

### ***Preparing for Activities 11 - 13***

The next few Activities will involve a Track and Collision Cart. The Track should be leveled, but you should check to make sure.

1. Push the Cart and let it run up and down the Track a few times to warm up the bearings in its wheels.
2. Place the Cart near one end of the Track and give it a very gentle push. It should drift a few centimeters and stop. Give the Cart a very gentle push in the opposite direction: it should drift a few centimeters and stop. If the Cart has a tendency to stop and reverse its direction then the Track needs leveling. The Track may not be perfectly straight, so checking it at both ends can be worthwhile.

The feet under the Track are adjustable by loosening the lock nut and rotating the feet. Be sure to tighten the lock nut when you have the Track level. The Instructors have a level, which may help. The level will be required if you suspect that the Track is not level along the axis perpendicular to its length.

Please do not adjust the positions where the feet are mounted on the Track.

Note that although the Carts have low friction, the fact that they do slow down and stop means the friction is not zero.

At this time, you will find it convenient to measure and record the distance between the feet. The mounts for the feet provide a convenient way to do this. Estimate the position of one of the mounts with the scale mounted on the Track and the corresponding position of the other mount.

You will notice that there is a Cart Launcher mounted on one end of the Track. When the Launcher is used the Track tends to recoil. Thus the bracket for the feet closest to the Launcher is braced with double-rod assembly connected fixed to the tabletop with two table clamps.

You are provided with a set of blocks which will be placed under the feet tilt the Track. There are blocks that are 1.000 cm, 0.500 cm, and 0.100 cm thick. In addition, for one of the Activities you will need finer adjustments than these blocks provide. It turns out that good quality playing cards are carefully controlled in all their dimensions, and are typically 0.029 cm thick. You are provided a deck of playing cards with the card thickness written on the box.

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**Course Concepts Activity 11**

A Cart Launcher is mounted on one end of the Track. Raise the other end of the Track by raising the feet 3.000 cm. The Launcher may be cocked by pulling back the horizontal rod until the disc mounted on it latches to the “finger” on the base. Cock the Launcher and place the Cart against it. Fire the launcher.

You want the Cart to travel almost but not quite all the way up the Track. You want the highest position to be at least a few cm away from the magnetic bumper mounted on the far end of the Track, so the cart does not interact with the bumper. You may need to adjust the Launcher to achieve this. There is a disc mounted on the rod that pushes the Cart whose position can be adjusted to get the desired force.

- A. Sketch a multiple-flash photographic sequence (taken at approximately equal time intervals) of the movement of the Cart up the Track from a moment after it leaves the launcher until it comes to rest. It should have some resemblance to one of the multiple-flash photographic sequences in Mazur’s Ch.2 problems, for example, Figure P2.27 on page 28.
- B. Roughly, what is the time between each successive dot of Part A?

Remember that best laboratory practice is to record *everything*. The Launcher includes a scale that reads how far the spring has been compressed when it is cocked. You should record this value.


**Expt Activity 12**

This Activity uses the same setup as Activity 11.

Note and record the position of the Cart as measured by the scale on the Track when it is resting against the Launcher when it is not cocked.

- A. Launch the Cart and note the position on the scale of the Track where the Cart is at its maximum distance. Repeat a few times, recording each position. Are the values exactly the same for each launch?
- B. What are all the reasons you can think of to explain why the positions are not exactly repeatable? The manufacturer of the Launcher says it will launch the cart “with the same force each time.” Is this statement correct?
- C. How can you quantitatively characterize the spread in values of the positions that you measured?

- D. Is it possible to have an apparatus similar to this one for which the positions would be exactly the same each time?
- E. What is the mean, i.e. average, value of the positions you measured? What is the mean value of the total distance the Cart travels up the Track between launch and momentarily coming to rest at the top of the Track?

 **Course Concepts** *Activity 13*

Now raise the feet on the end of the Track opposite the Launcher by 3.500 cm. Measure the distance the Cart travels up the Track. Although you may do a careful measurement like you did in Activity 12, just estimating the position of the Cart at its greatest distance to the nearest centimeter will be sufficient. Remember to keep the end of the Track with the Launcher against the U-shaped rod to minimize rebound.

- A. The total distance the Cart travels is less than in Activity 11. So the angle of the Track and the distance the Cart travels are both different. What about the vertical height that the Cart traveled as it climbed the slope? Was it the same as it was in Activity 11? Based on what you might know about gravitational potential energy, should it have been?
- B. It is unlikely that your answer to Part A came out numerically perfect. What are all the reasons you can think of to account for the small variation from perfection?

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Last revision by Jason Harlow: Sep. 15, 2014.