Q1. (a) What is ultrasound?

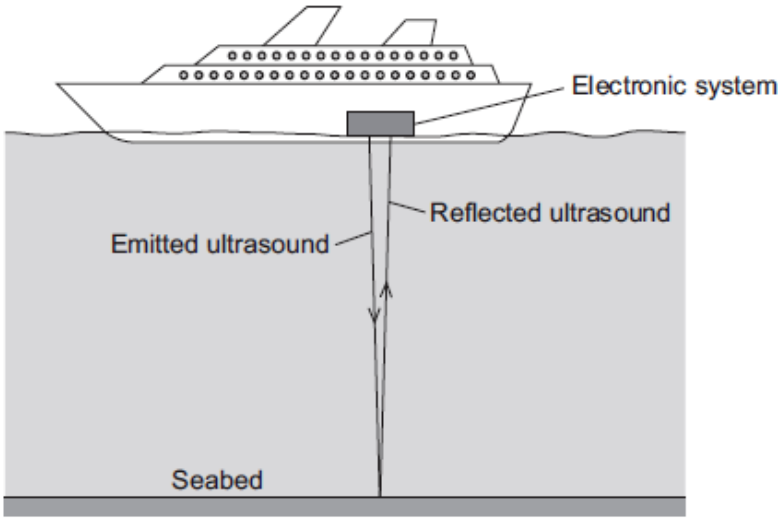
.....

.....

(1)

(b) **Figure 1** shows how ultrasound is used to measure the depth of water below a ship.

Figure 1



A pulse of ultrasound is sent out from an electronic system on-board the ship.

It takes 0.80 seconds for the emitted ultrasound to be received back at the ship.

Calculate the depth of the water.

Speed of ultrasound in water = 1600 m / s

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

.....

Depth of water = ... metres

(3)

(c) Ultrasound can be used in medicine for scanning.

State **one** medical use of ultrasound scanning.

.....

(1)

(d) Images of the inside of the human body can be made using a Computerised Tomography (CT) scanner. The CT scanner in **Figure 2** uses X-rays to produce these images.

Figure 2

monkeybusinessimages/iStock/Thinkstock

State **one** advantage and **one** disadvantage of using a CT scanner, compared with ultrasound scanning, for forming images of the inside of the human body.

Advantage of CT scanning .....

.....

.....

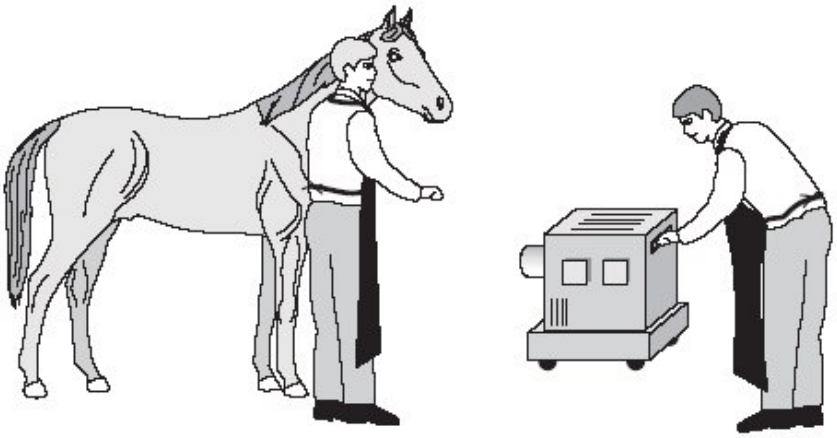
Disadvantage of CT scanning .....

.....

.....

(2)
(Total 7 marks)

Q2. The picture shows a horse being prepared for an X-ray.



The person who will take the X-ray and the person holding the horse are wearing special aprons. These aprons have a lead lining.

Explain why the lead lining is important.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

.....

.....

.....

.....

.....

.....

(Total 3 marks)

Q3. Ultrasound and X-rays are waves used in hospitals to create images of the inside of the human body. To produce the images below, the waves must enter the human body.

Ultrasound scan of an unborn child

© Isabelle Limbach/Thinkstock

X-ray of a broken bone

© itsmejust/iStock

(a) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate*.

Describe the features of ultrasound and X-rays, and what happens to each type of wave after it has entered the human body.

.....

.....

.....

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.....

.....

(6)

(b) It would **not** be safe to use X-rays to produce an image of an unborn child.

Explain why.

.....

.....

.....

.....

(2)

(c) Ultrasound can be used for medical treatments as well as for imaging.

Give **one** use of ultrasound for medical treatment.

.....

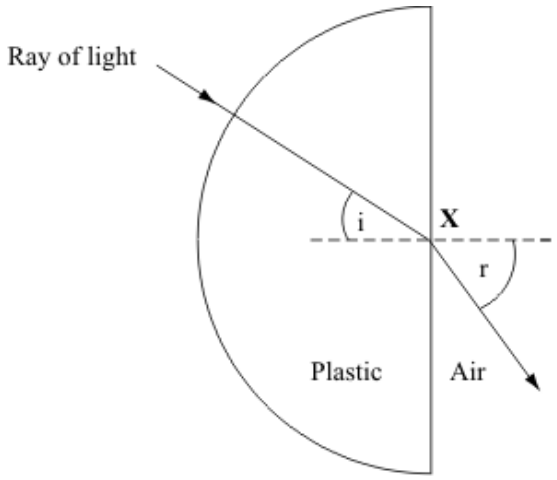
.....

(1)
(Total 9 marks)

Q4. (a) A student investigated the refraction of light as it passes out of a transparent plastic block.

She aimed a ray of light at point **X**. She marked the position of the ray as it passed through the transparent plastic block and into the air.

The angle *i* is the angle of incidence.



(i) What is the name of angle **r**?

.....

(1)

(ii) What is the name of the dashed line?

.....

(1)

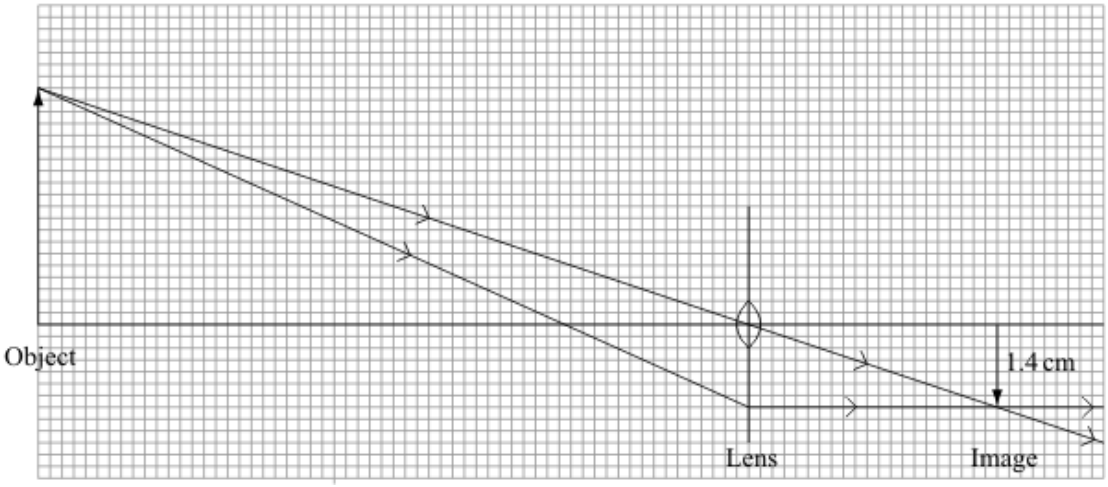
(b) A camera uses a lens to produce an image which falls on a light detector.

Name a light detecting device which may be used in a camera.

.....

(1)

(c) The diagram shows the position of an image formed in a camera.



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

.....

(1)

(ii) 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) Why does the image formed in a camera have to be a real image?

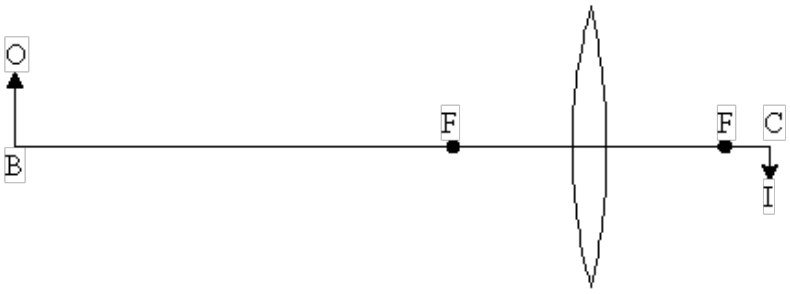
.....

.....

(1)

(Total 7 marks)

Q5. The diagram shows the image IC formed by a lens, of an object OB a long way from it. The points F mark the focal points of the lens.



(a) Describe, either by writing below or drawing on the diagram, how the size and position of the image changes:

(i) when the object OB is moved towards the focal point F.

.....

.....

(ii) when the object OB is moved past F to a point nearer the lens than the focal point.

.....

.....

(4)

(b) Explain how a converging lens in a camera is used to produce sharp images on the film when the object is a long distance away from the camera, and when it is close to the camera.

.....

.....

.....

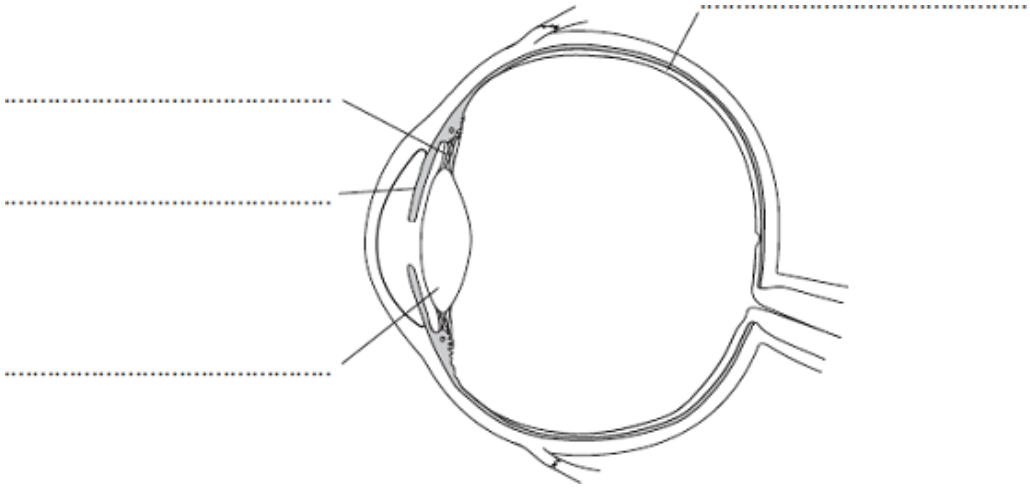
.....

.....

(3)

(Total 7 marks)

Q6. (a) The diagram shows a section through a human eye.



(i) Use words from the box to label the diagram.

Ciliary muscle	**Cornea**	**Iris**	**Lens**	**Pupil**	**Retina**

(4)

(ii) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

Describe the functions of the ciliary muscle **and** the iris.

.....

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.....

(6)

(b) Draw a ring around the correct answer to complete the sentence.

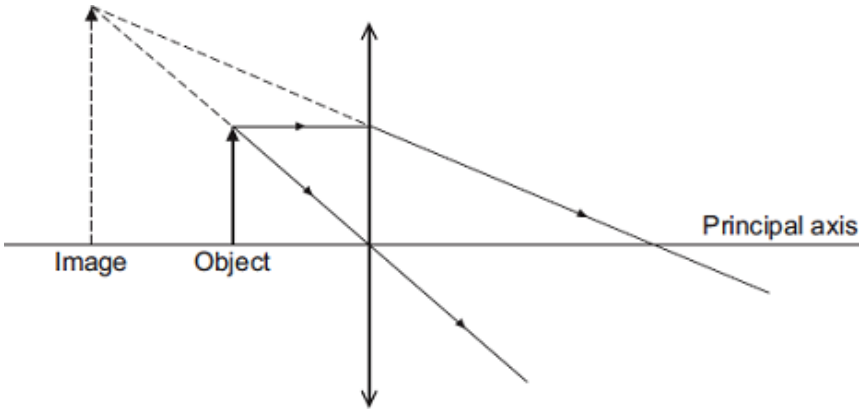
Long sight can be caused by the

eyeball being too long.
eyeball being too short.
cornea being irregularly shaped.

(1)

(c) The diagram shows how a convex lens forms an image of an object.

This diagram is **not** drawn to scale.



(i) Which **two** words describe the image?

Draw a ring around each correct answer.

diminished **inverted** **magnified** **real** **upright**

(2)

(ii) The object is 4 cm from the lens. The lens has a focal length of 12 cm.

Calculate the image distance.

Use the correct equation from **Section B** of the Physics Equations Sheet.

.....

.....

.....

Image distance = ... cm

(3)

(d) What does a minus sign for an image distance tell us about the nature of the image?

.....

(1)

(Total 17 marks)

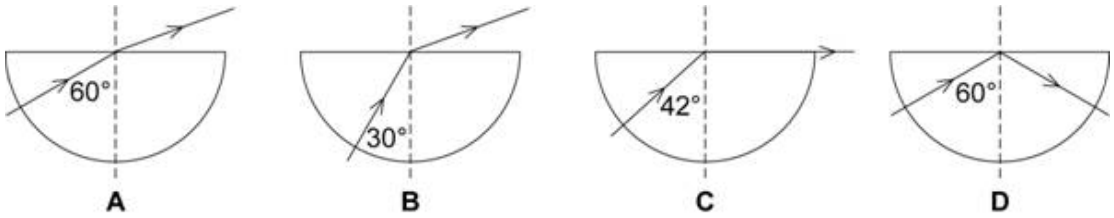
Q7. Lenses are used in many optical devices.

Complete the table below about the images formed by some optical devices.

OPTICAL DEVICE	NATURE OF IMAGE	SIZE OF IMAGE	POSITION OF IMAGE
Eye	real		
Projector		Magnified	
camera			Closer to lens than the object

(Total 6 marks)

Q8. (a) Each diagram shows a light ray incident on a glass-air boundary.
The critical angle for glass is 42°.



Which **one** of the diagrams, **A**, **B**, **C** or **D**, shows total internal reflection?

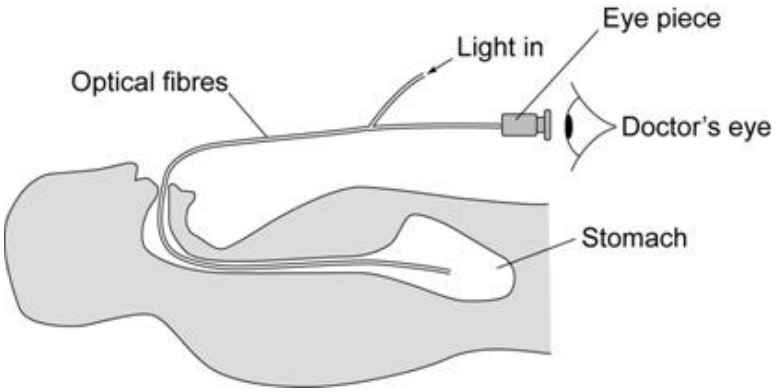
Write the correct letter in the box. ☐

(1)

(b) (i) Complete the diagram to show the path taken by the light ray as it travels through the optical fibre.

(2)

(ii) The diagram shows an endoscope being used by a doctor to look inside a patient's stomach. Light travels into the stomach through a bundle of optical fibres.



The following sentences describe how the endoscope allows the doctor to see inside the patient's stomach. The sentences are in the wrong order.

Q Light passes through a bundle of optical fibres into the patient's stomach.

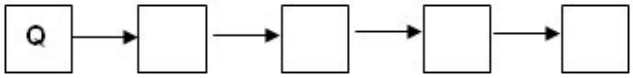
R The inside of the stomach reflects some of the light.

S The optical fibres take the light to an eyepiece.

T The doctor looks through the eyepiece to see inside the patient's stomach.

U The reflected light passes through a second bundle of optical fibres.

Arrange these sentences in the correct order. Start with letter **Q**.



(3)
(Total 6 marks)

M1. (a) (sound waves) which have a frequency higher than the upper limit of hearing for humans

or

a (sound) wave (of frequency) above 20 000 Hz

sound waves that cannot be heard is insufficient

a wave of frequency 20 000 Hz is insufficient

1

(b) 640

*an answer of 1280 gains **2** marks*

*allow **2** marks for the correct substitution*

ie 1600 × 0.40 provided no subsequent step

*allow **2** marks for the substitution* $\frac{1600 \times 0.80}{2}$ *provided no subsequent step*

*allow **1** mark for the substitution 1600 × 0.80 provided no subsequent step*

*allow **1** mark for the identification that time (boat to bed) is 0.4*

3

(c) any **one** from:

- pre-natal scanning / imaging
- imaging of a named organ (that is not surrounded by bone), eg stomach, bladder, testicles

  accept heart

  *do **not** allow brain **or** lungs (either of these negates a correct answer)*
- Doppler scanning blood flow

1

(d) advantage

any **one** from:

- (images are) high quality or detailed or high resolution

  clearer / better image is sufficient
- (scan) produces a slice through the body
- image can be viewed from any direction

  allow images are (always) 3D / 360°
- an image can be made of <u>any</u> part (inside the body)

  allow whole body can be scanned
- easier to diagnose **or** see a problem (on the image)

1

disadvantage

any **one** from:

- (the X-rays used **or** scans) are <u>ionising</u>

  allow a description of what ionising is
- mutate cells **or** cause mutations **or** increase chances of mutations

  allow for cells:

  DNA / genes / chromosomes / nucleus / tissue
- turn cells cancerous **or** produce abnormal growths **or** produce rapidly growing cells
- kill cells

  damage cells is insufficient
- shielding is needed

can be dangerous (to human health) unqualified, is insufficient

1

[7]

M2. Quality of written communication

*award for a sensible sequence of **two** points*

1

X-rays do not go through lead

accept lead protects them from the X-rays
accept not exposed to X-rays

1

lead stops / reduces risk of X-rays harming / damaging / killing (persons) cells

accept X-rays (may) cause cancer
accept organs for cell
*do **not** accept references to electric shock*
*do **not** accept stops bones of people showing on X-ray*
answers involving the horse wearing an apron are incorrect
references to gamma rays are incorrect

1

[3]

M3. (a) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the Marking guidance, and apply a 'best-fit' approach to the marking.

0 marks
No relevant / correct content.

Level 1 (1-2 marks)
There is a basic description of either wave
OR
What happens to either wave when they enter the body. However there is little other detail.

Level 2 (3-4 marks)
There is either:
A clear description of BOTH waves
OR
A clear description as to what happens to BOTH waves inside the body
OR
A clear description of ONE of the waves with clear detail as to what happens to either wave inside the body.

Level 3 (5-6 marks)
There is a detailed description of BOTH of the waves
AND
A detailed description as to what happens to EITHER wave inside the body.

Examples of the points made in the response:

Description of an X-ray

- X-rays are electromagnetic waves / part of the electromagnetic spectrum
  *do **not** allow a description of a property – eg X-rays travel*
- X-rays are (very) high frequency (waves)
  through a vacuum / at the speed of light
- X-rays are (very) high energy (waves)
- X-rays have a (very) short wavelength
- Wavelength (of X-rays) is of a similar size to (the diameter of) an atom
- X-rays are a transverse wave
  correct description acceptable – oscillations / vibrations are perpendicular (at 90°) to direction of energy transfer
- X-rays are ionising radiation

Description of ultrasound

- ultrasound has a frequency above 20 000 (hertz)

  or

  ultra sound is above 20 000 hertz
- ultrasound is above / beyond the human (upper) limit (of hearing)
  accept ultrasound cannot be heard by humans
- ultrasound is a longitudinal wave
  correct description acceptable – oscillations / vibrations (of particles) are parallel (in same direction) to direction of energy transfer

Statement(s) as to what happens to X-rays inside the human body:

- X-rays are absorbed by bone
- X-rays travel through / are transmitted by tissue / skin

Statement as to what happens to ultrasound inside body:

- ultrasound is (partially) reflected at / when it meets a boundary between two different media
- travel at different speeds through different media

6

(b) (because the X-rays) are ionising
accept a description of what ionising is

1

(they will) damage cells

instead of cell, any of these words can be used:
DNA / genes / chromosomes / nucleus

or

mutate cells / cause mutations / increase chances of mutations

or

turn cells cancerous / produce abnormal growths / produce rapidly growing cells

*do **not** accept they can be dangerous (to human health)*
*do **not** accept damage to soft tissue*

or

kill cells

1

(c) any **one** from:

- removal / destruction of kidney / gall stones
- repair of damaged tissue / muscle

accept examples of repair, eg alleviating bruising, repair scar damage, ligament / tendon damage, joint inflammation
accept physiotherapy
*accept curing prostate cancer **or** killing prostate cancer cells*

- removing plaque from teeth

cleaning teeth is insufficient

1

[9]

M4. (a) (i) (angle of) refraction

*take care **not** to credit 'angle of reflection'*

1

(ii) normal

*do **not** credit 'horizontal'*

1

(b) **either**

(photographic) film

or CCD(s) (charge-coupled device(s)) / CMOS(s) (sensor(s)) / (active) pixel sensor(s)

accept 'LDR(s)' / 'light dependent resistor(s)'
***not** lux meter*
*do **not** accept light sensor(s)*

1

(c) (i) converging

***or** 'convex'*

1

(ii) **either**

(0).35

or (0).4(1...)

*do **not** give any credit for an answer greater than 1*

or

*7 ÷ 20 for **1** mark*

or

*clear evidence that appropriate measuring / counting, has been made for **1** mark*

2

(d) otherwise it will have no effect on the light detector

or otherwise no (real) light will fall on the light detector

***or** 'a virtual / imaginary image will have no effect on the light detector'*

allow error carried forwards for 'light detector'

allow so it can be formed on the film

1

[7]

M5. (a) (i) Image distance increases
Image size increases
Remains inverted
Remains real

for 1 mark each

2

(ii) Image distance decreases
Image size decreases
Becomes upright
Becomes virtual

for 1 mark each

2

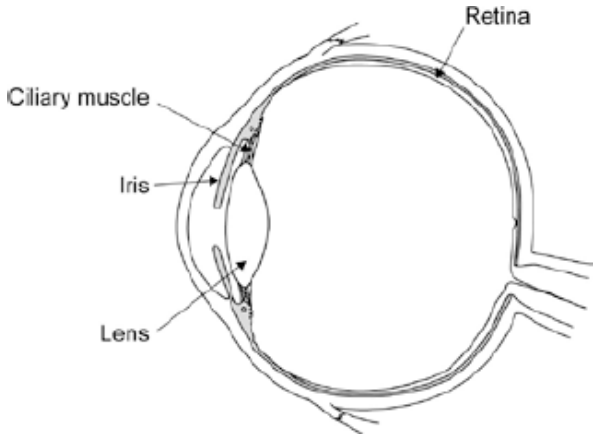
(b) Move lens with respect to film
Closer for distant objects
Further for near objects

for 1 mark each

3

[7]

M6. (a) (i)



award **1** mark for each correct label

4

(ii) Marks awarded for this answer will be determined by the quality of communication (QoC) as well as the standard of the scientific response. Examiners should apply a best−fit approach to the marking.

0 marks
No relevant content.

Level 1 (1 − 2 marks)
There is a basic description of at least one of either ciliary muscle **or** iris in terms of function.

Level 2 (3 − 4 marks)
There is a clear description of the function of ciliary muscle **and** iris
or
a full, detailed description of either ciliary muscle **or** iris.

Level 3 (5 − 6 marks)
There are clear and detailed descriptions of the functions of both ciliary muscle **and** iris.

examples of the physics points made in the response:

Ciliary muscle:
- changes the shape of the lens
- relaxes to flatten lens
- allowing light to be focused from distance
- contracts to round lens
- allowing light to be focused from close objects

Iris:
- controls the amount of light entering the eye
- expands / relaxes making pupil smaller
- in bright light
- contracts making pupil larger
- in low light
- helps protects the retina (in bright light)

6

(b) eyeball being too short

1

(c) (i) magnified

1

upright

1

(ii) v = −6(cm)

*max **2** marks if no minus sign*
*6(cm) gains **2** marks*
1/v = 1/12 − 1/4 = −1/6
*gains **2** marks*
1/12 = 1/4 + 1/v
*gains **1** mark*
−5.99(cm)
*using decimals gains **3** marks*

3

(d) it is <u>virtual</u>

1

[17]

M7. **Eye –** Diminished/smaller than object
Nearer the lens than object or on the retina
for 1 mark each

2

Projector – real
Further from lens than object
for 1 mark each

2

Camera – real
Smaller (than object)
for 1 mark each

2

[6]

M8. (a) **D**

1

(b) (i) total internal reflection shown

1

2 or 3 reflections only

1

(ii) **R U S T**

correct order

*allow **2** marks for two in correct place*

*allow **1** mark for one in correct place*

3

[6]