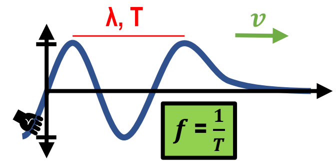
CONCEPT: VELOCITY OF WAVES ON A STRING



● Remember: ALL waves have a wave speed given by $v = \lambda f$

● Wave speed is also determined by the physical properties of the *medium* itself.

- For waves on a string, these properties are the **Tension**, **Mass**, and **Length**: $v_{string} = \sqrt{\frac{\quad}{\quad}} = \lambda f$

(where $\mu = \frac{m_{string}}{L_{string}}$) = "mass density"

EXAMPLE: You pull a string with a Tension of 100N and then flick it up-and-down to create a wave. If the string has a mass of 0.5kg and a length of 1.2m, what is the frequency of the wave you create if the wavelength is 15cm?

PROBLEM: A rope with length 2.50 m and mass 0.10 kg is stretched and pulled to create transverse waves of frequency 40.0 Hz and wavelength of 0.750 m. How much tension is exerted on the rope?

A) F_T = 36 N
B) F_T = 6 N
C) F_T = 1.2 N
D) F_T = 22,500 N

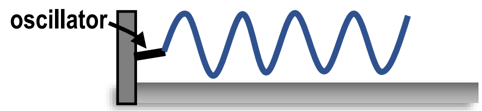
PROBLEM: You and your friend hold a rope at both ends, and pull it taut with a tension of 30N. The rope is 7.5m long, and has a mass of 0.5 kg. How long does it take for a wave pulse to travel from you to your friend?

WAVES
$v = \lambda f$
$v = \sqrt{\frac{F_T}{\mu}}$ (for *strings only*)

CONCEPT: SOLVING WAVES ON STRINGS PROBLEMS

● It's often difficult to understand which variables affect others in wave speed problems, so here are some simple rules:

$$\sqrt{\frac{F_T}{\mu}} = v_{string} = \lambda f$$



1) v depends on **Tension**, **Mass**, and **Length**, so changing these will *always* change v.
2) f depends *only* on the *oscillator* frequency (object creating the wave), so changing it affects f and λ, NOT v.

EXAMPLE: An oscillating blade creates transverse waves on a stretched string at a frequency of 35Hz. The Tension F_T in the string is 98N, and **μ** = 2 kg/m. Initially, you calculate the wave speed is 7m/s, and the wavelength is 0.2m.

a) You quadruple the Tension on the string. What is the new wave speed?

b) You double the frequency of the oscillator. What is the new wave speed and wavelength?

PROBLEM**:** An oscillating blade creates waves on a string**.** If the amplitude of the wave doubles, what happens to the wavelength **λ** and **v**?

A) **λ** and **v** remain the same
B) **λ** doubles, **v** remains the same
C) **λ** remains the same, **v** doubles

WAVES
$v = \lambda f$
$v = \sqrt{\frac{F_T}{\mu}}$ (for *strings only*)

PROBLEM**:** The wave speed for a string under Tension is 20 m/s**.** What is the new wave speed if the Tension is cut in half?

WAVES
$v = \lambda f$
$v = \sqrt{\frac{F_T}{\mu}}$ (for *strings only*)