Physics with Synno – Waves-Light – Lesson 3

LW.9 Reflection

Video: Fixed and Free End Springs
Waves in Slinky Springs
Interference of Waves on a Spring
Constructive Interference (Waves of Different Heights)
Destructive Interference
Superposition

LW.9.1 Reflection of Waves in One-dimension

When waves reach a boundary the energy they carry may be absorbed by or transmitted in to a new medium. During this process some of the energy may be reflected. Exactly what happens depends on the boundary. We will consider a spring with one end either fixed or free.
The spring with the fixed end is reflected with little energy transfer and it is inverted. This effect is sometimes referred to a phase reversal, phase shift or change of phase.
The spring with the free end has some energy transfer, but no change of phase.

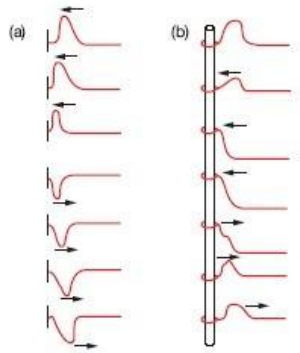
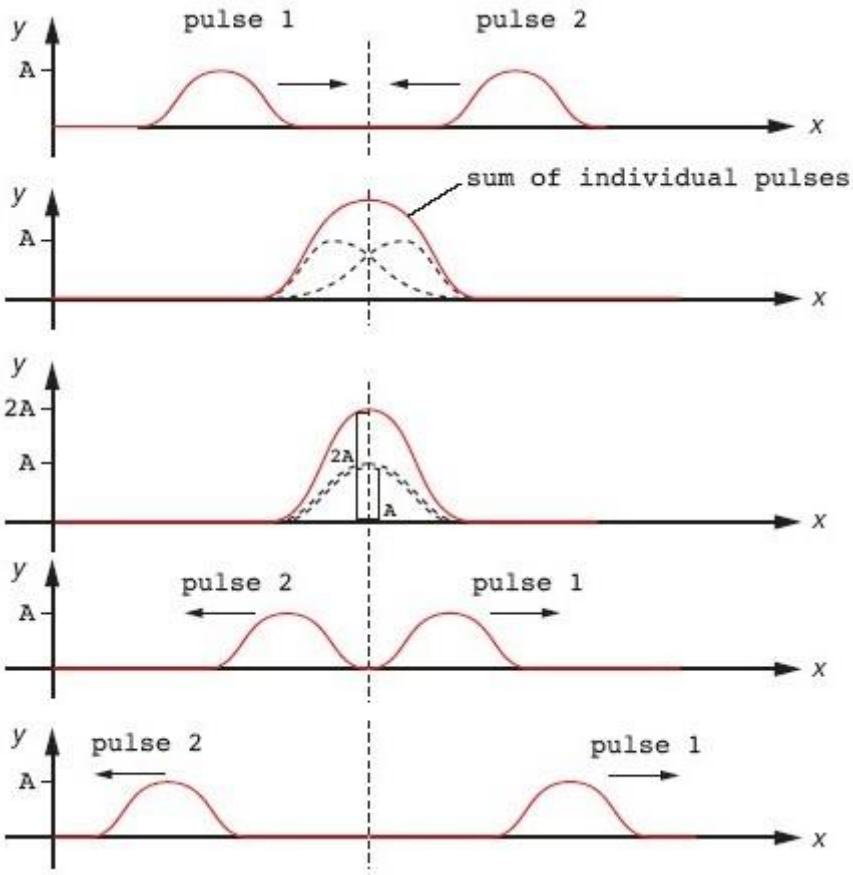


Figure 1.18 (a) The reflection of a wave at an unyielding boundary produces a phase shift of $\frac{1}{2}\lambda$. Note that otherwise the shape of the wave is unaltered. (b) The reflection of a wave at a free-end boundary does not produce a phase shift.

LW.9.2 Interference (Superposition)

When two waves meet they will interfere with each other. Depending on the direction of travel, the wavelength and amplitude of the waves some interesting effects can be observed. These effects all rely on the principle of superposition. Which states that when two waves meet the resulting wave is the sum of the displacements of the individual waves.



Superposition can result in one of two types of interference, constructive or destructive.

Constructive interference occurs when the crest of one wave meets the crest of another. Thus constructing a larger wave. Similarly this occurs when two troughs meet.

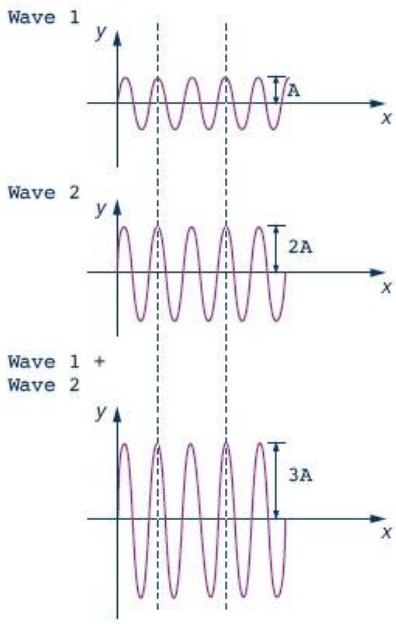


Figure 1.22 The superposition of continuous waves that are in phase and travelling in the same direction will result in constructive interference.

Destructive interference occurs when the crest of one wave meets the trough of another, thus destroying the wave.

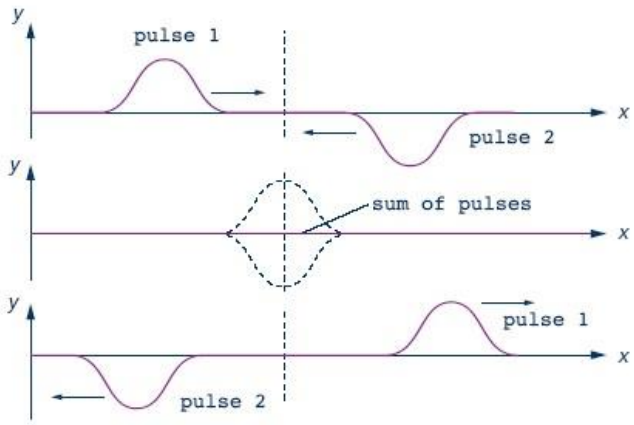


Figure 1.21 Superposition of two pulses of equal but opposite amplitudes travelling toward one another.

Of course in real life the patterns produced are more complex, but the principle behind their formation remains the same.

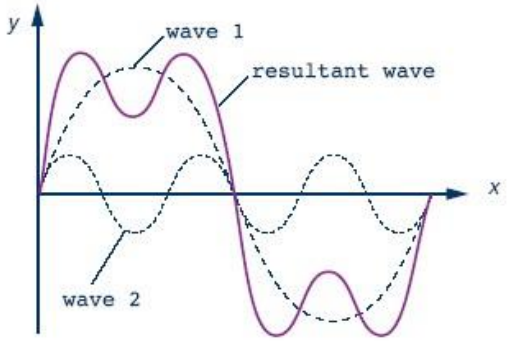
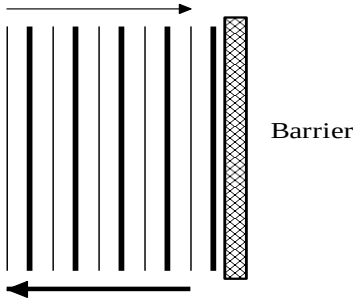


Figure 1.23 The addition of waves of different wavelengths results in complex wave patterns.

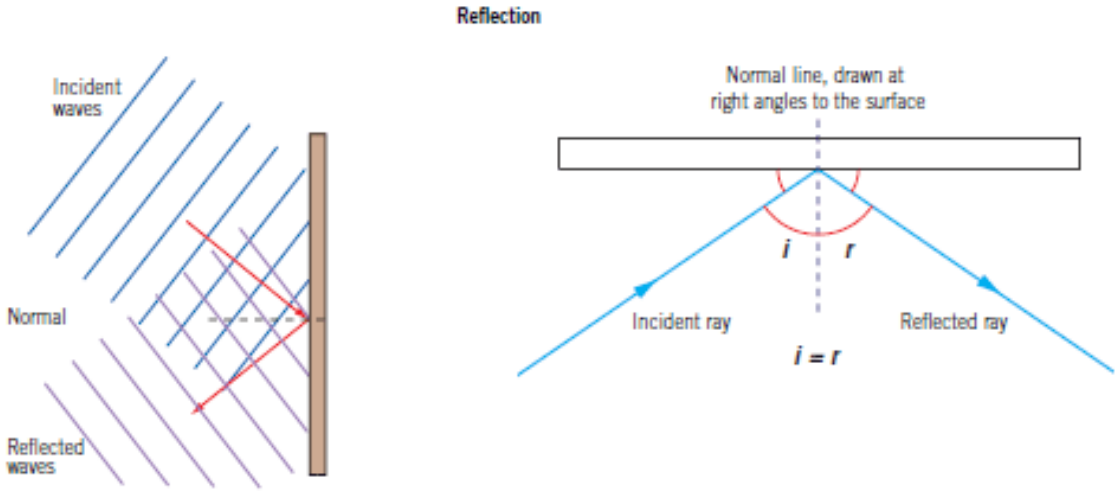
LW.9.3 Reflection of Waves (in 2-D)

Video: Ripple Tank Experiment 3: Reflection of Straight Wave by Straight Barrier
Ripple Tank Experiment 4: Circular Wave Reflected by Straight Barrier
Ripple Tank Experiment 6: Reflection of Straight Wave by Curved Barrier

Water waves reflect in a similar fashion to light. (In fact anything that is formed from waves will behave in this way. e.g. microwaves, radiowaves, etc.). That is, if waves travel straight towards a barrier then they reflect straight back.



When we increase the angle between the waves and the barrier we again observe that the waves reflect in a similar fashion to light.



The angle of incidence is the angle between the direction of propagation (travel) of the incident waves and the normal. The angle of reflection is the angle between the direction of propagation of the reflected waves and the normal.
Also

$$i^\circ = r^\circ$$

LW.9.4 Diffuse Reflection

Diffuse reflection is the sort of reflection that allows us to see the objects around us. It occurs when light is reflected from a rough surface, such as a picture screen.

The angle of incidence (i) equals the angle of reflection (r), but because of the rough surface the light is reflected in a large range of directions.

LW.9.5 Resonance

Video: Wine glass resonance in slow motion
Tacoma Narrows Bridge Collapse Gallopin' Gertie

All objects have a natural frequency of vibration. If a sound of the same frequency is made near an object then it will start to vibrate, this is called resonance. This phenomenon is used in musical instruments to make the sound louder.

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