New Document 1

Name: ________________________

Class: ________________________

Date: ________________________

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Time: 188 minutes

Marks: 188 marks

Comments:
Q1.
(a) A camera was used to take a photograph. The camera contains a convex (converging) lens.

Complete the ray diagram to show how the lens produces an image of the object.

(b) State two words to describe the nature of the image produced by the lens in the camera.

1. _________________________________________________________________
2. _________________________________________________________________

Q2.
(a) The diagram shows how parallel rays of light pass through a convex lens.

(i) Mark the position of the focus.

(ii) Is this a **converging** lens, a **diverging** lens, **both** or **neither**?

(b) The diagram shows how parallel rays of light pass through a concave lens.
(i) Mark the position of the focus.

(ii) Is this a **converging** lens, a **diverging** lens, both or neither?

(c) Complete these sentences by crossing out the two lines in each box that are wrong.

In a camera, a **lens** is used to produce an image of an object on a **screen**.

The image is **larger than** the object.

The image is **further from** the lens, compared to the distance of the object from the lens.

(d) In a cinema projector, a convex lens is used to produce a **magnified, real** image.

(i) What does **magnified** mean?
(ii) What is a real image?

(1)

(e) You are in a dark room. You have a box containing some lenses. Only one of them is a converging lens.

Describe how, by just feeling the lenses, you can pick out the converging lens.

(2)

(Total 12 marks)

Q3.

(a) Figure 1 shows a section through a human eye.

Write the correct letter, A, B, C or D, in each empty box to identify the parts of the eye labelled in Figure 1.

<table>
<thead>
<tr>
<th>Part of the eye</th>
<th>A, B, C or D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cornea</td>
<td></td>
</tr>
<tr>
<td>Lens</td>
<td></td>
</tr>
<tr>
<td>Retina</td>
<td></td>
</tr>
</tbody>
</table>

(b) The table shows how the mass of 1 cm³ of different materials varies with refractive index.
<table>
<thead>
<tr>
<th>Material</th>
<th>Refractive index</th>
<th>Mass in g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>1.33</td>
<td>1.00</td>
</tr>
<tr>
<td>Glass X</td>
<td>1.52</td>
<td>2.54</td>
</tr>
<tr>
<td>Glass Y</td>
<td>1.70</td>
<td>2.93</td>
</tr>
<tr>
<td>Glass Z</td>
<td>1.81</td>
<td>3.37</td>
</tr>
</tbody>
</table>

(i) Describe the pattern shown in above table.
__________________________________________________________________________
__________________________________________________________________________

(1)

(ii) Lenses used for correcting visual defects often have a low refractive index.

State one advantage and one disadvantage of using lenses with a high refractive index for correcting visual defects.

Advantage ____________________________________________________________________
Disadvantage __________________________________________________________________

(2)

(iii) The eyesight of a person can change throughout their lifetime. Scientists have designed cheap spectacles that allow the wearer to change the focal length of the lenses as their eyesight changes.

Two designs are:

• using water-filled lenses where water is pumped in or out of the lens to change its shape
• using a pair of specially shaped lenses for each eye that are able to slide across each other.

Figure 2 shows these two designs.

**Figure 2**

[Spectacles with water-filled lenses with water store and pump]

[Spectacles with sliding lenses made from glass Z with knob to adjust position of sliding lens]

Suggest one advantage and one disadvantage of each design.
__________________________________________________________________________
Figure 3 shows parallel rays of white light from a distant point being refracted towards a screen by a lens.

The lens is made from a glass with a much greater refractive index than glass normally used for correcting visual defects.

What would you notice about the image on the screen?

State two observations.
1. _________________________________________________________________
   ___________________________________________________________________
2. _________________________________________________________________
   ___________________________________________________________________

Q4.

At night, it is important that the lights of a car can be seen by other drivers but it is dangerous if these lights dazzle them.
The diagram shows a rear light of a car.

(a) (i) Name part A.

______________________________________________________________

(1)

(ii) Name the process which occurs at point B and at point C.

______________________________________________________________

(1)

(b) A headlamp of a car contains a lens.

The ray diagram shows the position and size of the image, I, of an object, O, formed by a lens similar to the one inside a car headlamp.

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

Draw a ring around your answer.

converging    diverging    plane
(ii) The ray diagram is drawn to scale.

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

\[
magnification = \frac{\text{image height}}{\text{object height}}
\]

Show clearly how you work out your answer.

\[
\text{Magnification} = \frac{\text{image height}}{\text{object height}}
\]

(Total 5 marks)

Q5.

An aquarium contains only one fish. But if you look at the corner of the aquarium, there seem to be two fish.

The diagram below shows the top of the aquarium.

Two light waves have been drawn from the fish.

(a) Complete the diagram to show how the light waves reach the eye.
(b) Complete each sentence by using the correct words from the box.

<table>
<thead>
<tr>
<th>colour</th>
<th>diffraction</th>
<th>longitudinal</th>
<th>reflection</th>
</tr>
</thead>
<tbody>
<tr>
<td>refraction</td>
<td>speed</td>
<td>transverse</td>
<td></td>
</tr>
</tbody>
</table>

When the light waves pass from glass into the air they change ________________

This causes a change in direction called ________________

Light waves are ________________ waves.

(Q6. (Total 5 marks)

(a) The diagram shows a wave pattern.

Which letter, L, M or N shows:

(i) the wavelength? __________

(ii) the amplitude? __________

(c) Describe how you could show that visible light travels in straight lines. You may wish to draw a diagram to help explain your answer.
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 to calculate the magnification.
Q8.

A student investigated how the nature of the image depends on the position of the object in front of a large converging lens.

The diagram shows one position for the object.

(a) Use a ruler to complete a ray diagram to show how the image of the object is formed.
Q9.

A puppy can see an image of himself in a plane mirror.
The diagram shows how the puppy can see his disc.

(a) On the diagram, use a ruler to draw a ray to show how the puppy can see the top of his ear, which is marked as T.

(b) What is a plane mirror?

___________________________________________________________________
___________________________________________________________________

(Total 4 marks)

Q10.

The diagram shows a lens, the position of an object and the position of the image of the object.

(a) What type of lens is shown?
(b) What is the name of the points, F, shown each side of the lens?

___________________________________________________________________

(c) (i) The image is real and can be put on a screen.

How can you tell from the diagram that the image is real?

___________________________________________________________________

___________________________________________________________________

(ii) Draw a ring around a word in the box which describes the image produced by the lens.

<table>
<thead>
<tr>
<th>inverted</th>
<th>larger</th>
<th>upright</th>
</tr>
</thead>
</table>

(d) A student investigates the relationship between the distance from the object to the lens and the magnification produced by the lens. The student's results are given in the table. The student did not repeat any measurements.

<table>
<thead>
<tr>
<th>Distance in millimetres</th>
<th>Height of object in millimetres</th>
<th>Height of image in millimetres</th>
<th>Magnification produced</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>20</td>
<td>58</td>
<td>2.9</td>
</tr>
<tr>
<td>50</td>
<td>20</td>
<td>30</td>
<td>1.5</td>
</tr>
<tr>
<td>60</td>
<td>20</td>
<td>20</td>
<td>1.0</td>
</tr>
<tr>
<td>70</td>
<td>20</td>
<td>14</td>
<td>0.7</td>
</tr>
<tr>
<td>80</td>
<td>20</td>
<td>12</td>
<td>0.6</td>
</tr>
<tr>
<td>90</td>
<td>20</td>
<td>10</td>
<td>0.5</td>
</tr>
</tbody>
</table>

The student plots the points for a graph of magnification produced against distance.
(i) Draw a line of best fit for these points.

(ii) Complete the following sentence by drawing a ring around the correct word in the box.

A line graph has been drawn because both variables are described as being

categoric.
continuous.
discrete.

(iii) Describe the relationship between magnification produced and distance.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

(2)

Q11.

A student investigates how the magnification of an object changes at different distances from a converging lens.

The diagram shows an object at distance $d$ from a converging lens.
(a) (i) The height of the object and the height of its image are drawn to scale.

Use the equation in the box to calculate the magnification produced by the lens shown in the diagram.

\[
\text{magnification} = \frac{\text{image height}}{\text{object height}}
\]

Show clearly how you work out your answer.

Magnification = ______________________________ (2)

(ii) The points \( F \) are at equal distances on either side of the centre of the lens.

State the name of these points.

______________________________________________________________ (1)

(iii) Explain how you can tell, from the diagram, that the image is virtual.

______________________________________________________________

______________________________________________________________ (1)

(b) The student now uses a different converging lens. He places the object between the lens and point \( F \) on the left.

The table shows the set of results that he gets for the distance \( d \) and for the magnification produced.

<table>
<thead>
<tr>
<th>Distance ( d ) measured in cm</th>
<th>Magnification</th>
</tr>
</thead>
</table>

His friend looks at the table and observes that when the distance doubles from 10 cm to 20 cm, the magnification doubles from 1.5 to 3.0.

His friend’s conclusion is that:

The magnification is directly proportional to the distance of the object from the lens.

His friend’s observation is correct but his friend’s conclusion is not correct.

(i) Explain, with an example, why his friend’s conclusion is not correct.

(ii) Write a correct conclusion.

(iii) The maximum range of measurements for $d$ is from the centre of the lens to $F$ on the left.

The student cannot make a correct conclusion outside this range.

Explain why.

Q12.

(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.
(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.

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

(Total 7 marks)
Q13.

(a) A light bulb is placed between a convex lens and the principle focus of this lens, at position $N$ shown in Figure 1. The light bulb is then moved to position $M$, a large distance from the lens.

**Figure 1**

---

Describe how the nature of the image formed changes as the light bulb is moved from position $N$ to position $M$.

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

(3)

(b) An object, $O$, is very near to a convex lens, as shown in Figure 2.

Complete Figure 2 to show how rays of light from the object form an image.

**Figure 2**
(c) The object distance is the distance from an object to the lens. The image distance is the distance from the lens to the image.

**Figure 3** shows how the image distance changes with the object distance, for two identically shaped convex lenses, A and B. Each lens is made from a different type of glass.
(i) When the object distance is 4 cm, the image distance for lens A is longer than for lens B.

State why.

__________________________________________________________________________________________

__________________________________________________________________________________________

(1)

(ii) When the object is moved between lens B and the principal focus, the image size changes. The table shows the magnification produced by lens B for different object distances.

<table>
<thead>
<tr>
<th>Object distance in cm</th>
<th>Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>1</td>
</tr>
<tr>
<td>5.0</td>
<td>2</td>
</tr>
<tr>
<td>6.7</td>
<td>3</td>
</tr>
<tr>
<td>7.5</td>
<td>4</td>
</tr>
<tr>
<td>8.0</td>
<td>5</td>
</tr>
</tbody>
</table>

Using information from Figure 3 and the table, describe the relationship between the image distance and the magnification produced by lens B.

__________________________________________________________________________________________

__________________________________________________________________________________________

(2)

(iii) A third convex lens, lens C, is made from the same type of glass as lens B,
but has a shorter focal length than lens B.

Lens B is shown in Figure 4.

Complete Figure 4 to show how lens C is different from lens B.

Figure 4

Q14.

The diagram shows a lens being used as a magnifying glass.

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

Draw a circle around your answer.

concave converging diverging

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

The object and image in the diagram have been drawn to full size.

\[
magnification = \frac{image\ height}{object\ height}
\]

Show clearly how you work out your answer.
The diagram shows how the image changes when the object has been moved closer to the lens.

Complete the following sentence by drawing a ring around the correct line in the box.

Moving the object closer to the lens does not change the magnification produced by the lens.

Q15.
(a) The visible light spectrum has a range of frequencies.

*Figure 1* shows that the frequency increases from red light to violet light.

As the frequency of the light waves increases, the wavelength
of the light waves ______________________________ and
the energy of the light waves ______________________________ .

(2)

(b) Bottled beer will spoil if the intensity of the light passing through the glass bottle into
the beer is too high.

Figure 3 shows the intensity of the light that is transmitted through three different
pieces of glass.

![Figure 3](image.png)

(i) The pieces of glass all had the same thickness.

Suggest why.

______________________________________________________________
______________________________________________________________

(1)

(ii) Bottles made of brown glass are suitable for storing beer.

Suggest why.

______________________________________________________________
______________________________________________________________

(1)

(Total 4 marks)
In the diagram below, a frog sits on a rock in a pond.

(a) Complete the following sentences by drawing a ring around the correct line in the box.

(i) The frog can see its image in the pond because the surface of the pond acts like a

- concave
- convex
- plane

mirror.

(ii) Draw a ring around each of two words from the box below to describe the image in the pond.

- bigger
- inverted
- real
- smaller
- upright
- virtual

(b) There is an insect underneath the rock.

Use a ruler to draw rays of light on the diagram to show how the frog uses reflection to see the insect.

Mark the direction of the rays.

Q17.

The drawing shows someone ironing a shirt. The top of the ironing board is covered in a shiny silver-coloured material.
Explain why the shiny silver-coloured material helps to make ironing easier.

_______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________
(Total 2 marks)

Q18.
(a) The diagram shows two mirrors at right angles to each other. A ray of light shines onto one mirror as shown.

Carefully draw the path of the ray which is reflected from both mirrors.

Draw an arrow on the ray to show the direction of the light.

(b) Light can also be made to change direction as it passes into and out from a block of glass. Complete the ray diagram below.
Q19.

(a) The diagrams show rays of light. Each ray strikes a surface of a glass block.

(i) On the diagram draw the path of each ray through the glass block and out into the air again.

(ii) Label another angle on the diagram which is equal to the angle marked $X$. Label this angle $Y$.

(b) The diagrams show two beakers. Both beakers have a drawing pin inside as shown.
The first beaker is empty. The eye cannot see the drawing pin. The second beaker is full of water and the eye can see the drawing pin.

Explain how the eye is able to see the drawing pin in the second beaker. You may add to the diagram if it helps your answer.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(3)
(Total 7 marks)

Q20.

The diagram shows a ray of light travelling through a glass block.

(a) Complete the diagram to show what happens to the ray of light when it comes out of the glass.

(b) Explain why this happens to the ray of light.

___________________________________________________________________

(2)
(Total 4 marks)

Q21.

A man is walking along the bank of a river.

He sees a fish which seems to be at X.
(a) Show, on the diagram, where the fish **really** is.

Complete the ray of light which goes from the fish into the man's eye.

(2)

(b) Complete the sentence.

The ray of light is ____________________ as it passes from the water into the air.

(1)

(Total 3 marks)

**Q22.**

The diagram shows a glass prism.

(i) Explain why refraction has **not** occurred at point **X**.

___________________________________________________________________
___________________________________________________________________

(1)

(ii) (A) Give the full name for the process which has occurred at point **Y**.

___________________________________________________________________

(1)

(B) Explain why this process has occurred.

___________________________________________________________________

___________________________________________________________________
Q23.
(a) The diagrams below show rays of light striking a mirror and a perspex block.

Complete the paths of the three rays of light on the diagrams to show the rays leaving the mirror and the perspex block.

(b) The diagram below shows a beam of light striking a perspex block.

(i) Continue the paths of the rays AB and CD inside the perspex block.

(ii) Draw the wavefronts of the beam of light in the perspex.

(iii) Explain why the beam behaves in the way you have shown.

(c) The diagram below shows a ray of light striking a perspex-air surface from inside the perspex. The critical angle is 45°.
Q24.

The data given in the table below was obtained from an investigation into the refraction of light at an air to glass boundary.

<table>
<thead>
<tr>
<th>Angle of incidence</th>
<th>Angle of refraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>20°</td>
<td>13°</td>
</tr>
<tr>
<td>30°</td>
<td>19°</td>
</tr>
<tr>
<td>40°</td>
<td>25°</td>
</tr>
<tr>
<td>50°</td>
<td>30°</td>
</tr>
</tbody>
</table>

(a) Describe an investigation a student could complete in order to obtain similar data to that given in the table above.

Your answer should consider any cause of inaccuracy in the data.

A labelled diagram may be drawn as part of your answer.

___________________________________________________________________

___________________________________________________________________

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___________________________________________________________________

(b) State the reason why light is refracted as it crosses from air into glass.

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________
Q25.
(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.

![Diagram of light ray entering and exiting plastic block]

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

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

(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.
Q26.
The data given in the table below was obtained from an investigation into the refraction of light at an air to glass boundary.

<table>
<thead>
<tr>
<th>Angle of incidence</th>
<th>Angle of refraction</th>
</tr>
</thead>
</table>

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

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

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

\[
magnification = \frac{\text{image height}}{\text{object height}}
\]

Show clearly how you work out your answer.

Magnification = __________

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

(Total 7 marks)
Describe an investigation a student could complete in order to obtain similar data to that given in the table above.

Your answer should consider any cause of inaccuracy in the data.

A labelled diagram may be drawn as part of your answer.

_______________________________________________________________________
_______________________________________________________________________
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_______________________________________________________________________
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_______________________________________________________________________
_______________________________________________________________________

(Total 6 marks)

Q27.

(a) 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**

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

Calculate the image distance.

______________________________________________________________

______________________________________________________________

______________________________________________________________

Image distance = __________ cm

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

______________________________________________________________

(Total 6 marks)

Q28.

The diagram shows a model used to demonstrate an illusion known as 'Pepper's Ghost'.

A small light bulb and thin sheet of glass are put inside a box. The thin sheet of glass acts as a mirror. Although the light bulb is switched on, a student looking into the box cannot see the bulb. What the student does see is a virtual image of the bulb.
(a) Use a ruler to complete a ray diagram to show how the image of the light bulb is formed. Mark and label the position of the image.

(b) The image seen by the student is virtual.

Why?

___________________________________________________________________
___________________________________________________________________

Q29.

(a) The diagram shows two parallel rays of light, a lens and its axis.

(i) Complete the diagram to show what happens to the rays.
(ii) Name the point where the rays come together.

________________________________________________________________________

(1)

(iii) What word can be used to describe this type of lens?

________________________________________________________________________

(1)

(b) The diagram shows two parallel rays of light, a lens and its axis.

(i) Which point A, B, C, D or E shows the focal point for this diagram?

Point _________

(1)

(ii) Explain your answer to part (b)(i).

________________________________________________________________________

________________________________________________________________________

(1)

(iii) What word can be used to describe this type of lens?

________________________________________________________________________

(1)

(c) Complete the following three sentences by crossing out the two lines in each box which are wrong

In a camera a converging lens is used to produce an image on a

film  lens  screen

The image is larger than
Compared to the distance of the image from the lens, the object is

- further away from
- nearer to
- the same distance from

the lens.

(d) Explain the difference between a real image and a virtual image.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(3)
(Total 13 marks)
Mark schemes

Q1.
(a) any two correct construction lines:
   
   if more than 2 construction lines treat as a list
   
   • line passing straight through centre of lens (& out other side)
   • line travelling parallel to principal axis & then being refracted through principal focus (on RHS)
   • line travelling through principal focus (on LHS) & then being refracted to be parallel to principal axis (on RHS)

   inverted image drawn (with arrow) in correct location

   one arrowhead from object to image on any construction ray
   conflicting arrowheads negate this mark

(b) any two from:
   • inverted
     accept upside down
   • real
   • diminished / smaller
     allow ecf if ray diagram wrongly drawn but descriptions must relate to their image
     a converse negates mark, eg real and virtual scores zero

Q2.
(a) (i) point where the rays cross
(ii) converging (lens)

\textit{do not} accept convex

(b) (i) point where the rays appear to diverge from

\textit{this should appear to be within 10mm in front of the back of the arrows on the approximate centre line}

\textit{need not be accurately constructed using a ruler}

(ii) diverging (lens)

\textit{do not} accept concave

(c) converging

film

smaller than

nearer to

\textit{accept any clear indication of the response e.g. ticking, ringing, writing in after a mistake}

(d) (i) (image) bigger than object enlarge

\textit{accept just 'made bigger'}

(ii) it / real image can be put on a screen or real image on the opposite side of the lens to the object

\textit{accept 'not an imaginary or virtual image'}

\textit{assume 'it' refers to a real image}

\textit{do not credit 'it can be seen'}

(e) \textbf{either} (the converging lens is) thick in the middle thinner at the edge

\textit{thickest in the middle gains 2 marks}

or (both) sides bend outwards (1) in the middle (1)

\textit{convex gains 2 marks}

\textit{suitable diagrams gains 2 marks}

or one side bends in the middle (1) more than the other side bends inwards (in the middle) (1)

Q3. (a) B

\textit{must be in correct order}
(b)  (i)  mass increases as refractive index increases

*accept weight / density increases as refractive index increases*

(ii) thinner

*accept thin*

heavier

*accept heavy*

(iii)  maximum one advantage and one disadvantage of each design

**water-filled**

advantages:
• lenses are light
• wide range of focal length
• allows fine adjustment
• allows lenses to be altered independently.

disadvantages:
• unattractive
• lens might burst
• lens might leak
• uncomfortable.

**sliding lenses**

advantages:
• hard-wearing
• look like conventional glasses
• easy to adjust
• allows lenses to be altered independently.

disadvantages:
• heavy
• might slide out of position
• might get dirt between the lenses.

(c)  any two from:

the image is

• blurred
• coloured
• inverted
• diminished.

*accept not focussed*
Q4.

(a)  (i) (concave) mirror / reflector  

1  

(ii) refraction  

1  

(b)  (i) converging  

1  

(ii) 4  

allow 1 mark for correct substitution  

ie 20 / 5 or 4 / 1  

ignore any units  

2  

Q5.

(a) one mark for each ray correctly drawn straight to glass then bent towards pupil  

accept both rays hitting any part of eye  

judge straightness by eye  

accept dotted or dashed lines  

ignore any arrows  

N.B. the rays must reach the eye  

2  

(b) speed  

1  

refraction  

1  

transverse  

1  

Q6.

(a)  (i) L  

1  

(ii) N  

1  

(c) the answer should be in the form:  

not inside the eye  

either for both marks an arrangement which could demonstrate visibly light travels in straight lines  

full credit should be given for answer presented as a diagram  

and  

an explanation of how it shows the straightness
named device which uses principle of light travelling in straight lines to work
examples
light (from a street lamp) strikes an object producing a shadow
laser light travelling through (fine) dust shows a straight beam
three pieces of card with central holes need to be lined up to be able to see through the third hole from the first ray box type experiment using mirrors/prisms, etc beams on paper or in smoke torch beams through smoke example devices:—
—pinhole camera (qualification may get second mark)
—periscope
—optical fibre
—reflection ‘in a mirror

Q7.
(a) converging or convex
(b) (principal) focus or focal point
(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
(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’

Q8.
(a) any two for 1 mark each deduct (1) from the first two marks if a ruler has not been used but the intention is clear
ray from the object’s arrowhead
• through centre of lens
• parallel to the axis then, when it reaches the lens, through F on the right
• through F on the left then, when it reaches the lens parallel to the axis
example of a \textbf{4} mark response

if more than two construction lines have been drawn all must be correct to gain \textbf{2} marks
construction lines drawn as dashed lines do not score credit

image shown as vertical line from axis to where their \textit{rays} intersect
image need not be marked with an arrowhead but, if it is, it must be correct

ray direction shown
only one correct direction
arrow one correct but there must not be any contradiction

(b) any \textbf{two} from:

- inverted
  accept \textit{‘upside down’}

- magnified
  accept \textit{‘bigger’}

- real
  accept \textit{‘not virtual / not imaginary’}
  one correct feature gains \textbf{1} mark
  ignore any reference to position
  an incorrect feature negates a correct response

Q9.

(a) reflection at the mirror of ray from tip of real puppy's ear to real puppy's eye (1)
may be drawn freehand

accurate (1)
ruler must have been used and the reflected ray is an extension of the straight line from point virtual ear however the virtual part of the line need not be shown

arrow to show correct direction (1)
only one arrow needs to be shown but there must be no contradiction
example of (3) mark response
(b) flat

accept ‘it’s not curved/bent’
accept ‘it’s straight’

Q10.

(a) converging (lens)

accept ‘convex (lens)’
accept biconvex

(b) (principal) foci

accept ‘focus’ / ‘focuses’ / ‘focis’
focal point(s)

(c) (i) formed where (real) rays (of light) intersect / meet / cross

accept rays (of light) pass through the image
accept ‘image is on the opposite side (of the lens to the object)’
accept (construction) lines cross over
a response relating to a screen or similar is neutral
lines are solid and not dotted is neutral

(ii) inverted

accept any unambiguous correct indication

(d) (i) smooth curve which matches the points

judge by eye but do not accept point to point by ruler or otherwise

(ii) continuous

(iii) as distance increases, magnification decreases

accept negative correlation
a statement ‘inversely proportional’ is incorrect and limits
maximum mark for this part question to 1

further detail eg magnification falls steeply between 40 and 50 cm
or
magnification begins to level out after / at 70 cm

Q11.

(a) (i) answer in the range 3.0 ↔ 3.1 inclusive

accept for 1
3.6 ÷ 1.2 or 3.7 ÷ 1.2
or 36 ÷ 12 or 37 ÷ 12
or 18 ÷ 6 or 18.5 ÷ 6
or 10.2 ÷ 3.4 or 102 ÷ 34
or answer in the range but with a unit e.g. 3 cm

(ii) (principal) focus / focal point(s) / foci / focus
    accept ‘focusses’
    accept foci
    do not accept focal length

(iii) at the intersection of virtual / imaginary rays
    or ‘where virtual / imaginary rays cross’
    or the rays of (real) light do not cross
    or the image on the same side (of the lens) as the object
    or the image is drawn as a dotted line
    or the image is upright
    do not accept ‘cannot be put on a screen’
    do not accept any response which refers to reflected rays

(b) (i) another correct observation about relationship between values of d (1)
    (but) not the same relationship between corresponding values for magnification (1)
    example
    15 is three times bigger than 5 but
    2.0 is not three times bigger than 1.2

(ii) when the distance / d increases the magnification increases
    or the converse
    accept ‘there is a (strong) positive correlation’
    do not accept any response in terms of proportion / inverse proportion

(iii) (student has) no evidence (outside this range)
    accept data / results / facts for ‘evidence’

Q12.
(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

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

(ii) (x) 3.0
accept 3.0 to 3.5 inclusive

or

their image height

\[
\frac{\text{object height}}{	ext{image height}}
\]
correctly calculated
accept 1 mark for correct substitution into equation using their figures
ignore any units

(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

Q13.
(a) the image would decrease in size
the image would change (from virtual) to real

accept that the image (of bulb M) can be projected on to a screen

the image would change (from non-inverted) to inverted

(b) a ray through the centre of the lens

rays should be drawn with a ruler
ignore arrows

a ray parallel to the principal axis and passing through the principal focus to the right of lens

accept solid or dashed lines
accept a ray drawn as if from the principal focus to the left of the lens, emerging parallel to the principal axis

image drawn where rays cross

image should be to left of the lens

(c) (i) (because the glass in) lens A has a greater refractive index

accept lens A is more powerful
accept lens A has a shorter focal length

(ii) when the magnification increases by 1, the image distance increases by 10 cm

accept for 1 mark it is a linear pattern
as the image distance increases, the magnification increases 
do not accept directly proportional

(iii) diagram showing the surfaces of a convex lens C having greater curvature than lens B

the size of the lens drawn is not important

Q14. 
(a) (i) converging

(ii) (x) 2

allow 1 mark for correct substitution

ie 10/5 or 20/10 or 2/1

ignore any units

(b) decreases

Q15. 
(a) decreases

correct order only

increases

(b) (i) intensity (of transmitted light ) depends on thickness

or

to enable a valid comparison

or

it is a control variable

accept absorption depends on thickness

it would affect the results is insufficient

fair test is insufficient

(ii) transmits the least light

or

absorbs the most light

accept very little light is transmitted

do not accept transmits none of the light

do not accept absorbs all of the light

any reference to heat negates this mark

Q16.
(a)  (i)  plane
    accept any unambiguous indication

(ii)  inverted
    virtual
    accept any unambiguous indication

(b)  reflection takes place at the surface of the pond and angle of incidence = angle of reflection
    as judged by eye
reflected ray is a straight line to frog’s eye through the air

correct direction arrow either from insect or to frog’s eye
    only one arrow essential but
    do not accept if either arrow contradicted example of a fully correct response

Q17.
silver is a (good) reflector of heat (radiation) or
silver reflects the heat (radiation)
    fact
    heat = infra red
    ignore references to light
    accept shiny for silver
    good radiator negates the mark
    ignore references to good conductor
    do not accept bounce back

less heat is lost through the board or more heat is retained by the shirt
explanation
Q18.
(a) first reflection vertically down to the fourth hatch line or just to the left of it reaching mirror (must come from incident ray given)

\[
\text{Source of light}
\]

second reflection back parallel to incident ray must be linked to first part of ray appropriate arrow on a part of the ray (may be given if lines wrong)

\text{(must come from source of light)}

\text{maximum of one mark to be lost for poor diagrams not using a ruler for straight lines}

\text{first time you come across wavy line, it is penalised}

(b) ray in block bent downwards, not beyond the normal

\text{do not credit if exactly on normal}

emergent ray parallel to incident ray

\text{do not credit a continuation of the line straight through the block these are independent}

Q19.
(a) (i) Ignore arrows on rays perpendicular rays goes straight in and out other ray refracts towards normal (not along) emerges parallel incident ray (by sight) if refraction correct (ignore reflections)

\text{for 1 mark each}

(ii) emergent angle marked Y if emerges parallel to right of normal

\text{for 1 mark}

(b) straight ray to water surface refracts/bends straight to eye/towards surface on right image correctly shown
Q20.
(a) ray shown refracted \(\text{to rhs or along normal}\)
\[\text{gains 1 mark}\]

but
ray shown refracted \(\text{away from normal}\)
\[\text{gains 2 marks}\]

(b) idea that
travels at a different speed
\[\text{gains 1 mark}\]

\(\text{allow refracted / travels slower in air / air is less dense (do not allow bent)}\)

but
travels more quickly in air
\[\text{gains 2 marks}\]

Q21.
(a) line (from fish) to complete ray to eye
\[\text{[mark awarded even if begins outside the box]}\]
\[\text{[credit only if fish shown to left of normal]}\]

• fish within the region shown or X or start of ray
\(\text{(i. e. not necessarily directly below x) each for 1 mark}\)

(b) bent/refracted/deviated/speeded up
\[\text{for 1 mark}\]

Q22.
(i) (incident) ray along the normal
\[\text{or (incident) ray at 90° (to the surface)}\]

(ii) (A) total internal reflection
\[\text{all three words required do not credit total internal refraction}\]
(B) **EITHER** angle of incidence is greater than the critical angle

*or angle of incidence is greater than 42°*

**OR**

angle of incidence is 45°

---

**Q23.**

(a) Reflection correct
Normal incidence correct in and out
Correct refraction in
Parallel ray out

*each for 1 mark*

(b) (i) Each ray correctly refracted in

\[1 + 1 = 2\]

(ii) Wavefronts perp sides
Wavefronts closer

*(Cannot score wavefront marks if refracted rays clearly wrong)*

(iii) Speed reduces
Starting at B
Then D

*each for 1 mark*

(c) TIR correct

*gets 2 marks*

Else rough reflection

*gets 1 mark*

---

**Q24.**

(a) **Level 3 (5–6 marks):**
A detailed and coherent plan covering all the major steps is provided. The steps in the method are logically ordered. The method would lead to the production of valid results.

A source of inaccuracy is provided.

**Level 2 (3–4 marks):**
The bulk of a method is described with mostly relevant detail. The method may not be in a completely logical sequence and may be missing some detail.

**Level 1 (1–2 marks):**
Simple statements are made. The response may lack a logical structure and would not lead to the production of valid results.
0 marks:
No relevant content.

Indicative content

place a glass block on a piece of paper
draw around the glass block and then remove from the paper
draw a line at 90° to one side of the block (the normal)
use a protractor to measure and then draw a line at an angle of 20° to the normal
replace the glass block
using a ray box and slit point the ray of light down the drawn line
mark the ray of light emerging from the block
remove the block and draw in the refracted ray
measure the angle of refraction with a protractor
repeat the procedure for a range of values of the angle of incidence

Possible source of inaccuracy

the width of the light ray
which makes it difficult to judge where the centre of the ray is

(b) velocity / speed of the light decreases
   allow velocity / speed of the light changes

Q25.

(a) (i) (angle of) refraction
   take care not to credit ‘angle of reflection’

(ii) normal
   do not credit ‘horizontal’

(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)

(c) (i) converging
or ‘convex’

(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

(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

Q26.

Level 3 (5–6 marks):
A detailed and coherent plan covering all the major steps is provided. The steps in the
method are logically ordered. The method would lead to the production of valid results.

A source of inaccuracy is provided.

Level 2 (3–4 marks):
The bulk of a method is described with mostly relevant detail. The method may not be in a
completely logical sequence and may be missing some detail.

Level 1 (1–2 marks):
Simple statements are made. The response may lack a logical structure and would not
lead to the production of valid results.

0 marks:
No relevant content.

Indicative content

place a glass block on a piece of paper

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replace the glass block

using a ray box and slit point the ray of light down the drawn line
mark the ray of light emerging from the block
remove the block and draw in the refracted ray
measure the angle of refraction with a protractor
repeat the procedure for a range of values of the angle of incidence

**possible source of inaccuracy**
the width of the light ray
which makes it difficult to judge where the centre of the ray is

Q27.
(a) (i) magnified

upright

(ii) $v = -6\text{(cm)}$

*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
$-5.99\text{(cm)}$
*using decimals gains 3 marks*

(b) it is virtual

Q28.
(a) two rays drawn from the bulb and reflected by the glass

*angle I = angle R judged by eye*
allow 1 mark for one incident and reflected ray even if angle I doesn’t equal angle R

at least one arrow drawn in correct direction
*any conflicting arrows negate this mark*
ignore any arrows drawn on construction lines behind the glass

position of image correct
Q29.

(a) (i) rays continued to meet on the right hand side of the lens and beyond

must be straight lines from the right hand side of the lens
ignore details through the lens

(b) image is formed by virtual / imaginary rays crossing

accept construction lines only show where the light seems to come from
accept the image is behind the glass / mirror
accept image is seen through the glass / mirror
accept (real) rays of light do not pass through the image
accept (real) rays do not cross
accept the image is a reflection (of the object)
accept the image is formed by reflection
do not accept a virtual image can’t be formed on a screen
do not accept the object / image is reflected

judged by eye
allow if no arrows

meet exactly on the axis

negate mark if contradictory arrow(s) added
do not need to go beyond the focus for this mark

(ii) (principal) focus
    or focal (point)

(iii) converging
    or convex

(b) (i) A

(ii) rays seem to come from this point
    or words to this effect
    or shows this on the diagram

(iii) diverging
    or concave

(c) film

accept any unambiguous method of showing the correct response

smaller than

further away from

(d) any three from:

• real image can be put on a screen
    allow film

• virtual image cannot be put on a screen / film

• virtual image is imaginary

• real image is formed where (real) rays cross / converge
    allow real image has light travelling through it

• virtual image is where virtual / imaginary rays (seem to) come from
    or virtual image is where rays seem to come from

• virtual image formed where virtual rays intersect / cross