Name: _____

Electromagnetic Radiation

Questions

Date:

Time:

Total marks available:

Total marks achieved: _____

Questions

Q1.

When white light crosses the boundary between air and glass, it can split up into the colours of the spectrum.

Explain, in terms of speed, why the light behaves like this.

(3)

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(Total for question = 3 marks)

Q2.

Sound waves are longitudinal waves.

Water waves are transverse waves.

Describe the difference between longitudinal waves and transverse waves.

(3)

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(Total for question = 3 marks)

Q3.

Lenses are used in spectacles to treat some vision defects.
The two main lens types are converging lenses and diverging lenses.

(i) Diverging lenses always produce virtual, diminished images.

Which row of the table describes the images produced by a converging lens?

Put a cross (☒) in the box next to your answer.

(1)

	type of image	size of image
☒ **A**	only real	only magnified
☒ **B**	either real or virtual	either magnified or diminished
☒ **C**	either real or virtual	only magnified
☒ **D**	only virtual	only diminished

(ii) Describe how the power of a lens is related to its shape.
You may draw labelled diagrams if it helps your answer.

(2)

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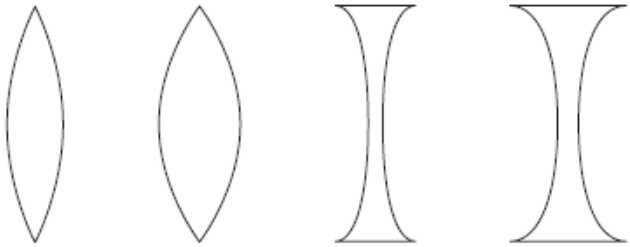
Q4.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer

with a cross ☒.

(i) Which lens is a converging lens with the greatest power?

(1)



☐ **A** ☐ **B** ☐ **C** ☐ **D**

(ii) The equation that relates the power of a lens to the focal length of the lens is

$$\text{power (in dioptres)} = \frac{1}{\text{focal length (in metres)}}$$

The power of a lens is 5 dioptres.

Use the equation to calculate the focal length of the lens in cm.

(2)

focal length = ... cm

(Total for question = 3 marks)

Q5.

Figure 3 shows a semicircular glass block.

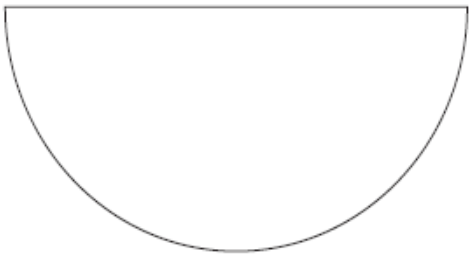


Figure 3

Describe how a student could use the semicircular glass block and other apparatus to determine the critical angle for a glass-air boundary.

You should add to the diagram in Figure 3 to help with your answer.

(4)

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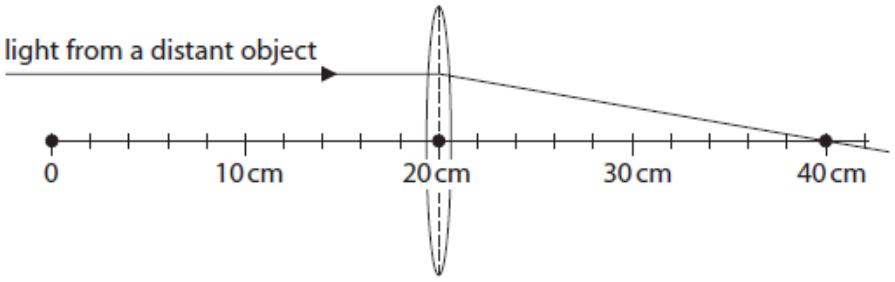
(Total for question = 4 marks)

Q6.

(a) The diagram shows a thin lens placed at the 20 cm mark of a metre rule.



A ray has been drawn from a distant object.
Complete the sentence by putting a cross (☒) in the box next to your answer.

The focal length of the lens is

(1)

☐ **A** 10 cm

☐ **B** 20 cm

☐ **C** 30 cm

☐ **D** 40 cm

(b) The linear magnification of a thin lens is given the symbol *M*.
The following equation for *M* is used for lenses in cameras.

$$M = \frac{f}{(d - f)}$$

where *f* is the focal length of the lens and *d* is the distance between the lens and an object.

A lens has a focal length of 12 cm.

(i) Use the equation to calculate *M* when the distance from an object to the lens is 14 cm

(2)

M = ...

(ii) Use the equation to calculate *M* when the distance from an object to the lens is 11 cm

(1)

M = ...

(iii) The table shows the magnifications produced by this lens for different distances between object and lens.

d / cm	*M*
3.0	–1.3
9.0	–4.0
15	4.0
21	1.3

Suggest what the sign of *M* indicates about the image produced by the lens.

(1)

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Q7.

A student investigates what happens when light travels from air to glass.

Figure 2 shows some of the apparatus used in the investigation.

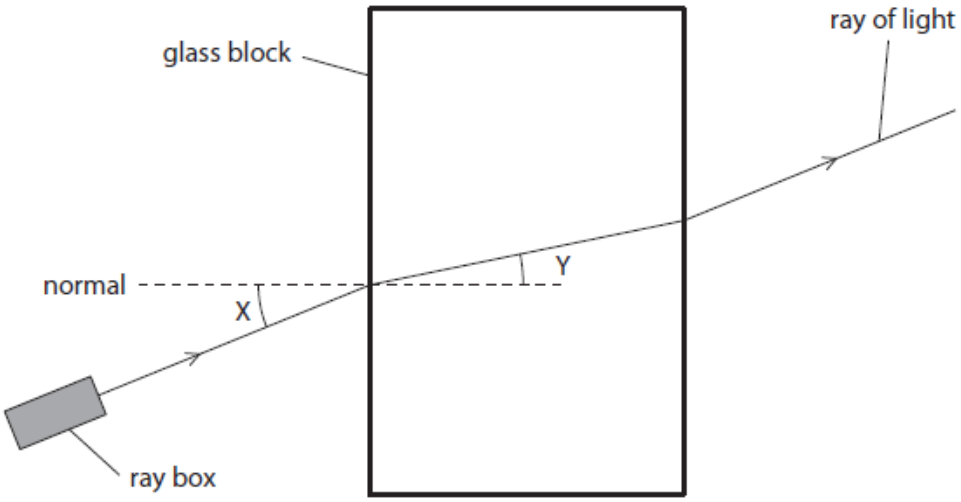

Figure 2

(i) In Figure 2, angle Y is the angle of

(1)

- ☒ **A** deflection
- ☒ **B** incidence
- ☒ **C** reflection
- ☒ **D** refraction

(ii) Figure 3 is a graph of the student's results.

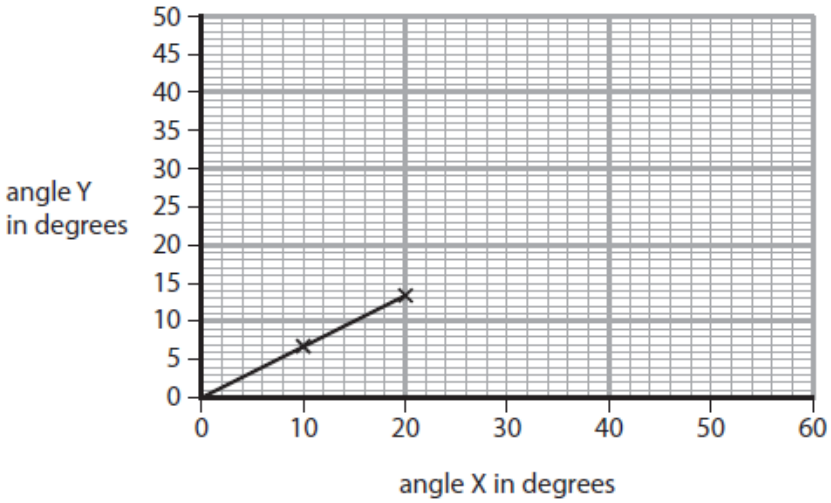

Figure 3

Use the graph to calculate a value for

$$\frac{\text{angle Y}}{\text{angle X}}$$

(2)

$$\frac{\text{angle Y}}{\text{angle X}} = \text{.....}$$

(iii) The student concludes that angle Y is directly proportional to angle X.

Explain what the student must do to test this conclusion in more detail.

(3)

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(Total for question = 6 marks)

Q8.

The lens shown in the diagram has a focal length of 12.0 cm.

(a) Complete the sentences by putting a cross (☒) in the box next to your answer.

(i) This lens can produce

(1)

☒ **A** only inverted images

☒ **B** only real images

☒ **C** only virtual images

☒ **D** both real and virtual images

(ii) The power of the lens is

(1)

☒ **A** 8.3 dioptre

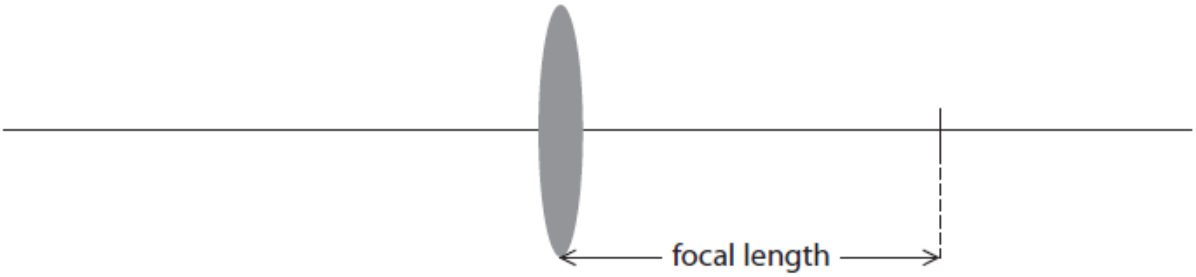
☒ **B** 8.3×10^{-1} dioptre

☒ **C** 8.3×10^{-2} dioptre

☒ **D** 8.3×10^{-3} dioptre

(iii) The diagram shows a converging lens with its focal length marked. Over this diagram draw a converging lens of greater power and mark in its focal length.

(2)



(b) An object is placed 8.5 cm in front of a converging lens of focal length 12.0 cm.

Calculate the image distance.

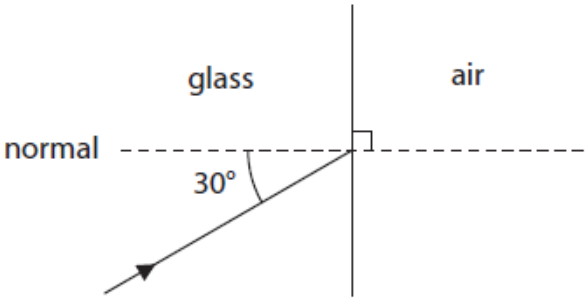
(4)

image distance = ... cm

(Total for Question = 8 marks)

Q9.

(a) The diagram shows a ray of light incident on a boundary between air and glass.



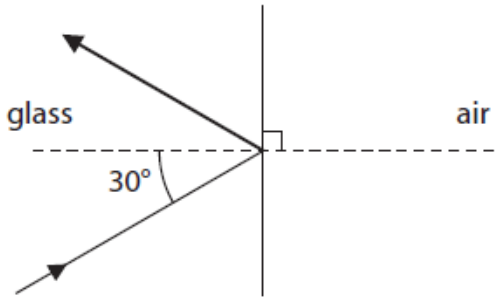
The critical angle for glass in air is 42°.

Which of these diagrams shows the ray of light after it meets the boundary between glass and air?

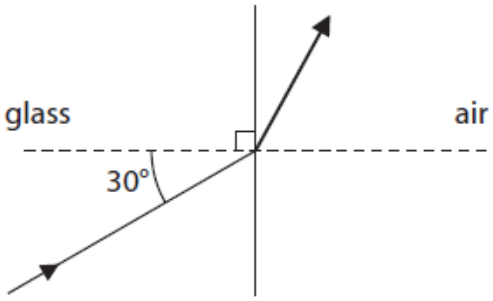
Put a cross (☒) in the box next to your answer.

(1)

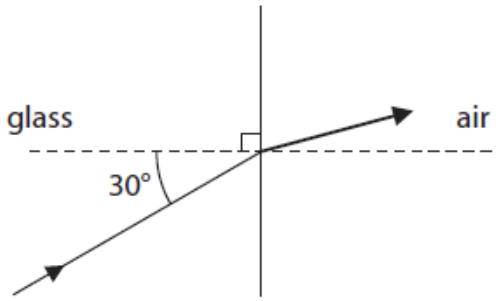
☐ **A**



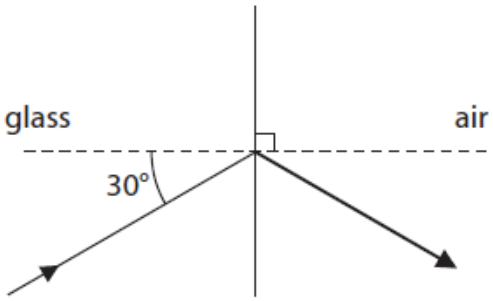
☐ **B**



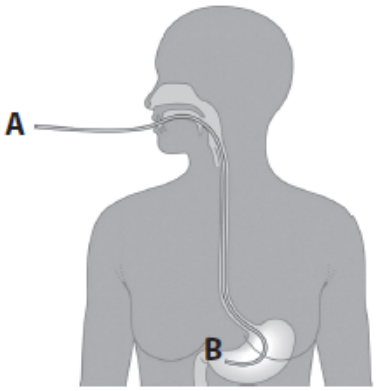
☐ **C**



☐ **D**



(b) The diagram shows how an endoscope is used to see inside a person's stomach.
Light is shone into the optical fibres in the endoscope at A and it comes out at B.



(i) The cross-sectional area of an optical fibre is 6.3×10^{-6} m^2.
The intensity of the light entering the optical fibre is 3.2×10^{7} W/m^2.

Calculate the power of the light entering the optical fibre.

(3)

power = ... W

(ii) Explain why the power of the light at B is the same as the power of the light at A.

(2)

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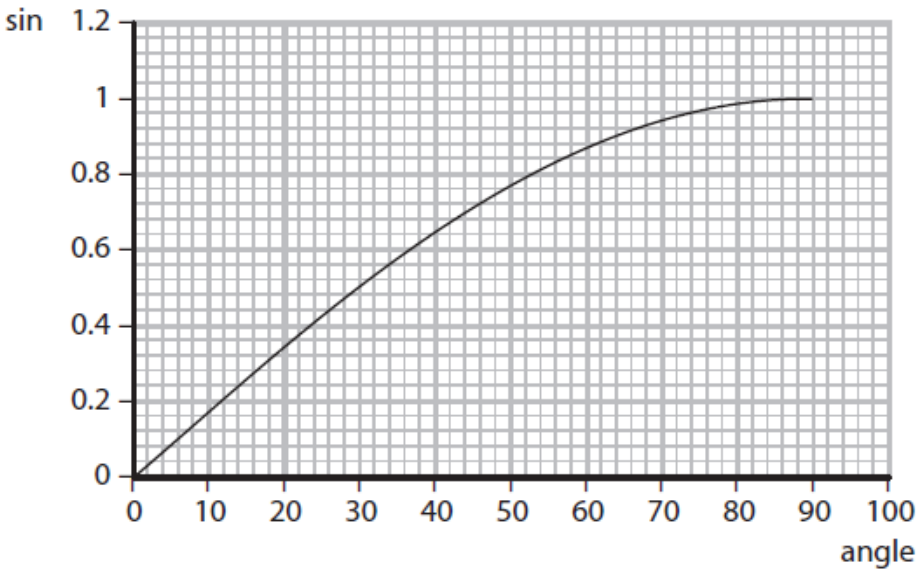
(c) The optical fibre cable in an endoscope has a refractive index of 1.70.

The critical angle for a material can be calculated using the equation

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

where c is the critical angle
and n is the refractive index

The graph shows the relationship between an angle and the sine of the angle.



Use the equation and the graph to calculate the critical angle for the optical fibre.

(2)

critical angle = ... °

(Total for Question = 8 marks)

Q10.

Diagram 1 shows a glass prism which can be used to turn an image the right way up.

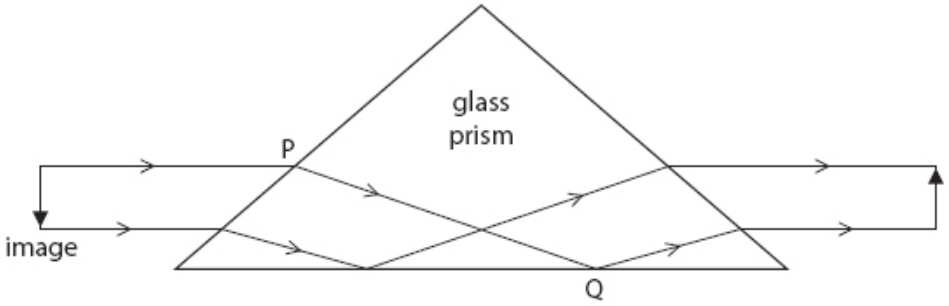


Diagram 1

(a) (i) In diagram 1, total internal reflection occurs at Q.
Explain why total internal reflection occurs at Q.

(2)

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(ii) The way in which the light changes direction at P is shown in diagram 2.

Mark on the diagram (*i*) for the angle of incidence and (*r*) for the angle of refraction for the ray of light shown.

(2)

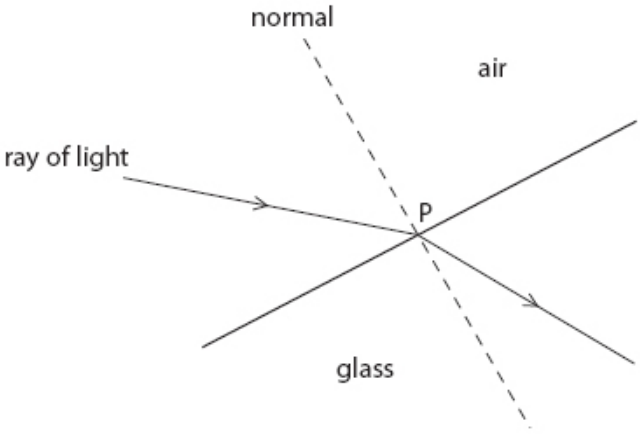

Diagram 2

(iii) Which of these is correct for the light as it enters the prism at P?

Put a cross (☒) in the box next to your answer.

(1)

☒ **A** frequency decreases

☒ **B** frequency increases

☒ **C** speed decreases

☒ **D** speed increases

(b) Light waves and sound waves are both used in the diagnosis and treatment of medical conditions

(i) A doctor uses an endoscope to look inside the body of a patient.

Explain how optical fibres are used in endoscopes.
You may draw a labelled diagram to help with your answer.

(3)

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(ii) Describe how ultrasound can be used as a medical treatment for illness or injury.

(2)

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(Total for Question = 10 marks)

Q11.

The photograph shows a meteor exploding above Russia in 2013.

(a) The noise from the explosion was described as the loudest sound ever detected on Earth.
However, human beings could not hear this sound.
State the **two** sound frequency ranges that human beings cannot hear.

(2)

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(b) Meteors sometimes collide with the Earth's surface.
These collisions produce both P-waves and S-waves.

(i) Which of the following is correct for a P-wave?

Put a cross (☒) in the box next to your answer.

(1)

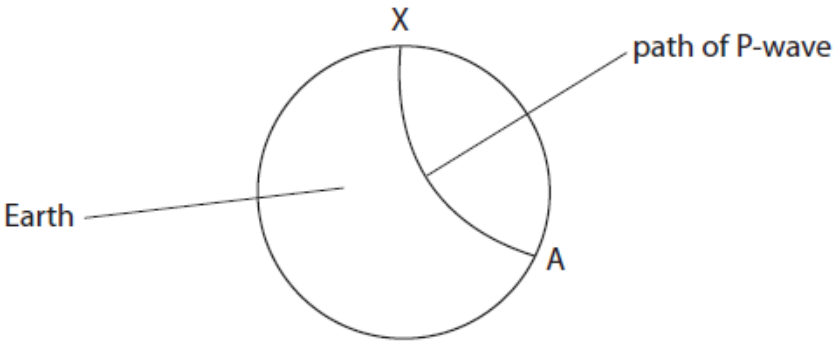
☒ **A** It is a transverse wave travelling faster than an S-wave.

☒ **B** It is a transverse wave travelling slower than an S-wave.

☒ **C** It is a longitudinal wave travelling faster than an S-wave.

☒ **D** It is a longitudinal wave travelling slower than an S-wave.

The diagram shows the path of a P-wave.
The P-wave travels from the collision at X, through the Earth, to another point, A.



(ii) Explain why the path of the P-wave is not a straight line.

(2)

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(iii) Explain why there are regions on the Earth's surface where S-waves from the collision at X cannot be detected. You can add to the diagram to help your answer.

(3)

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(iv) Describe how a meteor colliding with the Earth could set off an earthquake.

(2)

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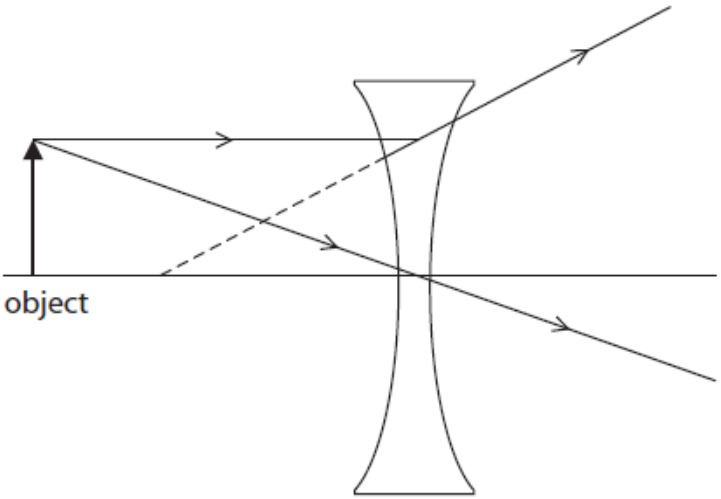
(Total for Question = 10 marks)

Q12.

The diagram shows the formation of an image produced by one type of lens.



(i) On the diagram, draw and label the image produced.

(1)

(ii) On the diagram, show and label the focal length of the lens.

(1)

(iii) The type of lens shown in the diagram is used to correct a vision defect.

Name this vision defect.

(1)

.....

(iv) This lens has a focal length of −0.33 m.
An object is 0.50 m in front of the lens.

Calculate the distance of the image from the lens.

(4)

distance of image from lens = ... m