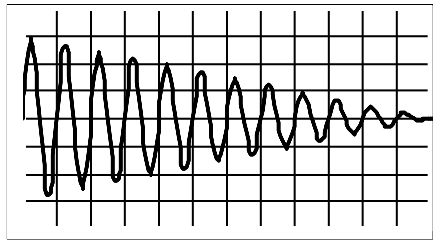
Name: ____________________

Period: ____________________

Wave Actions

Damping

No motion can last forever. A pendulum will eventually stop swinging due to air friction. A wave will eventually lose its energy as well. Friction or the restoring force eventually causes the motion to lose its energy and to die out. This gradual reduction of amplitude we call ***damping***.



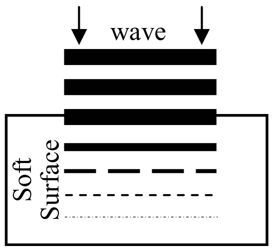
This graph shows the damping of harmonic motion over time until it has stopped (returned to its equilibrium position).

Boundary Reactions

There are four ways a wave can react depending on the boundary it encounters: ***Absorption; Reflection; Refraction; Diffraction.***

Soft Boundaries Absorb

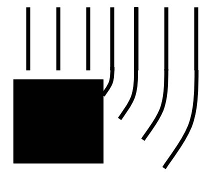
Absorption—a wave's energy dies out in a soft material (damping). *Example: Yelling into a pillow. The soft pillow* ***absorbs*** *the sound.*



Absorption

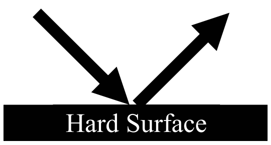
Corners Diffract

Diffraction—part of a wave bends around a corner. This is partially how we hear around corners and how some light can be seen around corners. What happens is the corner drags the wave slowing it down and turning it. *Example: talking to someone around a corner.*



Diffraction on

Hard Boundaries Reflect



Reflection

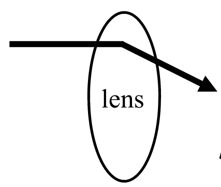
Reflection—a wave bounces off when it hits a hard boundary. *Example: When you yell against a wall, the sound wave* ***reflects*** *off of the wall.*

Light diffracts. ***PROVE IT****: Put your hand up to your eye. Look between two of your fingers. As you close your fingers together you see "lines" – almost like your skin is "jumping the gap." These dark lines are where two diffracted light waves are canceling each other out to produce* <u>*darkness*</u>*. How do they cancel each other out? By destructive interference: see back page.*

We call sound that is reflected back to us ***echoes***. Many animals use ***echolocation*** to see through dark water or at night! An animal makes a noise and uses the echo to figure out where an object or prey is located.

Humans use echolocation, too, in ***sonar*** (submarines using sound waves), ***radar*** (airports using light waves), and ***sonograms*** (sound waves to see inside soft parts of the human body).

Transparent Boundaries Refract



Refraction

Refraction— a wave bends when entering a transparent boundary. *Example: Light going into water bends toward the water. Light also bends going through the lenses of eyeglasses to magnify objects.*

Natural Frequency

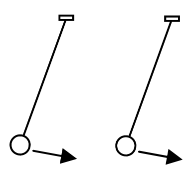
All objects have a ***natural frequency***—the frequency that they vibrate at when disturbed. Musical instruments easily show natural frequencies, but most other objects have them, too: bridges, buildings, etc.

Resonance

Resonance is the reinforcing of an object's natural frequency so that the amplitude increases quickly. Harmonics show resonance. If you have ever been talking in a bathroom and notice that certain notes are very loud—that's resonance: that loud note is the natural frequency of that room. Resonance is how a soprano can break a glass with her voice.

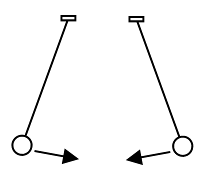
Phase

Phase—a particular part of a cycle.



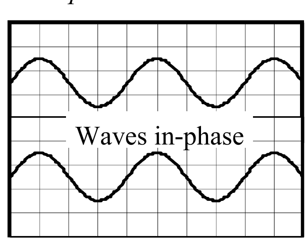
In-phase means they are at the same point in their cycles.

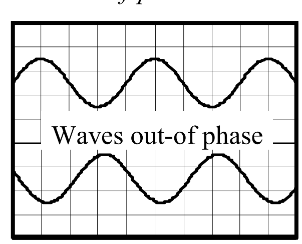
In-phase



Out-of-phase means they are at *different points* in their cycles.

180^o out-of-phase





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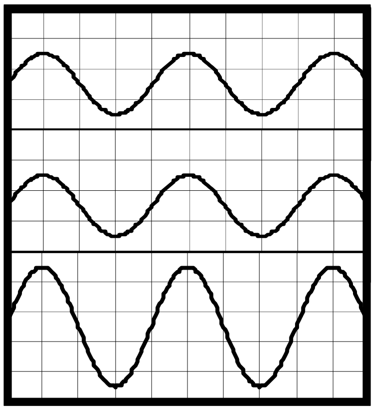
Interference

*When two waves interact they **interfere** with each other.*

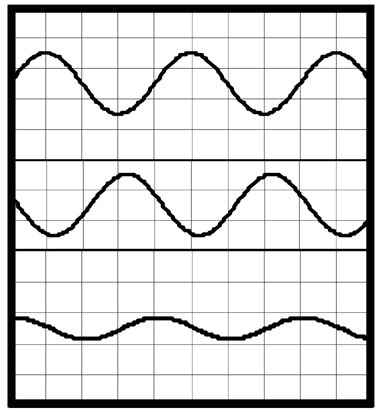
Constructive Interference—when **two waves** combine to **cause a larger wave** of greater amplitude, like pushing on a person on a swing when they are moving away from you: you give them energy.



Two smaller waves (lesser amplitude) that are ***in-phase constructively interfere*** to create one larger wave of greater amplitude.

Two singers on the same note cause a louder sound—constructive interference.

Destructive Interference—when **two waves** combine to **cause a smaller wave** of smaller amplitude. Pushing on a person on a swing as they are going toward you (at the wrong time) causes the amplitude to die out.



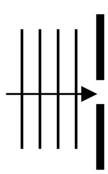
Two waves that are ***out-of-phase destructively interfere*** to create a smaller wave of lesser amplitude. They **cancel** each other out.

Modern headphones (and cars) have *noise-canceling technology* that transmits out-of-phase waves toward noise, canceling them out.

1. Phase	A. The process of harmonic motion losing amplitude over time.
2. In-phase	B. When two waves increase amplitude.
3. Out-of-phase	C. A single part of a cycle.
4. Damping	D. When two waves decrease amplitude.
5. Constructive interference	E. When two waves are at different parts of their cycles.
6. Destructive interference	F. When two waves are at the same part of their cycles.

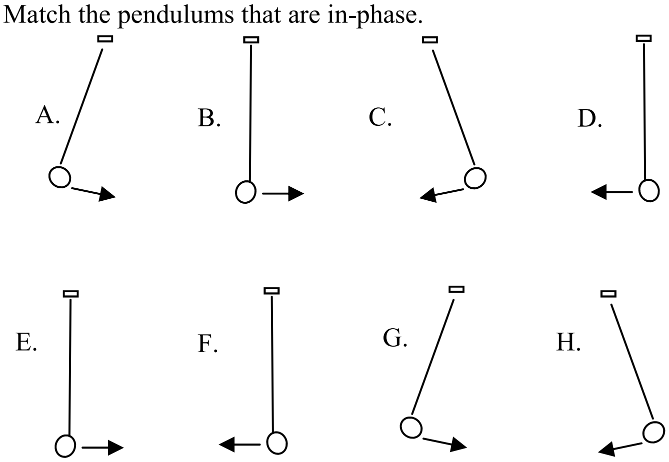
1. Absorption	A. When a wave bends at a corner.
2. Refraction	B. The frequency that an object has when disturbed.
3. Diffraction	C. A method of using sound instead of eyes.
4. Reflection	D. When a wave is dampened inside a soft boundary.
5. Echolocation	E. When a force reinforces the natural frequency of an object.
6. Natural Frequency	F. A wave bouncing off of a hard boundary.
7. Resonance	G. A wave bending inside transparent objects.

Draw what will happen to the wave as it goes through the hole.



What do we call this?

Match the pendulums that are in-phase.



Which one is 180^{o} out-of-phase of E? ____ With H? ____

Which one is 90^{o} out-of phase of F?____ with G? ____

Absorption, Reflection, Refraction, or Diffraction?

If a wave hits a hard wall, it bounces off by: ______________

If a wave hits a soft boundary, it dies by: ______________

A wave bends around a corner by: ______________

A wave bends inside a boundary by: ______________

Carpet can keep a room quiet by: ______________

Tile or marble makes for a loud room by:______________

Eyeglasses magnify objects by: ______________

Dark lines between your almost closed fingers by: __________

Light comes back from a mirror by: ______________

A string with a natural frequency of 15 Hz will likely show resonance at which frequencies: (could be more than one)

A) 20 Hz; B) 30 Hz; C) 40 Hz; D) 50 Hz; E) 60 Hz

What other frequencies would show resonance?

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