

# Reflection and Transmission of Mechanical Waves

LEARNING OBJECT- PHYS 101

By Itai Buxbaum

3/1/15

In this Learning Object, I will walk you through the key points in **hard and soft reflection of mechanical waves** using examples from the Phet “Reflection of Waves” simulation.

Sources:

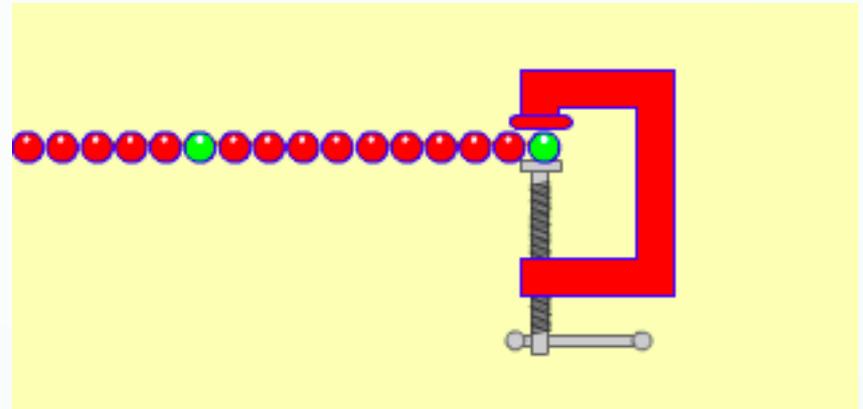
- *Physics for Scientists and Engineers Revised Volume 1 (Hawkes, Iqbal, Mansour, Milner-Bolotin, and Williams)*
- *Phet Interactive Simulations by the University of Colorado – Wave on a String*
- *Shutterstock.com*

# Hard reflection

- Imagine you have a rope tied firmly to a support as such

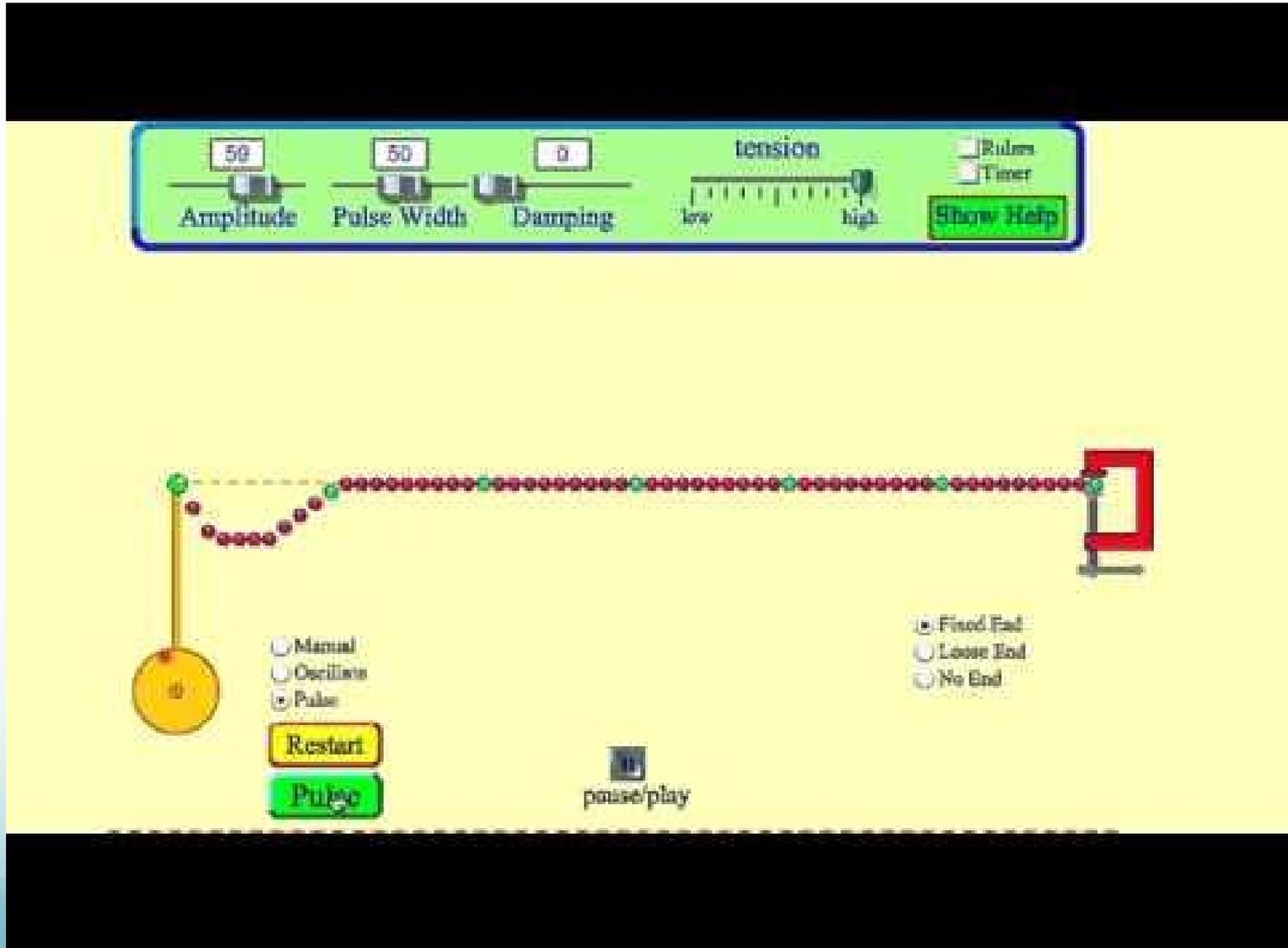


www.shutterstock.com · 132263432



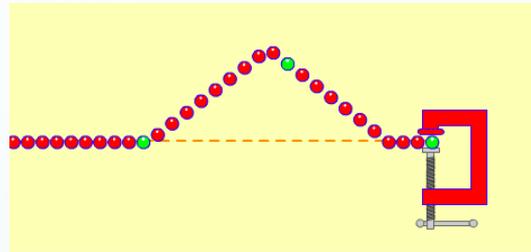
- If you were to start a pulse at the other end, what would happen?
- Lets take a look....

This is a video, please make sure to press the play button ■

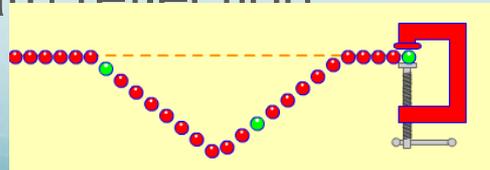


# Hard reflection- What is going on here?

- This is an application of Newton's Third Law of Motion:
- As we can see, the transverse pulse propagates through the string.
- The displacement of the incident pulse is upwards, so the string exerts an upwards force on the support when the pulse reaches the fixed end.



- But the support is **rigid**, so it **exerts an equal and opposite** reaction force on the string. **The reaction force generates an inverted pulse** that moves in the **opposite direction**. This is called a hard reflection.

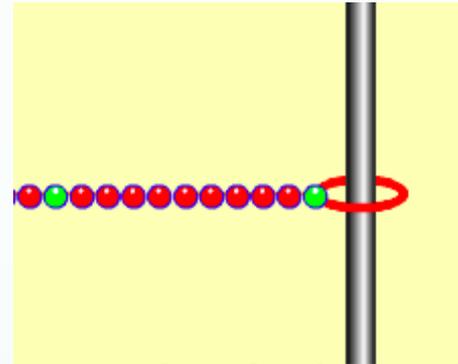


# Phase

- When the wave reflects from the fixed end, the wave is inverted with respect to the incident wave.
- They are out of phase by  $\pi$  radians because the incident and reflected waves cancel each other out at the rigid support which has zero displacement.
- That means that: **when a wave is reflected from a fixed end, its phase constant change by  $\pi$  radians**

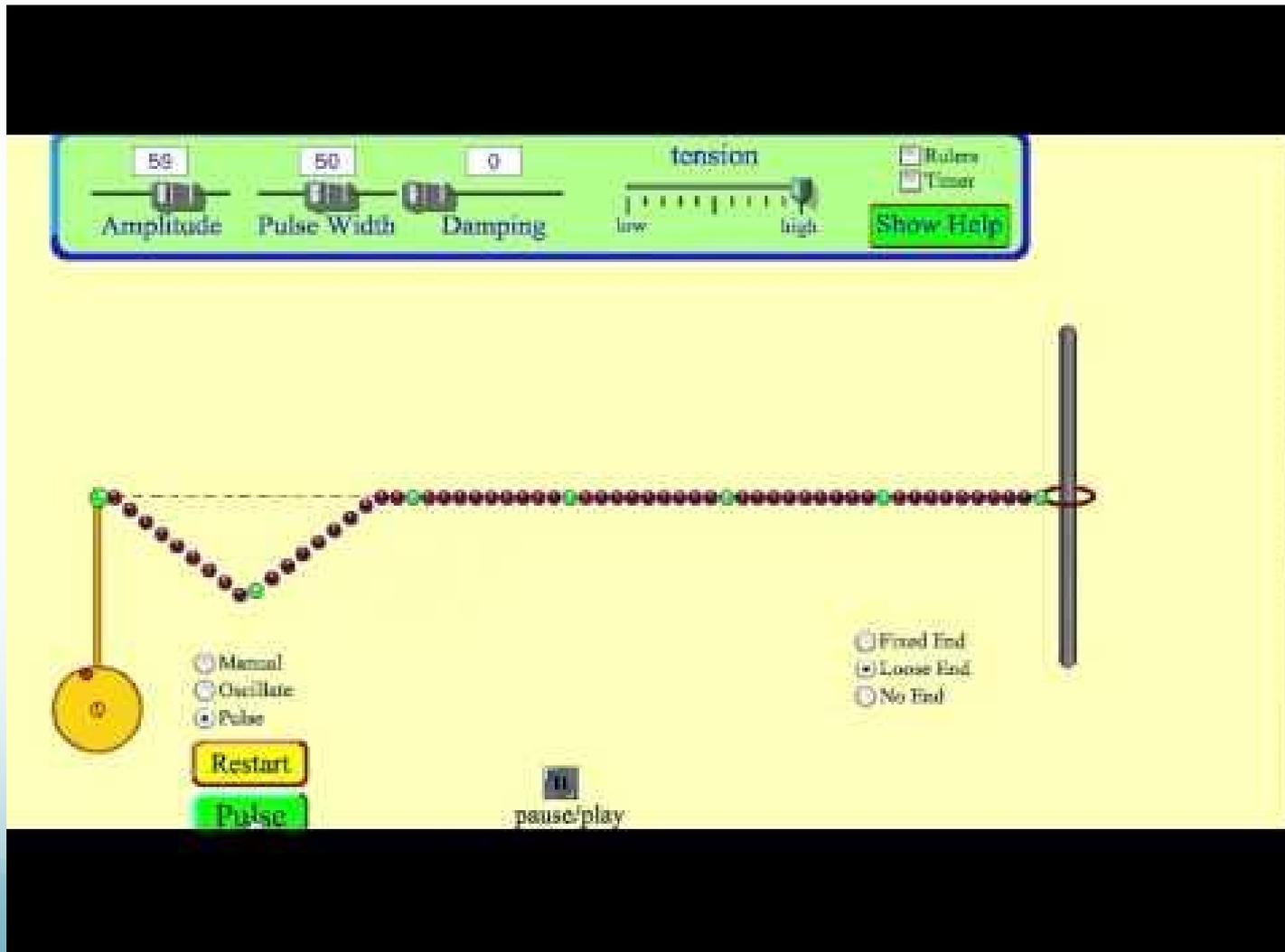
# Soft Reflection

- Now imagine that you had a string attached to a ring that was placed around rod. The idea is that the string is now free to move up and down, as it slides freely on the rod



- If you were to start a pulse at the other end, what would happen?
- Lets take a look....

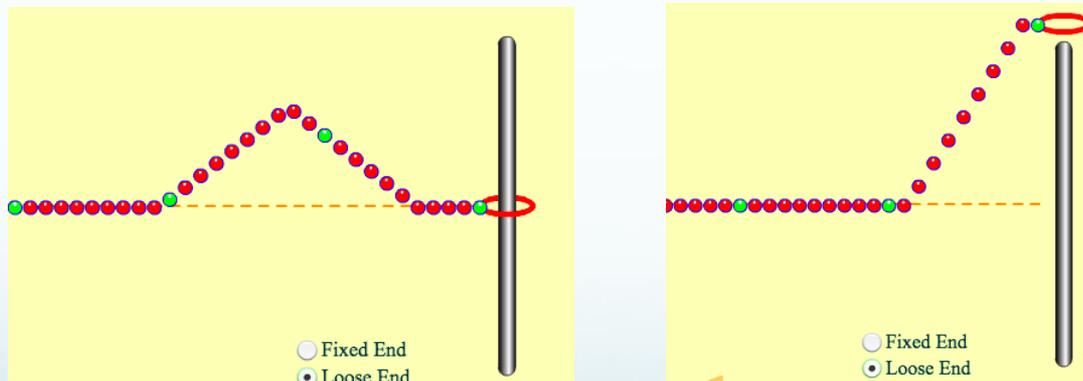
This is a video, please make sure to press the play button.



# Soft reflection-

## What is going on here?

- This is an example of reflection from a free end.
- The incident pulse exerts an upwards force on the ring, **causing it to accelerate upwards.**
- Notice- That the ring overshoots the maximum amplitude of the string and is pulling the string with it



- This is because of inertia.

# Soft Reflection and inertia in the ring

- Because of inertia the ring overshoots the maximum amplitude of the pulse and pulls the string along with it.
- **This generates a reaction force that is exerted onto the string by the ring.**
- This is what causes a **backward moving pulse that is not inverted, known as a soft reflection.**
- In this case, the incident pulse and the reflected pulse are in phase.

# Physics at Stanley Park!

- This is seen in waves:
- Think about the wave as if it was a soft reflection:
- The amplitude of the wave when it hits the sea wall is greater than the amplitude of the wave before...
- The result is a big splash!



Photo: [vancouver.sun.com](http://vancouver.sun.com)

# Sources

- <http://phet.colorado.edu/en/simulation/wave-on-a-string>
- *Physics for Scientists and Engineers Revised Volume 1  
By Hawkes, Iqbal, Mansour, Milner-Bolotin, and  
Williams, pages 408 and 409*
- *Shutterstock.com*
- *VancouverSun.com*