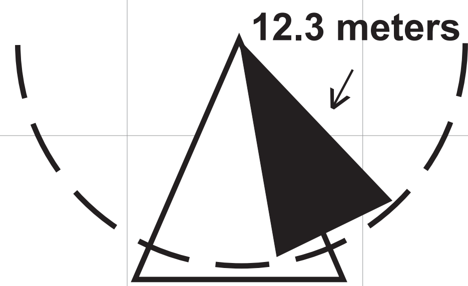


SEABREEZE PHYSICS

The Physics of Fun: Hands-on Learning Program

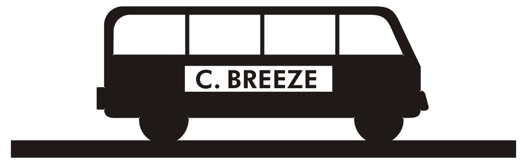
Developed in Cooperation with
Rush-Henrietta High School
Eastridge High School
Greece Arcadia High School

Seabreeze Amusement Park®

Rochester NY

Exercises Available for your Use:

– On The Road
– Carousel
– Revolution 360
– Whirlwind
– Sea Dragon
– Music Express
– Bumper Cars
– Wave Swinger
– Log Flume
– Scenic Train
– Seabreeze Flyers
– Jack Rabbit
– Anxiety Factor



Questions:

Starting up:

1) Draw the forces acting on you as you sit on the bus while the bus is moving at a constant speed.

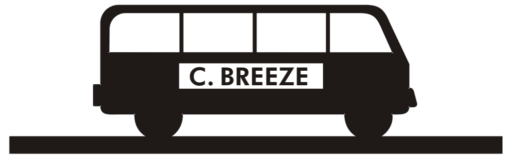
2) Observe a ball attached to a string suspended from the ceiling.
   Before leaving the school, predict the motion of the ball:
   a) at start up
   b) while moving at a constant speed
   c) coming to a stop at a traffic light
   d) making a left-hand turn
   e) making a right-hand turn

   Record the actual motion of the ball:
   a)
   b)
   c)
   d)
   e)

3) Explain the motion of the ball for one of the above observations.

SEABREEZE PHYSICS

ON THE ROAD, cont'd.



Questions:

4) When the bus is moving at constant speed, describe:

a) your motion relative to a person sitting next to you.

b) your motion relative to a person on the side of the road.

c) the motion of a person on the side of the road relative to you.

5) Determine the mass of the bus: (2.2 lbs = 1 kg)

Data: Surface area of one tire in contact with road _______sq.inches

# of people on the bus _______

Average weight of one person ______ pounds

Tire pressure as read from sidewall of tire ______ PSI (pounds/sq. in.)

Calculations:

Calculate the weight of the bus w/passengers knowing that pressure = force/area.

Actual weight of bus as found from bus driver.

6) With the help of a person in the front of the bus, time how long it takes to go from 0 mph to 25 mph (11 m/s) .

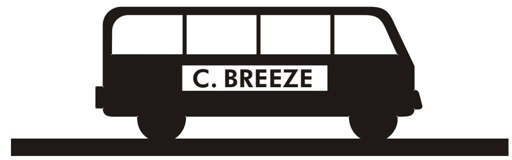
a) Calculate the acceleration of the bus in m/s/s time _____________ sec

b) Calculate the distance traveled as the bus reaches 25 mph

c) From the known mass of the bus and passengers, calculate the force needed to accelerate the bus to 25 mph.

SEABREEZE PHYSICS

ON THE ROAD, cont'd.



Questions:

Draw a vector diagram of the bus ride from school to Seabreeze Park. Determine the approximate resultant displacement, in both magnitude and direction. Be sure to include in your diagram the scale used to create the diagram.

SEABREEZE PHYSICS

CAROUSEL

Questions:

1) Measure the circumference of the circle made by the inner circle of horses and the circumference of the circle made by the outer circle of horses.

2) Determine the period of rotation for the carousel.

3) Using the horizontal accelerometer, measure the angle when riding an inner horse and an outer horse.

Data: Inner Circle Circum. ______m period of rotation ______m

Outer Circle Circum. ______m

Inner angle _____° outer angle _____°

1) Calculate the linear speed of the inner horse.

2) Calculate the linear speed of the outer horse.

3) Explain the difference in speeds between the two horses.

4) Calculate the centripetal force acting on you when riding the
   a) Inner horse

   b) Outer horse

5) Calculate the centripetal acceleration acting on you when riding the:
   a) Inner horse

   b) Outer horse

6) From the horizontal accelerometer, calculate the centripetal acceleration and compare those to #4 and #5, above.

7) Explain how the ride might be altered to achieve a greater angular acceleration without using a more a more powerful motor.

8) Imagine that once the carousel is turning, the motor suddenly turns off and continues to move freely with no losses due to friction. If riders moved from the inside horses to empty outside horses, which effect would this have on the motion of the carousel and why?

Questions:

9) The tangential velocity of:
   a) the inner ring of horses

   b) the outer ring of horses

10) The centripetal acceleration of:
   a) the inner ring of horses

   b) the outer ring of horses

11) Measure the centripetal acceleration using your horizontal accelerometer and compare to your calculated values in Question #10.
   a) the inner ring of horses

   b) the outer ring of horses

Thought Questions:

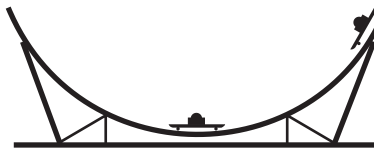
1) How does the centripetal acceleration depend on the distance you are from the center of the ride?

2. Explain how the ride might be altered to achieve a greater angular acceleration without using a more powerful motor.

3. Imagine that once the carousel is turning, the motor is suddenly turned off. Pretend that the carousel continues to turn freely with no loss in friction. If the riders moved from the inside horses to the empty outside horses, what effect would this have on the motion of the carousel? Please explain why.

SEABREEZE PHYSICS

REVOLUTION 360°



Ride Specifications:

Power: 105,000 Watts
Mass of Gondola: 9,342 kg
Passengers: 24 riders each with a mass of 68 kg
Maximum Ride Height: 14 m

Questions:

1) Calculate the total mass of the gondola and passengers.

2) Determine the total weight of the gondola and passengers.

3) Calculate the work done to lift the gondola and passengers to the top of the ride.

4) Determine the time it takes the motor to lift the gondola and passengers to the top of the ride.

5) Assuming the ride is operated at 440 V, determine the following:
   A. Current used by the Revolution 360.

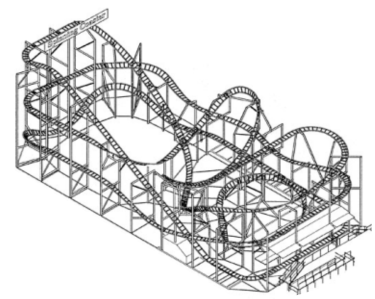
   B. Resistance of the Revolution 360.

   C. Electrical energy used in one 10-hour day of operation (in units of kWhr).

   D. The cost to run the Revolution 360 for one 10-hour day at $0.09/kWhr.

SEABREEZE PHYSICS

WHIRLWIND



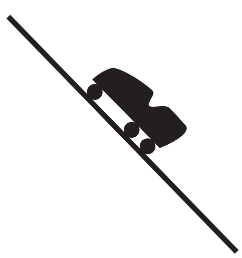
Ride Specifications:

Force to lift the car: 3.75×10^4 N
Angle of lift hill: 30°
Incline velocity up: 1.9 m/s
Mass of car: 1,200 kg

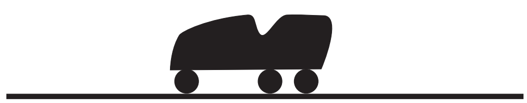
Qualitative Questions:

Draw a free body diagram for the car in each of the positions shown below. Draw vectors showing the direction of all of the forces that apply to each situation (F, F_f, F_G, F_N). Use a dotted line to label the direction of acceleration vector.

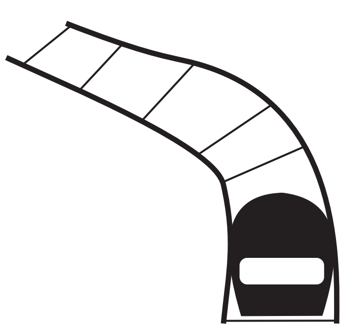
1) Going up the lift hill. (Side view)



2) Car coming to a stop at the end of the ride. (Side view)

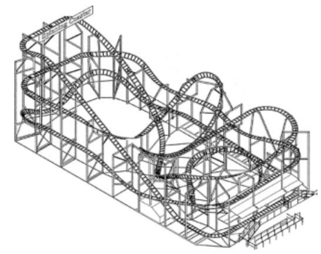


3) Turning on a flat curve. (Overhead view)



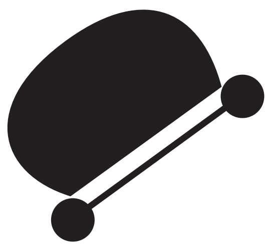
SEABREEZE PHYSICS

WHIRLWIND, cont'd.



Qualitative Questions, cont'd.:

4) Turning on a banked curve.



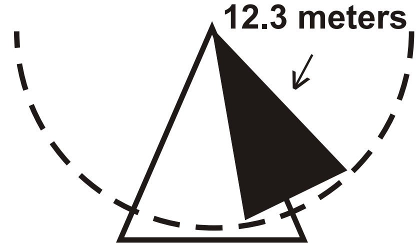
Questions:

1) Use the free body diagram you drew of the car on the lift hill to determine the net force acting on the car. (Assume the hill is frictionless)

2) Calculate the power rating of the motor.

SEABREEZE PHYSICS

SEA DRAGON



Use the accelerometer while on the Sea Dragon to determine the acceleration at the bottom of the swing.

From the ground, determine how long it takes for 5 complete oscillations for the Sea Dragon.

Data: Time for 5 oscillations: ______ seconds

Acceleration at bottom: ______

Questions:

1) Calculate the period of oscillation using data from above.

2) Assume that the Sea Dragon behaves like a simple pendulum. Use the equation:

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

and calculate the period of oscillation of the Sea Dragon.

3) Which of the values (1 or 2, above) is the more reliable and why do you think so? (Include in your discussion, sources of error.)

4) Using conservation of energy principles, calculate the velocity of the Sea Dragon at the bottom of its swing.

5) Calculate the centripetal acceleration of the Sea Dragon at the bottom of its swing.

6) Compare the acceleration measured while on the ride with the value calculated above. Which value do you feel is more reliable and why? (Discuss sources of error in justification.)

SEABREEZE PHYSICS

MUSIC EXPRESS

Ride Specifications:

Weight of 1 car and 3 passengers: 4,310N
Radius of ride: 3.13 m
Length of Ride: 156 s

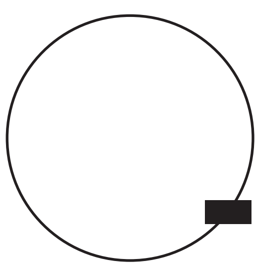
Data:

Number of Revolutions during length of ride: ________

Qualitative Questions:

1) You are riding the Music Express with your younger brother. Where would you prefer to sit (the seat closer to the center or the seat closer to the outside)? Why?

2) Draw a vector representing the centripetal acceleration and the centripetal force acting on you at the position shown.



3) The ride suddenly comes to a complete stop after rotating clockwise when you are in the position shown above. Draw a vector representing your velocity at this position.

SEABREEZE PHYSICS

MUSIC EXPRESS, cont'd.

Questions:

1) Calculate the period of revolution.

2) Calculate the linear velocity (speed).

3) Calculate the centripetal acceleration.

4) Calculate the mass of one car and three passengers.

5) Calculate the centripetal force acting on one car and three passengers.

SEABREEZE PHYSICS

BUMPER CARS

Ride Specifications:

-- Car Motor 120 volts, powered by 1 HP

Questions:

To perform this lab, you must find a partner to complete it with.

Mass of Bumper Car	460	lbs	__________	kg
Mass of Rider (YOU!)	___________	lbs	__________	kg
Total Mass of Car and Rider	___________	lbs	__________	kg
Total Mass of your Partner and His/Her Car			__________	kg

Observations While Driving:

(Note velocity changes in each situation below)

1) What happens to each car in a collision when:
   a) one car is not moving and is struck in the rear-end by the other?

   b) both cars are moving and there is a rear-end collision?

   c) the car strikes a stationary object such as a wall bumper?

2) In what situation listed above are you "thrown forward", so to speak? Explain why.

3) In which situation are you "thrown backward"? Again, explain why.

4) Assume that you are travelling at 2 m/s.
   a) Calculate the momentum of you and your car.

   b) You collide with a wall bumper and rebound at a speed of 1 m/s. Calculate the momentum of you and your car after collision with the wall bumper. (Keep in mind that momentum is a vector quantity!)

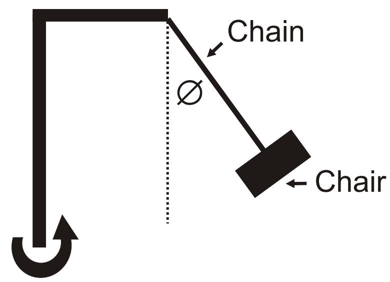
   c) Calculate the change in momentum of you and your car.

   d) Assume that you are moving at 2 m/s. You strike a wall bumper and come to rest in 0.5 seconds. Calculate the impulse acting on you and your car during collision.

   e) Calculate the force that caused the change in momentum.

SEABREEZE PHYSICS

WAVE SWINGER



Data:

Radius: 9.0 m

Time for one revolution ________ S

Qualitative questions:

1) Will an empty swing or one with someone in it ride higher? Why?

2). Describe your sensations as the ride increased in speed. Explain in terms of the physics of the ride.

3) Watch the ride from the beginning until it reaches full speed. What happens to the angle of the chain attached to the seats as the ride increases in speed? Why?

Calculations:

1) Calculate the maximum speed of the ride.

2) Calculate the centripetal force acting on you.

3) Calculate your weight in newtons.

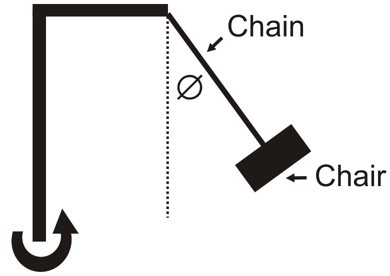
4) Draw the following to scale, using the picture to the right.

   a) the horizontal vector representing the centripetal force.

   b) the vector representing your weight (mg)

SEABREEZE PHYSICS

WAVE SWINGER, cont'd.



Questions:

5. Measure the swing's angle from the vertical when it is in motion but not tilted. How does the angle of an empty swing compare to an occupied one? Does the mass of the rider make any difference? Is the angle of the swing independent of the mass of the swing? If so, show this is so.

6. Draw a vector diagram of the forces acting on a rider when the swing is moving and tilted for each position:

a) going up

b) going down

c) at the top

d) at the bottom

SEABREEZE PHYSICS

LOG FLUME

Data and measurements:

Length of boat: ______ meters

Vertical drop of hill: 9.75 meters

Time for whole boat to pass any given
point before going up to top of hill: _______ seconds

Time for boat to come down hill: ______ seconds

Time duration of the splash at the bottom of hill ______ seconds

Time for whole boat to pass any given
point after splashing at bottom of hill: ______ seconds

Observations:

1) Why is there water on the slide or hill and not just at the bottom of the slide?

2) If there is a great deal of mass in the front of the boat, is the splash larger or smaller than if there is a smaller mass in the front? If so, explain why.

3) Is there an observable splash-time difference with a greater mass in the front than if the great mass is in the rear? If so, explain why.

4) Is there any place on the ride where the riders "lunge" forward involuntarily? Where does this occur and explain why.

LOG FLUME, cont'd.

Calculations:

1) Determine the average velocity of the log before going up hill.

2) Calculate the length of the hill.

3) Determine the average speed of the log down the hill.

4) Assuming the speed of the log at the top of the hill is the same as the speed before the hill, calculate the speed of the log at the bottom of the hill just prior to splashing.

5) Calculate the average acceleration of the log down the hill.

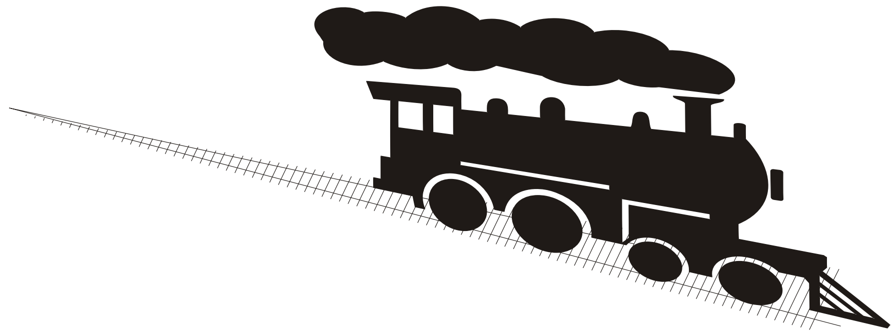
6) Calculate your momentum at the bottom of hill before splashing.

7) Calculate your momentum after splashing is complete.

8) Using the time of splash, calculate the average force you experience during the splash.

SEABREEZE PHYSICS

SCENIC TRAIN

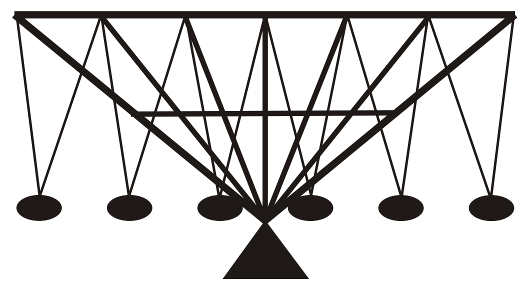


Question:

1) Determine the length of the train ride in meters. Describe the method you used to determine the total distance the train travels around its curcuit.

SEABREEZE PHYSICS

SEABREEZE FLYERS



Ride statistics:

Length of Cables: 4.3 meters
Max. RPM: 10
25 HP Motor
Sweep Radius: 6.2 meters
1.0 Kw-hr Cost: $0.10
1.0 HP = 750 watts

Questions:

1) Calculate the maximum speed of the Seabreeze Flyers.

2) Describe how the change in flap direction changes the motion of the airplane.

3) If a 440-volt line is used to run the electric motor, what is the current in the line? (Use the ride statistics for further data for this calculation.)

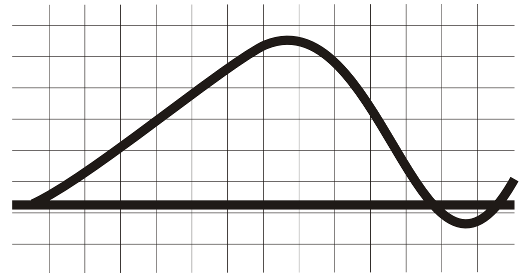
4) What is the internal resistant of the motor?

5) Assume the ride is operating for 6 hours. Calculate the cost of operation for one day.

6) What will be the cost of operating this ride for the three months of the summer?

SEABREEZE PHYSICS

JACK RABBIT



Ride Specifications:

Length of whole track:	655 meters
Length of track, top of first hill to brake application:	570 meters
Weight of 1 car in train:	295 kilos
Number of cars in train:	5

Questions:

1) By triangulation, determine the height of the first hill.

2) What is the maximum gravitational potential energy at the top of the first hill?

3) What is the maximum velocity at the bottom of the first drop? Assume the conservation of energy.

4) What is the average velocity of the train measured from the top of the first hill to the point where the brakes are applied?

5) How much power is developed as the train and passengers are lifted from the base to the top of the first hill?

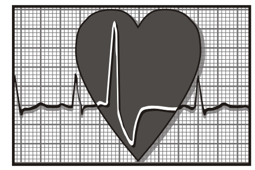
6) At the bottom of the first drop, the track makes as almost circular arc. Determine the radius of the circle and the centripetal acceleration of the train. How many "g"s of acceleration are experienced at the bottom of the drop?

7) How does the calculated centripetal acceleration compare to the centripetal acceleration measured using the accelerometer?

8) Determine the angle of ascent and descent for the first hill. Calculate the acceleration down the first hill based on the angle of descent.

SEABREEZE PHYSICS

THE ANXIETY FACTOR



Data:

For four (4) of the rides you analyze (including either the Jack Rabbit or the Whirlwind as one of the four rides you analyze), determine the following:

1) Your pulse rate immediately upon entering the ride.

2) Your pulse rate immediately after the ride ends.

To determine your pulse rate, count heart beats for either 10 seconds and then multiply this by 6, or 15 seconds and multiply this by 4, which will then give you your pulse rate in beats per minute. Fill in the chart below for the four rides.

Ride	Initial Pulse	Final Pulse

Analysis and calculations:

1) For each of the four rides analyzed, determine the change in pulse from the start of the ride to the finish of the ride.

2) Plot a bar graph of pulse change (y-axis) against ride (x-axis) with the smallest change first through the largest change last (ascending order).

Analysis:

1) Why do you think the rides that you analyzed produced the changes in pulse rate that you found?