

# EXTRA WAVE TOPICS

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## Part A-1: The Speed of Sound Inside a Material

### Speed of Sound

The speed of sound *depends upon the material* sound moves through. It moves fastest in *solids*, second fastest in *liquids*, and slowest in *gasses*.

### Speed of Sound

Material	Speed of Sound (meters / second)
Air (20 °C)	343
Water	1,484
Glass	4,540
Steel	6,100
Diamond	12,000
Vacuum	----- sound does not move through a vacuum

**A.1** Where does sound move fastest?

**A.2** Where does sound move slowest?

**A.3** Where does sound not move at all?

### Why is this?

Sound is a mechanical wave, a wave of moving matter. Sound depends upon each molecule hitting the molecule in front. The most dense and compact a material is, the faster sound moves. That's why it moves *fastest* in solids and *slowest* in gasses.

**A.4** Where does sound move faster: Water or steel?

**A.5** Where does sound move faster: Air or steel?

**A.6** Where does sound move faster: Air or water?

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## Part A-2: The Speed of Light Inside Materials

### Speed of Light

You should know “The speed of light is 300,000,000 m/s.”

However, this is really the speed of light *in a vacuum*.

In a medium (matter), light moves *slower* than it does in a vacuum (outer space).

Material	Speed of Light (meters / second)	Very accurate speed of light
Vacuum	$3.00 \times 10^8$	299,792,458 m/s
Air	$3.00 \times 10^8$ **	299,686,445 m/s
Glass	$1.97 \times 10^8$	
Water	$2.56 \times 10^8$	
Diamond	$1.24 \times 10^8$	
Steel	----- light does not move through steel	

\*\* The speed of light is a very little bit less in air than in a vacuum. You would need to go the fourth decimal place to see the difference.

**A.7** Where does light move fastest?

**A.8** Where does light move slowest?

**A.9** Think of three materials that light *does not* move through at all:

### Why is this?

Light is an electromagnetic wave and is not a wave of moving matter. Any matter gets in the way of light; the less matter the faster light moves. That’s why it moves *fastest* in a vacuum or gas and slower inside matter.

### A very important point:

Even though light slows down in matter, it is still *really really really really* fast.

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Light moves slowest in a diamond, but light in a diamond is still much much faster than anything else expect light that isn't in a diamond.

The main relevance of the changing speed of light is that it causes light to *refract*.

**A.10** Where does light move faster: water or diamond?

**A.11** Where does light move faster: water or glass?

**A.12** Where does light move faster: water or air?

**A.13** Where does light move faster: air or vacuum?

For **A.14** – **A.22**, answer true or false?

**A.14** Sound is faster than light.

**A.15** Sound moves slower in air than in water.

**A.16** Light moves slower in a vacuum than it does in matter.

**A.17** Light moves slower in water than it does in air.

**A.18** Sound moves faster in a steel train track than it does in air.

**A.19** Light moves faster in a diamond than it does in water.

**A.20** Sound moves faster in solids than in liquids.

**A.21** When light slows down in a diamond, it moves slow enough that you could run after it.

**A.22** Sound moves faster in solids because the particles are packed closer together.

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**A.23** For each material, *rank* the speed of light and sound.

Examples:

The material where *sound* moves fastest will have a “1” for sound.

The material where sound moves second fastest will have a “2” for sound. etc.

Any materials in which sound *does not travel* will have an “X” for sound.

Material	Speed of Sound Ranking	Speed of Light Ranking
Air		
Glass		
Steel		
Vacuum		
Diamond		
Water		

**A.24** You can tell if a train is coming by putting your ear on the train track:



Using the science facts from this packet, explain why this is:

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## Answers

Material	Speed of Sound Ranking	Speed of Light Ranking
Air	5	2
Glass	3	4
Steel	2	X
Vacuum	X	1
Diamond	1	5
Water	4	3