A-Level Physics

Physics of the Eye

Question Paper

Time available: 61 minutes
Marks available: 43 marks

1. An eye condition is corrected using a $+4.0\text{D}$ lens.

(a) Which eye condition could be corrected by using this lens?

Tick (✓) **one** box.

astigmatism ☐

hypermetropia ☐

myopia ☐

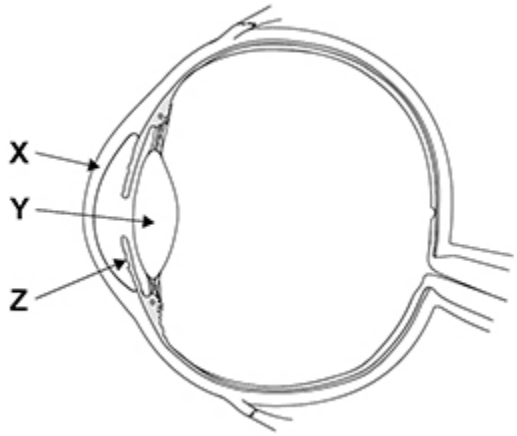
(1)

(b) Calculate the magnification produced by the $+4.0\text{D}$ lens when viewing an object $75\ \text{cm}$ from this lens.

magnification = _____

(3)

(c) The figure below shows a diagram of an eye.



State the name and primary optical function of **X**, **Y** and **Z**.

Name of **X** _____

Primary optical function of **X** _____

_____

_____

_____

Name of **Y** _____

Primary optical function of **Y** _____

_____

_____

_____

Name of **Z** _____

Primary optical function of **Z** _____

_____

_____

_____

(4)

(Total 8 marks)

2. (a) Which would be a correct lens prescription for a person with hypermetropia and astigmatism?

Tick (✓) **one** box.

−2.00	+0.50	75	☐
+2.00	−0.50	75	☐
−2.00	+0.50	255	☐
+2.00	−0.50	255	☐

(1)

(b) A student views an object **O** and cannot see it clearly unaided.
The student is diagnosed with myopia and is prescribed a suitable correcting lens.
Using the correcting lens, an intermediate image is formed that can be viewed clearly by the student.

The student states that she can see **O** more clearly because the intermediate image is enlarged.

Discuss the validity of the student's statement.
In your answer you should:

- describe how myopia affects vision
- draw a labelled ray diagram of the correcting lens, showing how the intermediate image of **O** is formed
- explain how the correcting lens enables the student to see clearly.

Space for diagram

(6)

(Total 7 marks)

3. (a) State and explain **two** differences between the perceived image of a brightly coloured object in bright light and the perceived image of the same object when viewed in very dark conditions.

In your answer you should refer to the visual receptors in the eye.

Difference 1 _____

_____

_____

_____

_____

_____

_____

Difference 2 _____

_____

_____

_____

_____

_____

_____

(5)

According to some legends, in the 17th century a pirate with two healthy eyes covered one eye with a patch to keep the eye in the dark. The patch was removed when going from bright conditions outside to the very dark conditions below decks in an enemy ship.

It was necessary for the pirate to put the patch on about 45 minutes before going into the very dark conditions inside the ship.

(b) What is the name of the process which occurs when the pirate's eye is covered by the patch?
Tick (✓) **one** box.

aberration ☐

accommodation ☐

adaptation ☐

adjustment ☐

(1)

(c) Discuss why it was necessary to wear the eye patch for 45 minutes before entering the ship.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(Total 9 marks)

4. Car drivers must be able to

- read a speedometer from a distance of 50 cm
- read a number plate from a distance of 20.5 m.

A driver has an unaided far point of 55 cm and an unaided near point of 25 cm.

(a) Identify the driver's eye defect.
Tick (✓) **one** box.

Astigmatism	
Hypermetropia	
Myopia	

(1)

(b) **Figure 1** shows the position of a number plate at a distance of 20.5 m in front of the driver's unaided eye.

Figure 2 shows the same situation and the position of a corrective lens.

Complete both ray diagrams to show how and where the image of the number plate is formed in each case.
Add a suitable lens to **Figure 2**.

Figure 1

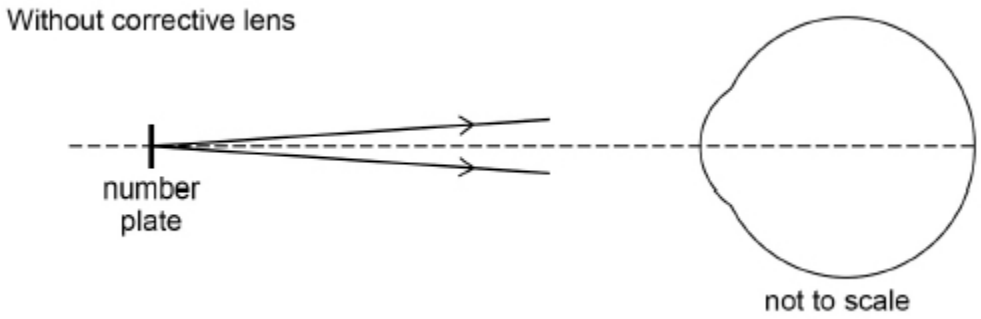
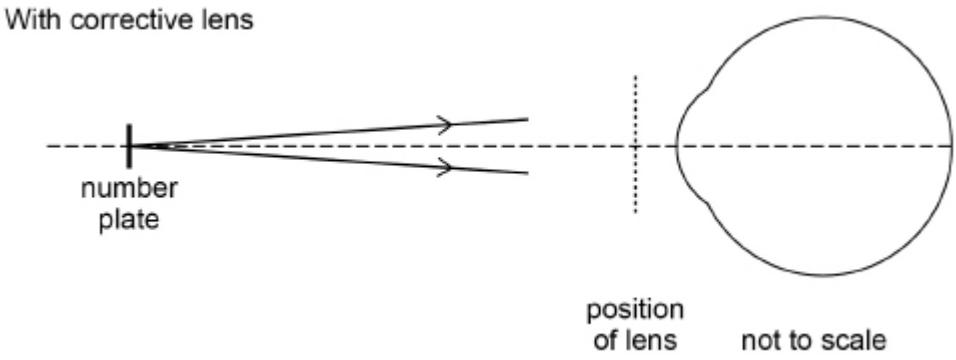


Figure 2



(4)

(c) An optician considers the use of **three** different lenses, **A**, **B** and **C**, for use by the driver when driving.

Power of **A** = –2.18D
Power of **B** = –1.77D
Power of **C** = +1.95D

Deduce which lens is suitable.
Support your answer with calculations.

_____

_____

_____

(5)

(Total 10 marks)

5. A person suffers from hypermetropia (long sight).
Use of a spectacle lens of power +2.0D allows the person to just see clearly an object placed 24 cm away from the eye.

(a) Explain why the unaided defective eye cannot form a clearly focused image of the object placed 24 cm from the eye.

_____

_____

_____

_____

_____

_____

(2)

(b) An object is placed 24 cm from the spectacle lens.

Calculate the distance of the image formed from the spectacle lens.
Give your answer to a suitable number of significant figures.

image distance = _____ cm

(3)

(c) What is the name for the position where the image is formed by the spectacle lens?

Tick (✓) the correct box.

The eye's aided far point	☐
The eye's aided near point	☐
The eye's unaided far point	☐
The eye's unaided near point	☐

(1)

(d) Draw a ray diagram to show how this spectacle lens forms an image of the object placed 24 cm from the spectacle lens.
On your diagram clearly label the object, image and a principal focus of the lens. Your diagram does not have to be drawn to scale.

(3)
(Total 9 marks)