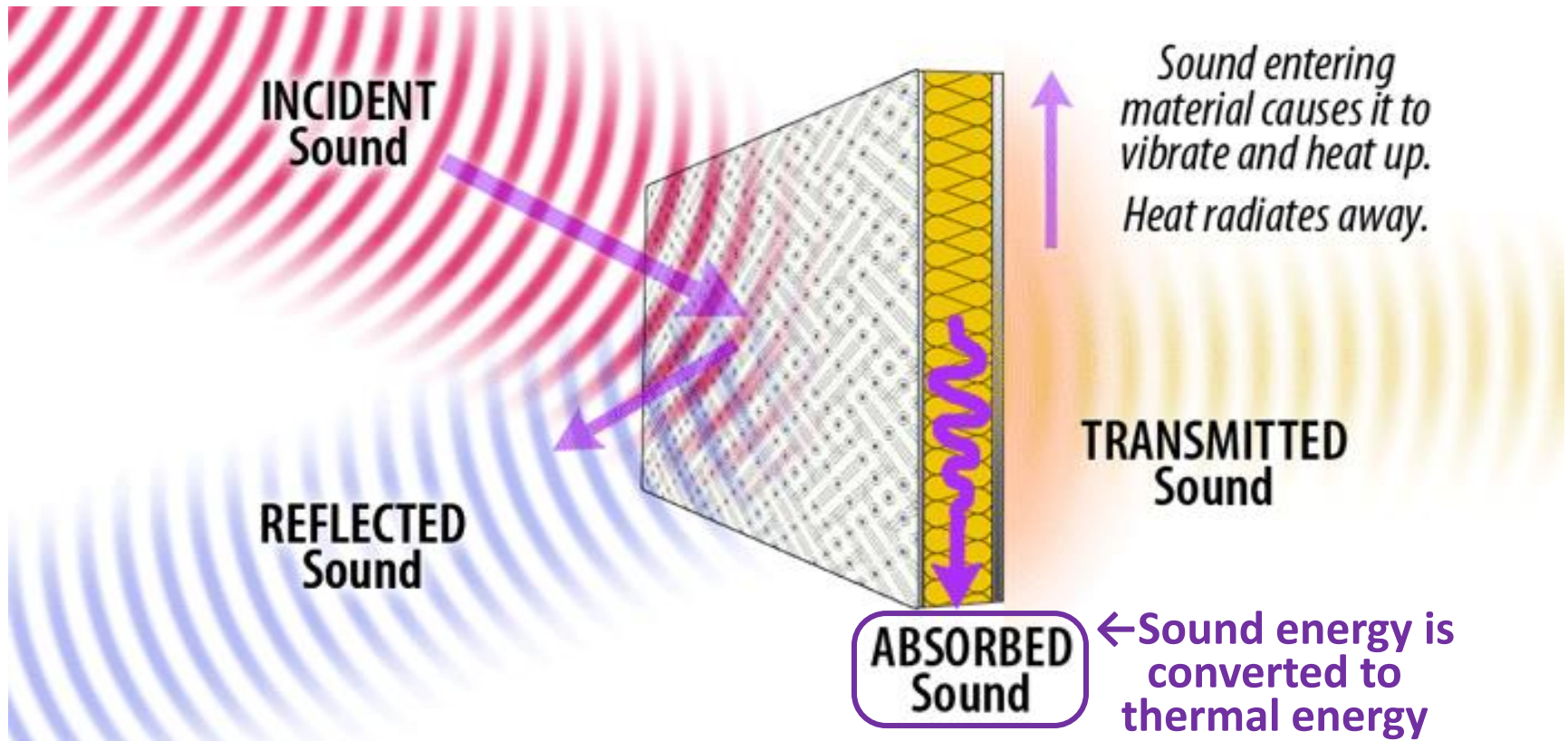


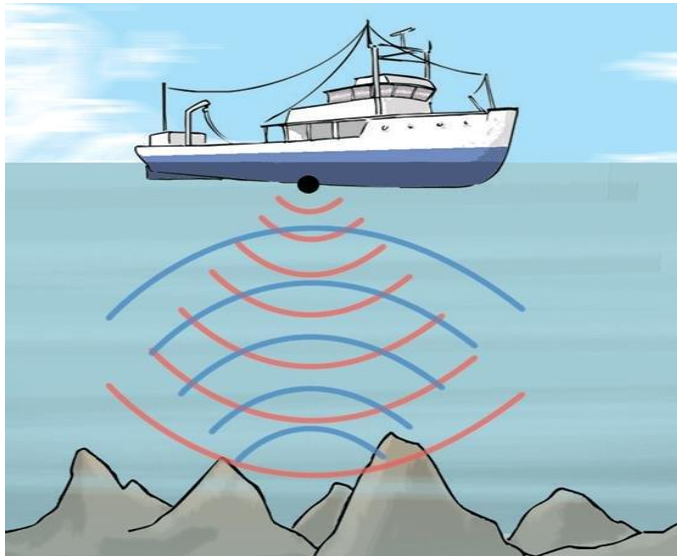
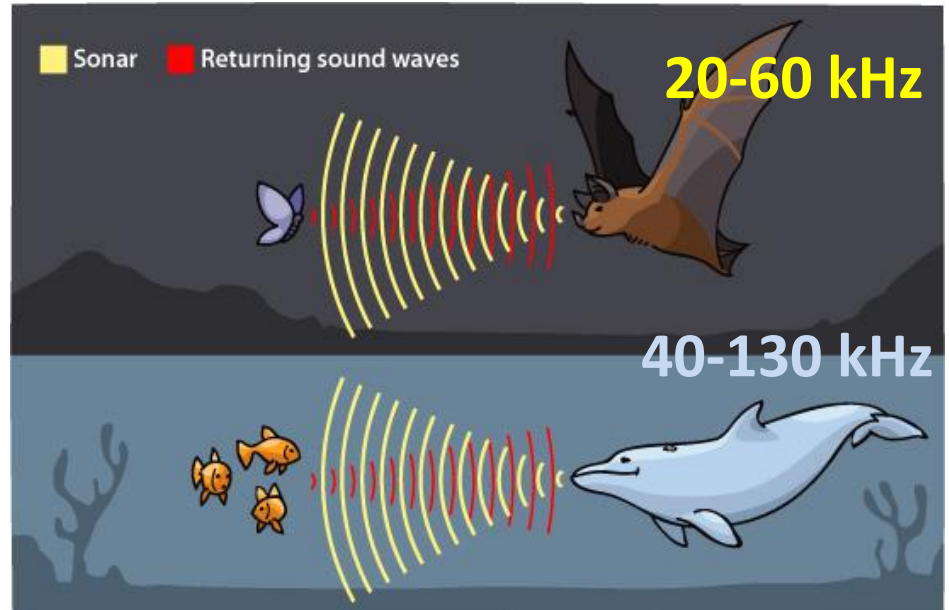
Reflection, Transmission, Absorption



- Sound is **reflected best from hard and/or smooth surfaces** (like walls in a large hall, mountain cliffs, surface of water in a well).
- **Soft and/or rough surfaces tend to absorb most of the sound.**

Echolocation and SONAR

- **Echolocation:** animals such as bats and dolphins send out **ultrasound** waves and use their echoes to identify the locations of objects they cannot see. Animals use echolocation to find prey and avoid running into objects in the dark.

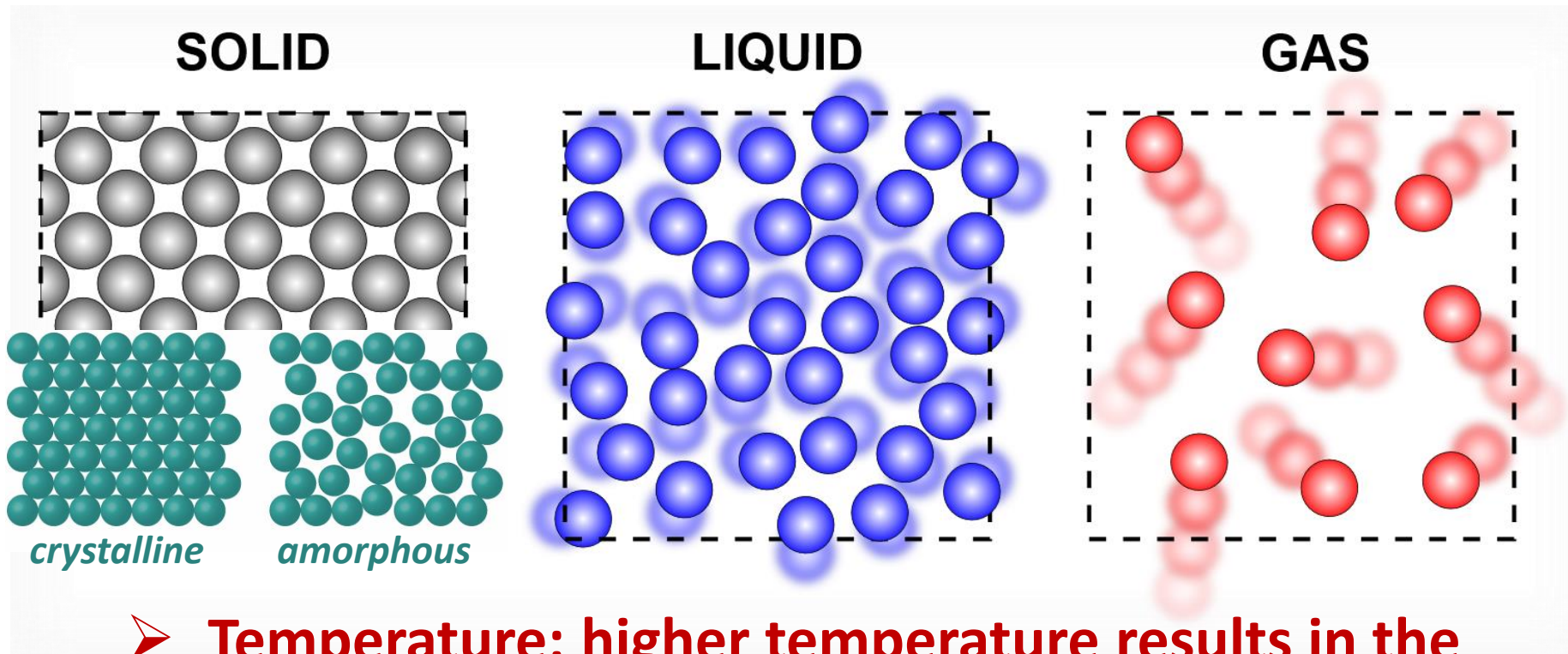


- **SONAR (sound navigation ranging)** is a technique that uses sound to navigate, communicate with or detect objects on or under the surface of the water. Sonars use a wide range of frequencies from **infrasonic** (provides longer range) to **ultrasonic above a megahertz** (provides high detail).

How does sound travel?

Vibrations are passed between neighboring particles of a substance, so the following properties are important:

- Particle arrangement: different states of matter, particular structure (*crystalline or amorphous*)

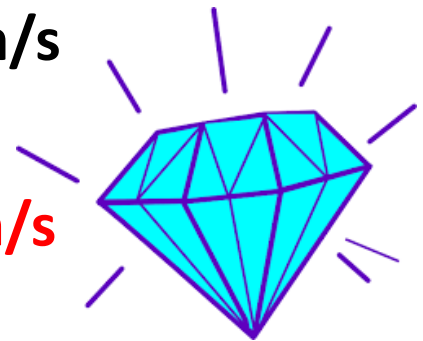


- Temperature: higher temperature results in the increased rate of interaction between particles

Speed of sound

varies from substance to substance

- sound travels **most slowly in gases**:
 - ✓ speed of sound **in air** at room temperature is **343 m/s**
- it travels **faster in liquids**:
 - ✓ speed of sound **in water** is about **1,400 m/s**
(about 4 times as fast as in air)
- and faster still in solids:
 - ✓ speed of sound in concrete is about 3,700 m/s
 - ✓ speed of sound in hardwood is about 4,000 m/s
 - ✓ speed of sound in iron is about 5,000 m/s
 - ✓ speed of sound **in diamond** is about **12,000 m/s**
(about **35 times as fast as in air** which is around the **maximum** speed of sound possible...)



The ultimate speed limit of sound

36
km/s

is determined by the maximum density of a material and how the atoms within it are bound together.

- Scientists have found that **the lighter the material - the faster the atomic motion**, which implies that the fastest sound can travel must occur in the lightest of all elements, **hydrogen**.
- In 2020, scientists predicted that **solid metallic hydrogen** – a material that *theoretically exists at the center of giant planets* like Jupiter – should have the **highest speed of sound, calculated to be ~36,000 m/s**.
- It's not possible to test this theoretical top speed in the real world!

