Art & Literature

Science

EDUCATION DAYS

LEARNING IS A SCREAM AT LAKE WINNIE!

LAKE WINNEPESAUKAH

Physics Day

Student Workbook

Come On, Get Happy
Lake Winnepesaukah
Amusement Park
CHATTANOOGA - TENNESSEE

MATH & PHYSICS

SOCIAL STUDIES

Cannon Ball Roller Coaster

This is a wonderful ride for studying kinetic and potential energies, and for measuring the"g" forces that riders experience.

KINETIC AND POTENTIAL ENERGY

1. Measure the height of the first hill on the track, (using trigonometric relationships). Compare your results with your Physics Coach's results.

Height = ____________meters

Estimate the mass of the car and the riders =_______________kg
(Ask the operator for a hint.)

Your estimate of the highest speed obtained from the kinetic energy of the car is ______meters per second.

Is it reasonable to say that this roller coaster travels at speeds up to 55 mph, (which is 24.6 m/s? _______.

The height of the second highest hill, (hill#3) is 50 feet (=15.2m). How fast are you traveling at the top of this second highest hill? __________.

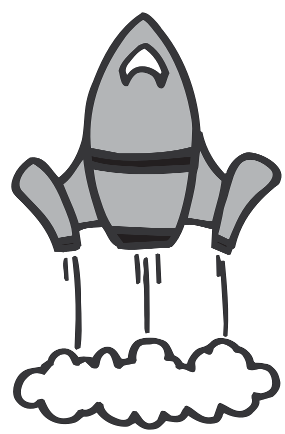
Speed at the top of the second highest hill = _______________m/sec.

KINETIC AND POTENTIAL ENERGY

Use the vertical accelerometer to measure the "g" forces at the top and at the bottom of the first and second hills. If you hold the accelerometer in the wrong orientation, you must ride the ride again! Please estimate your answers before riding the ride. The acceleration needed to move you along the circular path is v^2/R.

	(Estimate)	*(Ride)*
Acceleration at the top of the highest hill =	________g	________g
Acceleration at the bottom of the highest hill =	________g	________g
Acceleration at the top of the second hill =	________g	________g
Acceleration at the bottom of the second hill =	________g	________g

An acceleration of 3 g's is a typical acceleration experienced on the launch by space shuttle astronauts.



Use the CBL with the 3D accelerometer to measure your acceleration every 0.1 seconds for the entire 90 second ride on the roller coaster. Reconstruct the shape of the roller coaster path from your acceleration data. This is a project for the classroom.

The Ferris Wheel

In order to move in a circular path, you must experience a net force directed toward the center of motion. At the top and bottom of the ride, this force is colinear with your weight. You can feel the force, so why not measure it?

Ride the Ferris Wheel while sitting on a bathroom scale. Measure the force!

Measure or estimate the following values:

Radius of the motion of the gondola = R = ______meters.

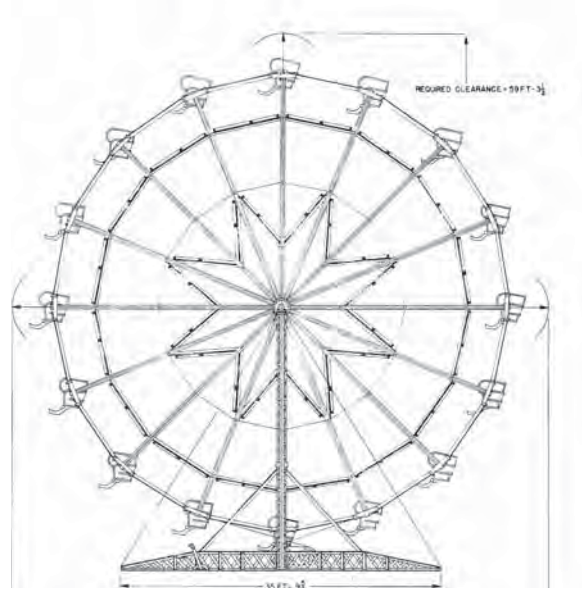
Average time for one revolution = _____seconds.

Your at rest sitting weight (lbs) x 4.45 = Wo.

Wo = __________Newtons.

Your sitting weight at the top while moving, (lbs) x 4.45 = ______Newtons.

Your sitting weight at the bottom while moving, (lbs) x 4.45 = ______Newtons.



CALCULATE

Speed of the gondola = ________m/s (=2 pi R/T).

The force that you exert on the bathroom scale at the bottom is:
$F = mg + mv^2/R$ = _________Newtons.

The force that you exert on the bathroom scale at the top is:
$F = mg + mv^2/R$ = _________Newtons.

m is your sitting mass, m = Wo/g. Use $G=9.8m/s^2$. By substitution, these two equations can be written;

$F = Wo+/-Wov^2/Rg=Wo(1+/-v^2/Rg)$

Do you feel lighter at the top or the bottom? Does this agree with your calculations?

The Carrousel

SPEED

This ride starts from rest and accelerates to a constant angular speed, w. However, your actual speed depends upon how far you are standing from the center of the ride. Let's measure and calculate these quantities. To determine the angular speed, we need the period of revolution. Measure the time for 2 complete revolutions and divide by 2 to obtain the average period of revolution, T.

w = 2 pi/T = 6.28/T = ______radians per second.

w = 360°/T = _______ degrees per second.

We need w in units of radians per second for our next calculation. Your actual speed, v, at any position on the ride is:

V = Rw = _________meters per second

= __________miles per hour.

where R is your distance from the center of the rotation. Estimate the distance, R, while the ride is stopped. Note that 15mph is 6.7 meters/sec., and 30mph is 13.4 meters/sec.

The Swinging Pirate Ship

This ride is very similar to the Ferris wheel and the Cannon Ball Roller Coaster, and the accelerations that you experience are jsut the ones to move you along a circular path. In addition, this swinging ship is a pendulum, which should be a well-studied example from your physics textbook and physics lab.

PENDULUM

If you remember the simple pendulum results, the period of oscillation, T, for a pendulum of length L is:

T = 2 pi (L/g^1/2

Estimate the length of the pendulum and measure its period.

Length (L) = __________m

Period (T) = ________sec.

How well does the simple pendulum equation predict the period when the oscillations are not small and the pendulum is not simple? Calculate the period expected for a simple pendulum.

Period caluclated from the pendulum's length = ______sec.

PHYSICS DAY

Student Guide

PENDULUM (cont'd)

Does the theoretical prediction agree with your measurement, within 5%?

Just like the Ferris Wheel, the force you experience at the bottom of the ride can be measured as a change in your weight.

Ride the Pirate Ship while sitting on a bathroom scale. Measure the force!

ACCELERATIONS

Measurements of the "vertical" accelerations reveal some amazing accelerations. Where do you predict the accelerations to be greatest when the ride is moving, and in what direction are the accelerations? Check one.

______At the top of the swing

______At the bottom, the "resting position".

Where is your speed on the ride zero meters per second, during the time the ride is being operated? Check one.

______At my highest position above the ground.

______At my lowest position above the ground.

______Never.

MEASURE OR ESTIMATE THE FOLLOWING VALUES.

Your at-rest sitting weight (pounds) x 4.45 (N/lb) = Wo

Wo = ________Newtons

Your sitting weight at the bottom while moving (pounds) x 4.45 (N/lb) = Wbot

Wbot = _________Newtons

CALCULATE

Your weight at the bottom of the ride's motion is:

Wbot = (Wo/g)a, so that your accelerations is:

a = (Wbot/Wo)g = ________g = _________m/s^2

If you measured the acceleration with a vertical spring accelerometer, how do the two measurements compare?

a (from the spring accelerometer) = _________g