Amusement Park PHYSICS

PLAYLAND

PHYSICS and SCIENCE DAY 2024

Anatomy and Physiology 12

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Amusement Park Physics

and the new Secondary School Curriculum

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.

This year's curriculum reflects the different demands that are placed on students in Anatomy and Physiology 12. We have sought to align the worksheets with the Provincial Ministry Anatomy and Physiology 12 guidelines and their intended outcomes.

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, analyst of results and communicating a conclusion.

Amusement Park Physics

We are excited to welcome you back to Playland for what is the 36th year of ***Amusement Park Physics***. Although we have missed some time due to the pandemic, we are eager for teachers and students to get back into the park and apply their scientific knowledge to all the amazing rides.

This project was started by James (Jim) Wiese in 1988 with his senior Physics students and was expanded in 1990 with the addition of the Grade 9 program. A while later Jim added an elementary school version called ***The Science of Fun.*** In 2008 a French Version for elementary schools was added called ***La Science du Plaisir*** and a curriculum for Grade 8 and Grade 10 Science. 2011 saw the addition of a version for Biology 12 (Anatomy & Physiology 12) and in 2012 Chemistry 11 and Chemistry 12 were added. A special thanks to Mike Eckert at Lord Tweedsmuir for helping with the Chemistry Module. 2016 saw the addition of activity sheets for the Beast and Haunted House. Rather than having them for specific grades, we added questions at the bronze, silver, and gold level. This allows teacher to choose the appropriate level for their students.

The purpose of ***Amusement Park Physics*** is to provide students with practice applying concepts learned in the classroom to real situations and experiences felt and seen on the rides. While working with a group of their peers or individually, students can problem solve, discuss possible solutions, communicate their ideas, and finally come to a conclusion about what they are experiencing. The process is far more important and rewarding than the final answer.

Due to the success of ***Amusement Park Physics***, we have spread the event 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 lineups at the rides to ensure 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 Anatomy & Physiology 12. You may choose to only download and print the version(s) that you will be using. Please feel free to adapt any materials to better suit your needs.

I'd like to thank all those involved in ***Amusement Park Physics 2024***: Michelle Pattison, Jacob Simms, Rob Decman, Jennifer Campbell, Peter Male and all the staff of the Pacific National Exhibition and Playland for their support. The work and dedication of all these people make ***Amusement Park Physics 2024*** possible.

2024 marks the first year that Jim Wiese will be taking a behind the scenes role and enjoying retirement a little more. It's a real honour that Jim has asked me to keep ***Amusement Park Physics*** moving forward and guarantee that for the coming years, students will be welcome at the park to apply all the scientific principles that they have learnt in class. As a former physics 11 attendee of ***Amusement Park Physics*** and now as a teacher, I understand the important of having students get outside the classroom and explore science in a fun and engaging setting.

Look forward to seeing you at Playland,

Steve Simms

New Safety Regulations at Playland

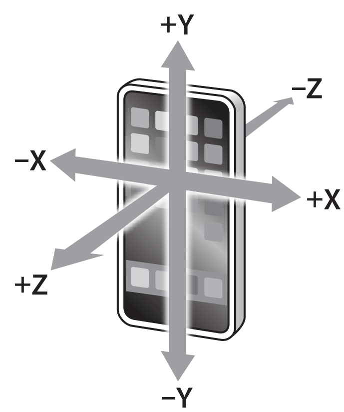
Due to newly aligned amusement ride safety regulations in BC, hand-held measuring devices, or anything classified as a "loose item", are not permitted on amusement park rides and attractions.

As portable G-Meters and accelerometers are no longer permitted, we recommend the use of a third-party accelerometer app on securely stores cell phones in place of these devices. Seach for "accelerometer" and "roller coaster" to review the options available. Although we don't endorse any specific apps, we have found the free app Phyphox to be effective. Please ensure accelerometer apps are downloaded to all devices in advance as Playland does not have Wi-Fi on site.

To securely store cell phones during ride cycles, students are permitted to bring their own arm bands or hip packs. Playland has a limited number of arm bands or hip packs that can be used by students who do not bring their own. Please ensure students who borrow Playland items return them at the end of each ride cycle.

As students are not permitted to hold devices while the ride is in operation, please ensure the app has been started prior to loading, as use of the app is not permitted while the ride is in motion.

Be sure to know and understand the orientation of the cell phone to properly interpret the data. We suggest you practice using it before coming to the park to understand how the data is interpreted with different orientations. Depending on your level of understanding and familiarity using the app(s), you may want to use the absolute value feature that will allow you to see just the magnitude.



The use of cell phone accelerometers is not required to experience Amusement Park Science. The exciting curriculum provides other questions or investigation opportunities that can be incorporated with many of our rides without the use of these accelerometers.

***Note*: Using your cellphone on a field trip is your responsibility.**
Playland is not responsible for any lost or damaged items.

Table of Contents

Introduction

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.

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. Portable blood pressure device (optional)
5. Calculator

Critical Safety Note

As hand-held devices are not permitted on amusement park rides, students may use apps installed in advance on cell phones. During rides, phones must be securely stored in arm bands or hip packs.

Sample Timetable

Please adapt to fit your circumstances

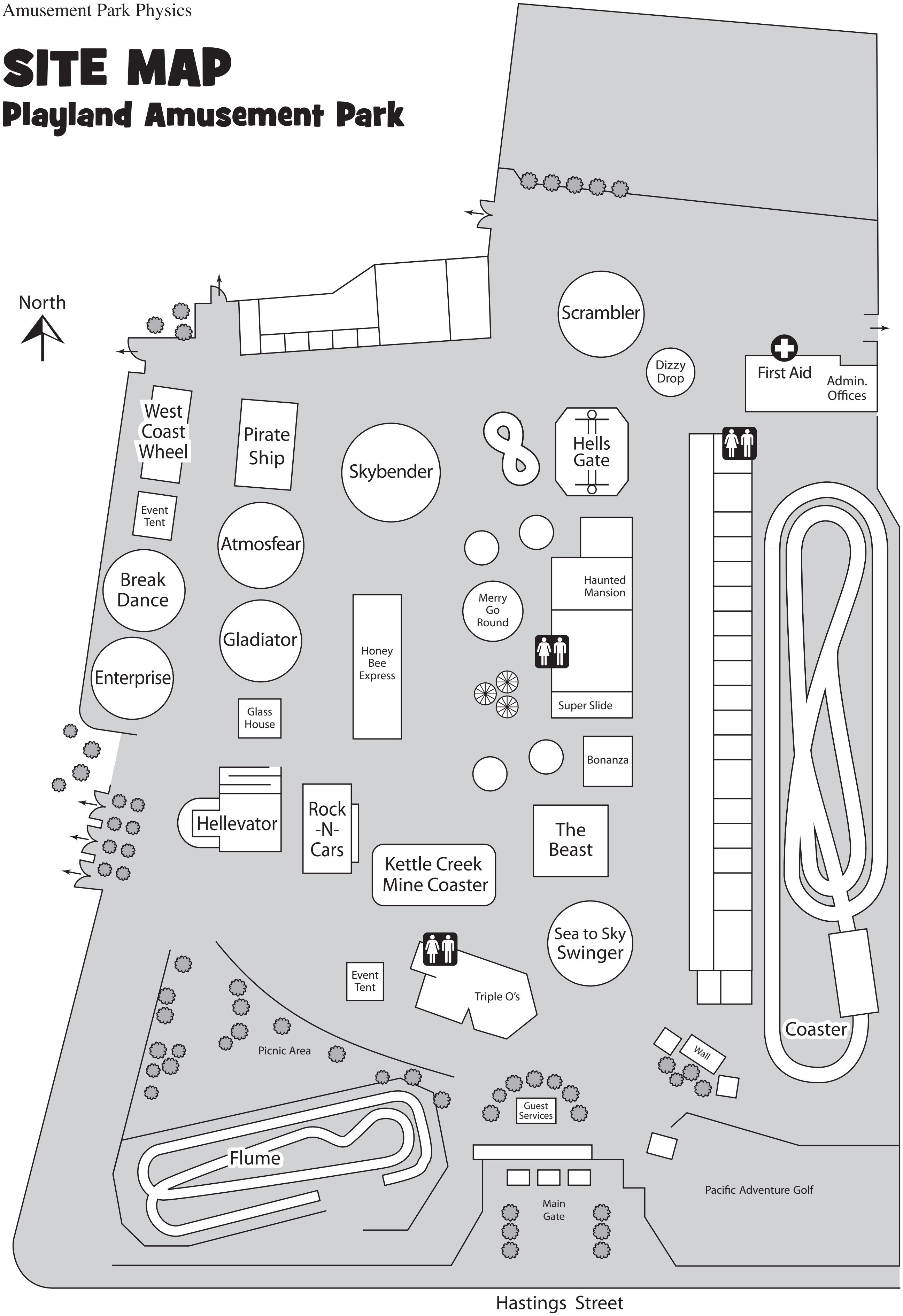
Time Schedule

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:

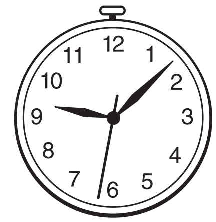
- ❏ BRING A LUNCH (You will <u>NOT</u> be allowed to leave the park for lunch)
- ❏ BRING A PENCIL
- ❏ Bring a calculator if you wish
- ❏ Don’t forget to bring this assignment package!
- ❏ Try to bring a watch with a second hand or digital seconds to record times on the rides. A digital watch with a stopwatch mode works very well.
- ❏ Try to return all equipment (stop watches, sphygmomanometers, etc.) to your teacher when you are not using them during the day. You’ll be sharing them with other students and we need to make sure everyone gets a chance to use them.

SITE MAP
Playland Amusement Park



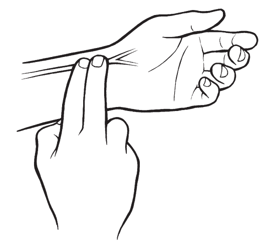
Section A
Making Measurements

Time



The times that are required to work out the problems can be measured by using a watch with a second hand or a digital watch with a stopwatch mode. When measuring pulse rate, it is best to use a consistent time interval, such as 30 seconds or 1 minute. Remember that you will give pulse rates in beats per minute, so you'll have to convert your measurements if you use any time interval other than 1 minute.

Pulse Rate



A pulse rate measures the number of times the heart beats in one minute. The pulse rate can be taken at any spot on the body where an artery is close to the surface and a pulse can be felt. There are two easy places to measure pulse rate: the radial artery on the inside of the wrist or carotid artery in the neck. You should always use your fingers to take your pulse, not your thumb, especially when recording someone else's pulse, as you can sometimes feel your own pulse through your thumb.

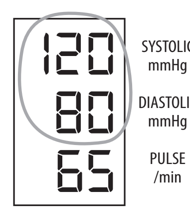
Radial Pulse (wrist)

Place your index and middle finger together on the opposite wrist, about 1 cm on the inside of the joint, in line with the index finger. Once you find a pulse, count the number of beats you feel within your time period.

Carotid Pulse (neck)

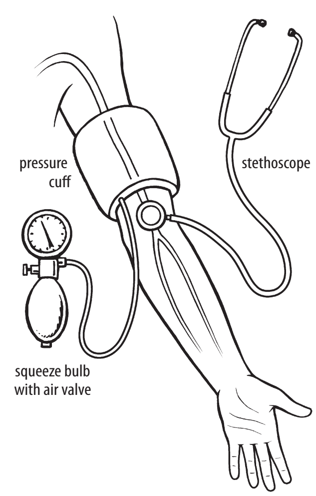
Place your index and middle fingers on one side of your neck, just below your jaw line. Be careful not to press to hard. Once you find a pulse, count the number of beats you feel within your time period.

An alternate method would be to use some kind of external heart rate monitor. These will usually give you an accurate reading as well.



Blood Pressure

Blood pressure is measured in millimeters of mercury (mm Hg). A typical, normal blood pressure is 120/80 mm Hg, or "120 over 80." The first number represents the pressure when the heart contracts and is called systolic blood pressure. The second number represents the pressure when the heart relaxes and is called the diastolic blood pressure.



Blood pressure is measured, whether using a blood pressure cuff (sphygmomanometer) and a stethoscope or an automatic blood pressure device, in basically the same manner. First, the cuff is wrapped snugly around the upper arm. The cuff is then rapidly inflated until the pulse in the upper is no longer felt. At this point blood flow in the underlying blood vessel is cut off by the pressure in the cuff. Next a stethoscope is placed over the brachial artery on the inside of the elbow and the cuff is slowly deflated, while someone listens through the stethoscope. The pressure in the cuff is slowly deflated and you listen for the turbulent blood flow in the artery. When you hear the heart beat, the cuff pressure matches the pressure in the artery and blood flow resumes. This is the systolic blood pressure. The cuff is slowly deflated further until the sounds stop. This is the diastolic blood pressure.

It is recommended that you take two or more readings to determine average blood pressure. If your reading differ by more than 5 mm Hg, additional readings should be taken and averaged.

If you are using an automatic blood pressure device, follow the instructions that come with the device.

Cardiac Output

Cardiac output is the volume of blood being pumped by the heart in a minute. This is usually measured in litres per minute (L/min). It is calculated using the following formula:

Cardiac Output = Stroke Volume × Heart Rate

There is no easy way to measure stroke volume at an amusement park. For that reason, you'll use average values. These are listed below:

Males: 0.08 L/beat
Females: 0.06 L/beat

Example
Using the average values, if a female's measured heart rate was 76 beats per minute, her cardiac output would be calculated as follows:

Cardiac Output = Stroke Volume × Heart Rate

Cardiac Output = 0.06 L/beat × 76 beats/minute

Cardiac Output = 4.56 L/min

Section B
Anatomy and Physiology 12
Worksheets

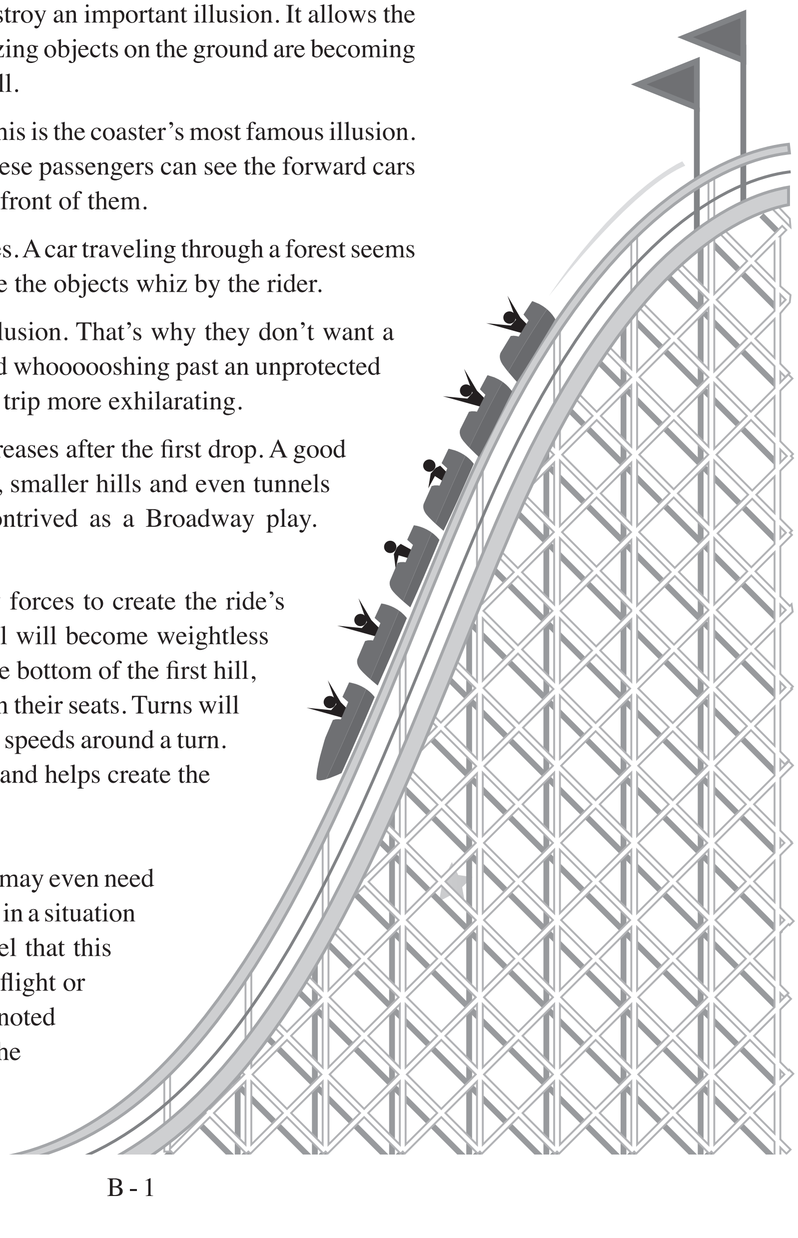
Designing a Coaster that People Want to Ride

Have you ever wondered why people ride coasters? There are probably many answers, all of which hold some truth. The most common answer is that riding a coaster is a form of sensation. Some researchers think that sensation seeking is one of man's primary needs and a source of much of our creativity. It also allows for the riders to overcome some of their own fears. It should be noted that many people would not be frightened of coasters if they know all of the elaborate safety measures that amusement parks regularly employ. A good ride gives the illusion of danger while keeping the rider perfectly safe.

Coaster designers understand these ideas when they create the rides. John Allen, one of the most well known coaster designers of the 20th century, mentioned some key ideas he keeps in mind. They include:

1. Being slowly towed to the top of the first hill intensifies its height. Cars could be rapidly drawn to the top but this would destroy an important illusion. It allows the riders to sightsee, alarming them into realizing objects on the ground are becoming smaller as the cars rise to the top of the hill.
2. Make the first hill as vertical as possible. This is the coaster's most famous illusion. It is intensified in the back cars because these passengers can see the forward cars curling over, down and under the track in front of them.
3. Have the cars pass by taller structural pieces. A car traveling through a forest seems to be going at a much faster speed because the objects whiz by the rider.
4. The wind is part of the coaster's speed illusion. That's why they don't want a windshield. The sound and feel of the wind whoooooshing past an unprotected rider makes the speed seem faster and the trip more exhilarating.
5. The speed and momentum of the ride decreases after the first drop. A good designer is aware of this and adds curves, smaller hills and even tunnels to hide this decrease. A coaster is as contrived as a Broadway play. It's all about pacing and choreography.
6. A good ride will take advantage of many forces to create the ride's thrills. Riders at the top of the second hill will become weightless when the cart crests. Seconds before, at the bottom of the first hill, a rider will feel themselves pushed down in their seats. Turns will create lateral centripetal forces as the rides speeds around a turn. The shifting of forces disorients the body and helps create the illusion of danger.

Some researchers have noted that humans like and may even need to be scared. Amusement park rides let us be scared in a situation where we will be sure to survive. Researchers feel that this scared feeling could be linked to the needs of the flight or fight mechanism to be stimulated. They have also noted that there is also a group effect when you all face the same fear together—and survive! So enjoy the thrills and know you'll survive.



Questions

1. Choose one ride at Playland. How does is incorporate some of John Allen's amusement park and coast design factors?

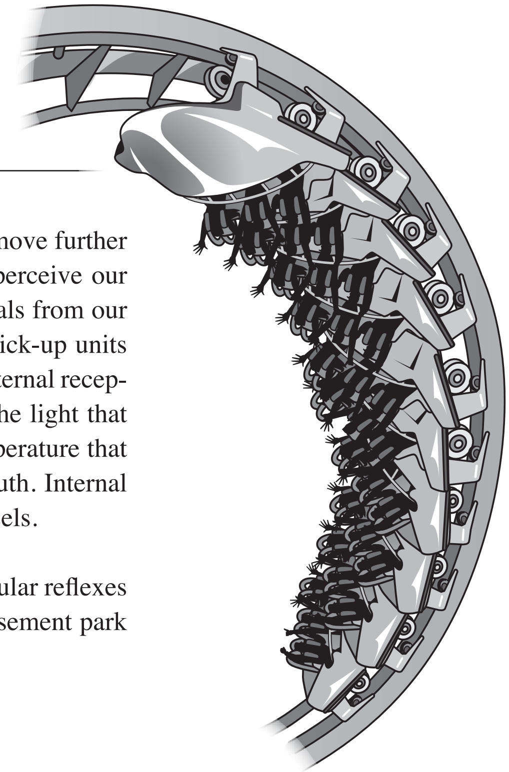
2. How do the factors you described in question 1 affect human physiology? Use the concepts and terminology you have learned in Anatomy and Physiology 12 to explain your answer.

3. Describe some of the safety features you see on the rides.

Ride	Safety Features

4. Does knowing that safety features exist on the rides make the experience any less scary? Explain your answer.

How Amusement Park Rides Affect Our Body



With the coaster design features from the previous activity in mind, we can move further into how the human body senses the rides effect our senses. The way we perceive our body and our surroundings is a function of the way our brain interprets signals from our various sensory systems, such as sight, sound, and touch. Special sensory pick-up units (or sensory "pads") called receptors, translate stimuli into sensory signals. External receptors (exteroceptors) respond to stimuli that arise outside the body, such as the light that stimulates the eyes, sound pressure that stimulates the ear, pressure and temperature that stimulates the skin and chemical substances that stimulate the nose and mouth. Internal receptors (enteroceptors) respond to stimuli that arise from within blood vessels.

Also involved is our postural stability which is maintained through the vestibular reflexes acting on the neck and limbs. They influence how our bodies sense the amusement park rides. These reflexes are under the control of three classes of sensory input:

Proprioceptors
Vestibular System
Visual Inputs

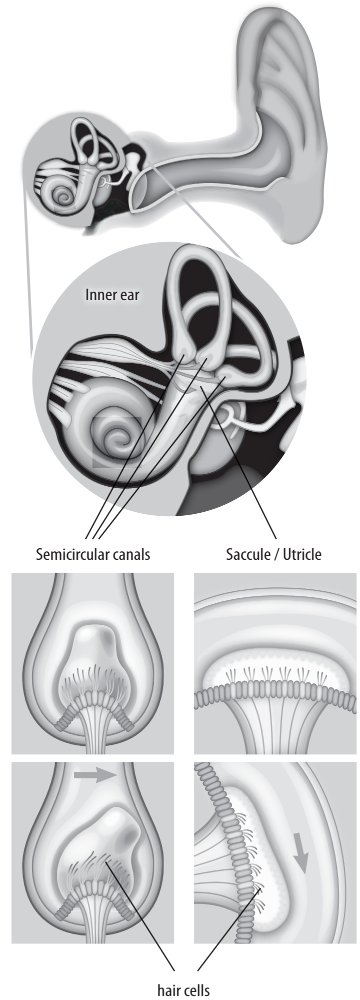
Proprioceptors

Proprioceptors are receptors located in your muscles, tendons, joints and the inner ear, which send signals to the brain regarding the body's position. An example of a "popular" proprioceptor often mentioned by aircraft pilots, is the "seat of the pants". Proprioceptors respond to stimuli generated by muscle movement and muscle tension. Signals generated by exteroceptors and proprioceptors are carried by sensory neurons or nerves and are called electrochemical signals. When a neuron receives such a signal, it sends it on to an adjacent neuron through a bridge called a synapse. A synapse "sparks" the impulse between neurons through electrical and chemical means. These sensory signals are processed by the brain and spinal cord, which then respond with motor signals that travel along motor nerves. Motor neurons, with their special fibres, carry these signals to muscles, which are instructed to either contract or relax.

In other words, these sensors present a picture to your brain as to where you are in space as external forces act on your body. For example, picture yourself sitting at a red traffic light in your car. The light changes to green and your foot presses the accelerator. As you accelerate away from the traffic light, you will "feel" yourself being pushed back in to the seat. That experience is transmitted to your brain via the proprioceptors, in particular, through the sensors in your backside and back. The brain interprets this information as an acceleration in the forward sense. If you now slam on the brakes to stop suddenly, you will find different proprioceptors at work. The deceleration will be felt through your hands and feet and your backside will now be trying to slide forward in the seat. This information is again presented to your brain and thus it interprets the deceleration taking place. In turn, the brain now signals the muscles in your arms and legs to contract and stop you from sliding forward in the seat. A similar sensation will take place when you turn a corner. If you turn left, your body will slide across the seat toward the right and vice versa for a turn to the right.

The downfall with our internal motion sensors is that once a constant velocity is reached, these sensors stop reacting. Your brain now has to rely on visual cues until another movement takes place and the resultant force is felt. In amusement park rides, when our internal motion sensors can no longer detect motion, a "washout" of the motion system may occur. A constant velocity coaster wouldn't be much fun at all.

Vestibular System



The Vestibular System is the balancing and equilibrium system of the body that includes the vestibular organs, ocular system, and muscular system. The vestibular system is contained in the ***inner ear***. It consists of three ***semicircular canals***, or tubes, arranged at right angles to one another. In space, there are three planes that we can move through, forward/backward (longitudinally), left/right (laterally), and up/down (vertically), and there is one canal assigned to detect movement in each plane. Each canal is partially filled with fluid and has a series of ***hair cells*** which stand vertically inside each tube. The fluid indicates rotation in the yaw, pitch, and roll axes. When acceleration takes place in a particular direction, the fluid in the appropriate canal is displaced which in turn causes the hair cells to move. The movement of the hairs is interpreted by the brain as an acceleration. Three semicircular canals are orthogonal and deal with angular (or circular) turns. The ***saccule*** with vertical linear movement, the ***utricle*** with horizontal movement.

There is however a problem with this clever piece of biological engineering. If sustained acceleration (10 - 20 seconds) takes place in one direction, the fluid in the appropriate canal also remains continually displaced. As a result, the hair cells will eventually return to the vertical position and the brain will perceive that the acceleration has stopped. In addition, there is a fixed acceleration threshold when the semicircular canals cannot sense any motion at all. During rotational motion, spatial disorientation can occur, (also referred to as "the leans"), when movement is below the threshold of sensitivity for the semicircular canal. This threshold of sensitivty is approximately 2 degrees per second. In other words, slow and gradual enough motion below the threshold will not affect the vestibular system. This fact allows the washout movement to be effective, as the vestibular system is unable to interpret continued or sustained acceleration. During washout movements, our human sense of sight takes over and interprets the games visual output into the body and craft position.

Visual Inputs

Our eyes are the most important source of information in motion simulation. They send pictures to the brain about the body's position, velocity, and attitude relative to the ground. As a result, it is equally important that the motion works in direct synchronization to what is happening in the ride.

When you turn left on a ride, the car relative to the scenery also rolls left. Simultaneously you also feel yourself, through the body's proprioceptors and vestibular system, turn to the left. If your eyes perceive movement that doesn't match what the rest of your body is telling your brain, dizziness and motion sickness can occur. These body reactions to motion are all intensified by the amusement park ride design.

One last factor comes into play on an amusement park ride. How does the brain perceive the experience? In one research project in which riders attempted to describe how long a free fall experience lasted, the results of the test found that each participant thought that their fall had lasted 36% longer than it actually took. Why would this happen? Their belief was that the brain would speed up due to adrenaline increases during the free fall. What is actually happening, according to the study, is a result of your memory of the event. According to the study, the part of the brain called the amygdale becomes more active, and lays down extra sets of memories that go along with the actual events. In this way, frightening events are associated with richer and denser memories. And the more memories you have of an event, the longer you believe it took.

Questions

1. What are the 3 classes of sensory input for the human body?
How does each help us sense an amusement park ride.

2. Choose one ride at Playland and describe how the human body senses the ride.
Describe all 3 classes of sensory input that are involved, if possible.

3. Besides an amusement park ride, what other experiences have you had that use sensory input? Explain.

Extension Activity

Go through the Haunted Mansion on the midway of Playland. Near the end of your travels inside the Mansion, you walk across a bridge surrounded by spinning lights. How did your trip across that bridge make you feel? Explain why you feel that way, based on what you read in this activity and what you've learned in Anatomy and Physiology 12 this term.

Human Physiology on Amusement Park Rides I

The purpose of this activity is to investigate the effects of different amusement park rides on the human body.

Data Collection:

Blood Pressure and Heart Rate:

Collect data for 3 or 4 different rides. Take your blood pressure and pulse rate twice: first, while standing in line, then immediately after you get off the ride.

	Blood Pressure	Blood Pressure	Blood Pressure	Blood Pressure	Heart Rate	Heart Rate
Ride Name	Systolic Before	Diastolic Before	Systolic After	Systolic After	Pulse Rate Before	Pulse Rate After
a.						
b.						
c.						
d.						

Qualitative Tasks

1. Compare the average blood pressure before the ride and after the ride. What is the general trend you see?

2. Explain the trends you identified in question 1 using your knowledge of adrenalin and the nervous system.

3. Compare the average pulse rate before the ride and after the ride. What is the general trend you see?

4. Explain the trends you identified in question 3 using your knowledge of adrenalin and the nervous system.

5. Why do the trends you observed occur even though you are not exercising?

Quantitative Calculations

1. Calculate the cardiac output before and after each ride. Remember that cardiac output is calculated using the formula **cardiac output = stroke volume × heart rate**.
Use average values for stroke volume (Males: 0.08 L/beat; Females: 0.06 L/beat)

Ride a. ________________________

Ride b. ________________________

Ride c. ________________________

Ride d. ________________________

2. Which ride had the most effect on cardiac output? Why to you think that happened?

Questions

1. How is the human respiratory system affected during the rides?

2. If a person screams or holds their breath, how does that action affect their respiratory system? How does it affect their circulatory system? Explain your answer.

3. What is one question about the human body's reaction to amusement park rides that you would like answered. Design an experiment that would answer your question.

Human Physiology on Amusement Park Rides II

The purpose of this activity is to investigate the effects of different amusement park rides on the human body.

Data Collection:

Collect data on 3 or 4 rides.
List the symptoms from the list below before, during and after each ride.

1. dry mouth	4. unable to move	7. trembling	10. fast breathing
2. dizziness	5. cold hands	8. sweaty hands	11. stomach butterflies
3. tense muscles	6. enlarged eye pupils	9. upset stomach	12. other: ________________

Ride Name	Symptoms Before	Symptoms During	Symptoms After
a.			
b.			
c.			
d.			

Qualitative Tasks

1. Which rides caused the most symptoms for you?

2. Explain your symptoms using your knowledge of the sympathetic and parasympathetic nervous system.

3. Were there any irregularities in your symptom data? If so, explain.

Questions

1. How does your digestive system react to an amusement park ride?
   Describe how food in your digestive system could react.

2. What other systems in the human body are affected by riding amusement park rides?
   Describe and explain your answer.

3. If you could carry out one experiment that would investigate the human body's reaction to amusement park rides, what would it be? How would you design the experiment?

Extension Activity

Find two students to volunteer to ride the coaster after eating a bag of mini-donuts.
After the ride, how do they feel? Explain your answer.

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.

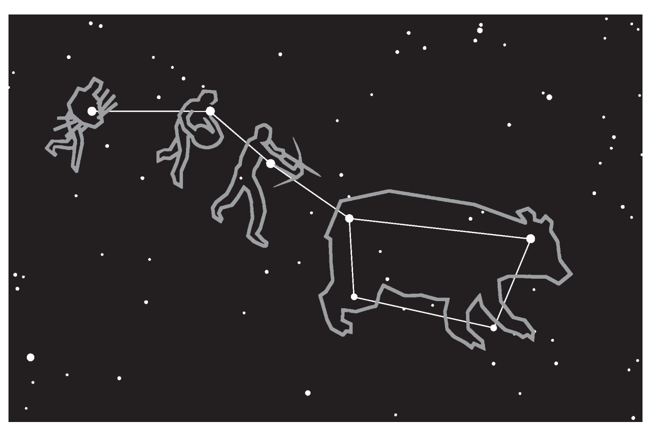
Food and Agriculture

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.

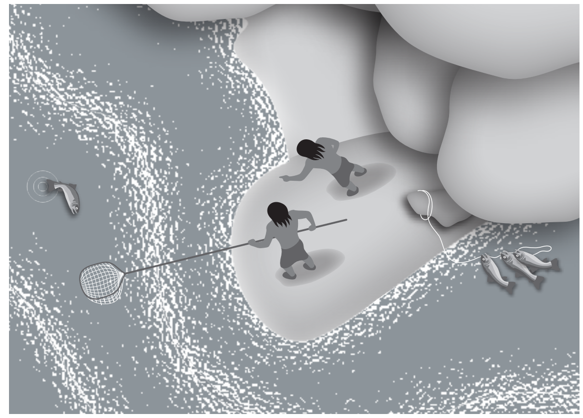


Medicine

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.