

## Graph Matching Activity—Teacher’s Notes

In preparation for your participation in Physics Day at Six Flags, you may find it helpful to orient students to the rides and type of data they will be analyzing. On the website you will find a set of QuickTime videos for the following rides: Batman, Highland Fling, The Joker, Mr. Freeze, Riverview Racer, and Rush Street Flyer. These video clips can be played on virtually any computer with Apple’s free Quicktime Player. Quicktime Player can be downloaded from <http://www.apple.com/quicktime>.

This activity is designed to give students practice correlating the motion of the rider of a given ride with various graphs associated with that motion. Each group of students will be assigned one of the six videos to analyze. They will be asked to determine which of the six graph sets matches the video to which they were assigned. Students will be given the numbered graph sets, SetofNumberedGraphs.pdf, from which to make their matches. The answer key to the activity is provided at the bottom of this document.

Each page of the “graphs” documents shows three or four graphs of data collected from the respective rides. There are either two or three graphs of data collected using a three-axis accelerometer, and one graph of data collected using a barometer. The “accelerometer” readings are scaled to show the Force Factor. Force Factor vs. time graphs show the ratio of the normal force in the direction of measurement to the magnitude of the gravitational force. That ratio, the Force Factor, is really a multiplier that can be used to find the normal force on an object. See the Measurement document on the website for a detailed explanation of Force Factor. Because these sensors are fixed in orientation relative to the rider, the coordinate axes for measurement are named head-to-toe, front-to-back, and side-to-side relative to the rider. Coordinate axis names like “vertical” are clearly problematic when analyzing data taken while looping and spinning on rides.

The last graph on each page is labeled “inverted pressure” vs. time. These data were collected using a barometer probe. Since atmospheric pressure varies with altitude, changes in the vertical position of the rider can be sensed with a sensitive barometer. However, the pressure decreases as the altitude increases. For this reason, the barometer reading was multiplied by  $-1$  to effectively invert the data on the graph so that higher pressure readings would be lower on the graph and vice-versa. The graph can be effectively interpreted as an elevation vs. time graph. This graph is an important companion to the accelerometer graphs,

In one version of this activity, you will have one or more of the Quicktime video clips loaded on a separate computer for each group of students. You can assign a particular video clip to each group with the task to match the ride to the set of graphs that shows data from the ride.

Have available for each group, a printed copy of all six graphs that are numbered Graph 1 through Graph 6. As each group watches its assigned video, students should be looking for features of the graphs that match the motion observed in the video. When a group has determined which graph set matches their particular ride, the members of that group should prepare a presentation for the class in which they justify their choice. This presentation could be done with a projector, or on whiteboards. Suggest to students that it might be helpful in providing evidence for their match, to include force diagrams (free-body diagrams) for critical points on the graph. Students should be encouraged to correlate the motion or position they observe on the video with the features on the graphs that are consistent with the particular motion or position. Note that the pressure vs. time graphs have the same time scale as the Force Factor graphs. This is extremely helpful in determining whether hunches about what is being shown on the Force Factor graphs are correct since the pressure graph helps students locate the specific position on the ride at a particular time.

If a video data projector is available, it is very nice to allow students to show the video clip along with their presentation. This allows them to more clearly show the whole class how they decided which graph corresponds to their particular ride.

This activity is very helpful in preparing students to know how to analyze the graphs they will encounter when they attend Physics Day at Six Flags. It also provides an excellent review of much of the mechanics that students have studied in their introductory physics class.

Answer Key:

Graph 1: Batman

Graph 2: Mr. Freeze

Graph 3: Highland Fling

Graph 4: Riverview Racer

Graph 5: Rush Street Flyer