Name: _____

Light and Optics

Questions

Date:

Time:

Total marks available:

Total marks achieved: _____

Questions

Q1.

Light travels the 150 million km from the Sun to the Earth in about 500 s.
It takes about 2100 s for light to reach the Earth from Jupiter.
Using this information, calculate the approximate distance of Jupiter from the Earth.

(2)

distance of Jupiter from the Earth =.....million km

Q2.

The speed of light is 3.0×10^{8} m/s.

The wavelength of yellow light is 5.8×10^{-7} m.

Calculate the frequency of yellow light.

State the unit.

Use the equation

$$\text{frequency} = \frac{\text{speed}}{\text{wavelength}}$$

(3)

frequency = ... unit .....

(Total for question = 3 marks)

Q3.

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)

Q4.

Light and sound waves are produced at the same time by an explosion on Earth.

(i) The sound of the explosion is heard 1920 metres away 6.0 seconds after the explosion has happened.

Calculate the speed of sound in air.

(2)

speed of sound in air = ...m/s

(ii) A scientist is standing a long way from the explosion.

Explain why he hears the explosion a few seconds after he sees it.

(2)

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Q5.

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)

Q6.

Ultraviolet waves cover a range of frequencies.

Scientists divide this range into three types, UVA, UVB and UVC.

The table in Figure 11 shows the frequency range for each type.

type	frequency range in Hz
UVA	7.5×10^{14} to 9.4×10^{14}
UVB	9.4×10^{14} to 10×10^{14}
UVC	10×10^{14} to 30×10^{14}

Figure 11

Figure 12 is a diagram about the effect that the Earth's atmosphere has on three types of ultraviolet radiation.

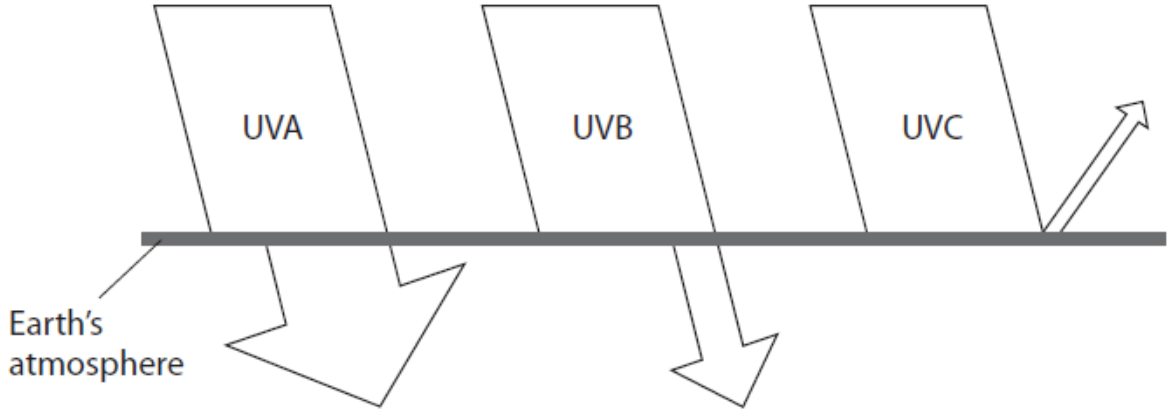

Figure 12

Describe how the effects change with **wavelength**, using information from Figure 11 and Figure 12.

The width of the arrows drawn indicates the amount of radiation that is involved.

Calculations are **not** required.

(4)

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(Total for question = 4 marks)

Q7.

Radio waves from Jupiter take 40 minutes to reach Earth.

Light waves from the Sun take 8 minutes to reach Earth.

Calculate how many times further it is from Earth to Jupiter than from Earth to the Sun.

State the property of electromagnetic radiation that is used in your answer.

(2)

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property .....

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(Total for question = 2 marks)

Q8.

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

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

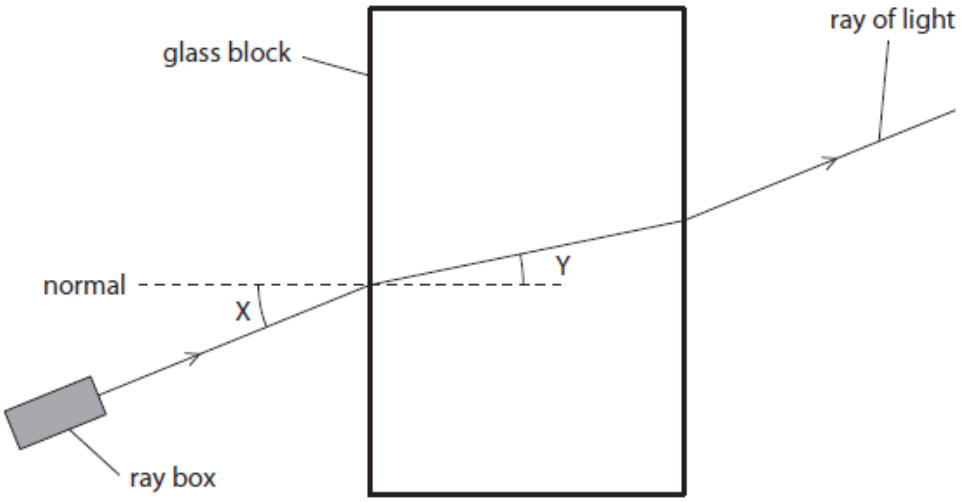

Figure 2

(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.

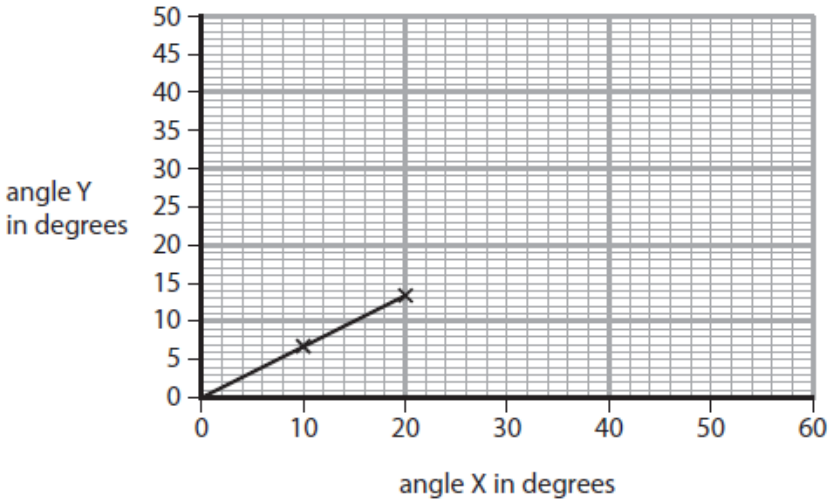

Figure 3

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)

Q9.

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

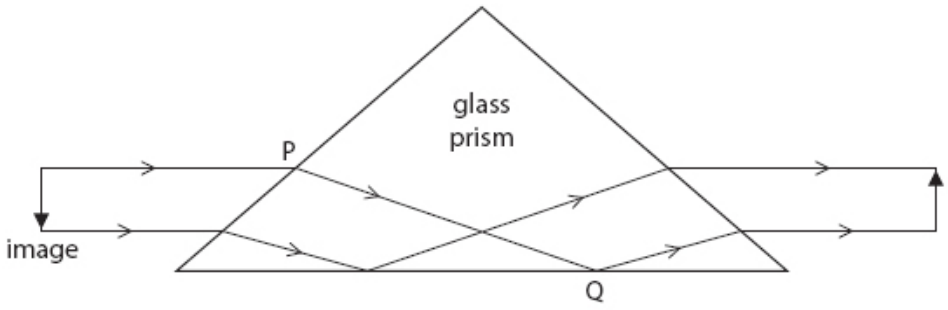

Diagram 1

(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)

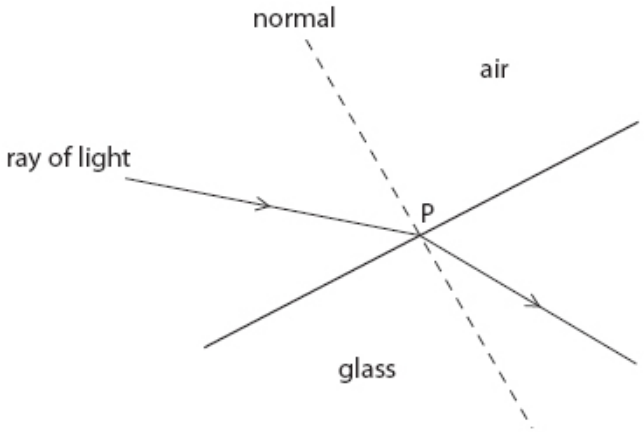

Diagram 2

(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)

Q10.

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)

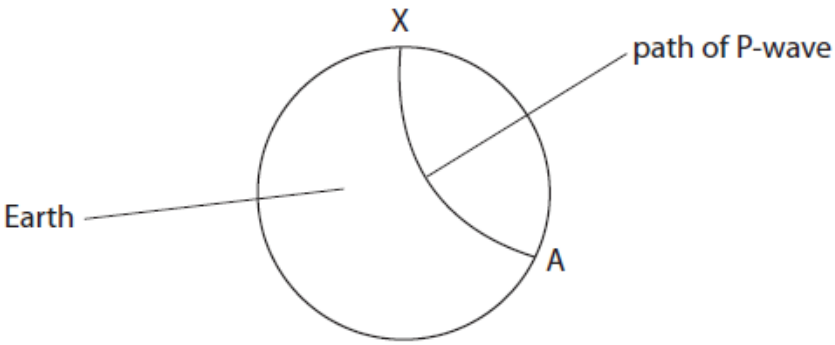
☒ **A** It is a transverse wave travelling faster than an S-wave.

☒ **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)