Learning Target: I can read passages about the density of media and wave speed and then use the information gathered to answer comprehension questions.

FSI 8th Grade Science Reading for Meaning – Density of Media & Wave Speed

Waves and the Density Connection

When you drop a pebble into a calm pond, ripples spread out in all directions. Those ripples are waves — a transfer of energy, not matter. The way waves move depends on the medium they travel through. A **medium** is any material — solid, liquid, or gas — that can transmit energy.

The Role of Density

Density measures how tightly matter is packed together, or the amount of mass in a given volume. A denser medium, like steel, has particles packed closely together, while air has particles that are far apart. The density of a medium affects the **speed** of a wave, but the effect isn't always simple.

For **mechanical waves**, such as sound, speed depends on both **density** and **elasticity** (how easily particles can return to their original position). In general:

- Sound travels **fastest in solids**, slower in liquids, and slowest in gases.
- Light, which is an **electromagnetic wave**, behaves differently — it travels **slowest in denser materials** because it interacts more with the particles.

Comparing Sound and Light

Let's look at two examples:

- **Sound Wave Example:** A sound wave moves through air at about **343 m/s**, through water at **1,480 m/s**, and through steel at **5,960 m/s**. Even though steel is much denser than air, its high elasticity allows sound waves to move faster.
- **Light Wave Example:** Light travels at **300,000 km/s** in a vacuum (space), but slows to **225,000 km/s** in water and about **200,000 km/s** in glass. Here, the denser medium (glass) slows the wave because the particles interact more with the electromagnetic energy.

Predicting Patterns

Scientists use data like this to make **predictions** about how waves behave when entering different materials. For instance, when light passes from air into water, it **slows down and bends** — a process called **refraction**. When sound passes from air into water, it **speeds up**, though some energy is reflected because of the density difference.

Recognizing these patterns helps engineers design technologies:

- **Sonar systems** rely on how sound waves travel through water to detect objects.
- **Fiber optics** use light's behavior in dense glass to transmit internet signals efficiently.

Understanding the relationship between **density and wave behavior** allows scientists to predict how energy will move through different materials — a key concept in communication, navigation, and medicine.

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Data Table: Wave Speed in Different Media

Medium	Density (kg/m³)	Type of Wave	Wave Speed
Air	1.2	Sound	343 m/s
Water	1,000	Sound	1,480 m/s
Steel	7,800	Sound	5,960 m/s
Vacuum	0	Light	300,000 km/s
Water	1,000	Light	225,000 km/s
Glass	2,500	Light	200,000 km/s

Multiple Choice Questions (DOK 3–4)

1. Based on the data, what pattern can you infer about the relationship between density and sound wave speed? (DOK 3)
A. Sound travels slower in denser media.
B. Sound travels faster in denser and more elastic media.
C. Sound travels at the same speed in all media.
D. Sound cannot travel in dense materials.

2. Why does light slow down when it moves from air into water, even though the two media are both transparent? (DOK 3)
A. Water reflects more light energy.
B. The increased density causes more particle interactions that slow the wave.
C. The air is less elastic than water.
D. Light gains energy when entering a denser medium.

3. Using the data, which prediction is most accurate if a sound wave moves from steel into water? (DOK 4)
A. The wave will slow down because water is less dense and less elastic.
B. The wave will speed up because water is denser than steel.
C. The wave will remain at the same speed due to equal elasticity.
D. The wave will stop moving at the boundary.

4. A student claims that "the denser the medium, the faster any wave travels." Based on the passage, what evidence disproves this claim? (DOK 4)
A. Sound waves move faster in steel than in air.
B. Light waves move slower in glass than in air.
C. Sound waves move slower in water than in steel.
D. Both B and C

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5. When designing fiber optic cables, engineers choose glass with very specific densities. Based on what you know, what is the purpose of this? (DOK 3)
A. To allow light to travel faster through the cable.
B. To control how much light is refracted and contained within the fiber.
C. To reflect all light back to the source.
D. To reduce sound interference in the glass.

6. A researcher measures sound traveling through an unknown solid at 4,000 m/s. Using the data table, what can she infer about the material? (DOK 3)
A. It has a density similar to air.
B. It is less dense than steel but more dense than water.
C. It must be a liquid.
D. It has low elasticity compared to steel.

7. Which statement best compares how density affects the speed of mechanical versus electromagnetic waves? (DOK 4)
A. Both types of waves speed up as density increases.
B. Both slow down in denser materials.
C. Mechanical waves speed up, while electromagnetic waves slow down, as density increases.
D. Density does not affect either wave type.

8. Suppose a submarine sends a sonar pulse through seawater that becomes colder and denser with depth. Predict what happens to the wave's speed. (DOK 4)
A. It increases slightly because the water becomes denser and more elastic.
B. It decreases because colder water absorbs sound.
C. It remains constant because density changes have no effect.
D. It reverses direction due to refraction.

9. A student graph shows wave speed vs. density for light. If the line slopes downward, what does that indicate about the relationship? (DOK 3)
A. Wave speed increases as density increases.
B. Wave speed decreases as density increases.
C. Wave speed remains constant regardless of density.
D. Density has no measurable effect on wave speed.

10. Engineers designing ultrasound machines for medical imaging use gel between the sensor and skin. Based on wave behavior, what is the gel's purpose? (DOK 4)
A. To reflect more sound back to the device.
B. To slow down sound waves so they don't penetrate too deeply.
C. To reduce the density difference between air and skin, improving wave transmission.
D. To absorb excess sound energy.

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