

Spool Tractor Challenge

Goal: Release a spool tractor that will accelerate on its own and cross between two designated points, one foot apart, at a velocity greater than 3m/s and as close as possible (no more than 0.45m/s away) to a velocity that you predict before the trial.

Prize: Fruit snacks, glory, and 1% added to your first test grade

Group size: 2 (if we have an odd number of students, we can have one group of 3)

Details:

- The “designated points” will be the edges of floor tiles. The building floor tiles are 1 foot across, so the distance between floor tile edges will be 0.305m. You can choose the location, but try to choose a location that is well lit.
- You may choose the specific floor tiles used for measuring, but they must be in a well-lit location near the classroom (same floor, not beyond the south wall of the chemistry rooms).
- Your tractor’s velocity between these floor tiles will be calculated by measuring the time interval between the front of the wire reaching one tile and the front of the wire reaching the next tile.
- You may release your tractor from any point.
- You will get two official tries (Mr. Stapleton will video twice), but they must take place within 2 minutes of one another, and only one counts. You get to choose which one counts, but if you do not notify Mr. Stapleton before he scores your tractor, the first run will count.
- Contest scoring will be based on percent error, calculated as your error in m/s divided by the actual velocity of your spool tractor. The lowest error wins. In the event that two groups’ errors are too close to call, the spool tractor with a velocity closest to 4m/s will be declared the winner.
- Grading: 15% error or less = 100%; 15-20% error = 90%; 20-25% error = 80%... (minus 10% for every additional 5% error).
- If you don’t like your grade, you can try again during Flex.

Suggested Steps:

1. Assemble a spool tractor and try it out.
2. Using a phone with slow motion capabilities. Find a free app that will allow you to advance video frame-by-frame. For iPhones, the free version of [coach my video](#) works well. *[Be aware that CMV occasionally does not advance the frame on a click. Don’t count those clicks.]*
3. Determine your camera frame rate. Hopefully it is at least 240fps. If it’s not, talk to Mr. Stapleton.
4. Video your tractor and determine its velocity at various points in its journey.
5. Develop a protocol for deciding where to release the tractor so that it will reach the right velocity at the right time – or for determining the location where your car will reach the right velocity, given its starting point.
6. You will be sharing parts with the other class. After the first day of testing, you will need to disassemble your spool tractors, and then you will need to reassemble them and recalibrate on the contest day. Some of the cardboard and wire parts are labeled with numbers. If you want to find the same, exact parts again, you could write down their numbers (or, in the case of the wheels, measure them). You might want to keep your own rubber bands for powering the “motor.”