# Fun With Physics At Quassy Amusement & Waterpark

Presented by Quassy Amusement & Waterpark in cooperation with the American Association of Physics Teachers

Quassy Amusement Park, Route 64, Middlebury CT 06762
www.quassy.com 203-758-2913

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# Introduction

Physics Day at an amusement park such as Quassy Amusement Park is an appropriate end of the year activity for both elementary and middle school students. The physics of the rides is the basic material of a first-year physics course. Roller coasters demonstrate the conversion of gravitational potential into kinetic energy; rotating swing rides illustrate the vector addition of forces. Rotating rides of all sorts allow for computation of centripetal accelerations and all of those terrifying falls allow students to experience free fall and near weightless conditions. Students who think about and experience physics in the park develop a deeper understanding of the principles taught in the classroom. By becoming part of the laboratory equipment, the students experience the excitement of understanding and learning along with the enjoyment of the rides. In addition, a visit to an amusement park might serve as a stimulus for younger middle school students to continue their study of science, especially physics, in high school.

The contents of this booklet relating to the many exercises and experiments for middle school students have been taken from a number of sources, including the book *Amusement Park Physics*. Carole Escobar edited this book with contributions from many teachers. The book is available from the American Association of Physics Teachers and includes many other useful resource materials and references. Other materials are used with the permission of Clarence Bakken from the Gunn High School in Palo Alto, California. Finally, some of the ride activities are from written by David Myers and Tom Wysocki of Eleanor Roosevelt High School in Greenbelt, Maryland.

Quassy Amusement Park, with the assistance of Project Explore Students from Rochambeau Middle School, Southbury, Conn., designed a number of experiments related to the rides in the park.

This booklet, along with the references provided, is intended to present the basic information needed to both plan a trip to a park and to use the physics of amusement park rides in the classroom. Some of the materials are to be used by the teacher; other sections can be copied and used by the students.

Warren W. Hein
American Association of Physics Teachers
whein@aapt.org

# Learning Goals and Objectives

## Cognitive Goal

Upon the completion of the activities, the student will have an enhanced understanding of the following laws and concepts of physics:

1. Forces
2. Work
3. Power
4. Friction
5. Kinematics
6. Newton's laws of motion
7. Rotational motion
8. Conservation of energy
9. Conservation of momentum

The student will:

1. Determine the forces acting on a passenger in circular motion rides and roller coasters.
2. Determine the changes in forces as the student moves in a vertical circle on a roller coaster.
3. Calculate the work done against friction on roller coasters.
4. Estimate the power required to haul a roller coaster train and its passengers up the first hill.
5. Apply the method of triangulation to determine the heights of and distances to various structures.
6. Measure the linear displacement of a chair on the rotating swing ride as it moves through a complete revolution.
7. Calculate the centripetal acceleration of a passenger in circular motion by the use of an accelerometer.
8. Apply Newton's laws of motion.
9. Apply the rules of kinematics and principles of conservation of energy to determine the velocity and acceleration of an object after falling a given vertical distance.
10. Calculate the momenta of objects and quantitatively determine conservation of momentum.
11. Measure and record the student's personal responses to experiences during various rides.

## Attitude Goal

Upon completion of the activities, the student will develop a positive attitude toward the physical sciences.

The student will:

1. Be motivated to study physics by being challenged with significant tasks that allow the student to comprehend personal experiences.
2. Gain an appreciation of the physics involved in the design and engineering of the rides.
3. Gain an appreciation for the safety devices built into the rides and controls.

## Appreciation Goal

Upon completion of the activities, the student will bridge the gap between school, work, and life education by seeing them as interactive rather than isolated from one another.

The student will:

1. Gain an appreciation of the applicability of physical principles studied in the classroom to large-scale phenomena.
2. Gain an appreciation of the value of working in teams to accomplish measuring and calculating tasks.

# Pre-Trip Class Activities

1. Review kinematics and dynamics. It is helpful to present the students with workbook pages for preview in class. You can give students typical data and have them perform the calculations.
2. To demonstrate a ride, set up a model of a rotating swing ride or a Hot Wheels track with a vertical loop. Students can take measurements of the angle of the swing chains as a function of the speed of rotation, or of the mass of the passengers. They can practice measuring the time needed for a car to pass through a point on the track by taping two cars together to make a measurable train. Ask from what minimum height the car must fall in order to stay on the track of the vertical loop. This experiment is good for both demonstration and laboratory purposes. It leads naturally to the role of friction in consuming energy that would otherwise be available for increased speed. Students are prepared for the fact that their calculation, using ideal conditions, will differ from the actual velocities that they will measure in the park.
3. Construct accelerometers. If you cut the plastic tubing ahead of time, both horizontal and vertical devices in the PASCO scientific kit can be constructed easily in a single class period. Calibrating the horizontal device takes some explanation and is a good homework assignment. Accelerometer kits come in class sets of 15 (15 vertical and 15 horizontal devices). Order using catalog no. ME9426, from PASCO scientific, 10101 Foothills Blvd., Roseville, CA 95678, 1-800-772-8700 E-mail: sales@pasco.com Web site: http://www.pasco.com/
4. Run one of the triangulation activities as a laboratory exercise. The flagpole in front of the school is a favorite object for measuring heights. Remember that the equations assume that the pole is perpendicular to the baseline. If your pole is on a mound, the activity will not give accurate results.
5. Practice measuring by pacing. Triangulating a horizontal distance can lead into a discussion of how we know the distances to stars and across unbridged rivers.
6. Show a video, Web site, or slides of actual rides to give students some concept of the size and speed of certain rides. Slides can be used to practice estimating heights and angles of elevation of devices such as roller coasters. Call Quassy for photos that can be e-mailed prior to your visit.
7. Emphasize that students do not have to take the rides. Only the accelerometer readings are taken on the rides. All other measurements are taken by an observer on the ground.
8. Post a map of Quassy Amusement Park. Encourage students to ride the most popular attractions.
9. Set up laboratory groups for the park. Students should stay in groups for educational and safety reasons. Announce requirements and options, when the work is due, and how it will be graded.
10. Preview the workbooks in class and then collect them for distribution on the bus.

## *Tips to the Teacher*

1. Equipment needed in the park:
   a) Stopwatch (at least one per group)
   b) Accelerometers (doubling as clinometers for angles of elevation)
   c) Measuring string or knowledge of their pace
   d) Calculator, pen, pencil
   e) Soft item tied to a string (18-24 inches in length) to use as a pendulum
   f) Extra clothes, if participating on water rides

2. Hand out advance-sale ride tickets, if provided, as they exit the bus. This speeds entry into the park.

3. Remind students to double-check the restraints on each ride. Be sure that they understand that safety is not a joke.

4. Announce the lateness penalty for either boarding the bus at school or leaving the park.

5. If the student workbooks are due as the bus arrives back at school, you will get them on time but they will be more ragged than if they are due the next day. Have each team leave one copy of the workbook on the bus. That's the one that will be submitted for grading.

6. An interesting option is to allow students to design activities for rides that are not covered in the workbook.

7. If you do not have students check in with you during the day, make a habit of being visible, and check

8. Be sure you have a minimum of two adults on each bus in case you need someone to stay with an ill student.

9. Be sure to explain to students that stopwatches should be used for timing rides while **watching** and not **riding.**

# Safety Precautions At Quassy

1. Form laboratory groups of four to six students.

2. Shoes or sneakers **are a must**. Sandals, loose footwear, loose jackets, and long hair are dangerous on some rides. Remind your students that they must observe any posted regulations, including height requirements at each ride.

3. Evaluate your measuring devices for safety before you leave school. Avoid anything with sharp ends. Devices must be lightweight and capable of being tethered to the wrist to avoid loss during a ride. Tethered devices are not allowed on round rides (i.e. Paratrooper, Reverse Time, Yo-Yo).

4. Remind students to check that seatbelts and harnesses are secured. The rides are designed to be safe. Students should double-check for themselves.

5. The sun can be a problem. Sun block and sun visors are a must on what may be their first full day in the sun this year.

6. Remember -*No one is forced to ride.* Measurements can be taken from the ground and accelerometer readings can be shared.

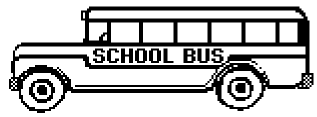
7. Remind students to follow all safety guidelines listed at Quassy and at each ride site.

# MIDDLE/HIGH SCHOOL

While many of the following pages are geared toward students in middle school grades, teachers may find some experiments and observations appropriate for elementary grade levels. Review and print the pages accordingly and your students will engage in some fun and educational amusement park physics during their visit to Quassy.

# CONSCIOUS COMMUTING

As you ride to Quassy Amusement Park, be conscious of some of the PHYSICS on the way.




## A. Starting Up

### THINGS TO MEASURE:

As you pull away from the school or from a stop light, find the time it takes to go <u>from stopped to 20 miles per hour</u>. You may have to get someone up front to help on this.

**t** = ______________ sec

THINGS TO CALCULATE: Show Equations used and your substitutions.

1. Convert 20 mph to m/s. (1.0 mph = 0.44 m/s)

   **v** = ______________

2. Find the acceleration of the bus in $m/s^2$.

   **a** = ______________

3. Using your mass in kilograms, calculate the average force on you as the bus starts up. (1 kg of mass weighs 2.2 lbs)

   **F** = ______________

4. How does this compare to the force gravity exerts on you (your weight in newtons)?

   Circle One: More Less

   (Force calculated)/(Force gravity normally exerts) = _______ g's

THINGS TO NOTICE AS YOU RIDE:

5. As you start up, which way do you FEEL thrown, forward or backward?

6. If someone were watching from the side of the road, what would that person see happening to you in relation to the bus? What would that person see happening to you in relation to the ground underneath you?

7. How can you explain the difference between what **you feel** as the bus starts up and what **the observer** sees? (You may want to use the concept of FRAME OF REFERENCE.)

## B. Going at a Constant Speed

### THINGS TO NOTICE

8. Describe the sensation of going at a constant speed. Do you feel as if you are moving? Why or why not? (Try to ignore the effects of road noise.)

9. Are there any forces acting on you in the direction you are moving? Explain what is happening in terms of the principle of inertia.

## C. Rounding Curves

### THINGS TO NOTICE:

10. If your eyes are closed, how can you tell when the bus is going around a curve? Try it and report what you notice. (Do NOT fall asleep!)

11. As the bus rounds a curve, concentrate on a tree or a building that would have been STRAIGHT AHEAD. See if you can sense that you are TRYING TO GO STRAIGHT but are being pulled into the curve by a centripetal force.

What is supplying the centripetal force, the seat, your seatmate, the wall, the arm of the seat, or a combination?

How does this change when the curve is tighter or the bus is going faster?

Write a few sentences about this experience. How does it connect with what happens on the rides at the amusement park?

# THE SOUND OF MUSIC

## OVERVIEW

Music is used extensively throughout Quassy Amusement Park to enhance the customer's experience and create special moods. Music is a mood-inducer and affects how we interact with our environment. Listen to the beat and notice how it affects you as you move through Quassy Amusement Park!

## GOALS

Listening
Analysis of Forms
Music
Writing
Aesthetic

## MATERIALS

Paper and Pencil
Tape Recorder

## DIRECTIONS/ACTIVITY

1. Select an area in Quassy Amusement Park.
2. Listen to the music.
3. Describe the tempo (fast, upbeat, slow, romantic etc.)
4. Close your eyes. Try to develop a mental image created by the music. What emotions do you feel?
5. What mood does the music try to create?
6. How does Quassy Amusement Park use music to enhance this area?

## EXTENSIONS/ENRICHMENT

1. Identify the song title and performer. Why was this selection chosen for this area? Would you recommend another selection? Defend your choice.
2. How would different types of music influence different groups of people? Would you use heavy metal music in an area developed for small children?
3. Research the use of music in different environments (hospitals, groceries etc.).
4. Tape record the music in one area. Take the tape to another area. Play the music. How is the mood affected by different music?

# SPINNING WHEELS

## OVERVIEW

Some of the rides at Quassy Amusement Park have one or more circular routes. The diameter of the circle, the number of circles, and the speed of the ride all contribute to unique ride experiences. The force exerted by the seat, the gravitational force, and inertia combine to keep you in your seat. Inertia is a physical property that keeps moving things moving or keeps motionless things still, unless an outside force acts on them. Centripetal force provided by the seat causes an object to turn in a circular path.

## GOALS

Observing
Classifying
Patterns
Mathematical Structure

## MATERIALS

Paper
Pencil

## DIRECTIONS/ACTIVITY

1. Select three rides that travel in a circle.
2. Compare and contrast the rides by filling in the data table. Fill in the names of three rides.
3. Count how many circles are involved in the ride.
4. Identify where centripetal force (if any) is used and how.
5. Using the numbers 1 through 3 and with the number 1 being the fastest circle, rate the three rides from fastest to slowest.
6. Diagram the path you take as you ride the ride.
7. Does the location where you sit in the rides have an effect on your ride? Explain for each ride.
8. Which ride would you least like to ride in a car with a 350-pound gorilla?

## EXTENSIONS/ENRICHMENT

1. Select another geometric shape and define. Try to find examples of these definitions.
2. How could the rides be applied to everyday uses? Does the idea of a Ferris wheel relate to anything you know? Find other rides that correspond to something in your daily life.
3. Calculate the actual speed of each circular ride.

# SPINNING WHEELS WORKSHEET

| DATA TABLE | | | |
|---|---|---|---|
| Ride | | | |
| Number of Circles | | | |
| Use of Centripetal Force | | | |
| Rank the Speed 1-3 | | | |
| Actual Speed of Each Ride | | | |

# PACING THE PATH

## OVERVIEW

One definition of a circle is a cycle, a period, or a complete or recurring series usually ending as it begins. The paths throughout Quassy Amusement Park all circle back to the main entrance to the park at the Ticket Booth. You can estimate the length of the paths by using your pace.

## GOALS

Computing
Patterns
Problem-Solving

## MATERIALS

Meter Stick, Chalk to Mark on Pavement, Paper, Pencil, Map of Quassy Amusement Park

## DIRECTIONS/ACTIVITY

Find your pace

1. Mark a starting point.
2. Measure 10 meters.
3. Mark an ending point.
4. Using a natural stride, pace off the 10 meters three times. Total the number of steps.
5. Find the average number of steps in 10 meters for the three trials (Average = total number of steps divided by 3). This is your "pace."
6. Use your "pace" to measure distances and complete the following formula:

   $$\text{Distance in meters} = \frac{\text{(number of steps) X 10 m}}{\text{your "pace"}}$$

7. Start at the entrance to Quassy Amusement Park – the ticket booth.
8. As you enter, go straight down into the park past the restaurant.
9. Keep count of your normal paced steps.
10. Figure the distance in meters to the Quassy Restaurant.
11. This is an estimated figure. How can you check your answer?
12. Retrace your steps and figure again.
13. Keep a log for the day of how far you travel while visiting Quassy Amusement Park.

## EXTENSIONS/ENRICHMENT

1. Using the map of Quassy Amusement Park, find a "circle" to measure.
2. Have another student measure the same circle. How do the two measurements compare? Take an average of the two measurements. Is this a better estimate? Explain.
3. How could you get an exact measurement of the circle? Try it if you have the material.

# BUMPER CARS AND THRILL RIDES

## OVERVIEW

There seem to be different patterns of facial expressions of riders as they ride the bumper cars and as they ride the thrill rides.

## GOALS

Observation
Production
Creative Thinking

## MATERIALS

Notebook Paper
9” x 12” Manila Paper
Pencil

## DIRECTIONS/ACTIVITY

1. Observe the faces of riders as they ride one of the coaster rides and as they ride the bumper cars at Quassy. List different emotions or feelings that you see on their faces. What indicators did you use to come to that conclusion?
2. Make two sketches. Each sketch should be a close-up look at a rider’s face as this person rides a coaster ride and then as they ride the bumper cars.
3. Write a paragraph on the back of each drawing describing how you think the person was feeling as he or she rode the ride.

## EXTENSIONS/ENRICHMENT

Back in the classroom, have students focus on one of the drawings and make a mask that captures the emotion of riding the ride.

# 'Wooden Warrior' Roller Coaster

## OVERVIEW

Climbing, climbing, climbing. It can seem to take forever to get to the top of a tall amusement park ride. Then, just as you reach the top and begin to settle back, the rush of wind intensifies to a crushing force. Just how fast are you going anyway?

## GOALS

Observing
Mathematical Reasoning
Mathematical Procedures
Data
Expanding Existing Knowledge
Measuring
Writing
Measurement
Independent Learning

## MATERIALS

Stopwatch or Watch with a Second Hand
Chart of Distances

## DIRECTIONS/ACTIVITY

You can do this from a distance. The length of the coaster car can be obtained from the data table and by timing how long it takes the train to pass a certain point; you can find its average speed.

1. Don't blink you might miss it.
2. Find the points on the ride where each timing will begin.
3. As the train reaches the start, begin timing the ride.
4. When the end of the car passes that point, stop the watch.
5. Record your time on the data table.
6. Repeat the timing to ensure its accuracy (take an average of your times).
7. Record your data on the data table.
8. Before riding, observe the speed of the ride from the ground. Describe your thoughts.
9. As you ride the ride, describe the effect its speed has on you.
10. Explain the effects "velocity" has on the degree of thrill or entertainment provided by the ride.

## EXTENSIONS/ENRICHMENT

1. Find the number of feet in a mile and seconds in an hour. Now, determine the speed of the ride in miles per hour.
2. Determine the velocity of the ride at other points in its travel.

Discuss the reasons people might give for liking "fast rides." Poll 25 people before they ride. Poll another 25 people who have already ridden.

# DATA TABLE

Speed = (length of car or train) / (time for car or train to pass a point on the track)

Name of Ride (you select)____________________________________________

Steepest Climb:

Length of car or train (given)________________________________________

Time for car or train to pass a point on track (seconds)_____________________

Speed (m/s)___________________________________________________

Steepest Drop:

Length of car or train (given)_________________________________________

Time for car or train to pass a point on track (seconds)_____________________

Speed (m/s)___________________________________________________

Total Ride:

Length of entire ride (given)____________________________________

Total time for ride (seconds)____________________________________

Average speed (m/s)__________________________________________

Note: Track length of Wooden Warrior is 1,250 feet; Little Dipper is 280 feet.

# ROUND IN CIRCLES

## OVERVIEW

Sometimes you just go and go, yet never seem to get anywhere. You're just running in circles. So, how far did you really go to get nowhere?

## GOALS

Observing Computing Creative Thinking
Mathematical Reasoning Number Problem Solving
Data Resourcefulness and Creativity
Expanding Existing Knowledge

## MATERIALS

Watch with Second Hand or Stopwatch (for extension only)

## DIRECTIONS/ACTIVITY

1. As the ride begins to move (you can do this as you ride or while watching the ride from the side), count the number of times you go around before the ride stops.
2. Record this number on the data table.
3. Repeat your count several times to ensure its accuracy. You may want to take an average of your counts.
4. Which ride took you the greatest distance?
5. Explain what it means if a person says, "You get your money's worth out of these rides."

## EXTENSIONS/ENRICHMENT

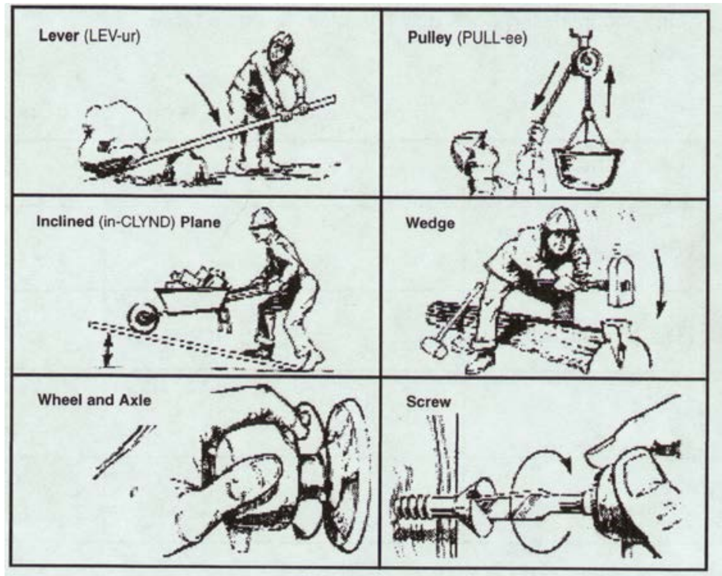
1. By timing each of the rides you can also determine its speed. How long did the average ride last? Which of the rides was the fastest? Do you prefer a long ride or a fast ride? Explain.
2. The horses on the carousel are always jumping. How many jumps do they make during one full revolution of the carousel? How far can they jump? If the ride continued non-stop for an hour, how far would they run and how many times would they jump?
3. Discuss the reasons people might give for liking "go-nowhere" rides. Poll 25 people before they ride. Poll another 25 people who have already ridden. Graph the results of your poll. What can you infer about this type of ride.

DATA TABLE

(Use pi=3.14)

| Ride | Radius (m) | Circumference C=2(pi)(radius) | Number of Revolutions (N) | Distance Traveled |
|---|---|---|---|---|
| Carousel | 7.62 (m)<br>25 (ft) | | | |
| Paratrooper | 5.7912 (m)<br>19 (ft) | | | |
| Reverse Time | 3.9624 (m)<br>13 (ft) | | | |
| Yo-Yo | 11.1252 (m) full Swing (73 feet) | | | |
| Tilt-A-Whirl | 5.791 (m)<br>19 (ft) | | | |

# CREATING FUN THROUGH WORK




## OVERVIEW

A simple machine is a device that changes a force or direction of a force. Simple machines allow us to work easier or faster. ***Here are the six kinds of simple machines.*** Complex machines are a combination of two or more simple machines. All of the rides at Quassy Amusement Park are made of simple and complex machines.

## GOALS

Observing
Identifying and Analyzing Systems
Collecting Data
Drawing Conclusions

## MATERIALS

Copy of the Data Table
Pencil

## DIRECTIONS/ACTIVITY

1. Look at the examples of simple machines. Identify how we use these machines in everyday life.
2. What combinations of simple machines can you name? Make a list. Identify the simple machines that combine to make the complex machine. What work do they make easier or faster?
3. Observe the amusement park rides on the data table. Fill in the information.

# CREATING FUN THROUGH WORK DATA SHEET

Find the following rides and complete the data table.

| Ride | Simple Machines Used | Complex Machines Used |
|---|---|---|
| Reverse Time | | |
| Free Fall 'N | | |
| Tea Cups | | |
| Little Dipper | | |
| Music Fest | | |
| Paratrooper | | |

DIRECTIONS/ACTIVITY

After completing the data table, select one of the rides you observed and answer the following questions.

1. How does the machine add to the sensation of the ride?
2. How does the machine make work easier on the ride?
3. Would the ride be possible without the machines working? Explain.
4. What other forces are at work on the ride?

EXTENSIONS/ENRICHMENT

Using one or more simple machines, design an amusement park ride. Draw the ride, label the simple machines, and describe how the machines operate together to create a ride. Is your ride designed for thrill or pleasure? Explain.

# UP, UP, UP THEN DOWN!

## OVERVIEW

As you slowly ascend toward the sky on the Free Fall 'N tower, prepare yourself for a plunge into the nether world.

## GOALS

Observing
Measuring
Collecting Data
Applying Data
Identifying Variables

## MATERIALS

Stopwatch
Paper
Pencil

## DIRECTIONS/ACTIVITY

1. Select a spot near the Free Fall 'N tower to observe one of the sets of seats. Make sure you have a clear view.
2. Using a stopwatch, time the interval from release of the car at the top to the braking (slowing down) near the bottom.
3. Time the car at least 3 times.
4. Create a data table to display your observations.
5. Did you get the same results for each car?
6. What variables contribute to the difference in times?
7. If you observed another car, would your results be the same?
8. How could you get the same results each time?

## EXTENSIONS/ENRICHMENT

Ride the Free Fall 'N tower (or interview someone who has). Compare the sensation of a free-fall ride to another type of ride (like a roller coaster or a spinning ride). What creates the different sensations?


# The Big Flush Raft Ride

## OVERVIEW

A two-person raft is lifted up a hill and then descends down a flume through a number of twists before splashing as the end of the shoot.

## GOALS

Observing
Measuring
Collecting Data
Applying Data
Identifying Variables

## MATERIALS

Stopwatch
Paper
Pencil

## DIRECTIONS/ACTIVITY

1. Select a spot near the Big Flush to observe one of the rafts. Make sure you have a clear view.
2. Using a stopwatch, determine the time it takes the raft to leave the launching pad at top of the flume until it stop at the bottom of the flume.
3. Time at least 3 different rafts.
4. Create a data table to display your observations.
5. Did you get the same results for each raft?
6. What variables contribute to the difference in times?
7. Could you get the same results each time? How?

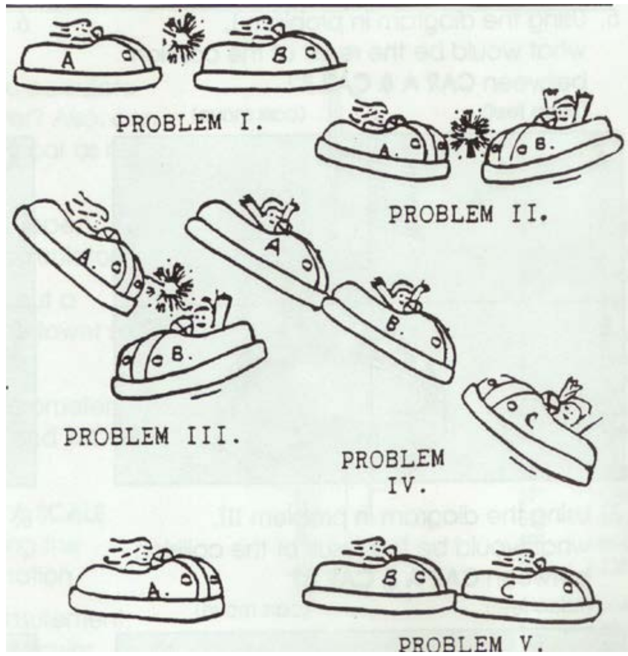
## EXTENSIONS/ENRICHMENT

1. Why is there water on the slide and not just at the bottom?
2. At what point on this ride is the speed the greatest?

# Quassy Bumper Cars

**OVERVIEW**

In a collision between two or more cars, the force that each car exerts on the other is equal in magnitude and opposite in direction according to Newton's Third Law. The speed and direction that each car will have after a collision can be found from a law called Conservation of Momentum.




## GOALS

Observation
Analysis
Computing

**MATERIALS**

Calculator
Paper
Pencil

Mass of Car = 200 Kg
Maximum Car Speed = 1.7 m/s
Assume Rider Mass = 65 Kg

## PROCEDURE

1. Calculate the **momentum** of one car traveling at maximum speed (add your mass to the mass of the car).

   Momentum = mass X speed
   or in symbolic form $p = mv$

2. Define **momentum**.

3. Define the **Law of Conservation of Momentum**.

**Use the diagrams on this page to answer the questions on the next page**

4. Using the diagram in problem I, what would be the result of the collision between car A and car B?

| (riders feel) | (cars move) |
|---|---|
| A | |
| B | |

5. Using the diagram in problem II, what would be the result of the collision between car A and B?

| (riders feel) | (cars move) |
|---|---|
| A | |
| B | |

6. Using the diagram in problem III, what would be the result of the collision between car A and B?

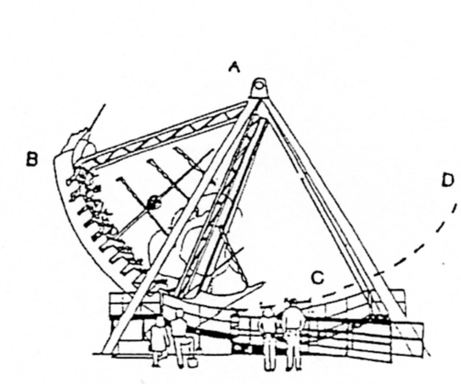
| (riders feel) | (cars move) |
|---|---|
| A | |
| B | |

7. Using the diagram in problem IV, what would be the result of the collision between cars A and B crashing into car C?

| (riders feel) | (cars move) |
|---|---|
| A | |
| B | |
| C | |

8. Why do automobiles have “airbags” and specials headrests on the back of seats?

# 'Galleon' Pirate Ship




A swinging pirate ship that moves like a pendulum in motion giving riders the sensation of weightlessness.

**OBJECTIVE**

The objective of this activity is to measure the period of the boat and compare it to the period of a pendulum with the same length. To calculate Force Factors at various locations on the ride.

**MEASUREMENTS**

Measure the period of the boat swing when it is near the start of the ride, when the angle is small, and when the boat is swinging at its maximum angle.

WHILE WATCHING FROM THE GROUND

| Measurement | **Time to make three cycles (seconds)** | **Period (time/3) (seconds)** |
|---|---|---|
| Small angle | | |
| Large angle | | |

READINGS ON RIDE
Use the accelerometer on the ride and record your data below.

Use the diagram above to help answer the following questions. Point B represents the higher extreme position, point D represents the lower extreme position, and point C represents the lowest position in the middle of the cycle.

| **Section of Ride** | **Accelerometer Reading** | **Sensation compared to normal weight (normal, larger, smaller, none)** |
|---|---|---|
| Point C during small angle | | |
| Point C during large angle | | |
| Greatest reading at point B | | |
| Greatest reading at point D | | |

**OBSERVATIONS**

1. Look at the Period measurements above. Did the size of the angle effect the period of the boat's swing?

2. At what point or points was the speed of the boat a minimum? Maximum?

3. At what point or points did you feel the heaviest?  Lightest?

4. Was there a difference in sensation when comparing points B and D?

**CALCULATIONS**

(Show all Work)

1. Calculate the period of a simple pendulum that has a length of 12.2 m.

$$T = 2\pi\sqrt{\frac{L}{g}}$$

| *Period* = __________ *s* |
|---|

2. Compare this period to the periods you measured for the small and large angle swings.  Within experimental error can the 'Galleon' Pirate Ship ride be considered a simple pendulum?

# Elementary School & Other Fun Stuff For Middle School Students

**You can have some fun and learn along the way while touring Quassy Amusement Park and even go on some of the rides. This section allows student teams to complete the worksheets while faculty and chaperones observe.**

**Teachers are encouraged to set a time limit to have the worksheets completed and handed in.**

# Power Of Hydraulics


1. Go to the "Yo-Yo" Super Swing ride. The ride operates totally on "hydraulics." Write down your definition of "hydraulics."

2. Now watch the "Yo-Yo" ride as it operates. Name the three phases of operation the ride goes through, which are all driven by "hydraulics." (1) ______________ (2) ________________ (3)_______________.

3. Now you can relate to the power of "hydraulics' on this amusement ride. As a better example, complete this quiz:
   There are _________ yellow arms on the ride. Each arm weighs 600 pounds.
   There are __________ seats on the ride. For this math puzzle, we will say each seat and passenger weigh a total of 100 pounds. Now do the math.
   The total weight the center hydraulic cylinder is lifting (arms, seats and passengers) is ___________ pounds, or __________ tons.

4. Find at least TWO more rides in the park which incorporate hydraulics into their operation. Name the rides and then one component of hydraulic operation on the ride (rotation, lift, tilt etc.) (1) ________________________________________________
(2) __________________________________________________________________

# Roller Coaster Physics

1. Go to the "Wooden Warrior" roller coaster and watch as the train drops from the first hill. Thanks to ____________ the train rolls down the hill, picking up enough speed to climb the second hill. (circle your answer below)

   A. an electric motor in the train
   B. gravity (the force that pulls things toward the center of the Earth)
   C. A cable pulls the train up the second hill

6. While at the "Wooden Warrior," you will complete an average speed experiment. The coaster track length is 1,250 feet. Time one ride from start to finish (leaving the station and returning – coming to a complete stop). The average speed of the coaster is _____ mph.

Formula: Average speed = distance % time _____ feet per second (60 MPH = 88 feet per second). Take the average speed – feet per second – multiply by 60 (seconds) divided by 88 = ___________mph for the "Wooden Warrior" roller coaster.

Later, do the same at the Little Dipper roller coaster. The track length is 280 feet. The average speed of the Little Dipper is ___________ mph.

Will the roller coasters at Quassy run at the same speeds all of the time? Explain your answer based on the nature of the rides, naming at least two principles of physics applied in the operation of the roller coasters:

# How Does Your Pendulum Swing?

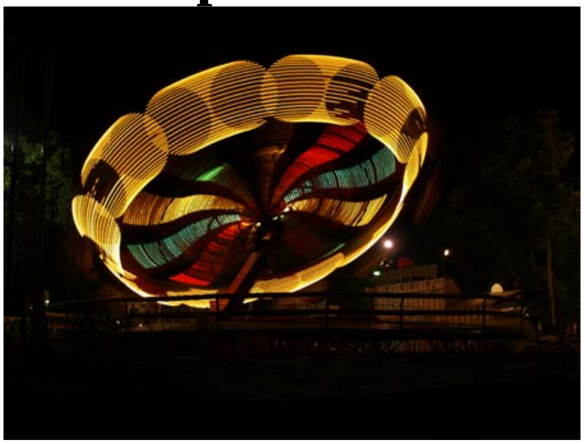
1. Experiment: “Slowly Rotating Coordinate System.” Using a soft, small toy or other item tied to the end of a string; take a seat on a chariot on the Grand Carousel (DO NOT sit on a carousel animal for this experiment). Hold the string with the toy suspended from it and set in motion as a pendulum. As the ride starts to rotate, gently keep your pendulum moving. Now watch the action of your pendulum.

2. What shape does your pendulum seem to draw as the carousel rotates? (1) circle (2) square (3) star (4) none – it simply goes back and forth. Answer ____________.

3. Can you provide a reason for your answer?

For details on how and why your experiment proves the Earth rotates, look up the Foucault Pendulum on the Internet or in your physics books.

# Don't Spill The Water!



Experiments at the "Paratrooper" ride.

Go to the "Paratrooper" ride. The spinning action of the ride generates ___________________ force. Also, can you write down the definition of this force?

Now ask the operator to put the bucket of water on one of the seats. The operator will start the ride and as the seats tilt out the bucket of water will spill or not spill. Explain your answer here: _____________________________________________________
____________________________________________________________________.

Now you have to determine how the RPMs of the "Paratrooper." You will need a stopwatch or second hand on your watch.

1. What is RPM? __________________________________________
2. Time the "Paratrooper" at least three times. Once the ride reaches full speed, are the RPMs constant for each ride cycle? Write down your findings here: Cycle 1 __________ Cycle 2 __________ Cycle 3 ______

# Need A Lift? Try A Little Hydraulics

The helicopters are fun for all ages. They are lifted into the air by “hydraulic” cylinders located on the center for the ride. Oil is pumped into the cylinders under high pressure (hydraulics). Do you see another ride in the park which has a shiny hydraulic cylinder? Write down the name of another ride in the park that uses hydraulics.

____________________

# Now, The Spin Cycle

The “Tilt-A-Whirl” cars spin very fast at times. Watch the ride from the sidewalk. Do they all spin in the same direction, or can they go in different directions. Don’t be fooled! Circle your answer: SAME direction     DIFFERENT directions

Now you must find the “Grand Carousel” in the park. Which direction does it rotate: CLOCKWISE or COUNTER-CLOCKWISE (circle your answer)?

The “Flying Dragon” rotates in which direction? CLOCKWIDE or COUNTER-CLOCKWISE (circle your answer).

Most “spinning rides” at Quassy Amusement Park rotate in which direction: CLOCKWISE or COUNTER-CLOCKWISE (circle your answer)

One ride in the park still operates with a gasoline engine. Can you name it?

____________,

# Man On The Moon?

Riding the "Galleon" Pirate Ship gives you the sensation of weightlessness. If you are tall enough to go on the "Galleon," ride the ship. If not, simply observe from the walkway.

At what point during the ride cycle do patrons encounter the out-of-this-world sensation?

# The Chase Is On - What's That Made Of?

What are the balls on the arcade Skee-Ball alleys made of (watch a player, or you may have to ask someone in the arcade)? Circle your answer

A. Plastic
B. Aluminum
C. Wood

The floor in the Grand Carousel building is made of FIBERGLASS, STEEL, WOOD, CONCRETE (circle your answer).

The track on the "Little Dipper" roller coaster is made of: WOOD or STEEL (circle your answer).

# It's Math Time!!!
# + - = % !!!!!   Go Figure!!

11. The "Yo-Yo" Super Swing ride has how many seats? ________

12. If 16 people were in line at the "Yo-Yo" what percentage of the seats would be filled for the next ride? ___________ %

13. If eight people were in line at the "Yo-Yo" what percentage of the seats would be filled for the next ride? _____________ %

14. If 24 people were in line at the "Yo-Yo" what percentage of the seats would be filled for the next ride? ____________ %

15. The "Paratrooper" ride holds 20 adults per ride and a complete ride (loading, running and unloading) takes five minutes. If running at capacity for one hour, how many adult riders would go on the ride during that time? __________________

16. The "Tilt-A-Whirl" has seven seats with each seat capable of holding up to four people. How many people can a maximum ride hold? _____________

17. The "Tilt-A-Whirl" running at 50 percent capacity would hold how many people? __________

18. Now, if the "Yo-Yo", "Paratrooper" and "Tilt-A-Whirl" were all running with full loads, how many people would be on ALL THREE RIDES? ________________

19. A Candy Apple at Quassy costs $3.50. You have $15. How many Candy Apples could you buy? ___________.   Will you have any change left, and if so, how much? _________

20. A prize you would like to take home in the Quassy Redemption Arcade requires 550 tickets. Each time you play Skee-Ball you win 25 tickets. How many Skee-Ball games must you play to win your prize? _____________

# Part 4 - Count Me If You Can!

21. How many horses are on the "Grand Carousel?" Remember, a horse is a horse, not a lion, tiger or bear - oh my! ______________

22. The "Sky Fighter" jet ride in kiddyland has how many seats? (Be careful! We asked "seats," not jets) _______________

23. There are 657 gumballs in the arcade gumball machine. Today, we sold 227. How many are left in the machine? __________________

24. If 2,489 people came to Quassy this Sunday and 1,622 went into the beach, how many people would remain in the rest of the park? ________________

25. You're almost done! What a fun day at the park! You are taking home three boxes of popcorn. Each box contains 232 popped kernels. How many kernels are there in all three boxes? _________________

TURN in your paper! Don't forget your name and school.

Name ___________________________________________

School __________________________________________

Score (Don't even think about writing in this space!) ______________________

**Ask about the other educational programs at Quassy Amusement Park. Visit the park office for details.**