1. Much of our knowledge about stars comes from the light we receive from the stars.

(i) It is very useful to produce a spectrum of the light from a star.

Draw a labelled diagram to show how a prism can produce a spectrum from a beam of light.

[3]

(ii) What is the name of the process in the prism that causes the spectrum?

Put a (ring) around the correct answer.

absorption parallax reflection refraction

[1]

(iii) What else can be used to produce a spectrum, other than a prism?

[1]

2. The lenses in a telescope are used to bend the light from stars.

(i) Complete the diagram to show how the light from a star will be bent by the lens.

[2]

(ii) The lens bends the light.

What is the name of this process?

Put a (ring) around the correct answer.

diffraction magnification reflection refraction

[1]

(iii) What happens to the light as it enters the lens?

Put ticks (✓) in the boxes next to the **two** correct answers.

The image becomes clearer. ☐

The light wave turns upside down. ☐

All the light is reflected by the lens. ☐

The speed of the light wave changes. ☐

The direction of the light wave changes. ☐

[2]

3(a). This question is about earthquakes.

(i) Which of the following statements about earthquakes are correct?

Put ticks (✓) in the boxes next to the **two** correct statements.

Earthquakes happen only in mountains. ☐

Earthquakes never happen under the sea. ☐

Earthquakes are caused by global warming. ☐

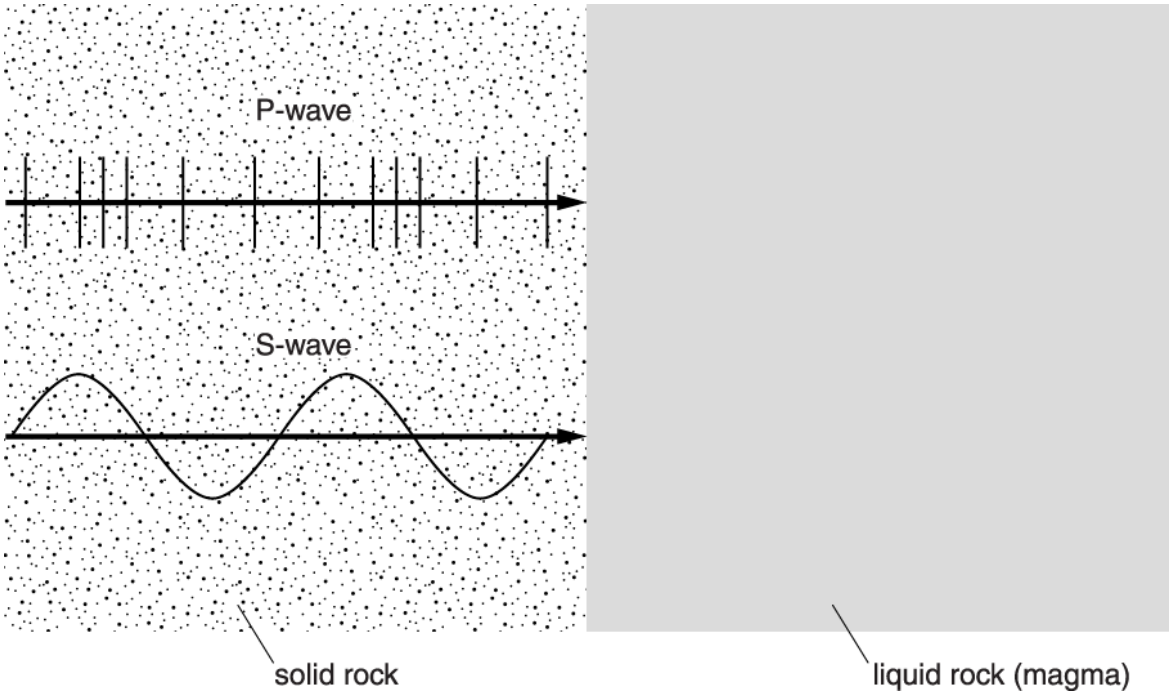
Earthquakes usually happen where tectonic plates meet. ☐

Volcanoes are often found in regions where earthquakes are common. ☐

[2]

(ii) In some parts of the Earth's crust there are large regions of liquid rock (magma).

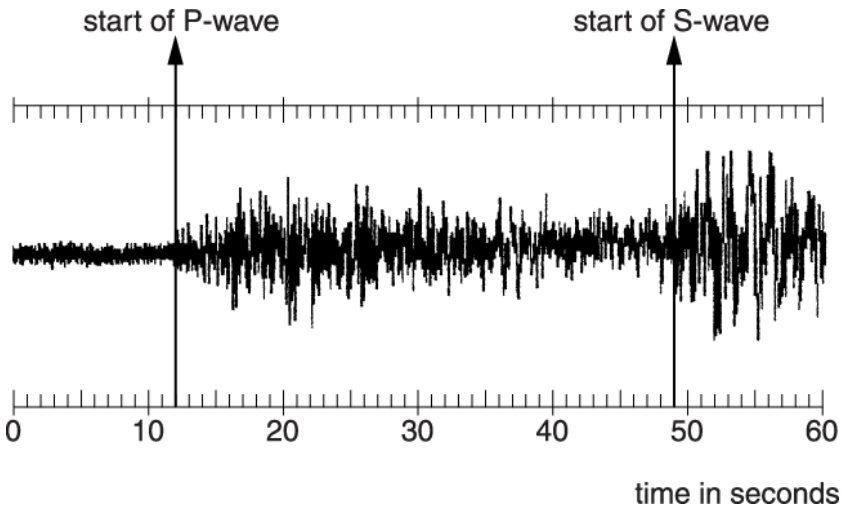
The diagram shows an earthquake P-wave and an S-wave travelling through solid rock and arriving at a region of magma.



What happens to each wave when it reaches the magma?

---[2]

(b). The diagram shows the record at a detector of an earthquake.



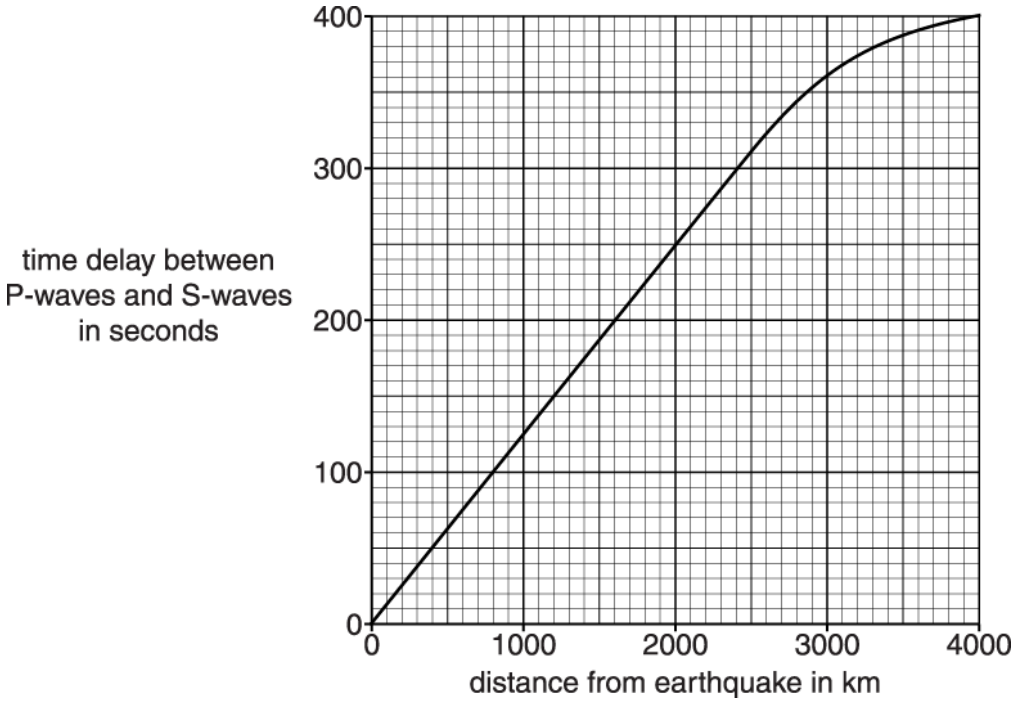
Earth scientists estimate the distance from an earthquake to the detector using the rule:

1 second of time delay between the arrival of the P-waves and the arrival of the S-waves corresponds to a distance of 8 km.

(i) Use the diagram to find the distance between the earthquake and the detector.

answer = _____ [2]

(ii) The graph shows the actual time delay for different distances from the earthquake.



Use the graph to show that the '8 km for every second of delay' rule works much better at a distance of 2000 km than at a distance of 4000 km.

---

[2]

4. On a clear night, we can see the Moon.

Complete the following sentences to explain how we see the Moon.

Use words from the list.

absorbed **emitted** **reflected** **transmitted**

Light is _____ by the Sun.

When the light reaches the Moon it is _____ towards the Earth.

The light is then _____ by our eyes, so we can see the Moon.

[3]

5(a). Complete the sentences about earthquake waves.

Use the best words from the list.

amplitude **disturbance** **energy** **frequency** **matter** **wavelength**

Earthquake waves are a _____ caused by vibrating rocks in an earthquake.

Earthquake waves transfer _____ in the direction the wave travels,

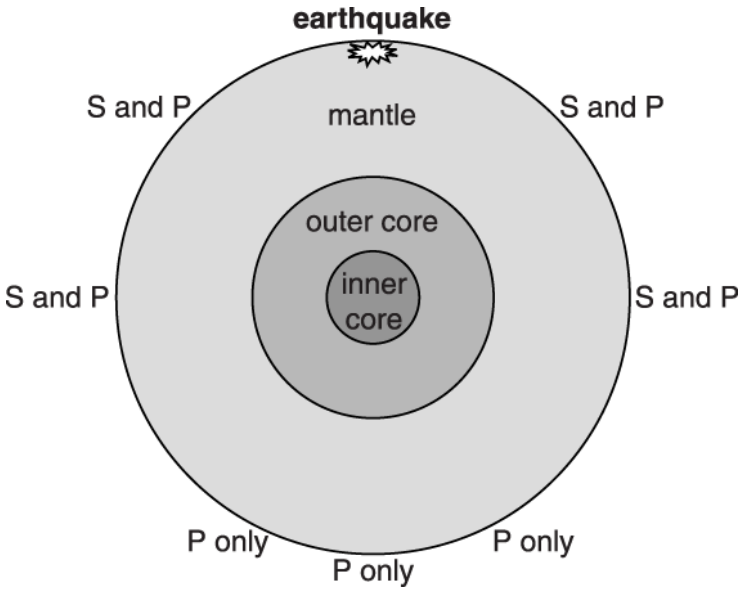
but the earthquake waves do not transfer _____.

[3]

(b). Information from earthquake waves can be used to find out about the structure of the Earth.

- S-waves can only travel through solids.
- P-waves can travel through both solids and liquids.

The diagram shows which waves are detected at different points on the Earth from an earthquake.



This evidence can be used to make conclusions about the structure of the Earth.

Complete the table to show which conclusions can be made from **this evidence**.

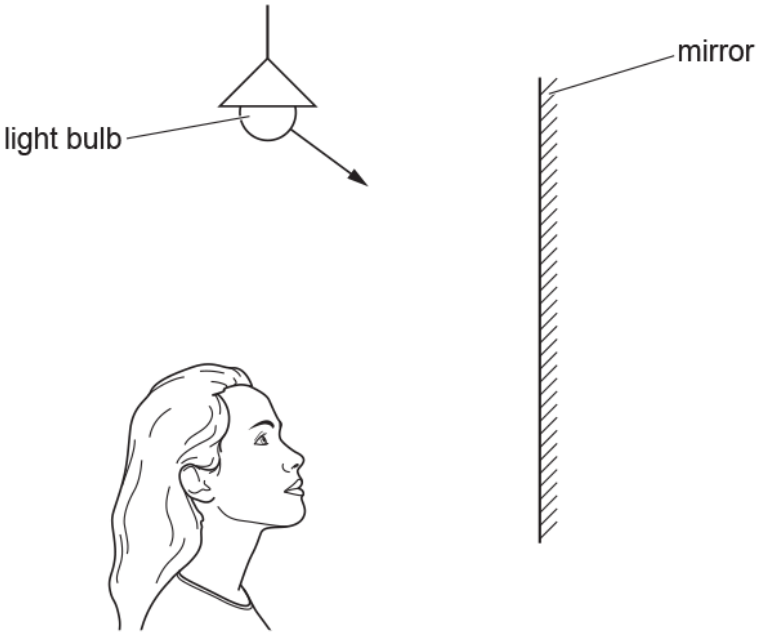
Put one tick (?) in each row.

	is liquid	is solid	cannot tell
crust			
mantle			
outer core			
inner core			

[3]

6(a). Jane sees the reflection of the light bulb in her bathroom mirror.

Complete the diagram to show the path taken by the reflected light.



[2]

(b). Jane fills the bath with hot water. The mirror 'steams-up' and is now covered in tiny drops of water. This makes the surface of the mirror look white.

(i) Jane says, 'The water on the mirror came from the bath'.

Explain how this happened.

---[2]

(ii) Explain why the water droplets covering the mirror make it look white.

---[2]

END OF QUESTION PAPER

Question			Answer/Indicative content	Marks	Guidance
1		i	prism with a triangular cross section (1) diverging rays inside or outside of the prism (1) at least one continuous ray that changes direction at a boundary (1)	3	**accept** idea of dispersion with colour labels (which may not be diverging)
		ii	refraction	1	
		iii	diffraction grating	1	**accept** reasonable correct suggestion e.g. CD / DVD / Oil film / water droplets / soap bubbles / crystals / etc. **ignore** mirror, glass
			Total	**5**	
2		i	parallel rays into lens (1) rays converge to a focus (1)	2	arrows not needed but do not accept if the direction is incorrect **ignore** star labels **allow** – – – – – for rays Examiner's Comments This question was about the use of lenses in telescopes. Overall the question differentiated well, however in part (i) only a small majority of responses gained one or both marks for showing refraction of rays through a convex lens.
		ii	refraction	1	**allow** any unambiguous indication e.g. refraction circled or underlined
		iii	The image becomes clearer. ☐ The light waves turn upside down. ☐ All the light is reflected by the lens. ☐ The speed of the light wave changes. ✓ The direction of the light wave changes. ✓	2	
			Total	**5**	

Question			Answer/Indicative content	Marks	Guidance
3	a	i	Earthquakes usually happen where tectonic plates meet. Volcanoes are often found in regions where earthquakes are common.	2	ticks in last two boxes each correct box = (1) extra ticks: mark as a list (see 11c above) **Examiner's Comments** Almost all candidates ticked at least one correct box and most ticked two.
		ii	One stops and one carries on (1) P-waves carry on / can travel through liquids OR S-waves stop / can't travel through liquids (1)	2	**allow** marks for clear indication on diagram **ignore** reflections of P wave at boundary **ignore** changes direction / refraction **allow** P wave slows down OR changes speed. **allow** S waves reflects OR cannot travel through liquid **ignore** disappears **Examiner's Comments** Many candidates wrote answers that differentiated between the P waves and the S waves. Some candidates knew that one type of wave stopped while the other carried on, and some knew that it was the S waves that stopped (or the P waves that continued). Candidates needed to understand that the diagram was incomplete and did not show that both waves stopped.
	b	i	(time delay = 49 ? 12 =) 37 (s) (1) (distance = 8 × 37 =) 296 (km) (1)	2	**ignore** incorrect or missing units **allow** ± 1 s on difference, i.e. 36, 37 or 38 gets the first mark ecf own time delay : 2nd mark is for 8 × (whatever) = result 36s gives 288 km and 38s gives 304 km **Examiner's Comments** Some candidates scored for this question, aimed at higher ability candidates. To get the marks for this question, candidates needed to state the time delay and then multiply their delay by 8 km/s. Showing their working sometimes scored a mark in case of error.

Question			Answer/Indicative content	Marks	Guidance
		ii	A calculation from data for 2000 km confirming the rule (1) Shows that data for 4000 km does not confirm the rule (1)	2	calculation needed e.g. 250 × 8 = 2000 (km), 2000/8 = 250 (s) or 2000/250 = 8 (km/s) ? working must be shown e.g. (4000/400 =) 10 (km/s), (4000/8 =) 500 (s)or (400 × 8 =) 3200 (km). Accept any of the three answers linked to 4000 km as evidence of equation not working **allow** 2nd mark for reference to graph curving / levelling out after 2000 km but not just 'graph curves over' with no reference to when Examiner's Comments Candidates needed to write down a calculation that showed the rule worked at 2000 km for 1 mark, or write down a calculation that showed the rule did not work at 4000 km for 1 mark. Both of these calculations scored 2 marks.
			Total	8	
4			emitted reflected absorbed	3	Examiner's Comments The full range of possible answers were seen with the most common error being transmitted instead of emitted.
			Total	3	

<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>5</td><td>a</td><td></td><td>disturbance

energy

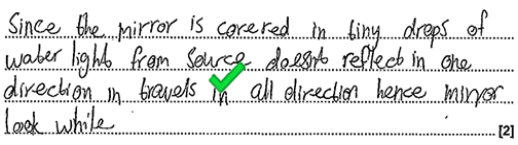
matter</td><td>3</td><td><u>Examiner's Comments</u>

Whilst some candidates scored all three marks on this question. the majority scored two. In general the most common correct answer was disturbance and the most incorrect answer was for matter.</td></tr>
<tr><td></td><td>b</td><td></td><td><table><tr><th></th><th>liquid</th><th>solid</th><th>cannot tell</th></tr><tr><td>crust</td><td></td><td>?</td><td></td></tr><tr><td>mantle</td><td></td><td>?</td><td></td></tr><tr><td>outer core</td><td>?</td><td></td><td></td></tr><tr><td>inner core</td><td></td><td></td><td>?</td></tr></table></td><td>3</td><td>all 4 correct = 3 marks
3 correct = 2 marks
1 or 2 correct = 1 mark

<u>Examiner's Comments</u>

The majority of candidates knew the earth’s crust was solid but the answers to the other three parts were far less known.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>6</td><td></td></tr>
</table>

Question			Answer/Indicative content	Marks	Guidance
6	a		Ray from bulb continues in straight line to touch mirror ✓ Reflected ray is straight line from point of reflection to face (anywhere between eye and chin) ✓	2 (AO 1.2) (AO 2.2)	Must be a solid line. Examiner's Comments Candidates were expected to extend the arrow already shown on the diagram, ideally using a ruler, so that the line reached the surface of the mirror. The reflected ray should then be drawn from the point of intersection to the Jane's face, but there was no expectation for candidates to use a protractor to ensure the angles of incidence and reflection were identical. As long as there was no gap between the two rays on the mirror and the reflected ray went to any part of Jane's face it was acceptable.
	b	i	water from the bath evaporates / changes to gas ✓ water / steam then condenses / changes back to liquid when it touches the mirror ✓	2 (AO 1.1 ×2)	ALLOW water changes to steam. Examiner's Comments Responses to this question were on the whole quite good. Most candidates were able to use the terms evaporate and condense correctly.

Question			Answer/Indicative content	Marks	Guidance
		ii	the light is scattered / reflected / refracted by water droplets ✓ all colours / all the light from light bulb / in all directions / diffuse /specular ✓	2 (AO 1.1 ×2)	<u>Examiner's Comments</u> This is a synoptic question, and some candidates found it difficult to relate ideas about the states of matter with ideas about reflection of light. Some candidates were able to explain something about light being reflected from the water droplets being different from reflecting light from a mirror, but few mentioned anything about white light being made up of the whole spectrum or that the water made the light rays travel in all directions. Exemplar 2  [2] This response has explained that the light is reflected in all directions so gains the second marking point but has not stated that the light is reflected from the water droplets covering the mirror.
			Total	6	