



Amusement Park Physics **MATCH GAME** Match Acceleration Traces to Cedar Point Rides

– Rides at an amusement park may be differentiated by the pattern of accelerations to which a rider is subjected. This acceleration experience, coupled with height, speed, and the unknown, is unique to each ride.

– Use your knowledge of accelerations and your familiarity with the rides to match the accelerations experienced on a ride with its name. The “feel” of each ride is different, but the acceleration pattern may look similar. **Think carefully and choose wisely!**

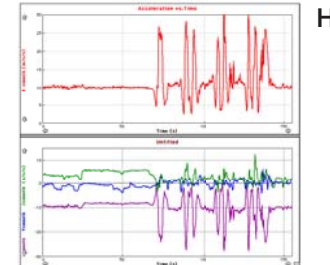
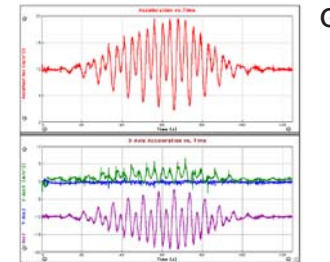
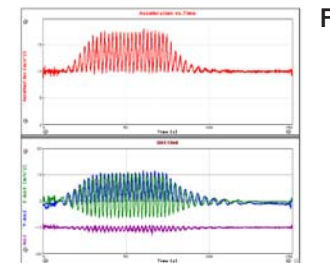
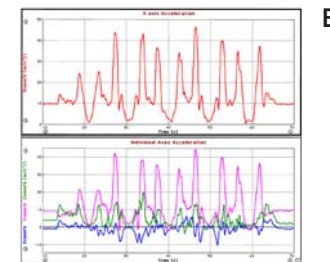
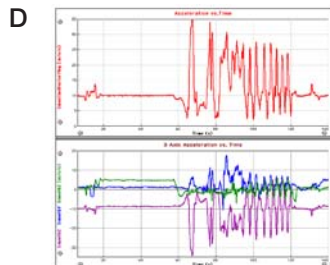
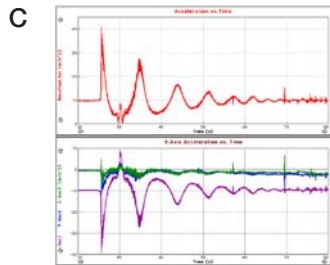
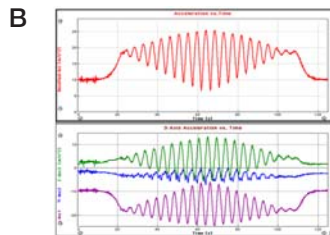
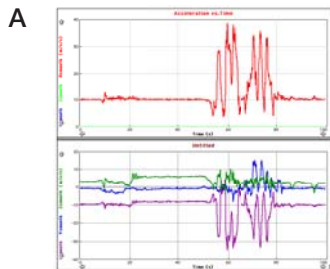
– **Linear acceleration** is a straight-line acceleration quite often experienced when a ride begins and ends. This may also be felt when a brake is applied during the course of a ride, such as on a roller coaster, to control the maximum speed.

– **Centripetal acceleration** is due to circular motion and quite often causes a rider to experience a force from the outer side of the car. This is found on circular rides, but also can be found on roller coasters going around a curve or a turnaround.

– Earth’s gravitational acceleration (1 g) is 9.8 m/s². The accelerations in these data plots were measured with an accelerometer (and thus reference frame) attached to the rider’s body.

- The **X-axis** is along the rider’s spine with positive being downward.
- The **Y-axis** is along the rider’s left arm with positive being outward.
- The **Z-axis** completes a right-handed coordinate system and is perpendicular to the rider’s chest with positive being forward.

– The **resultant acceleration** is the vector (root-sum-square) of the three individual axes.



1—GEMINI

The Gemini is a wooden roller coaster with two trains that “race” each other during the ride. Like most roller coasters, Gemini starts with a lift hill followed by a series of down and up hills interspersed with level turn-around sections. At the end of the ride each train enters a tight, 360-degree spiral before re-entering the station.

2—CORKSCREW

The Corkscrew roller coaster experiences three inversions with the first being a vertical loop while the later two are in the shape of barrel rolls. The train first leaves the station and reverses direction around a curve before entering the lift hill. After the lift hill is a short, fast, up and down hill before entering the vertical loop. Following the loop are the two barrel rolls to end the ride.

3—MAGNUM XL-200

The Magnum roller coaster is an out-and-back track design with a banked, dog-bone turnaround. It has very tall first and second hills, plus numerous shorter hills.

4—POWER TOWER

The Power Tower is another free-fall ride with four independent carriages. Each carriage has 12 seats facing outward from the support tower. Two of the four carriages (UP) blast the riders upward with a momentary thrust. After the thrust, the carriage is released for a moderate free fall. As the carriage descends, it bounces several times against compressed air pistons. The other two carriages (DOWN) are slowly raised to the top of the tower, pause at the top for a few seconds, and then are released in a fast free fall. The carriage also bounces several times against compressed air pistons after its release.

On which type of carriage was the rider sitting to reflect the data shown here?

5—WICKED TWISTER

The Wicked Twister is a back and forth linear roller coaster with two vertical ends and a track that twists 450°. Riders start in the station in the middle of the track and are suddenly accelerated forward and then up the front vertical hill. After coasting to a stop, the coaster falls backward down the front hill, accelerates again through the station, and finally rises backwards up the back vertical hill. After completing five trips up the hills, the coaster is brought to a stop in the station.

6—SCRAMBLER

This ride has three sets of four cars arranged in a circular fashion. Each set of cars rotate together around a vertical axis. Each axis (along with the axes of the other sets of cars) is rotated around a central vertical axis. When the ride is at operational speed, an individual car performs a cycloid-type motion. The Calypso is similar to the Scrambler, but the axes of rotation are tilted with respect to gravity.

7—WITCHES’ WHEEL

The Witches’ Wheel is a circular ride with a central vertical axis. The cars are suspended below a horizontal axis, which allows each car to swing from side to side. When the ride is moving at a high rate of speed, the cars swing outward due to centripetal acceleration. The central axis of rotation is then tilted until it is nearly horizontal. Centripetal force is strong enough to keep the cars outward from their rotational axis, which periodically positions each car (and its riders) upside down.

8—OCEAN MOTION

The Ocean Motion is a pendulum-type ride fashioned as a large boat holding about 50 riders suspended below a horizontal axis. Motors push the boat back and forth until it is swinging about 90 degrees end to end.

For the data shown here, where was the rider sitting in the boat?