Wave Properties

Because waves possess _____, but not _____, they have special properties.

1) Reflection

Something waves & particles share in common is _____.

If there is a sudden change in medium, most of a wave's _____ will reflect off the medium interface at _____ angle that it struck.

A common type of wave speed problem involves _____.
WARNING: if a wave echoes off a wall, the distance traveled _____ the separation.

2) Interference (Superposition)

When two waves "collide" they _____ _____ each other instead of _____ off each other. As they pass through, their amplitudes temporarily ____/_____. Addition is called constructive interference, _____ is called _____ interference.

a. Resonance (consistent additive _____)

When small _____ are added to an object at the same _____ as the object naturally wants to vibrate, the wave pulses keep _____ to form a _____ wave.

b. Beats (out of phase _____)

When two waves overlap but have slightly different _____/_____, the waves will sometimes interfere _____ and sometimes _____. This creates a pulsing to the _____ of the combine wave. If the frequency is different by ___Hz, then the higher frequency wave will complete _____ periods in 1 second. So, the "beat frequency" (oscillation between _____ and _____) will be _____.

1)c. Standing Wave (self-_____)

If a wave interferes with its own _____, a pattern of nodes and _____ is created.

At nodes, the two waves always _____ interfere. At _____, the two waves interfere _____. Since the nodes don't _____, it looks like a wave that is _____ is formed. Note: this appearance is illusion, because waves _____ stand still. Note: the notes of musical instruments are created by _____ _____.

3) Refraction

When waves move into a new medium, _____ will change (cuz it's based on _____), but _____ will stay constant (cuz it's based on the _____) The result is that in a slower medium wavelength _____ and the direction of travel of the wave bends _____ perpendicular.

Quantitatively, this is described by _____ Law: _____, where θ_i is the _____ angle a light ray makes with respect to _____ with an interface, θ_r is _____, n_i and n_r are the ratios of the speed of _____ to the speed of _____.

Note: Because a wave is bent away from normal when going from a _____ to _____ medium, it is mathematically possible for the refraction angle to become >_____. This means that refraction _____ possible, so all wave energy must be _____. (This is how _____ _____ and certain carnival toys are able to send light through curving paths.)

4) Diffraction

If you are playing tag with water guns, you can have a conversation with your opponent while hiding behind a wall and _____ worried about being hit by water. This is because water is made of _____ and follow _____ Law, but sound waves are able to _____ around corners.

3 vs 4 ****Diffraction is the _____ of waves in a _____ medium to turn a corner. Refraction is the _____ of waves in a _____ medium because of a _____ change.*

5) Doppler Effect

When you approach a wave source rapidly, you will hit crests _____ frequently. So, the perceived frequency is _____. This makes sound _____ pitch and light more _____. Running away has a _____ effect.

If a wave source moves away from you, the crests will be _____. So, the perceived frequency will be _____. This makes sound _____ pitch and light more _____. An approaching source has the _____ effect. (Think racecars passing a video camera.)

6) Polarization

A transverse wave, esp. light, may find passing through a _____ more or less _____ depending on the direction of its wiggle. A medium that blocks a vertical wiggle will create _____ light that only wiggles _____.

Interestingly, shiny surfaces better reflect light that wiggles parallel to its surface. So, reflections are _____ polarized.

Properties Applied To Light

- Light travels at a speed of _____ in outer space. (Incidentally, sound travels _____$^{m}/_{s}$ in __^{o}C air) Generally speaking, the denser the medium the _____ light travels, because the atoms of the medium bounce the light around.
- _____ – **A.** Since glass is _____ dense than air, specially shaped pieces of glass can change the _____ light travels. This changes the size and location an object appears to have (ie. _____, _____, _____, etc.) This is the basis of _____.
  B. Since hot air is _____ dense than cold air, light travels _____ in hot air. This can cause light from the sky to appear as though it is coming from the _____ (a.k.a. _____).
  C. It turns out that different light frequencies have different _____ in glass. So, they bend different amounts. This type of _____ effect is called dispersion and explains why chandelier glass, _____, _____, and _____ all sparkle with rainbow like colors.
- Diffraction can be observed for light if the light passes through a small enough hole creating a _____ pattern.
- Doppler Effect changes how stars look depending on whether they are _____or_____ Earth. Receding starlight gets red-shifted. _____

Wave-Particle Duality

- Light's wave properties are easy to observe, but light can also behave like a _____. (In fact, all tiny particles can be made to act like waves, and all wave pulses can be treated as particles under the right conditions.) Einstein won the _____ for showing that light delivers its energy when striking an object as if it were a _____ instead of being a _____. (Photo-Electric Effect)

Making Music

(Note: The ratio of the harmonics makes a trumpet sound different from a violin.)

- When a string on a guitar is plucked, waves travel in _____ directions and _____ off the ends. Most wavelengths disappear from _____ interference, but a few frequencies are just the right to create make _____ _____ with nodes located at the string's _____. So, the wave can vibrate the string _____ vibrating the instrument.

Strings & _____ **Closed-Pipe Resonator**

Harmonic/Diagram Wavelength Frequency Harmonic/Diagram Wavelength Frequency