

# Physics Invention Sequences Users' Guide: Stiffness

## STIFFNESS INVENTION SEQUENCE

**Includes:** *trampoline stiffness (analogous to spring constant), elastic cord stiffness (includes adding in series and parallel)*

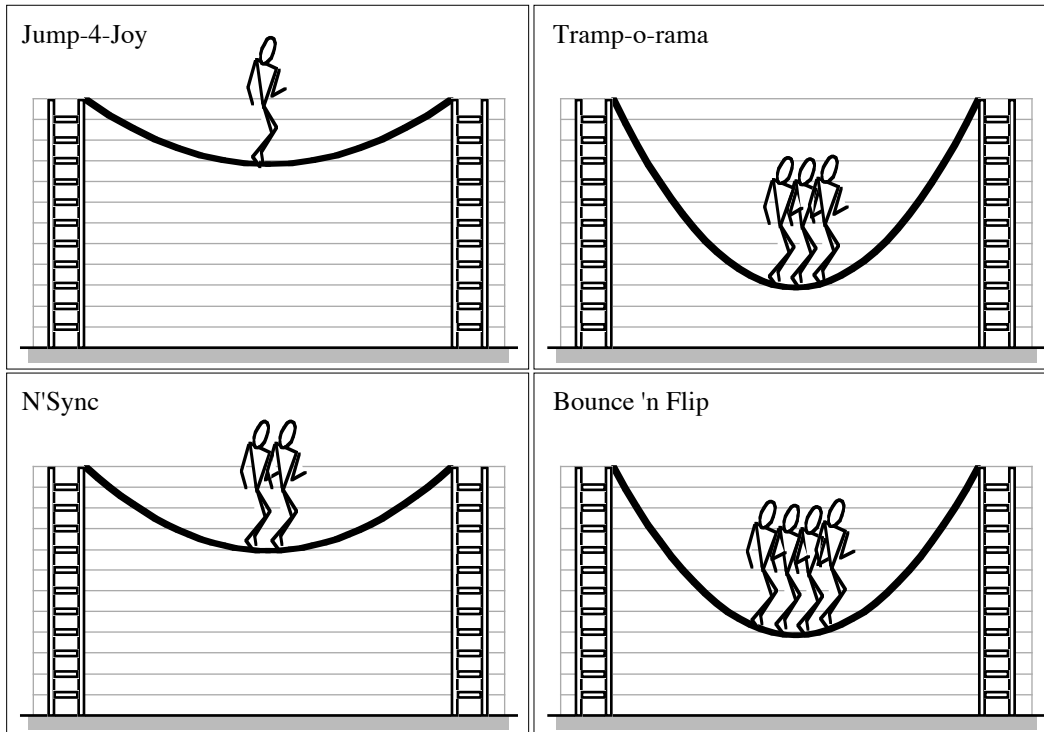
**Teacher Notes:** Students commonly do not understand “constant” in the same way we do. This activity provides an opportunity to explore material properties more carefully. The second activity helps them to build the reasoning about the effect of combining springs.

**Levels:** This sequence is most appropriate for all levels that discuss the spring constant mathematically.

### Trampoline Stiffness Index

You are comparing trampoline mats based on their response to being jumped on. The stronger the push down on the mat, the more it stretches. But not all mats stretch in the same way. Your goal is to find an index that allows you to compare mats and to predict how much stretch will occur for any strength of downward push.

Below are four trampolines, all of the same size but with potentially different mat fabrics. Each company has only one index value for its mat. A bigger value means that the mat is stiffer.



1. Do any of the trampolines use the same mat?
2. Which are the stiffest?
3. Provide a physical interpretation for the index you invented. Use “Bounce n’Flip” as a specific numerical example.

### Elastic Cord Stiffness

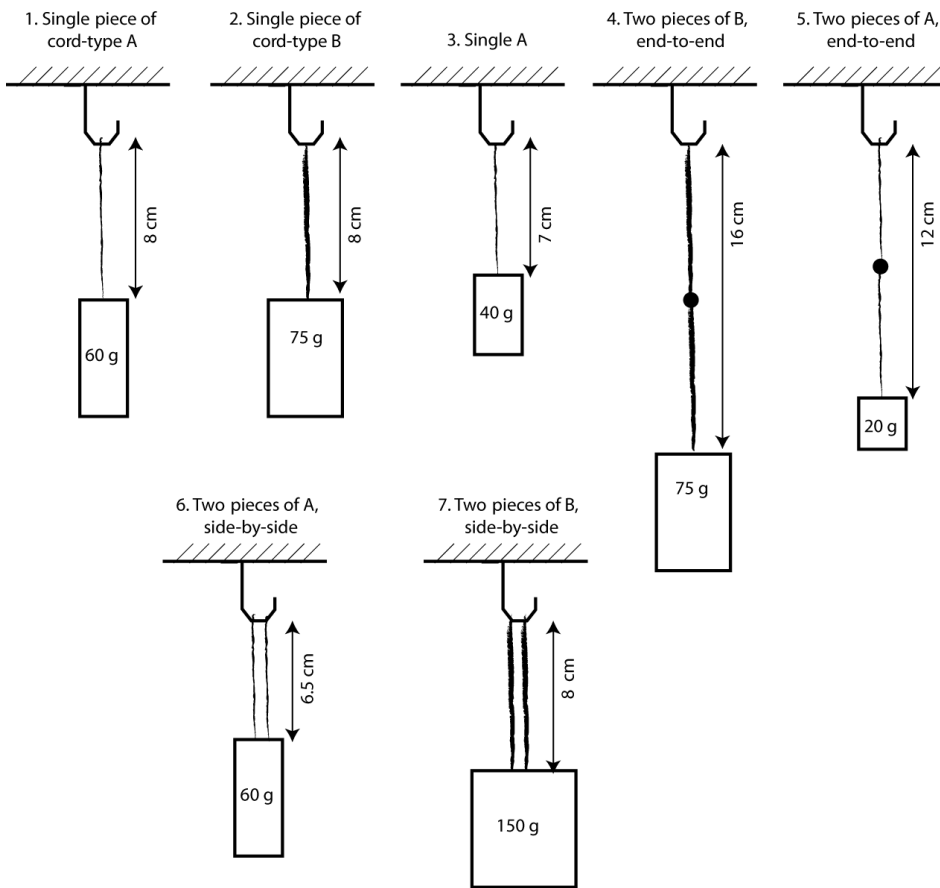
You have a summer internship with StretchLine®, a company that makes elastic cords for everything from underwear to bungee jumping. For one project, you are asked to invent a measure of cord “stiffness.” You want to come up with an index that describes the *type* of cord alone, independent of the length of the piece of cord that is being measured. In addition, you want a measure that has a larger value for a stiffer cord-type.

You have a number leftover “scraps” of two different types of cord. Each scrap has an unstretched length of 5 cm (see picture at right).

You put these together in various combinations and measure the stretched-out length for different suspended masses. (See below.)

5 cm piece of cord-type A

5 cm piece of cord-type B



#### Follow up questions:

1. Which type of cord is inherently stiffer, A or B?
2. Provide an *interpretation* of the index that you invented.
3. Which would be stiffer, a 30-cm long piece of type A or a 45-cm long piece of type B?
4. Suppose a 5-cm length of type A is joined *end-to-end* with a 5-cm length of type B. How many cm would this combination stretch out to if a 60 g mass were suspended from it?
5. Suppose a 5-cm length of type A is joined *side-by-side* with a 5-cm length of type B. How many cm would this combination stretch out to if a 60 g mass were suspended from it?