) Use the information in the figure above to calculate the refractive index of the glass used to make the lens.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

.....

Refractive index = ...

(3)

(ii) Different lenses of the same power can be made using glass of a different refractive index.

State **one** advantage of making spectacles using lenses made from glass of a higher refractive index.

.....

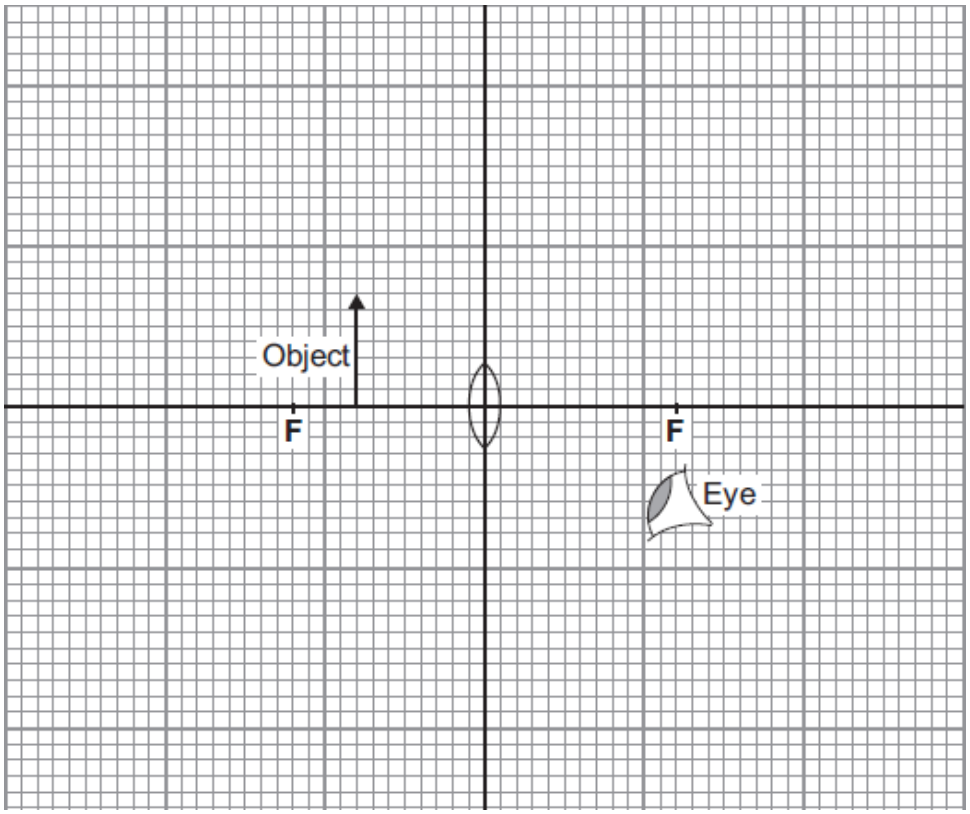
.....

(1)

(Total 10 marks)

Q5. (a) The diagram shows a converging lens being used as a magnifying glass.

(i) On the diagram, use a ruler to draw two rays from the top of the object which show how and where the image is formed. Represent the image by an arrow drawn at the correct position.



(3)

(ii) Use the equation in the box to calculate the magnification produced by the lens.

$$\text{magnification} = \frac{\text{image height}}{\text{object height}}$$

Show clearly how you work out your answer.

.....

.....

Magnification = ...

(2)

(b) A camera also uses a converging lens to form an image.

Describe how the image formed by the lens in a camera is different from the image formed by a lens used as a magnifying glass.

.....

.....

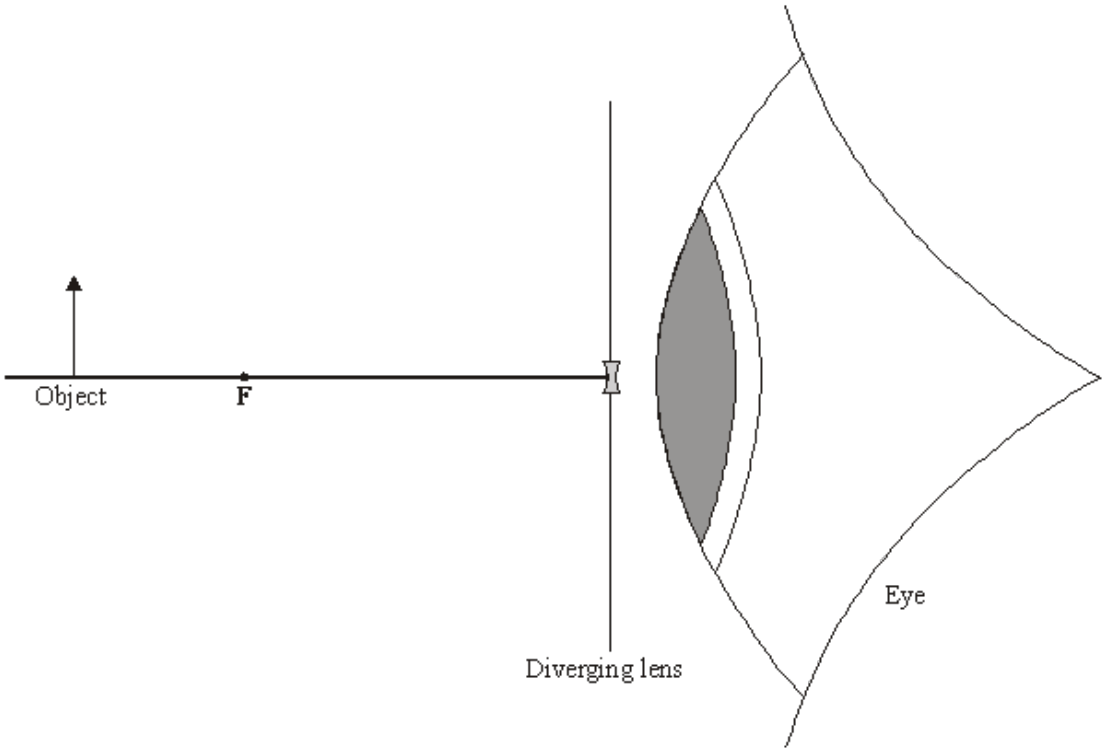
.....

.....

(2)
(Total 7 marks)

Q6. The diagram shows an object located vertically on the principal axis of a diverging lens. A student looks through the lens and can see an image of the object.

(a) Using a pencil and ruler to draw construction lines on the diagram, show how light from the object enters the student's eye and the size and position of the image.



(3)

(b) Describe the nature of the image by comparing it to the object.

.....

.....

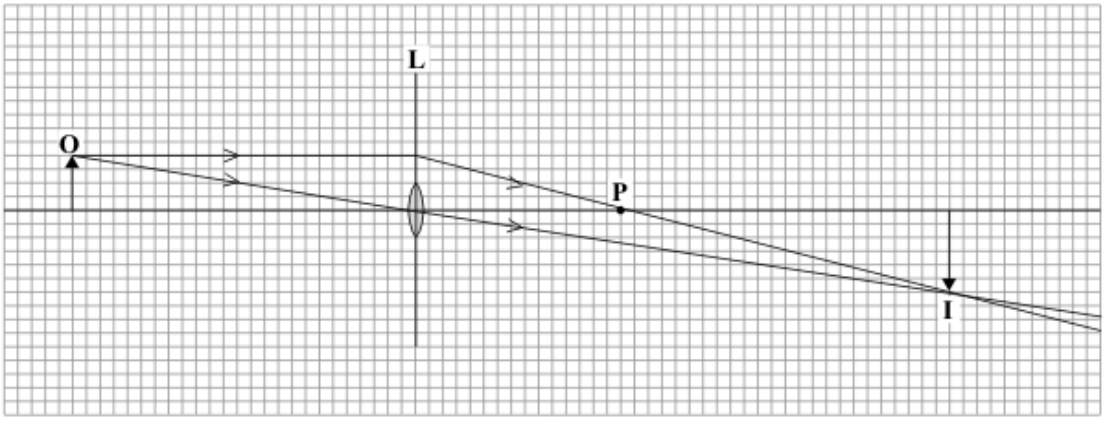
.....

.....

(2)

(Total 5 marks)

Q7. The ray diagram shows the position and size of the image, **I**, of an object, **O**, formed by a lens, **L**.



(a) What type of lens is shown in the ray diagram?

.....

(1)

(b) Name the point labelled **P**.

.....

(1)

(c) The ray diagram has been drawn to scale.

Use the equation in the box to calculate the magnification.

$$\text{magnification} = \frac{\text{image height}}{\text{object height}}$$

Show clearly how you work out your answer.

.....

.....

Magnification = ...

(2)

(d) How can you tell from this ray diagram that the image is a real image?

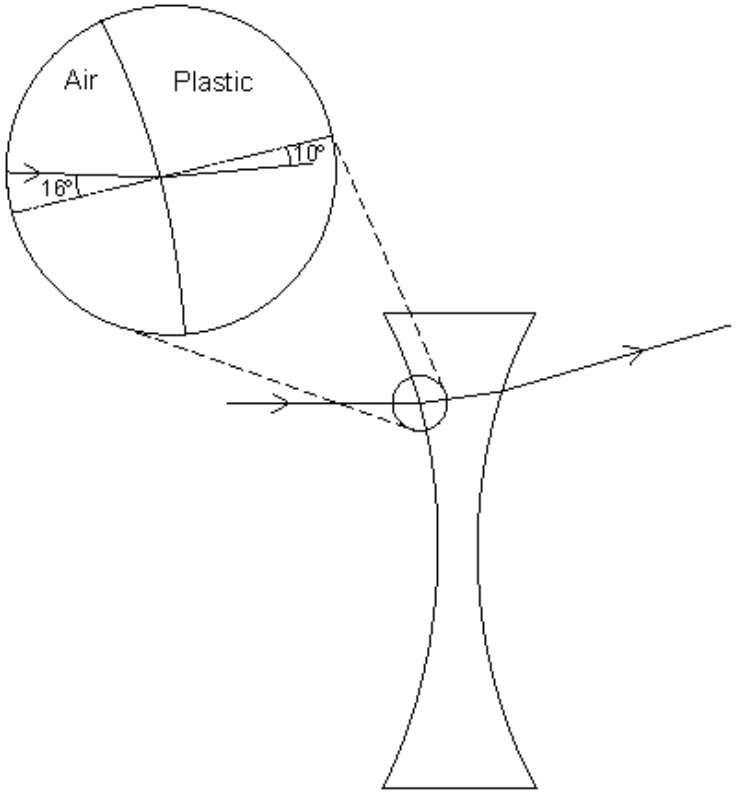
.....

.....

(1)

(Total 5 marks)

Q8. The diagram shows a ray of light passing through a diverging lens.



(a) Use the information in the diagram to calculate the refractive index of the plastic used to make the lens.

Write down the equation you use, and then show clearly how you work out your answer.

.....

.....

.....

.....

.....

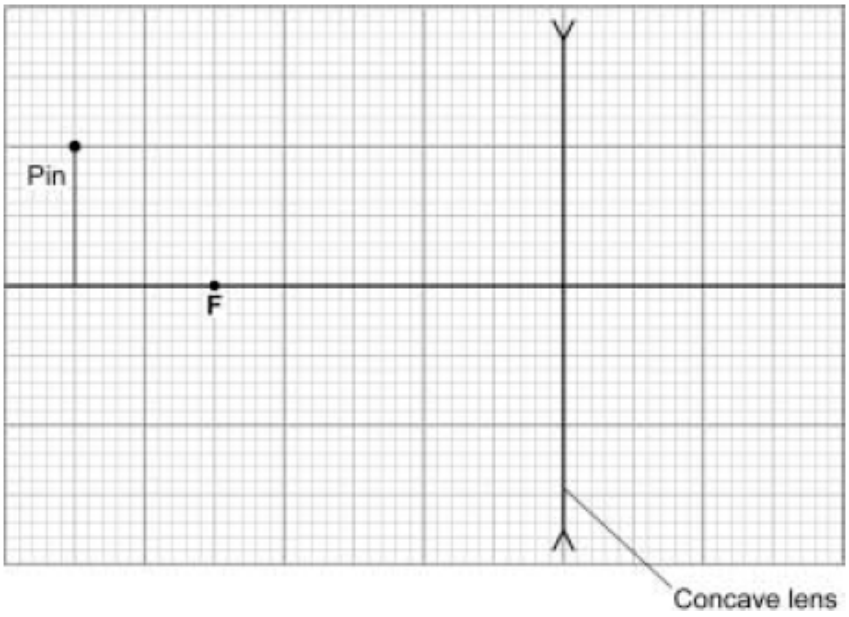
.....

Refractive index = ...

(2)

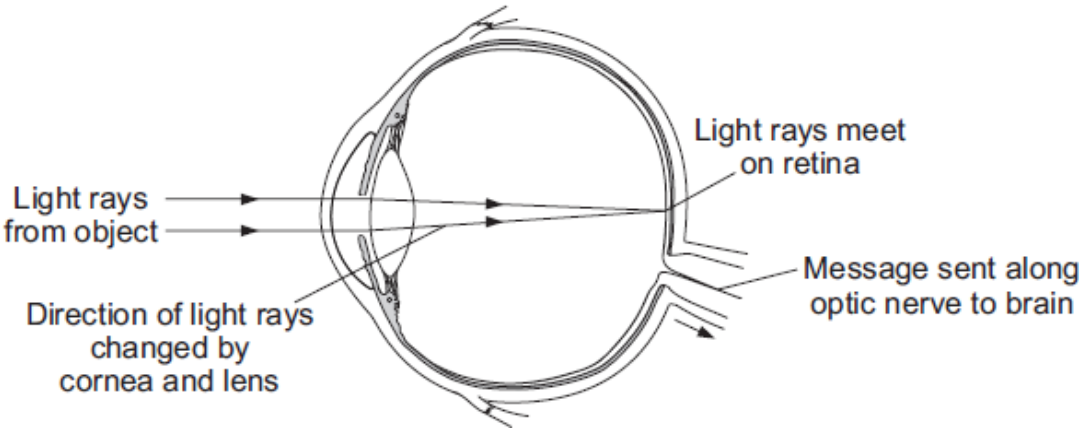
(b) The focal length of the lens is 5 cm. A student looking through the lens sees the image of a pin.

Complete the ray diagram below to show how the image of the pin is formed.



(3)
(Total 5 marks)

Q9. (a) The diagram shows the inside of the eye of a person with perfect vision.



Complete the sentence.

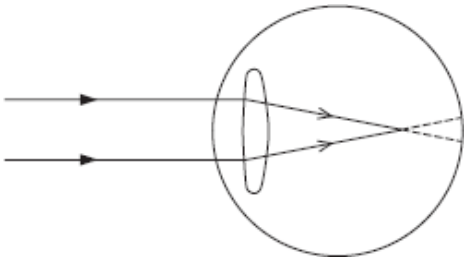
The process by which the cornea and lens change the direction of the light is called

..... .

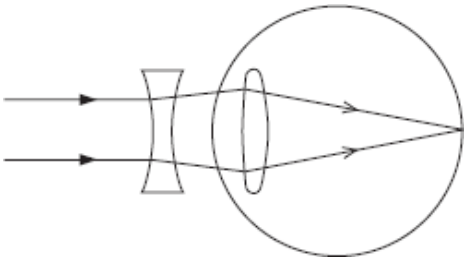
(1)

(b) (i) Not everyone has perfect vision.
A **short-sighted** person can only clearly see objects which are close.
Light from distant objects meets in front of the retina.

The diagrams show how an additional lens will correct **short-sightedness**.

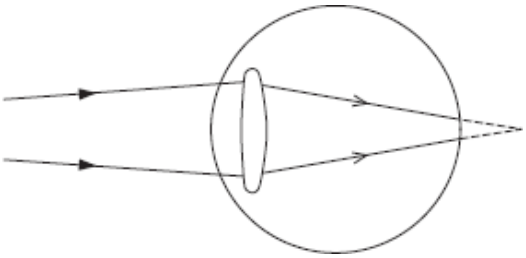


Uncorrected vision



Vision corrected with a diverging lens

The following diagram shows what happens when light from a close object enters the eye of a **long-sighted** person.



Light fails to come to focus on the retina

What type of additional lens will correct the vision of a **long-sighted** person?

.....

(1)

(ii) The additional lens changes the direction of the light before it enters the eye.

Why does this correct the person's vision?

.....

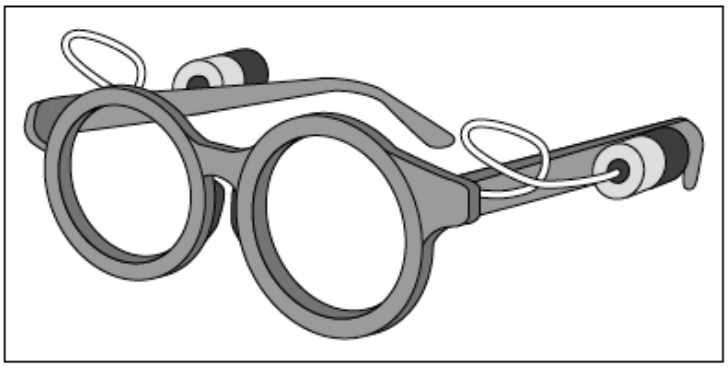
.....

(1)

(c) Read this passage from a magazine.

Professor's clear vision for the future

There are billions of poor people in the world who cannot see clearly and cannot afford the cost of having their eyesight corrected. A professor has invented adjustable glasses. They are cheap and a few minutes is all it takes for you to adjust them to suit your eyes.



When the adjusting screw is turned in one direction, silicone is pushed into the flexible lens which becomes thicker in the centre. Turning the screw in the opposite direction pulls silicone out, and the lens becomes thinner at the centre than at the edge.

Explain how these glasses are adjusted for a **short-sighted** person and how this adjustment allows the person to see distant objects clearly.

.....

.....

.....

.....

.....

(3)
(Total 6 marks)

Q10. **Figure 1** shows how a ray of light from a laser travels along an optical fibre.

Figure 1

(a) Why does the ray of light stay within the optical fibre?

.....

.....

(1)

(b) The material used to make the optical fibre has a refractive index of 1.50.

Calculate the critical angle of this material.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

.....

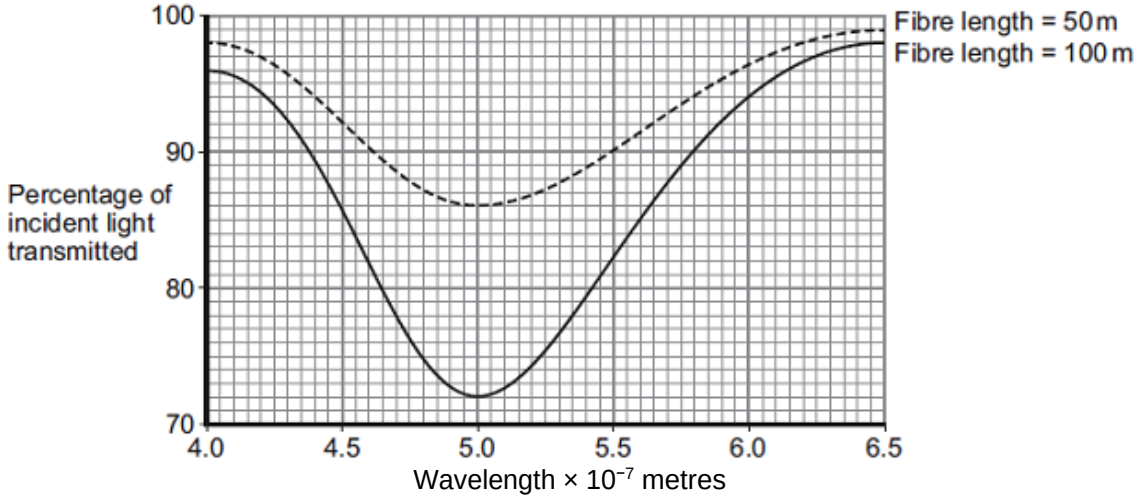
Critical angle = ... degrees

(2)

(c) Different wavelengths of light can be used to transmit information along optical fibres.

Figure 2 shows how the percentage of incident light transmitted through a fibre varies with the wavelength of light and the length of the fibre.

Figure 2



Compare the percentages of incident light transmitted through the two different fibres over the range of wavelengths shown.

.....

.....

.....

.....

.....

.....

.....

.....

.....

(3)
(Total 6 marks)

M1. (a) X-rays are ionising

or

X-rays kill / damage cells

accept cause cancer

1

any stray X-rays are absorbed by screen

1

which reduces the radiation dose to the radiographer

1

(b) medical records / X-ray records

1

of people with cancer

1

(c) a CT scan gives a 3D image

1

therefore the image can be observed from different directions

1

[7]

M2. (a) transmits

correct order

1

absorbs

1

(b) light

*allow ultra violet **or** UV **or** infrared **or** IR **or** gamma*

1

(c) 20

*allow **1** mark for correct working, ie* $\frac{60}{3}$ *provided no subsequent step*

2

(d) Killing cancer cells

1

[6]

M3. (a) (ultrasound) waves reflected

accept 'bounce off'

1

at boundary / from muscle

1

(b) (i) time

1

(ii) speed of (ultrasound) waves

1

[4]

M4. (a) CCD / charged coupled device

ignore sensor

*do **not** allow film*

1

pupil

*do **not** allow iris*

1

(b) the eye(ball) being too short

1

the (eye) lens being unable to focus (an image at the retina)

or

the (ciliary) muscles being unable to change the shape of the lens sufficiently

accept cornea / lens is not curved enough

*accept lens is not powerful enough **or** too weak*

accept lens being unable to accommodate

1

(c) 0.31(25)

*allow **1** mark for correct substitution, ie* $\frac{1}{3.2}$

2

(d) (i) 1.4

*allow **2** marks for* $\frac{0.5}{0.358}$

*allow **2** marks for 1.39*

*an answer of 0.72 gains **2** marks*

*allow **1** mark for correct substitution, ie* $\frac{\sin 30°}{\sin 21°}$

*allow **1** mark for both sine values correctly calculated ie 0.5 and 0.358*

ignore any units

3

(ii) the lenses can be made thinner

allow the lenses / spectacles / glasses are lighter

allow uses less glass

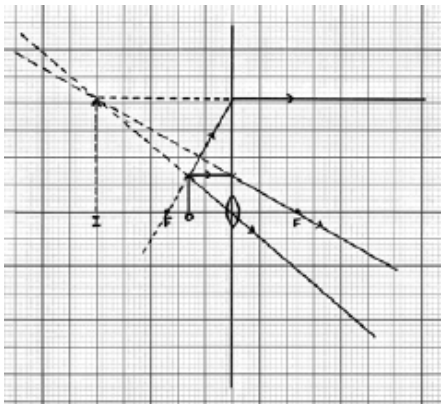
1

[10]

M5. (a) (i) **two** correct rays drawn

1 *mark for each correct ray*

- ray parallel to axis from top of object **and** refracted through focus **and** traced back beyond object
- ray through centre of lens **and** traced back beyond object
- ray joining top of object to focus on left of lens taken to the lens refracted parallel to axis **and** traced back parallel to axis beyond object



2

an arrow showing the position **and** correct orientation of the image for their rays

to gain this mark, the arrow must go from the intersection of the traced-back rays to the axis ***and*** *the image must be on the same side of the lens as the object and above the axis*

1

(ii) (x) 3.0

accept 3.0 to 3.5 inclusive

or

$$\frac{\text{their image height}}{\text{object height}}$$

correctly calculated

allow ***1*** *mark for correct substitution into equation using their figures*

ignore any units

2

(b) any **two** from:

in a camera the image is:

- real not virtual
- inverted and not upright

  accept upside down for inverted
- diminished and not magnified

  accept smaller and bigger
  accept converse answers but it must be clear the direction of the comparison
  both parts of each marking point are required

2

[7]

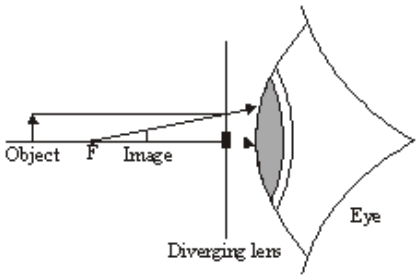
M6. (a) straight line from the tip of the object

… straight through the centre of the lens (1)

… parallel to the axis, then diverges from the lens as if from F (1)

image drawn from where **these** lines intersect, vertically to the axis (1)

example



3

(b) any **two** from:

- smaller (than the object)
- (both) upright
- image is virtual / imaginary (whereas object is real)

  no errors carried forward from the candidate's diagram
  *mark first **two** points given*

2

[5]

M7. (a) converging

or convex

1

(b) (principal) focus

or focal point

1

(c) **either** (×)1.5 **or** (×)1½ **or** 150%

*unambiguous evidence of appropriate measurements for **1** mark only eg 4 and 6 **or** 8 and 12 **or** 0.8 and 1.2*

2

(d) real rays cross to form it / formed at the intersection of real rays

accept 'image on the opposite side of the lens to the object'
accept 'can be put onto a screen'

1

[5]

M8. (a) 1.59

accept an answer that rounds to this

*allow **1** mark for correct substitution into correct equation*

ie refractive index $= \frac{\sin 16^\circ}{\sin 10^\circ}$

2

(b) 2 lines correctly drawn from the top of the pin through the lens

*allow **1** mark for each*

2

position of image correct

image must be upright

1

[5]

M9. (a) refraction

1

(b) (i) converging

accept convex

1

(ii) cause the light (rays) to meet on / focus at retina / back of eye

*do **not** accept hit the retina only*

1

(c) silicone is removed from the lens(es)

1

lens(es) thinner in / at the middle (than at the edge)
or
lens(es) became concave / diverging

1

diverges(s) the light which (now) meets / focuses at the retina / back of the eye

1

[6]

M10. (a) because the angle of incidence is greater than critical angle

accept the light is totally internally reflected

1

(b) 41.8

*allow **1** mark for correct substitution, eg* $1.5 = \frac{1}{\sin c}$

or

$\sin c = \frac{1}{1.5}$

or

$c = \sin^{-1} \frac{1}{1.5}$

2

(c) (for both fibres) increasing the wavelength of light decreases and then increases the percentage / amount of light transmitted

*accept for **1** mark:*

(for both fibres) increasing the wavelength (of light) to 5 (x 10^{-7} metres), decreases the (percentage) transmission

1

(for both fibres) the minimum transmission happens at 5 (x 10^{-7} metres)
or
maximum transmission occurs at 6.5 (x 10^{-7} metres)

*accept for a further **1** mark:*

(for both fibres) increasing the wavelength of the light from 5 (x 10^{-7} metres) increases the amount of light transmitted

increasing wavelength (of light), decreases the percentage transmitted is insufficient on its own

1

the shorter fibre transmits a greater percentage of light (at the same wavelength)

*accept for **1** mark:*
Any statement that correctly processes data to compare the fibres

1

[6]