■ Theme Music: Charlie Mingus

Tensions

■ Cartoon: Jef Mallet

Frazz
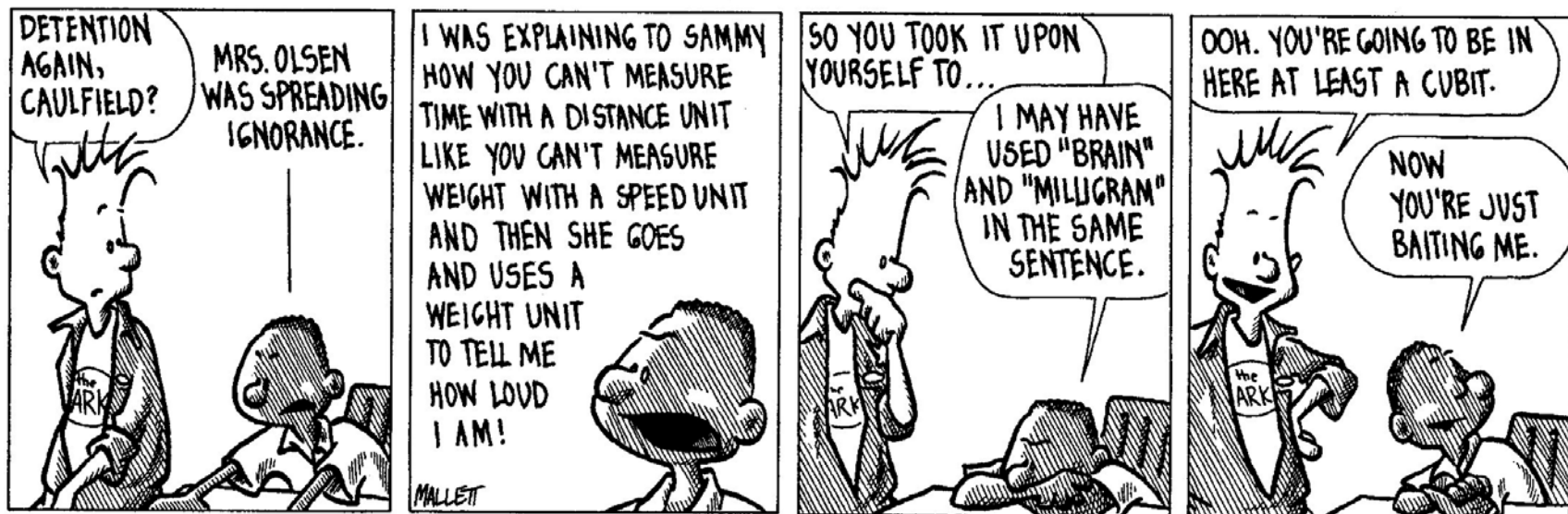
Tension:
The Ideal (Hooke's Law) Spring

■ An ideal spring changes its length in response to pulls (or pushes) from opposite directions.
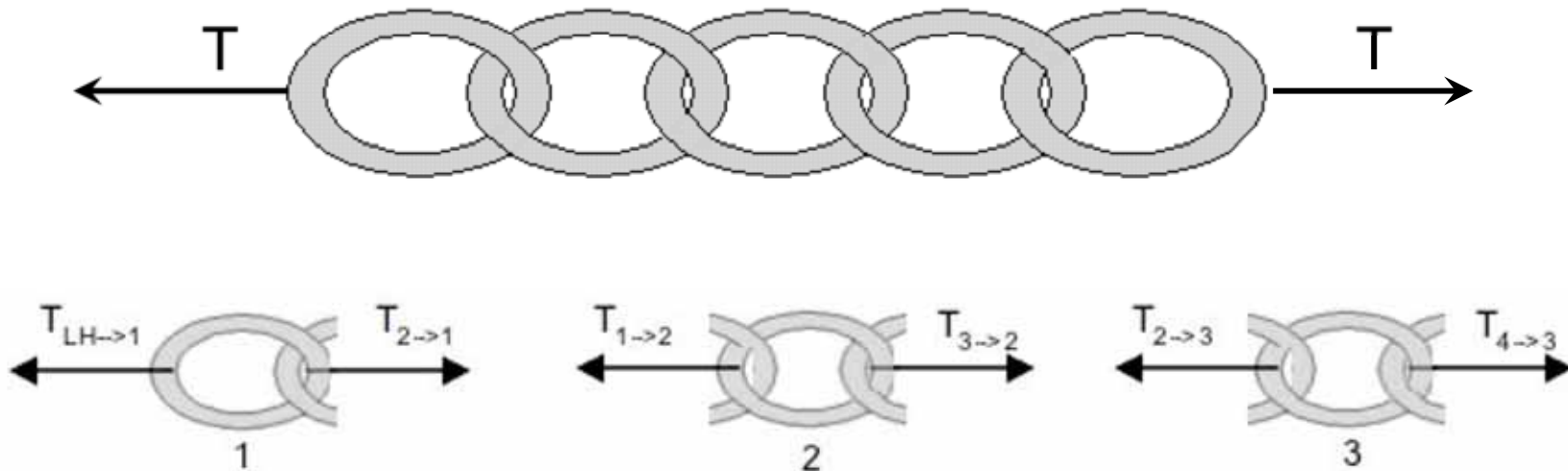
$$T = k \, \Delta l$$

Δl = change in length (stretch or squeeze)

Scalar vs. Vector Tension: The Chain

■ Consider a series of links of chain being pulled from opposite directions. What are the forces on each link?

Tension:
Scalar vs. Vector

- Note we are using the word "tension" in two distinct ways!

- The "tension" in a spring, chain, or string has no direction (or rather, both directions at once). It is a <u>tension scalar</u>.

- When tension appears at the end of a spring, chain, or string, the choice of end gives us a direction and lets us create a <u>tension force</u>.

Foothold ideas:
Resistive forces

■ Resistive forces are contact forces acting between two touching surfaces that are parallel to the surface and tend to oppose the surfaces from sliding over each other.

■ There are three types:
  – Friction (independent of velocity)
  – Viscosity (proportion to velocity)
  – Drag (proportional to the square of velocity)

Foothold Ideas:
Friction

■ Friction is our name for the interaction between two touching surfaces that is parallel to the surface.

■ It acts to oppose the <u>relative motion</u> of the surfaces. That is, it acts as if the two surfaces stick together a bit.

■ Normal forces adjust themselves in response to external forces. So does friction – up to a point.

Static   *Sliding*

$$f_{A \to B} \leq f_{A \to B}^{\max} = \mu_{AB}^{static} N_{A \to B} \qquad f_{A \to B} = \mu_{AB}^{kinetic} N_{A \to B} \qquad \mu_{AB}^{kinetic} \leq \mu_{AB}^{static}$$

■ Friction can oppose motion or cause it.