

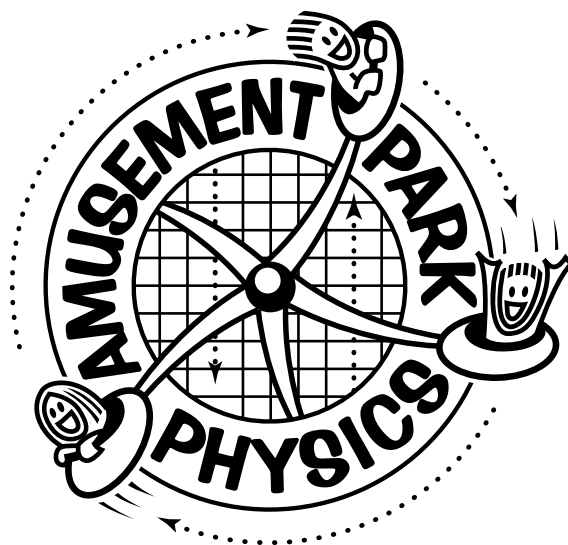
# Amusement Park **PHYSICS**



**PLAY**  
**LaNd**  
**At the PNE**  
**Vancouver**

**PHYSICS and**  
**SCIENCE DAY**  
**2019**

.....  
**Science 10**



These educational materials were created by *Science Plus*.  
Illustrations, typesetting and layout by  
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April 2019

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# Amusement Park Physics

## and the new Secondary School Curriculum

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Over the past few years, the educational system has seen a shift in the science curriculum and changes to how that curriculum is delivered. The current curriculum is more inquiry based with a focus on questioning, predicting, communication, planning and conducting investigations. In addition, students are asked to analyse not only the data they collect, but also the process that was used to collect the data.

The curriculum for Science has changed. Although forces are not directly in the curriculum, inquiry and investigation are at the forefront. **Amusement Park Physics** can now be applied to any number of classes as they all include an inquiry / investigative component. Teachers are able to adapt or enhance the curriculum packages currently supplied by **Amusement Park Physics** as they see fit. This gives you, as an educator, tremendous flexibility in terms of how you and your class spend your time at Playland. You could focus on one ride and do an in-depth study or perhaps investigate similar rides and compare them.

In addition, classes could choose to investigate / discuss Newton's three (3) laws and then attend **Amusement Park Physics** to apply them. This initial investigation could be done as a class or individually as a project.

The Ministry of Education has identified some curricular competencies that students are expected to meet. All of the below mentioned competencies could be done at **Amusement Park Physics**.

**Science 8:** "Demonstrate a sustained intellectual curiosity about a scientific topic or problem of personal interest"

"Collaboratively plan a range of investigation types, including field work and experiments, to answer their questions or solve problems they have identified"

"Observe, measure and record data (qualitative and quantitative), using equipment, including digital technologies, with accuracy and precision"

**Science 9:** "Collaboratively and individually plan, select, and use appropriate investigation methods, including field work and lab experiments, to collect reliable data (qualitative and quantitative)"

"Select and use appropriate equipment, including digital technologies, to systematically and accurately collect and record data"

**Amusement Park Physics** is designed to get students to get out of their classroom and explore real life science applications. Based on the current curriculum, students need to be able to design an investigation from start to finish, this includes data collection, analysis of results and communicating a conclusion.

# Amusement Park Physics

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It's hard to believe that *Amusement Park Physics* at Playland is in its **32<sup>nd</sup>** year. The project was started in 1988 with our senior Physics students and was expanded in 1990 with the addition of the Grade 9 program. Later we added an elementary school version *The Science of Fun*. In 2008 we added a French Version for elementary schools called *La Science du Plaisir* and a curriculum for Grade 8 Science and Grade 10 Science. In 2011 we added a version for Biology 12, and in 2012 we added a version for students in Chemistry 11 and 12. A special thanks goes to Steve Simms and Mike Eckert at Clayton Heights Secondary for helping with the Chemistry module. In 2016 we added activity sheets for the Beast and the Haunted House. Rather than have them for specific grades, we have questions at the Bronze level, Silver level, and the Gold level. Teachers can choose the level they want their students to do.

The purpose of *Amusement Park Physics* is to provide students with practice in applying to real situations some of the concepts learned in the classroom study of mechanics. It has been an enjoyable conclusion to that aspect of the curriculum and can assist in preparation for final examinations. With the involvement of students from other schools and other districts, the project serves to bring together teachers and students to share their common interest in science. We welcome your participation in either or both events.

Due to the success of *Amusement Park Physics*, we have spread the events to five days in the spring and one day in the fall. You may choose any of these days but we will be limiting numbers to 2500 students per day. These will be filled on a first come basis. This should help eliminate any lineup at the rides to let students make measurements multiple times on each ride.

There is a curriculum package for each grade level – Science 8, Science 10, Physics 11/12, Chemistry 11/12 and Biology 12. You need to only download and print the version that you need. Please feel free to adapt any materials to better suit your students.

I'd like to thank all those involved in *Amusement Park Physics 2019*: Michelle Pattison, Steven Simms, Jennifer Campbell, Peter Male and the staff of the Pacific National Exhibition and Playland for their support. The work and dedication of all these people make *Amusement Park Physics 2019* possible.

Jim Wiese

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# Introduction

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The accompanying materials have been divided into several sections: one with information concerning measurements, one containing information on instrument construction, and one with the ride worksheets. Teachers are given flexibility for its use but are reminded that this educational program is used by many schools.

**We try to have consistency between schools' implementation by asking each teacher to remind their students that this is an educational event. A rule of thumb is to have each student or group of students complete 3 or 4 of the modules. That is a reasonable expectation for them and keeps them on task during the day. Schools that are wishing to use this event as a reward for "hard work" through the year and that do not intend to have their students working on this material are asked to make arrangements to visit Playland at another time.**

This year's curriculum reflects the different demands that are placed on students in Science 8, Science 10, Physics 11 and Physics 12. This has hopefully brought it more in line with Provincial Ministry Physics guidelines and the Science 10 and Physics 12 Provincial Examinations.

**Students must be using the following materials throughout the day:**

1. Packet of activities
2. Pencil
3. Timing devices (digital watches with stopwatch mode are nice)
4. Vertical and lateral accelerometers (see packet for details – make arrangements for sharing between students if supply is short). Each school is responsible for providing their own accelerometers.
5. Calculator

## Critical Safety Note

Any instrument or devices carried on rides by students should be made of plastic and provided with some kind of a wrist tether made of heavy string, so that if dropped, the instrument will not break or fall off the ride and cause injury or damage.

# Sample Timetable

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**Please adapt to fit your circumstances**

## **Time Schedule**

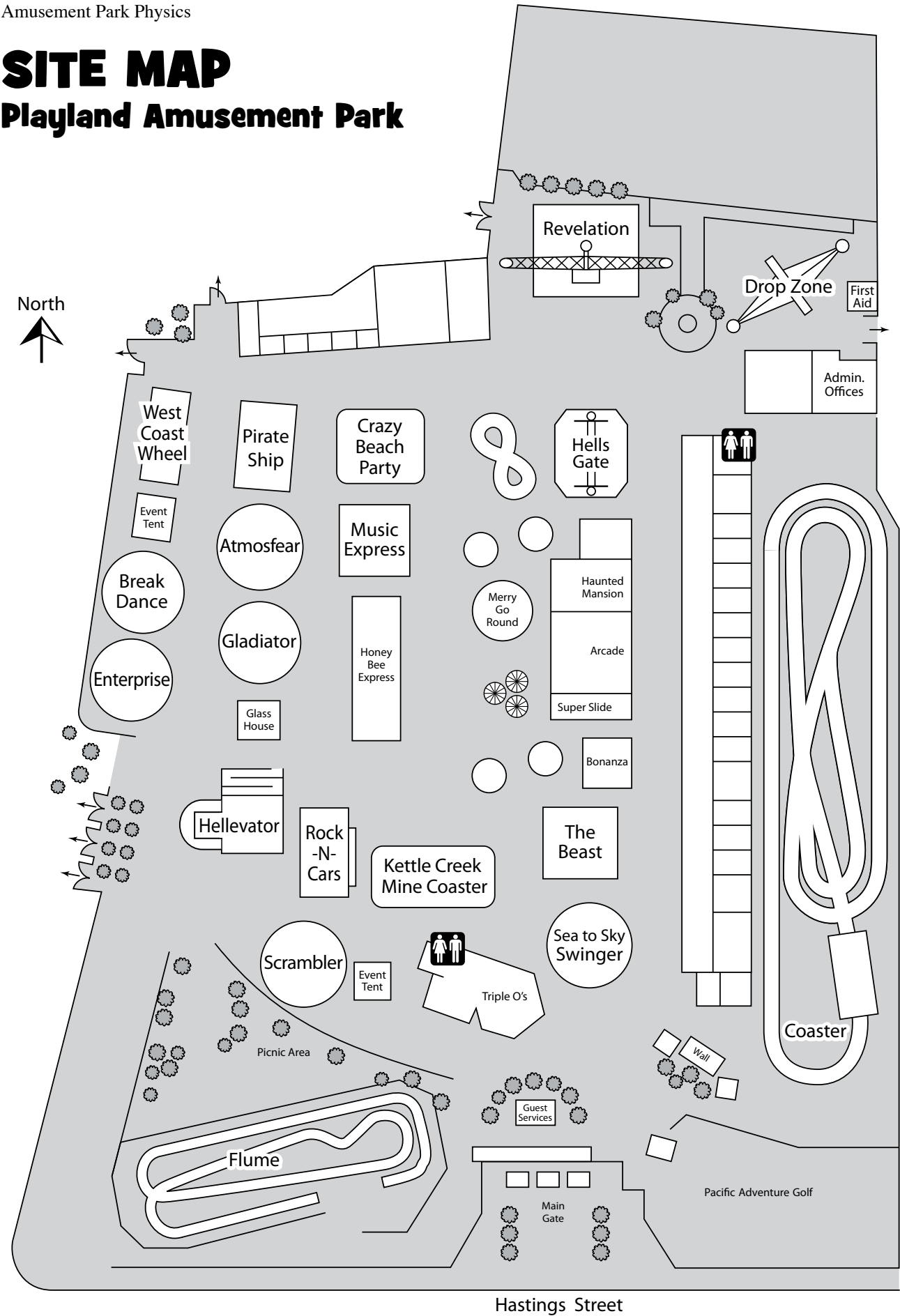
8:30	Buses leave school
9:15	Arrive at Playland
9:30	Enter Playland Amphitheatre for opening session
9:45 – 10:00	Opening Presentation at Playland Amphitheatre
10:00	Gates to Playland open to admit students
10:00 – 2:00	Carry out pre-planned activities involving observations and measurements of selected aspects of the rides. Arrange a meeting time with your teacher for problems that arise or questions you have.
2:00	Playland closes and event ends
2:15	Board buses for return to school
3:00	Buses arrive back at school

## **Things to Bring:**

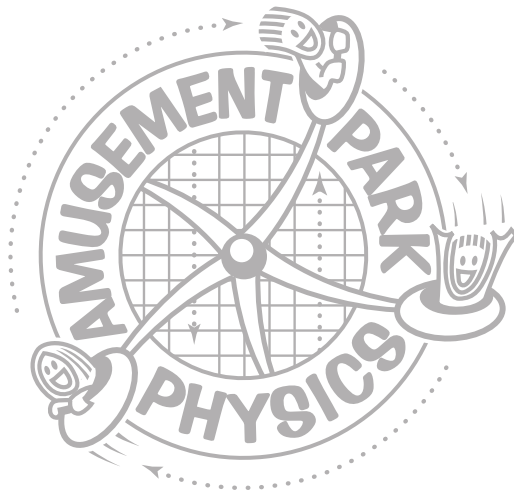
- ☐ BRING A LUNCH (You will NOT be allowed to leave the park for lunch)
- ☐ BRING A PENCIL
- ☐ Bring a calculator if you wish
- ☐ Don't forget to bring this assignment package!
- ☐ Try to bring a watch with a second hand or digital seconds to record times on the rides. A digital watch with a stopwatch mode works very well.
- ☐ Try to return the accelerometers (baby bottles & plastic tubes) to your teacher when you are not using them during the day. We'll be sharing them and we need to make sure everyone gets a chance to use them.

# SITE MAP

## Playland Amusement Park







# **Section A**

## **Making Measurements**

page	A-1	Time
page	A-1	Distance
page	A-3	Lateral Acceleration
page	A-4	Useful Formulae

## Time

The times that are required to work out the problems can easily be measured by using a watch with a second hand or a digital watch with a stop watch mode. When measuring the period of a ride that involves harmonic or circular motion, measure the time for several repetitions of the motion. This will give a better estimate of the period of motion than just measuring one repetition. You may want to measure the time two or three times and then average them.

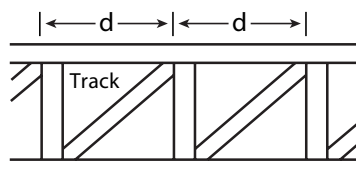
## Distance

Since you cannot interfere with the normal operation of the rides, you will not be able to directly measure heights, diameters, etc. All but a few of the distances can be measured remotely using the following methods. They will give you a reasonable estimate. Try to keep consistent units, i.e. meters, centimeters, etc., to make calculations easier.

**Pacing:** Determine the length of your stride by walking at your normal rate over a measured distance. Divide the distance by the number of steps and you can get the average distance per step. Knowing this, you can pace off horizontal distances.

My pace = \_\_\_\_\_ m

**Ride Structure:** Distance estimates can be made by noting regularities in the structure of the ride. For example, tracks may have regularly spaced cross-members as shown in *figure a*. The distance  $d$  can be estimated, and by counting the number of cross members, distances along the track can be determined. This method can be used for both vertical and horizontal distances.



*figure a*

**Triangulation:** For measuring height by triangulation, an astrolab such as that shown in *figure b* can be constructed.

*Practice this with the school flagpole before you come to Playland.*

Suppose the height  $h_T$  of the **Roller Coaster** must be determined.

- 1 Measure the distance between you and the ride. You can pace off the distance.

distance  $d$  = \_\_\_\_\_ m

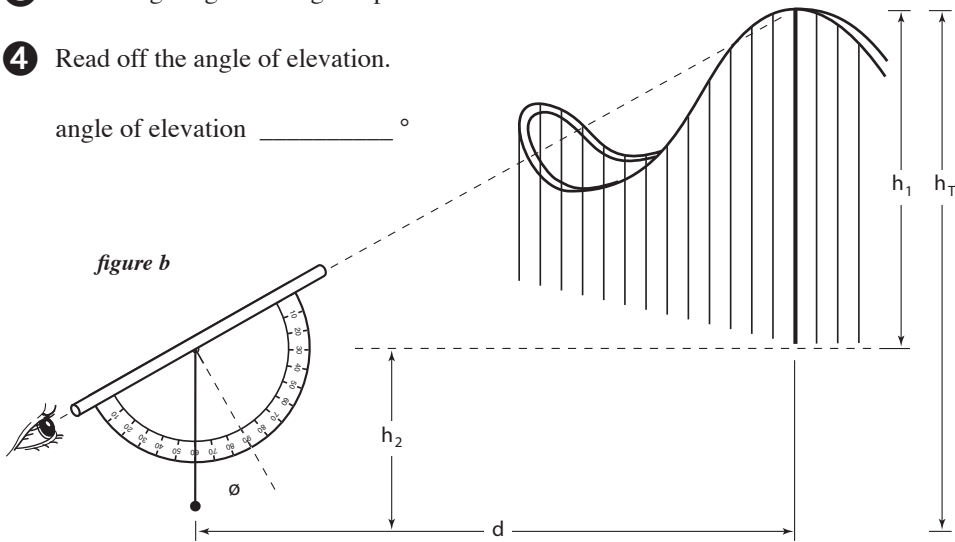
- 2 Measure the height of the string hole.

string hole height  $h_2$ :  $h_2$  = \_\_\_\_\_ m

3 Take a sighting at the highest point of the ride.

4 Read off the angle of elevation.

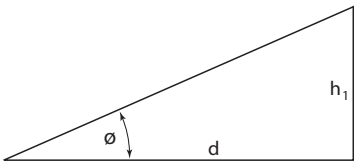
angle of elevation \_\_\_\_\_°



Then since  $h_1/d = \tan \phi$   
 $h_1 = d (\tan \phi)$

5 Look up the tangent value for the angle measured:

tangent value: \_\_\_\_\_



angle	tangent	angle	tangent	angle	tangent
0°	.00	30°	.58	60°	1.73
5°	.09	35°	.70	65°	2.14
10°	.18	40°	.84	70°	2.75
15°	.27	45°	1.00	75°	3.73
20°	.36	50°	1.19	80°	5.67
25°	.47	55°	1.43	85°	11.43

6 Multiply this tangent value by the distance from the ride:  $h_1 = \text{_____} \text{ m}$

7 Add this product to the height of the string hole:  
 $+ h_2 = \text{_____} \text{ m}$   
\_\_\_\_\_

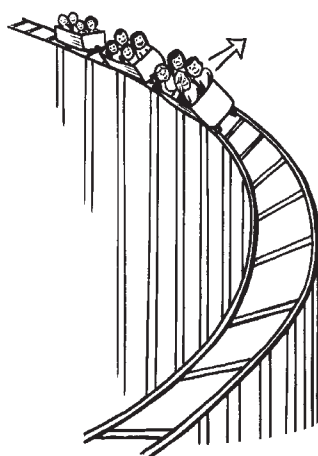
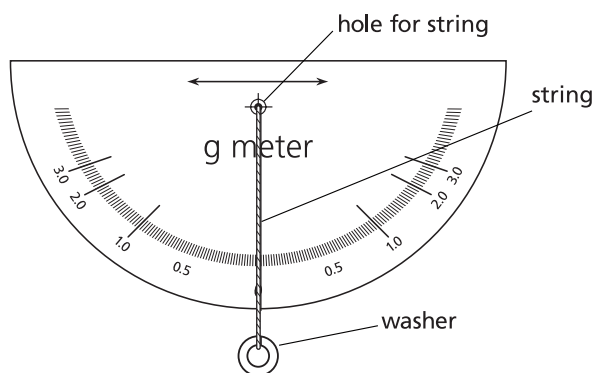
This number is the height of the ride.

$h_T = \text{_____} \text{ m}$

## Lateral Acceleration

### G Meter

A common unit to describe the forces we feel is the “g.” One g is equal to the force of earth’s gravity. With the help of a g meter, you can measure the lateral forces you feel. The device is held horizontally and the weight swings to one side as you round a curve. You can measure the “g” force you feel right off device.



## Useful Formulae

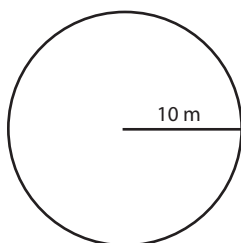
**Circumference of a circle**

$$C = 2\pi r \quad \pi = 3.14$$

$r$  = radius of the circle

*Example:* What is the circumference of a circle with a radius of 10 m?

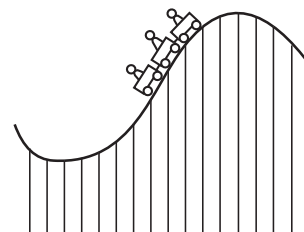
$$\begin{aligned} C &= 2\pi r \\ &= (2)(3.14)(10) \\ &= 62.8 \text{ meters} \end{aligned}$$

**Speed of an object in a straight line**

$$v = \frac{d}{t} \quad \text{speed} = \frac{(\text{distance travelled})}{(\text{time for the trip})}$$

*Example:* What is the speed of a roller coaster if it takes 53 seconds to make a trip of 700m?

$$\begin{aligned} v &= \frac{d}{t} \\ &= \frac{700 \text{ m}}{53 \text{ sec}} \\ &= 13.2 \frac{\text{m}}{\text{sec}} \end{aligned}$$



$$V_{\text{ave}} = \frac{\Delta x}{\Delta t} \quad \text{average velocity} = \frac{(\text{change in position})}{(\text{change in time})}$$

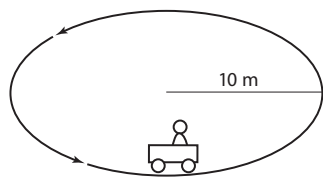
**Speed of an object in a circle**

$$v = \frac{2\pi r}{t} \quad \text{speed} = \frac{(\text{distance travelled})}{(\text{time for the trip})}$$

( $t$  = time for one revolution)

*Example:* What is the speed of a car around a ride that has a 10m radius and takes 6.1 seconds to make one revolution?

$$\begin{aligned} v &= \frac{2\pi r}{t} \\ &= \frac{2(3.14)(10 \text{ m})}{6.1 \text{ s}} \\ &= 10.3 \frac{\text{m}}{\text{sec}} \end{aligned}$$



$t = 6.1 \text{ s}$

**Acceleration of an object in a straight line**

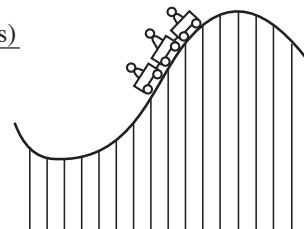
$$a = \frac{\Delta v}{\Delta t} \quad \text{acceleration} = \frac{(\text{change in velocity})}{(\text{change in time})}$$

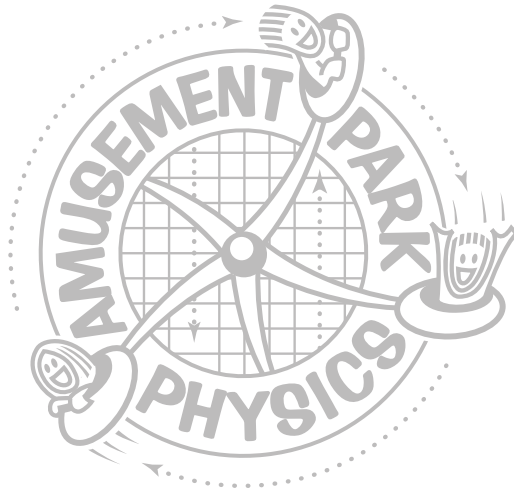
$$\Delta v = v_f - v_i$$

change in velocity = final velocity – initial velocity

*Example:* What is the acceleration of the roller coaster down the hill if it increases in speed from 5 m/s at the top to 11 m/s at the bottom in 2.5 seconds?

$$\begin{aligned} a &= \frac{\Delta v}{\Delta t} \\ &= \frac{(v_f - v_i)}{\Delta t} \\ &= \frac{(11 \text{ m/s} - 5 \text{ m/s})}{2.5 \text{ s}} \\ &= \frac{6 \text{ m/s}}{2.5 \text{ s}} \\ &= 2.4 \text{ m/s}^2 \end{aligned}$$





## **Section B**

# **Constructing The Equipment**

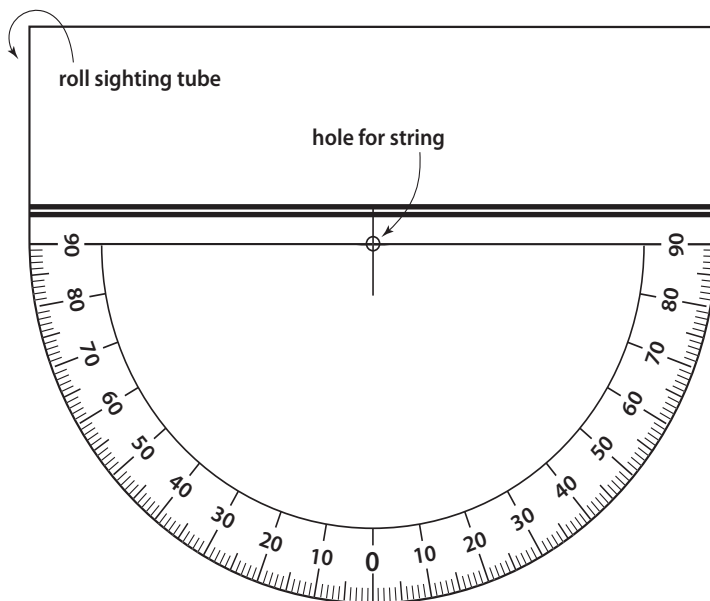
page B-1     Astrolab

page B-3     G-Meter

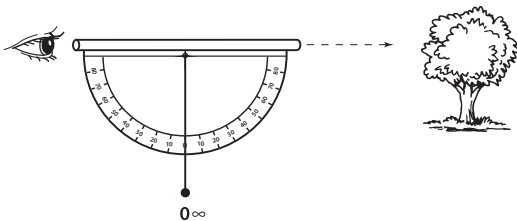
## ASTROLAB

### Triangulation Instrument and Accelerometer

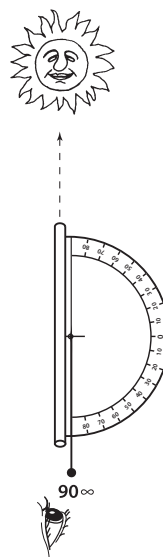
1. Cut out the Astrolab.
2. Fold the top section over a pencil and roll it down to the heavy double line to make a sighting tube.
3. Tape the rolled paper tube closed and then let the pencil slide out.
4. Glue the Astrolab to a 8" x 5" index card and trim.
5. Take about 20 cm of heavy thread and tie one end to a weight such as a key or washer. Tie the other end through the hole at the top of the Astrolab.
6. Let the thread hang free. The angle it marks off is the angular height of an object seen through the tube.



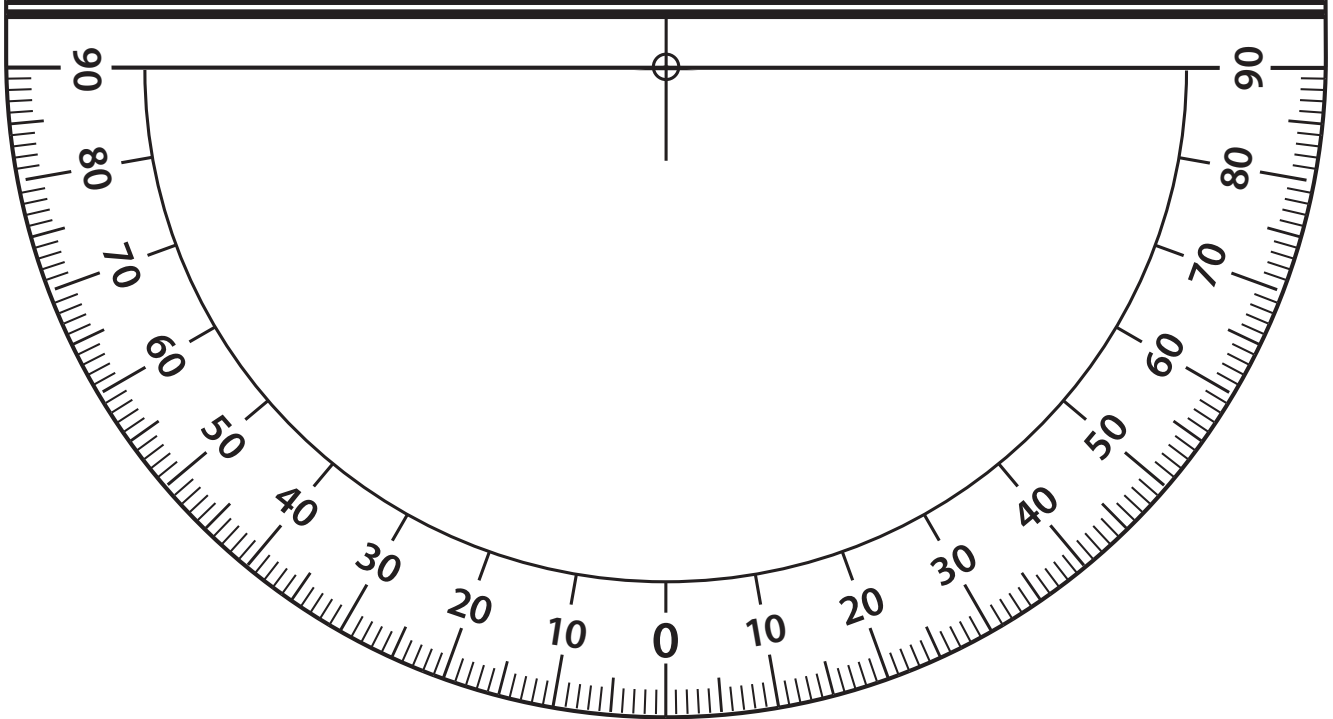
For instance:



An object on the horizon has an angular height of 0 degrees.

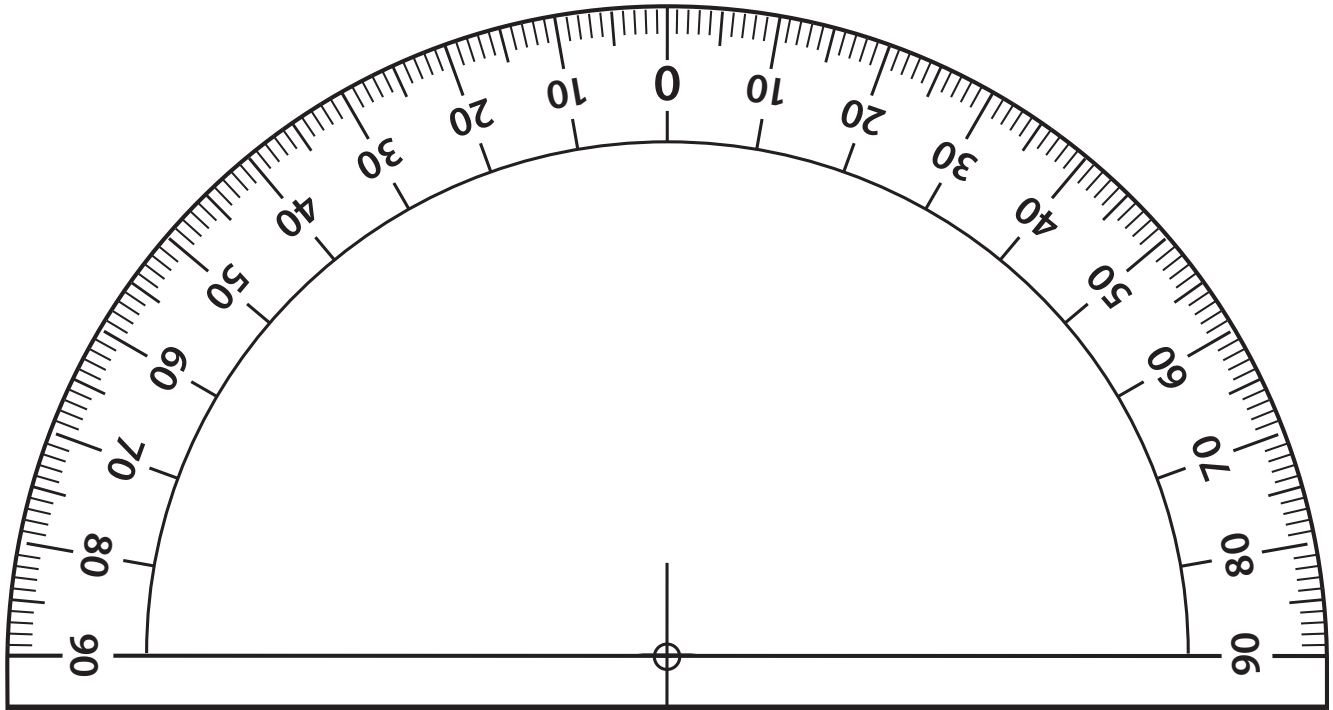


An object directly overhead has an angular height of 90 degrees.



Amusement Park Physics

Section B • Constructing the Equipment





## G-METER

A common unit to describe forces we feel is the “g.” One g is equal to the force of earth’s gravity. When the space shuttle takes off, astronauts feel about three g’s of force (three times the force of earth’s gravity). How many g’s do you feel on the swings, on your bicycle, on an amusement park ride, or in a car? You can make a “g” meter to measure these forces.

1. Obtain the following materials for each g meter:

- ☐ copy of g meter on next page
- ☐ thin cardboard
- ☐ glue
- ☐ scissors
- ☐ string or heavy thread
- ☐ metal washer

2. Make a copy of the g meter.

Cut out the g meter.

Glue the g meter to a thin cardboard and trim to size.

Take about 15 cm (6 inches) of heavy thread and tie one end to a weight such as a key or washer. Tie the other end through the hole at the top of the g meter.

Hold the g meter in front of you. Let the thread hang down so that it lines up with the 0 g mark.

If the g meter moves in the direction of the arrows, the weight and string will tell you the force in g’s.

In order to have the g meter work properly, the top edge must be horizontal, level with the horizon.

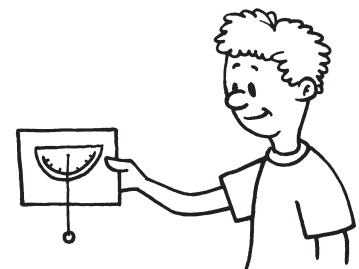
3. Now that you have your g meter, try it out.

Hold the g meter in front of you when your parents drive the car around a corner. How many g’s did you feel? Is there a difference between going around a corner slowly and going around it fast?

Hold the g meter beside you while you are on a swing. Hold it so that the arrows point in the direction you will be going. As you swing, how many g’s did you feel?

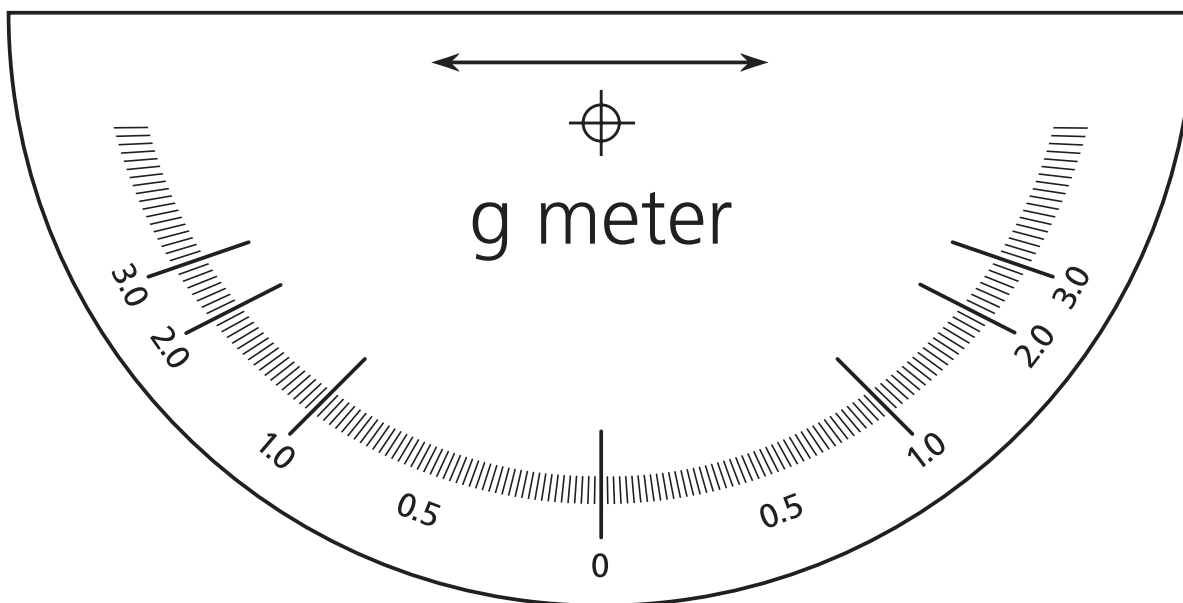
Use the g meter on the merry-go-round at the playground. Sit on the outside edge of the ride and point the arrow toward the centre. How many g’s do you feel? What happens to the number of g’s as the ride moves faster? What happens to the g’s if you sit closer to the centre of the ride?

Use the g meter on the Amusement Park rides. How many g’s does each ride create? How does each ride do it? Do some use speed or turns to create large forces?

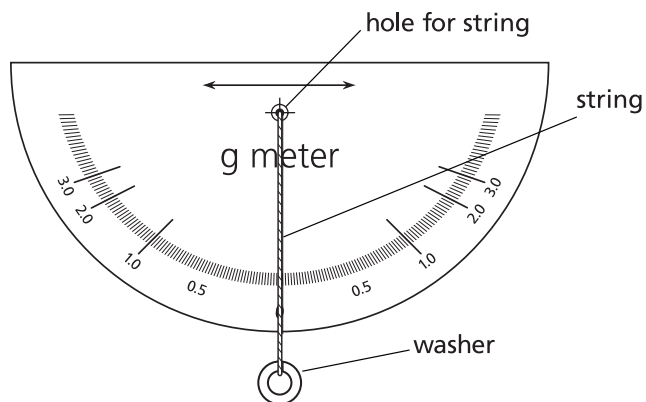


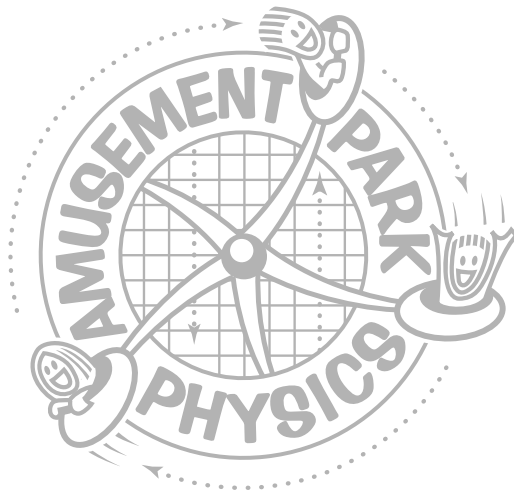
## G-METER

Trace and cut out this g meter.



Attach string and washer as shown.





## **Section C**

# **Science IO Worksheets**

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# Estimation at the Amusement Park

One skill that is important in science is *estimation*. An estimation gives you an approximate answer before you solve a problem. This estimation will tell you if your answer is reasonable. Try the following activities and sharpen your estimation skills. For each question, give your estimation *and the reasoning you used* to obtain that estimation. Remember, an estimation is not just a guess.

## Questions

**1** How tall is the Hellevator tower?

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**2** What is the average speed of the Coaster for a complete trip?

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**3** How many times does the Enterprise rotate during one day of operation?

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**4** How many soft drinks do all the concession stands combined sell during one day at Playland?

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**5** How many people are at Playland today?

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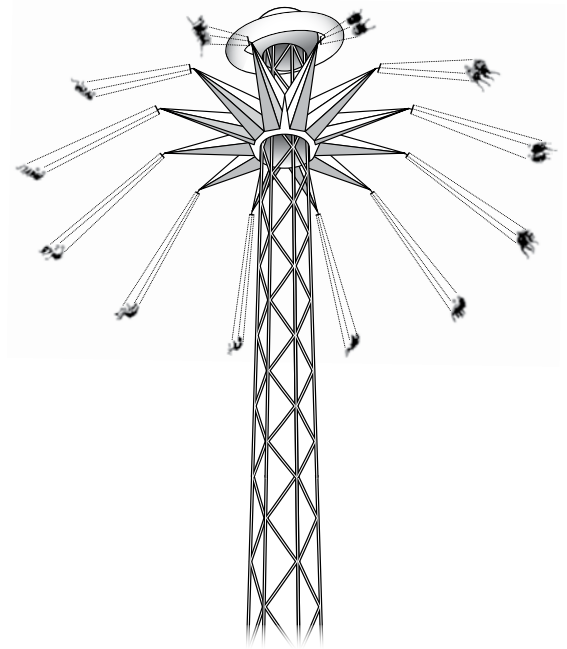
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# Atmosfear

## A. Data

- ➊ Distance from center of rotation to seat when ride is going full speed \_\_\_\_\_ m
- ➋ Time for three revolutions \_\_\_\_\_ s
- ➌ Time for one revolution \_\_\_\_\_ s
- ➍ Accelerometer reading \_\_\_\_\_ g's



## B. Qualitative Tasks

- ➊ Watch the ride from the beginning until it reaches full speed. What happens to the seats as the ride increases in speed? Why?  
\_\_\_\_\_  
\_\_\_\_\_
- ➋ What force causes the seats to change position?  
\_\_\_\_\_
- ➌ Describe your sensations as the ride increased in speed. Do you feel different looking at the chair in front of you compared to watching objects as they move by?  
\_\_\_\_\_  
\_\_\_\_\_
- ➍ Will an empty swing or one with someone in it ride higher? Why?  
\_\_\_\_\_  
\_\_\_\_\_
- ➎ During the ride, when do you feel the heaviest? the lightest?  
\_\_\_\_\_  
\_\_\_\_\_
- ➏ How many g's do you feel when the ride is going full speed? What causes the g's to occur?  
\_\_\_\_\_  
\_\_\_\_\_
- ➐ How is this ride similar to and different than the Sea to Sky Swinger? Are the physics different?  
\_\_\_\_\_  
\_\_\_\_\_
- ➑ What effect does the height of the ride have on the centripetal force created in the ride? What affect does its height have on the thrill of the ride?  
\_\_\_\_\_  
\_\_\_\_\_

calculations

C. Quantitative Calculations

1 Guess how fast you go on this ride.

\_\_\_\_\_ km/hr

2 Calculate the distance you travel in one revolution of the ride at full speed.  
(Hint: It’s the circumference of a circle).

\_\_\_\_\_ m

3 Calculate the speed you travel at during the ride.  
(Hint: Use velocity formula). Convert to km/hr.

\_\_\_\_\_ m/s

\_\_\_\_\_ km/hr

4 Compare #1 and #3. Explain the difference.

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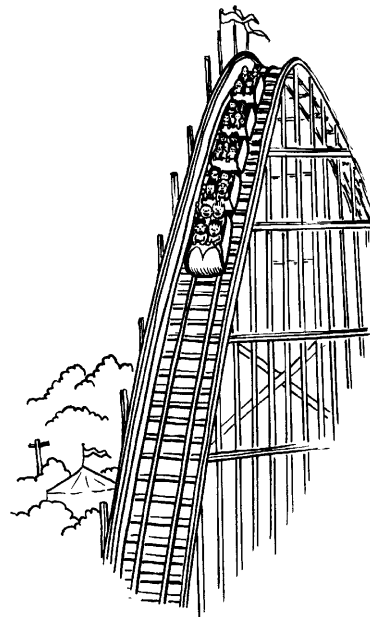
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# Coaster

## A. Data

Length of track 695 m

- 1 How many slopes are involved in this ride? \_\_\_\_\_
- 2 Estimate the height of the first hill. \_\_\_\_\_ m
- 3 Estimate time (in seconds) for the following questions:
  - (a) Time for one trip? \_\_\_\_\_ s
  - (b) Time it takes for train to go from bottom to top of first hill? \_\_\_\_\_ s
  - (c) Time it takes for train to go from top to bottom of first hill? \_\_\_\_\_ s



## B. Qualitative Observations

- 1 Where was the highest hill on the ride? Why was it there?  
 \_\_\_\_\_  
 \_\_\_\_\_
- 2 Were you thrown from side to side in the train? If so, what forces caused that feeling?  
 (Use a diagram if necessary to help explain).  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

- 3 Where on the ride did you feel you were going the fastest? Why?  
 \_\_\_\_\_  
 \_\_\_\_\_

- 4 Where on the ride did you feel like you were lifted off your seat?  
 How did the ride cause that feeling?  
 \_\_\_\_\_  
 \_\_\_\_\_

- 5 Why are there no seatbelts which strap you into this ride?  
 \_\_\_\_\_  
 \_\_\_\_\_

- 6 What would happen if you raised your arms up in the air at the crest (top) of a hill  
 and left them up as you descended?  
 \_\_\_\_\_  
 \_\_\_\_\_

calculations

**C. Quantitative Calculations**

- 1** Calculate the average velocity for the Coaster of one ride.

\_\_\_\_\_ m/s

\_\_\_\_\_ km/hr

- 2** Explain, in terms of forces, the difference between the time it takes:

(a) to get up a hill

(b) to get down a hill

- 3** List the types of friction which affect the train throughout the entire ride.

- 4** Show in a simple diagram of the ride, one place where your car is:

(a) accelerating

(b) decelerating

- 5** What is the distance the coaster travels in one ride? What is the displacement? Explain.

- 6** How would the coaster work on the Moon? Explain your answer.  
(Think about the acceleration due to gravity on Earth and the Moon.)



# Coaster Graphing

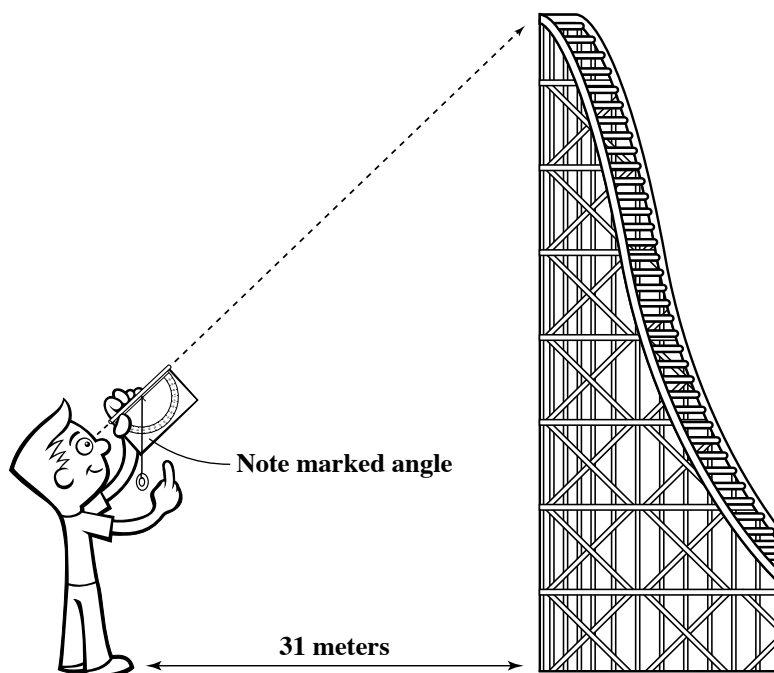
One way to calculate the height of a ride is by using a type of mathematics called **trigonometry**. Trigonometry is the study of the relationship among the sides and angles of triangles. These relationships are called trigonometric ratios. In this case, you'll use the tangent ratio.

## Procedure

- ➊ Measure or estimate a distance that is **31 m** from the base of the Coaster hill you are measuring.
- ➋ Face the hill, then look at the top of it sighting through the tube on the astrolabe. Instructions for making your astrolabe are in Section B.
- ➌ Without moving the position of the astrolabe, read the degrees where the string touches the astrolabe.
- ➍ Use the chart below to approximate the height of the object. Interpolate between these data values for angle measurements that aren't multiples for five.
- ➎ Remember that there are other ways to measure heights and distances. Refer to Section A for more ideas. You can also use other distances from the hill and their trigonometric values if you prefer.

$$\tan \theta = \frac{\text{opposite side length}}{\text{adjacent side length}}$$

- ➏ Record the time to reach each point in the data table below. Start with **t = 0** at the beginning of the ride.



Angle (in degrees)	Height of the Object (in metres)
5	2.7
10	5.4
15	8.2
20	11.2
25	14.4
30	17.8
35	21.5
40	25.8
45	31.0
50	36.7
55	43.9
60	53.3

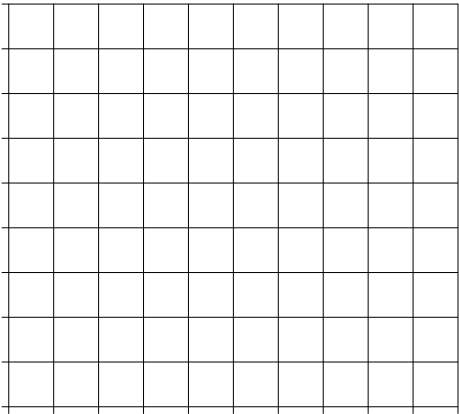
Data

Find the height of the Coaster locations using trigonometry.  
The blank spaces will let you put in other locations of your choice..

Location on the Coaster	Estimated Height from the ground (in m)	Time to reach this point (in s)
Start of the ride		
Bottom of first hill		
Top of first hill		
Bottom of second hill		
Top of second hill		
Bottom of next hill		
End of Ride		

Questions

1 Draw a graph of height (vertical axis) vs. time (horizontal axis), using the data from your Data Chart, on the graph at the right.



2 Describe the shape of your graph. Does it have a regular or irregular shape?

3 What does it mean when your graph shows a horizontal line?

- 4 What does it mean when your graph shows a line that it moving upward?  
What happens the motion of the cars then?

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- 5 What does it mean when your graph shows a line that is moving downward?  
What happens to the motion of the cars then?

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- 6 What does the slope of the line on your graph tell you about the motion of the ride?

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- 7 How would your graph be different if you selected a height of 0 for the starting point of the ride?

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**Bonus Question**

Collect data and draw a graph of the velocity vs. time for a ride on the Coaster.

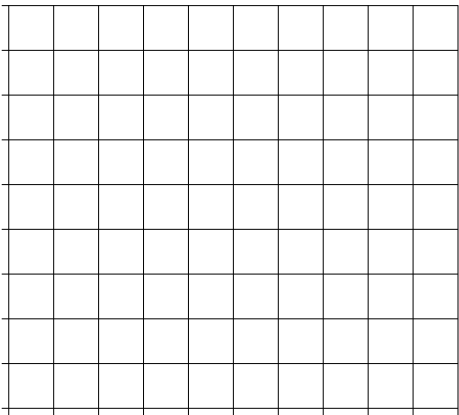
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# Pirate Ship

## A. Data

- 1 **Challenge:** Estimate the vertical distance from the top to the bottom of the ride. \_\_\_\_\_ m

- 2 How long does it take for this ride to make one complete swing? \_\_\_\_\_ s

- 3 The motion of this ride is a good example of a \_\_\_\_\_

- 4 Give examples of other devices that use this motion:

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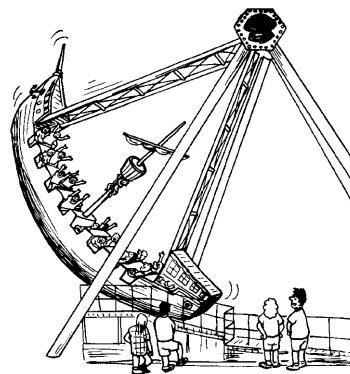
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- 5 How long does the whole ride last? \_\_\_\_\_ s

- 6 How many full swings does the pirate ship make?  
(a complete cycle is the time to swing over and back). \_\_\_\_\_



## B. Qualitative Tasks

- 1 When does the ride seem to be accelerating?

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- 2 When does the ride seem to be decelerating?

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- 3 a) What forces are acting upon you during this ride?

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- b) Why do you think seatbelts are not used for this ride?

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**4** Draw *simple* diagrams indicating at what point the forces acting upon the ride are:

a) balanced

b) unbalanced

**5** What term can you use to describe the force acting upon you at the point when the bow or stern of the pirate ship is highest?

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# Music Express

## A. Data

- ① Radius of the ride \_\_\_\_\_ m
- ② Time for one revolution at full speed \_\_\_\_\_ s



## B. Qualitative Tasks

- ① Describe the sensations that you felt on the ride.  
Include any differences you felt as the ride progressed.

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- ② Why do you think you were seated backward?

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- ③ Was there any difference in the sensation of speed at the highest point of the ride compared to the lowest point? If so, explain.

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- ④ Imagine that all the music system speakers were placed at one spot next to the ride.  
Would the music sound any differently to the passengers when approaching or travelling away from the speakers? Explain.

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calculations

C. Quantitative Calculations

1 Guess how fast you go on this ride.

\_\_\_\_\_ m/s

2 What is the distance a car travels in one revolution?

\_\_\_\_\_ m

3 Calculate the maximum speed that the cars go during the ride?

\_\_\_\_\_ m/s

\_\_\_\_\_ km/hr

4 Do you go faster up the hill or down the hill? Explain.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

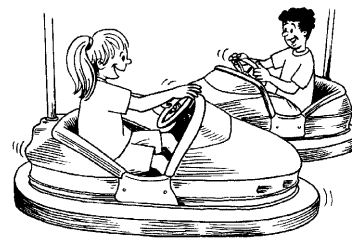
\_\_\_\_\_

\_\_\_\_\_

# Rock-N-Cars

## A. Qualitative Tasks

Make observations that will allow you to answer the following questions.  
State the observed facts that justify each of your answers.



- 1 List all energy transformations which take place from beginning to end of this ride.

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- 2 In words or short phrases, describe what it was like to participate in this ride.

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- 3 Do you have much control over movement by using the steering wheel? Why or why not?

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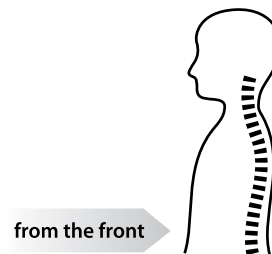
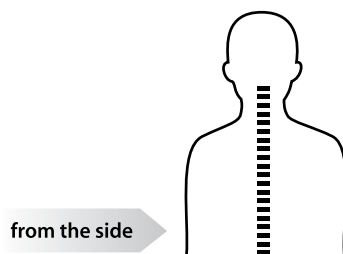
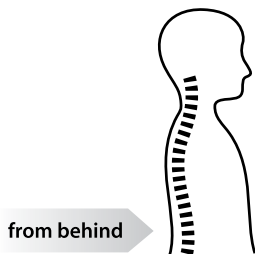
- 4 Can you go in reverse? If so, discuss how this is done.

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- 5 Draw, using arrows, the direction of the forces which act upon your spine and neck when you are hit by another car.



- 6 Draw three step by step simplified diagrams which show ("slow motion") how your body might react to a collision.

step 1

step2

step3



**7** Predict what would happen if:

a) there were more bumper cars;

b) there were fewer bumper cars;

c) the bumper cars were bigger;

d) the bumper cars were smaller;

e) the bumpers on the cars were larger;

f) the bumpers on the cars were smaller.

**8** Discuss the function of the safety strap by answering the following questions:

a) Does the strap adequately hold you in place upon impact from the side?  
from the front? from the rear?

b) Is it long enough to fit you comfortably?

c) How would the strap help you if, somehow, you flipped the bumper car?

**9** Suggest an alternative design to the bumper car safety strap.

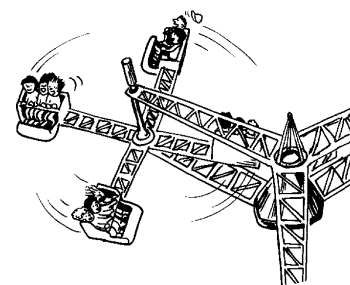
**10** Complete the following chart with a word or short phrase:

How I felt before the ride	How I felt after the ride

# Scrambler

## A. Data

- 1 Length of time for complete ride. \_\_\_\_\_ s
- 2 Length of time for seat to make a small circle/the seat will go back and forth across the ride twice during each small circle. \_\_\_\_\_ s
- 3 Maximum accelerometer reading \_\_\_\_\_  $g$ 's
- 4 Was the rotation clockwise or counterclockwise around primary axis? \_\_\_\_\_
- 5 Was the rotation clockwise or counterclockwise around secondary axis? \_\_\_\_\_
- 6 Concentrate your attention on one rider, and follow this single rider's path for at least one full rotation of the ride. Draw the path of the rider for one full rotation. *(Your diagram should be what you would see if you watched the rider's path while looking down on the ride from above.)*



## B. Qualitative Tasks

- 1 Describe the sensations you felt during the ride.  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_
- 2 Are the forces you feel the same for the whole ride? Explain any difference.  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

- 3** How did the accelerometer show your results in #2?

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- 4** What would happen if both the primary and secondary rotation were in the same direction? How would a ride like that feel? On your diagram, show where forces are the most and where they are the least.

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- 5** Where do you feel you travel the fastest? Where the slowest?

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calculations

### C. Quantitative Calculations

- 1** Approximate total distance travelled for the ride.

\_\_\_\_\_ m

- 2** Average speed

\_\_\_\_\_ m/s

\_\_\_\_\_ km/hr

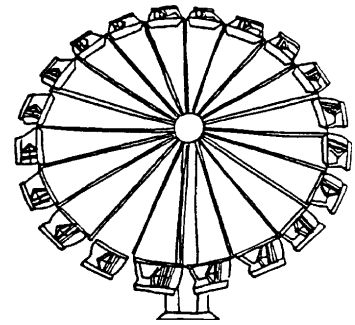
- 3** Draw a diagram showing both rotation axes. Where is acceleration additive (in same direction)? Where is acceleration in opposite direction?

- 4** Draw the net acceleration at each point in #3 (using vector arrows).

# Enterprise

## A. Data

- 1 Radius of the ride \_\_\_\_\_ m
- 2 Time of one revolution when ride is at full speed. \_\_\_\_\_ s



## B. Qualitative Tasks

- 1 Observe the Enterprise as it is starting out. As it starts to move in a horizontal orbit, what do you notice about the cars in relationship to the ride?

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- 2 Continue to watch the ride as it changes from horizontal to vertical. Now what do you notice about the cars in relationship to the ride?

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- 3 Why do you suppose that the cars changed their positions?

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- 4 In the upside down part of the ride, do you feel like you are going to fall down? If not, explain why.

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- 5 Towards the middle where the ride spins, does the center appear to be going faster or slower than the cars? Measure it out. What did you find?

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- 6 While riding the ride, notice at what particular point you appear to be going faster. Where on the ride do you feel this? (At the top, bottom, etc.) Why do you suppose that this is so?

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- 7** Also notice at what point in the ride you appear “heavier”.  
Where on the ride do you feel this? Why do you suppose that this is so?

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- 6** How do you feel as you leave the ride?

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calculations

### C. Quantitative Calculations

- 1** Calculate the circumference of the ride.

\_\_\_\_\_ m

- 2** Calculate the frequency of the ride at full speed.

\_\_\_\_\_ rev/s

- 3** Calculate your speed in the ride at full speed.

\_\_\_\_\_ m/s

\_\_\_\_\_ km/s

# Hell's Gate

Stand in a position where you can observe the ride. Take data and answer the following questions. After reading the questions, you must determine what data you need to collect.

## A. Data

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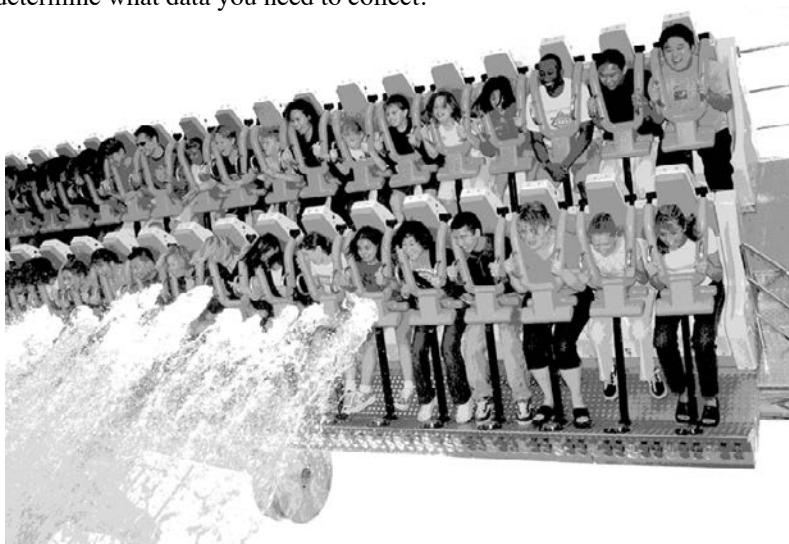
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Measurements while on ride: (using accelerometer)

Maximum **g** \_\_\_\_\_ g's at \_\_\_\_\_ (location)

Minimum **g** \_\_\_\_\_ g's at \_\_\_\_\_ (location)

## B. Qualitative Tasks

- 1 Have the riders take their pulse rate:
  - a) before they get on this ride. \_\_\_\_\_
  - b) immediately after they have finished this ride. \_\_\_\_\_
- 2 In a few words, have the riders describe how they felt:
  - a) before the ride started \_\_\_\_\_
  - b) during the ride \_\_\_\_\_
  - c) after the ride ended \_\_\_\_\_
- 3 Where on the ride do the riders experience:
  - a) more g's than normal \_\_\_\_\_
  - b) less g's than normal \_\_\_\_\_

- 4 Explain the riders' sensations and the g's they felt in #3 in terms of the physics of the ride.

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calculations

### C. Quantitative Tasks

- 1 Calculate the average speed during the ride in m/s.

\_\_\_\_\_ m/s

- 2 Estimate the mass of the ride and the riders.

\_\_\_\_\_ kg

- 3 Calculate the amount of work necessary to move the ride and the riders from the lowest point to the highest point on the ride.

\_\_\_\_\_ Joules

- 4 How much power do the motors have to supply to move the ride and the riders in calculation #3?

\_\_\_\_\_ kW

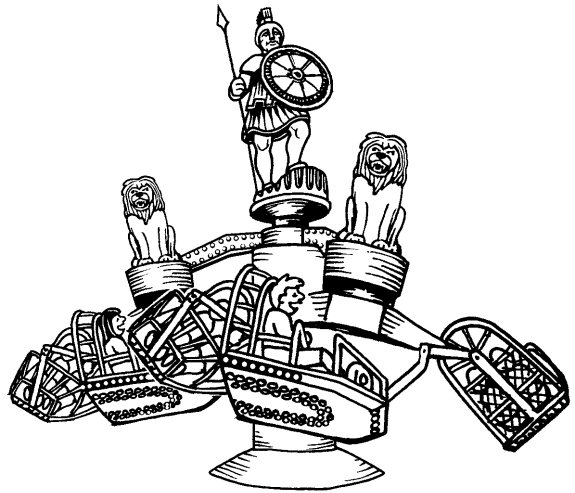
- 5 Present data and calculations for any other portion of the ride.

# Gladiator

This ride uses unusual centripetal force.

## Procedure and Questions

Ride the Gladiator and answer the following questions.



- 1** Does the large wheel at the centre of this ride turn clockwise (move to the left) or counter-clockwise (move to the right)? What other motion does the ride have?

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- 2** Describe the forces you felt while on the ride. Are the forces always the same or do they change during the ride? If the forces change on the ride, where do they change?

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- 3** How many g's does this ride create? Are the g's constant or do they change? Explain your answer.

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- 4** Concentrate your attention on one rider during the ride and follow this single rider's path for at least one full revolution of the ride. Draw a diagram of the path he took for that single revolution. (*Your diagram should be what you would see if you watched the rider's path while looking down on the ride from above.*)



# Question Page

## Instructions

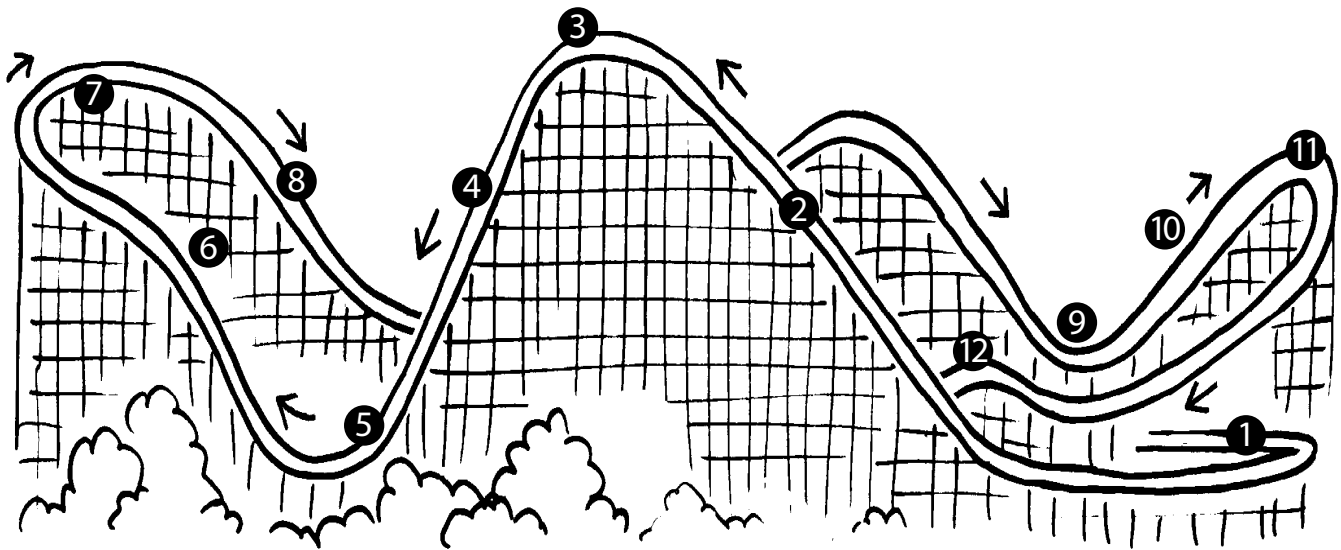
Choose one ride only and make up 10 of your own science questions specifically on that ride.

- 1. \_\_\_\_\_  
\_\_\_\_\_
- 2. \_\_\_\_\_  
\_\_\_\_\_
- 3. \_\_\_\_\_  
\_\_\_\_\_
- 4. \_\_\_\_\_  
\_\_\_\_\_
- 5. \_\_\_\_\_  
\_\_\_\_\_
- 6. \_\_\_\_\_  
\_\_\_\_\_
- 7. \_\_\_\_\_  
\_\_\_\_\_
- 8. \_\_\_\_\_  
\_\_\_\_\_
- 9. \_\_\_\_\_  
\_\_\_\_\_
- 10. \_\_\_\_\_  
\_\_\_\_\_

List five (5) surprising (unexpected) things that you discovered during **Science Day**.

- 1. \_\_\_\_\_  
\_\_\_\_\_
- 2. \_\_\_\_\_  
\_\_\_\_\_
- 3. \_\_\_\_\_  
\_\_\_\_\_
- 4. \_\_\_\_\_  
\_\_\_\_\_
- 5. \_\_\_\_\_  
\_\_\_\_\_

# Science Day Quiz



List the number (or numbers) on the roller coaster that best match the phrases below:

- \_\_\_\_\_ freefall area
- \_\_\_\_\_ weightless zone
- \_\_\_\_\_ where a machine makes the ride go instead of gravity
- \_\_\_\_\_ where car moves because of momentum roll
- \_\_\_\_\_ banked curve
- \_\_\_\_\_ parabolic arc
- \_\_\_\_\_ centripetal force at work
- \_\_\_\_\_ greatest gravitational potential energy
- \_\_\_\_\_ where the coaster's velocity increases
- \_\_\_\_\_ high g-force zone
- \_\_\_\_\_ where car moves the slowest assuming a frictionless track
- \_\_\_\_\_ where riders decelerate
- \_\_\_\_\_ greatest kinetic energy

# First Nations Science

We are taught and learn a Euro-centric view of science. That makes sense because in North America we were settled mainly by Europeans. But there are other points of view that are often overlooked. In this activity you will be given a chance to explore other points of view and contributions to science by other cultures. To make it easier we will divide it into sections: *transportation, housing, food and agriculture*, and others like *astronomy, medicine, fishing, sustainability*, and *environment*. So, here we go...



## Transportation

There are many surfaces we have to travel over: rivers, oceans, lakes, land, mountains, etc. Start with water. Two ways to travel on water are rowboat and canoe. Compare them. Research their use and development. Which is better for Canadian rivers, lakes, rapids, northern waters and oceans? Be prepared to present your findings to your class.



Next look at land travel. What are ways to move over land, including both flat land and mountains? Again be prepared to present your findings to your class.

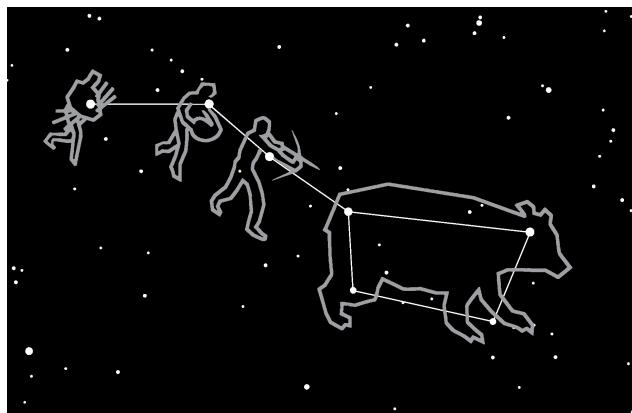
## Food and Agriculture

The origin of the foods we eat come from many places. Select a food and research it. Focus on its origin and importance to our diet. Which foods have a First Nations origin and which came from other countries?

## Astronomy

When humans developed into a farming society, it became important to know the yearly cycle and the seasons. There are examples of this around the world, from Stonehenge in England to structures in Mexico like Tulum and Chichen Itza. There are also several First Nations examples. For this topic, research one example of how we measure a year. Look at both past examples and modern ones.

Another thing people have done is look at the stars. They notice shapes of images that some stars seem to make, called constellations. Research one constellation. Draw a picture of the image made by the stars and write about the legend or story that goes with it. Do the First Nations people have a different name and story? Is the name or story different in another country? Finally, draw your own constellation of 3 to 5 stars. Draw the image they make and write a story about the image. Be prepared to tell the class what you learned.



## Medicine

Medicines and health remedies come from many places. For this topic, research the history of one medicine. Be prepared to present your findings to the class. Which medicines have a First Nations origin?

## Fishing

Besides plants, fish have long been a part of the human diet. Research one kind of food fish. Where does it live and how is it caught? Are these methods sustainable? Finally, has the fish been important for First Nations?

## Summary

Write three things you have learned in this activity that you didn't know before. What is one question you still have about First Nations science? How could you answer your question? Be prepared to share this with the class.

