Signals Below Earth

Use seismic data to investigate Earth's internal layers.

ESS.2A "Students will develop an understanding of the structure and composition of Earth and its materials. Analyze and interpret data to explain and communicate the differentiation of Earth's internal chemical structure (e.g., core, mantle..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline two statements that help you interpret seismic waves, then circle table values that support two different physical states inside Earth.

What Waves Reveal

1. During an earthquake, seismic waves travel through Earth. P waves pass through solids and liquids, but S waves pass through solids only. Changes in wave speed can signal a change in material or in how that material behaves. A missing S wave can point to liquid. Compare both types of waves before naming an internal layer.

2. Earth's lithosphere is a rigid shell made of the crust and the uppermost mantle. Beneath it, the asthenosphere is also solid, but its warmer rock can deform slowly. The mantle extends far deeper than either physical division. The table shows wave speeds estimated at several depths inside Earth.

ESTIMATED SEISMIC WAVE SPEEDS INSIDE EARTH

Depth (km)	P-wave speed (km/s)	S-wave speed (km/s)
40	8.0	4.5
150	7.7	4.3
1,000	11.0	6.0
3,000	8.0	0

3. Chemical layers describe composition, not stiffness. The crust and mantle are rich in silicate minerals, while the core is mostly iron and nickel. Heat from radioactive decay and gravitational energy released as dense material sank toward Earth's center helped shape its interior. Flowing liquid metal in the outer core generates Earth's magnetic field.

2 ANSWER WITH EVIDENCE

Use the passage

1. Compare the wave speeds at 40 km and 150 km. Which depth is more likely in the weaker asthenosphere? Use both speeds as evidence.

2. What change in physical state does the table suggest between 1,000 km and 3,000 km? Explain using the S-wave speeds.

3. A classmate says, 'The mantle and the asthenosphere are two separate chemical layers.' How would you correct this claim?

4. What does Earth's magnetic field suggest about the material in the liquid region indicated by the table?

3 YOUR TURN

Your own words

A probe on a fictional planet estimates P-wave and S-wave speeds of 7.1 and 3.8 km/s at 200 km, and 6.9 and 0 km/s at 2,600 km. In three sentences, propose a physical model for these depths, compare it with Earth, and explain one thing wave speeds alone cannot tell you about chemical composition.

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PART 1 · READ AND MARK

Underline two statements that help you interpret seismic waves, then circle table values that support two different physical states inside Earth. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Compare the wave speeds at 40 km and 150 km. Which depth is more likely in the weaker asthenosphere? Use both speeds as evidence.	**The 150 km depth is more likely in the asthenosphere. Its P-wave speed is 7.7 km/s rather than 8.0 km/s, and its S-wave speed is 4.3 km/s rather than 4.5 km/s.**
2	What change in physical state does the table suggest between 1,000 km and 3,000 km? Explain using the S-wave speeds.	**The material changes from solid to liquid. S waves travel at 6.0 km/s at 1,000 km but have a speed of 0 km/s at 3,000 km, and S waves cannot pass through liquid.**
3	A classmate says, 'The mantle and the asthenosphere are two separate chemical layers.' How would you correct this claim?	**The mantle is a chemical layer. The asthenosphere is a physical division within the mantle, identified by how its solid rock behaves.**
4	What does Earth's magnetic field suggest about the material in the liquid region indicated by the table?	**The magnetic field supports the idea that the liquid region contains flowing metal, because flowing liquid metal in the outer core generates the field.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

At 200 km, this planet has solid material because S waves travel there. At 2,600 km, the zero S-wave speed suggests liquid, similar to Earth's region at 3,000 km. Wave speeds alone cannot prove that this planet's liquid contains iron and nickel.

Accept other evidence-based descriptions of the fictional planet's physical layers. Students should not claim that wave speeds alone identify the layers' chemical composition.