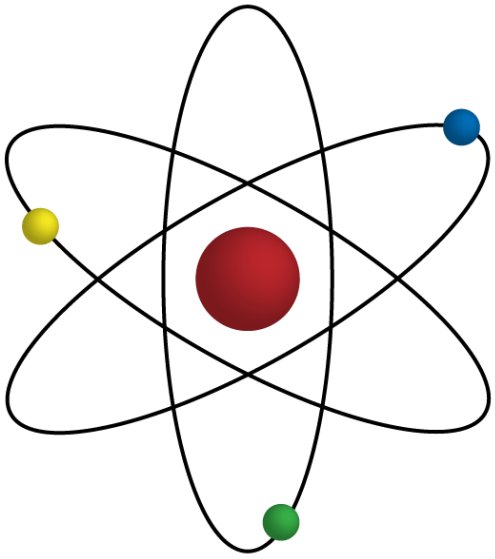
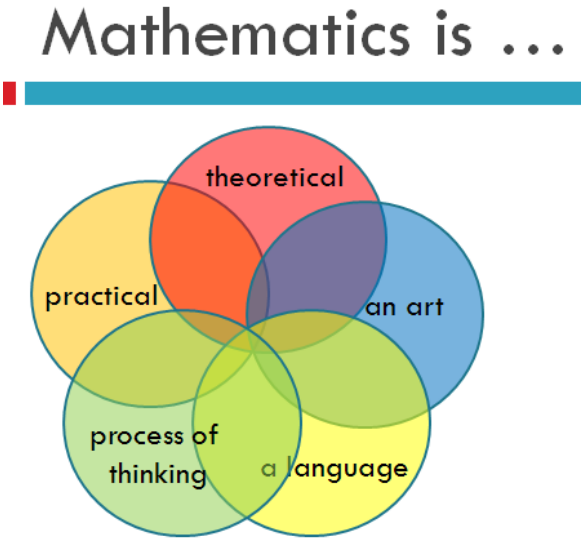
Math and Science Day





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Introduction

The following materials have been put together for Math and Science Day. This packet consists of activities that have been written primarily for grades 6-9. We have attempted to bring together activities which are best suited for use at Six Flags St. Louis, and have edited them for use there.

It is hoped that you and your students will find these materials conducive to an enjoyable and educational day at Six Flags. We are very interested in your reactions and comments about this set of material.

Six Flags St. Louis would like to acknowledge and thank the following people for their help and use of materials:

Elizabeth Tibbets

Deloris Randell — Northwest School District

The Amusement Park Physics Committee

Of

The St. Louis Area Physics Teachers Association

Howard L. Jones

James H. Rawe — University of Houston

Carolyn Sumners — Houston Museum of Natural Science

TO THE TEACHER

I. **Pre-Trip Preparation**
   a. You may want to do a sample page from the workbook in class a day or so before the trip.
   b. Post a MAP of the park with important points highlighted. Students should know where to find you or leave a message for you. Students should know where the First Aid station is location.
   c. Be sure the permission slip indicates any special MEDICAL NEEDS or allergies such as bee stings.
   d. Remind students to wear SECURE SHOES (No Sandals) and bring sun block.

II. **Organization Suggestions**
   a. Assign students to LAB GROUPS of four or six. This way each student has someone to interview if necessary, less equipment is needed, and there will be someone to go for help if the need should arise.
   b. Arrange times and places during the day for CHECK-IN with you and impose a penalty for failure to show up.
   c. Distribute TICKETS as students leave the bus so that entry to the park is efficient.
   d. Recommend that students GOT TO THE MOST IMPORTANT of the assigned rides early before the park gets crowded.
   e. Many teachers COLLECT THE WORKBOOKS at the end of the day, either as students arrive at the bus or as they depart back to school. This assures that work is done during the day and even on the ride back to school.

III. **Equipment for the Park**
   a. WATCH. At least one student per group, but as many as possible in order to average results, needs to wear a watch with a second hand.
   b. Pen or Pencil
   c. Zip-lock plastic bag large enough for booklet and other materials.

ORGANIZATIONAL CHECKLIST

_____ 1. Authorization from school/district administration. Review your school's liability coverage to be sure all necessary precautions are met to assure coverage.

_____ 2. Transportation.

Contact the bus company.

Reserve a bus as soon as possible.

Cost per bus $_____.

Seats per bus _____.

Deadline for finalizing or canceling _____.

_____ 3. Ticket information.

Cost per ticket $_____.

Deadline to receive tickets by mail _____.

_____ 4. Student workbook.

Reproduce workbook early enough to use practice problems in class.

Decide on your grading system.

_____ 5. In class activities.

Early on have a review of necessary formulas. Review measurement techniques. Just before the trip give instructions on lab group size, supplies to bring, forbidden materials, requirements and options, and when the workbook will be collected.

Give students instructions on where and when you will be available in the park. Be sure they know where First Aid is located and remind them to stay in their lab groups for both efficiency and safety. Announce meeting time and place in the morning. Reiterate meeting time and place for leaving the park and penalties for lateness.

_____ 6. Chaperones.

Arrange for faculty, administrators or parents to help chaperones.

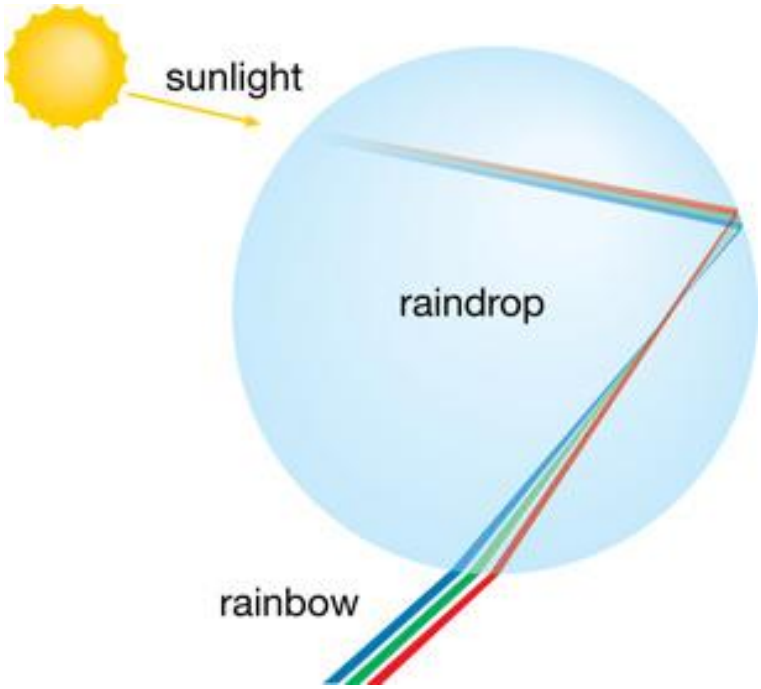
_____ 7. Lesson plan for substitute teacher.

Consider using the same workbook with supplied data for students who are unable to attend.

_____ 8. Send in money for bus & tickets.

Call and reconfirm the bus times.

Chasing Rainbows



A ray of sunlight is refracted as it enters and laves the water droplet and this causes the white light to spread out into a spectrum of colors.

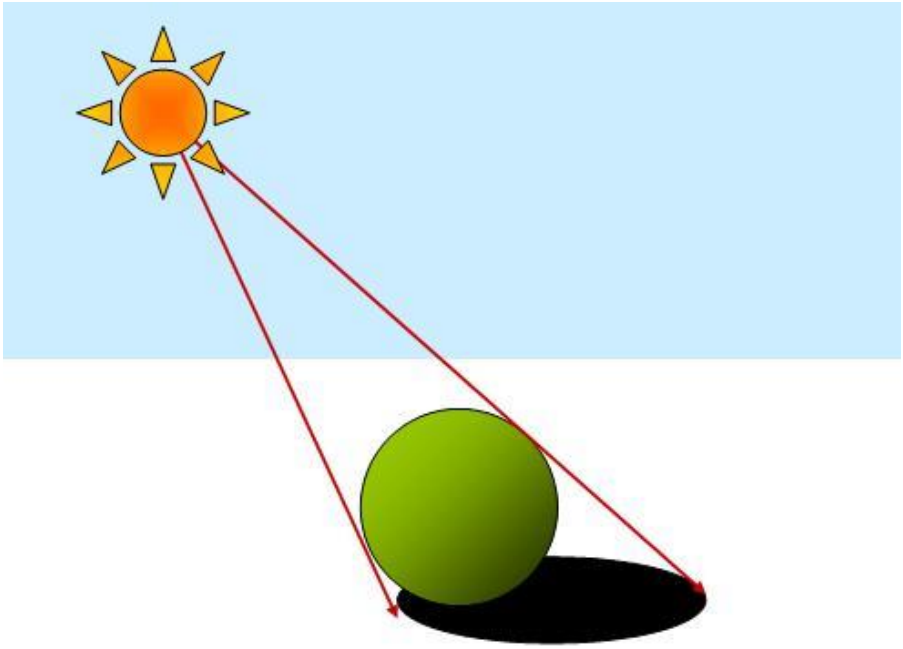
How is this similar to the way in which a prism works?

Explain why the water in a clear foundation or pool appears to be less deep than it really is.

Why is the sky blue?

Sun Time

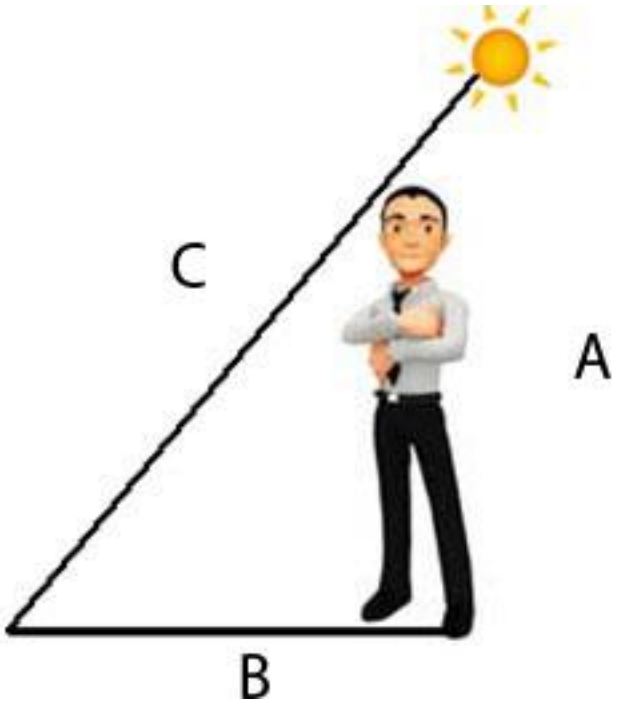
Each day the sun moves from east to west across the sky. As it moves, so do the shadows of trees and rides. Notice a shadow on the ground as you start your park visit. Locate a tree in front of the Palace Theatre. Wait an hour or two and see the shadow has moved. How could you make this shadow into a sun clock?



Sun Time

Measure your height against the vertical ruler. Assume that the length of your shadow equals your height. Apply the Pythagorean Theorem to find the diagonal distance from the top of your head to the end of your shadow.

$$a^2 + b^2 = c^2$$

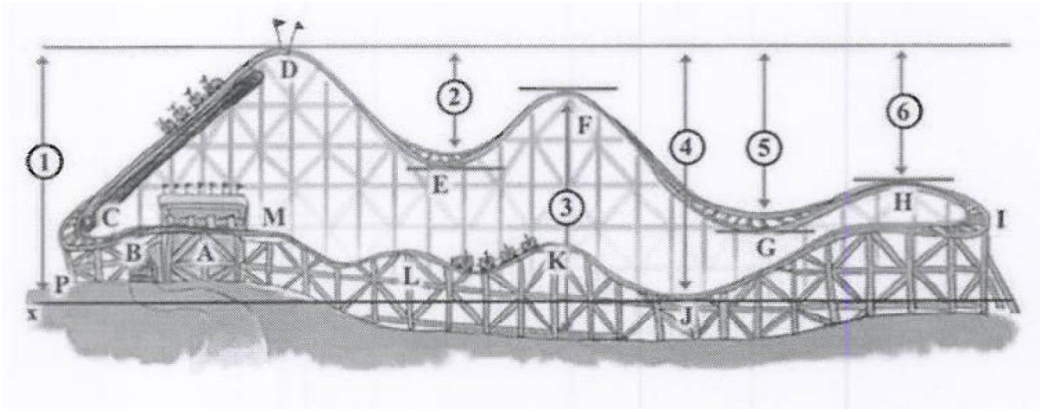


Keeping Cool

Why is the front mall area cooler to your feet than other parts of the park?

Why are roadways usually made of materials that are dark in color?

Science



List the number or letters on the roller coaster that best match the phrases below:

_____maximum velocity

_____maximum acceleration

_____maximum kinetic energy

_____maximum gravitational potential energy

_____freefall area

_____where a machine makes the ride go inside of gravity

_____where the care moves with almost uniform velocity

_____where the coaster's velocity increases

_____high "g-force" zone

_____where friction has greatest effects

_____where riders decelerate

Why is Point D higher than Point F?

Many amusement park rides secure the passengers in seats with high backs and hold them in place with foam padded harnesses that come over both shoulders and firmly secure the upper body in place. What kind of ride is likely to need this type of system to protect the riders? Discuss the reason for this type of system in terms of the inertia of the passenger and the forces exerted on the passenger.

Facing Fears

You know that thrill rides are safe…

But part of their excitement is that bit of fear that you still feel. At the park you have a chance to discover where fears come from, how they affect your body and what you can do to control them.

FIRST CHOOSE FROM A FEAR TO STUDY:

Gephyrophobia	(bridges)
Chremnophobia	(cliffs)
Claustrophobia	(confined places)
Demophobia	(crowds)
Semaphobia	(flashing lights)
Barophobia	(gravity)
Acrophobia	(heights)
Tachyphobia	(high speeds)
Anemphobia	(high winds)
Mechanophobia	(mechanical objects)
Kinesophobia	(movement)
Stenophobia	(narrow places)
Agoraphobia	(open places)
Phonophobia	(sounds)
Amasophobia	(being in vehicles)
Epistemophobia	(places of learning)
Updownaphobia	(roller coasters)
Roundaphobia	(circular rides)

NEXT CHECK FOR SYMPTOMS:

_____dry mouth
_____sweaty hands
_____cold hands and feet
_____trembling
_____big eye-pupils
_____fast breathing
_____stomach butterflies
_____pounding heart
_____high blood pressure
_____tense muscles
_____being unable to move

Write out the fears you experience.

Write out the symptoms that you experience.

Then try one method for curing your fear:

1. Identify what seems to cause your fear (like seeing a roller coaster). Try to think of something besides your fear when you see the object (like looking at the beautiful clouds over the track).
2. Relax. Take a deep breath. Hold it for 7 seconds. Release the air slowly while thinking of a pleasant scene. Think about relaxing your muscles as you breathe.
3. Gradually build up to the feared event (like riding smaller roller coasters before trying the big one).
4. Force yourself to feel the fear again and again until you are much less afraid (like riding the roller coasters over and over again until you have very little fear.)
5. Copy the behaviors of someone who does not fear the ride- and behave as though you are not afraid.
6. Ignore your fear by keeping your mind busy with other thoughts (like observing your motions and forces on a roller coaster).

Facing Fears

1. If you are afraid of going to school, what fear(s) could you be experiencing?

2. If you are afraid to ride the Tidal Wave, what fear(s) could you be experiencing?

3. If you are afraid to ride the Train, what fear(s) could you be experiencing?

4. If you are afraid to ride Moon Antique Cars, what fear(s) could you be experiencing?

5. If you are afraid to ride Batman the Ride, what fear(s) could you be experiencing?

Facing Fears

PHYSIOLOGY OF AMUSEMENT PARK RIDES

For each of the rides listed below, measure your pulse rate and breathing rate before and after the ride. Indicate the symptoms that you had by placing numbers of those appropriate from the list below.

Symptoms:

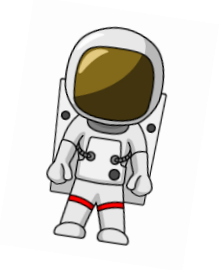
1. Dry Mouth
2. Dizziness
3. Tense muscles
4. Unable to move
5. Cold hands/feet
6. Enlarged eye pupils
7. Trembling
8. Sweaty hands
9. Upset stomach
10. Fast breathing
11. Stomach butterflies
12. Other

RIDE	PULSE RATE		BREATHING		SYMPTOMS	
	BEFORE	AFTER	BEFORE	AFTER	BEFORE	AFTER
Screamin' Eagle						
Carousel						
Ninja						
American Thunder						
River King Mine Train						
The Joker, Inc.						

QUESTIONS

Amusement Park rides are designed to give the illusion of danger and speed. Which rides based on the symptoms that you had, seem to give the greatest illusion?

Based on your observations, how could an amusement park design a ride to give great illusion of speed and danger? On the back of this page, describe a ride you would like to design.



Earthbound Astronauts

You are weightless when you feel NO forces. If you jump off a diving board, you feel no forces (except for air resistance) until the water stops your fall. A roller coaster track is shaped like the path of a diver. You feel weightless as you rush over the peaks and down the hills. You feel a sinking feeling as the valleys stop your fall.

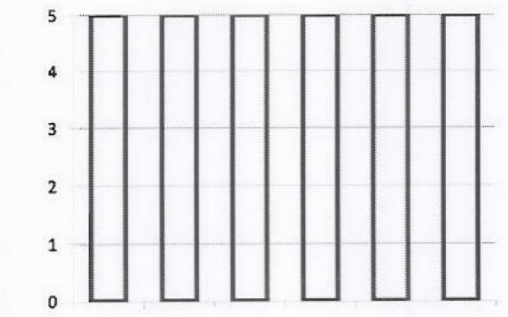
Space Shuttle astronauts feel this same weightlessness for days. The Shuttle is falling- but it moves so fast that it makes an orbit instead of falling to the earth.

Enjoy your moments of roller coaster weightlessness. Notice how your stomach seems to float and your bottom rises out of your seat. Talk with your ride companions and make a list of your reactions to weightlessness.

Astronauts use the word "g-force" to describe the forces that they feel. You feel about 1 g-force right now. When you feel more than 1-g, you feel heavier than normal. When you feel less than 1-g, you feel lighter than normal. Ride DISCOVERY sheets give the g-forces for the rides. Pick out a ride that gives you the same g-force as each on the space trip destination:

THE GREATEST FORCE:

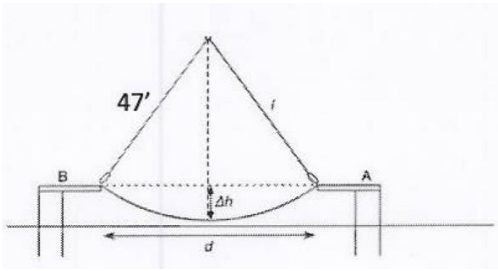
Use the ride discovery sheets to find the g-forces of 5 rides. Mark a bar graph showing the greatest g-forces felt on those rides. Label each ride bar with the name of the ride. A school bus ride which produces 1.2 g's is shown as an example.



PLACE	G-FORCE	RIDE
Orbiting Shuttle	0g	_____
The Moon	.17g	_____
Mars	.39g	_____
Jupiter's clouds	2.64g	_____
Shuttle life off	3.00g	_____

0 g	=Weightlessness
Between 0 g & 1 g	=Lighter than normal feeling
1 g	=Normal weight feeling
Over 1 g	=Heavier than normal feeling

The Joker, Inc.



1. Does the position of you seat affect the way you feel on this ride?

2. Describe the sensations of weight:

    a. At rest
    b. Moving through the lowest point
    c. At the highest point
    d. Halfway, going up
    e. Halfway, going down

3. What happens to the way you feel as the ride swings higher?

4. Do you feel the same swinging forward as you do swinging backward?

5. To feel the lightest, you should sit (closer to) (farther from) the center of the gondola?

6. When are you highest above the ground, you are traveling (slowest) (fastest)?

7. When are highest above the ground, you feel the (lightest) (heaviest)?

8. What two forces are acting on you during the ride?
    a.
    b.

9. If the Joker, Inc. made a full circle, what would be the circumference of that circle?
    $C=2\pi r$

The Joker, Inc. (cont.)

Assuming that the ride rotates at 180°, determine the period of the ride by timing 10 swings.

What is the speed of the ride?

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}} = \frac{\text{Circumference}}{\text{Period}}$$

On a circular or semi-circular ride, the time it take you to make one rotation is the period.

Water Rides

Each ride listed below includes the amount of water it requires. Use this information to answer the following questions.

Thunder River- 1,000,000 gallons

Log Flume- 600,000 gallons

Tidal Wave- 300,000 gallons

1. How many gallons of water are in all the water rides? _____

2. Each gallon of water takes up 231 cubic inches of space.
   How many cubic inches does the water in Thunder River require? _____

   2a. How many cubic feet will this water fill? _____
   (HINT: 1 cubic foot- 1,728 cubic inches)

   2b. How many cubic yards will this water fill? _____
   (HINT: 1 cubic yard= 27 cubic feet)

3. Draw a rectangular swimming pool that would hold the water in Thunder River.
   Label its dimensions.

4. Calculate the weight of the water in Thunder River. _____
   (HINT: Water weighs 62lbs. per cubic foot)

5. Calculate the total number of cubic yards of water in all the water _____
   rides at Six Flags St. Louis.

6. Calculate the total weight of all the water in the water rides. _____

7. Draw a cylindrical storage tank that will hold the water that park
   Needs for all its water rides. Label the tank's dimensions. _____

Screamin' Eagle

1. How many coasters could be placed back to back along the length of the track?
    a. How many cars?
    b. How many seats?
    c. How many people?

2. What formula did the engineer use to figure out that he would need 1278 footings to support the track?

3. If it takes 130,000 man hours to build the Screamin' Eagle, how many 8 hour days would it take one man to build?
    a. If he did not work weekends, how many weeks would it take?

4. If a roller coaster car has a speed of 2 meters per second at the top of a hill and it takes 3.8 seconds to travel down the hill and reach a maximum speed of 24 meters per second, what is the average acceleration of the car?

Screamin' Eagle (cont.)

1. If the cart went 40 below the zero mark and the rose 65 feet, what would be the location in relation to the zero line?

2. What is the distance between the lowest point and the highest point in terms of the number lines?

3. If a cart rose 50 feet from the -25 feet mark, what would be the location?

Screamin' Eagle (cont.)

Use the information in the following charts to answer the questions.

A few of the roller coasters at Six Flags St. Louis (SFSL)

Roller Coaster	*Steel (ft.)*	*Wood (ft.)*	*Length of the Ride (ft.)*
Screamin' Eagle	19,360	550,000	3,872
River King Mine Train	5,000	0	2,372
Ninja	25,640	0	2,600
Batman The Ride	16,800	0	2,693

Roller Coasters at Other Six Flags Theme Parks

Name of Park	Number of Roller Coasters	Steel (ft.)	Wood (ft.)	Length of Ride (miles)
Six Flags Over Texas (SFOT)	6	NA	1,250,000	2.86
Six Flags Over Georgia (SFOG)	5	+16,600	1,250,000	3
Six Flags Great Adventure (SFGA)	6	NA	850,000	3.08
Six Flags Magic Mountain (SFMM)	8	615,6000	3,500,000	6
Six Flags Great America (SFGAM)	7	105,300	2,000,000	4.7

NA=Not Available

1. How many feet of steel was used total on the roller coasters listed above at Six Flags Theme Parks?

2. If we could line up all the roller coasters listed above at SFSL in a straight line, how long would it extend?

3. What is the average length in feet of a roller coaster at SFSL?

4. What is the average length in feet of a roller coaster at SFGA?

5. What is the total length of all the Six Flags roller coasters in miles? In feet?

6. Which park used the most amount of wood per roller coaster?

7. Which park used the most amount of steel per roller coaster?

Grand Ole Carousel

1. There are 68 horses and 2 chariots on the Carousel. Each horse hold one rider and each chariot holds seven riders. What is the maximum capacity for this ride?

2. How much time is spent loading and unloading riders?

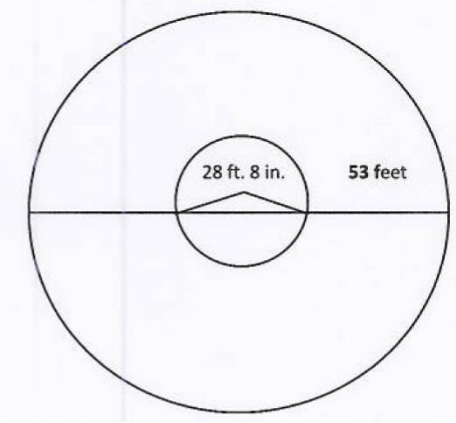
3. Count the number of revolutions the Carousel makes per minute?

4. Determine the number of revolutions the Carousel makes per minute?

5. Calculate the length of time for one complete ride, including loading and unloading.

6. Find the area of the center of the Carousel.

7. Find the area of the Carousel that holds the horses.



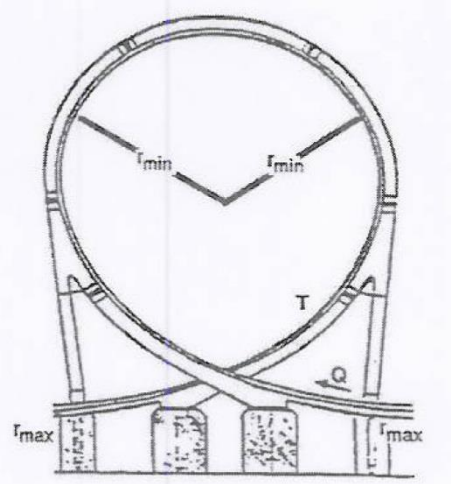
1. How many people can ride in each train?

2. There are 3 trains. Over a period of one hour, 2,000 people can ride the Ninja. How many times will each train leave the station in one hour?

3. The track length of the Ninja is 2,430 ft. The ride lasts approximately 2 minutes. What is the average speed of the Ninja? Calculate the speed in miles per hour.

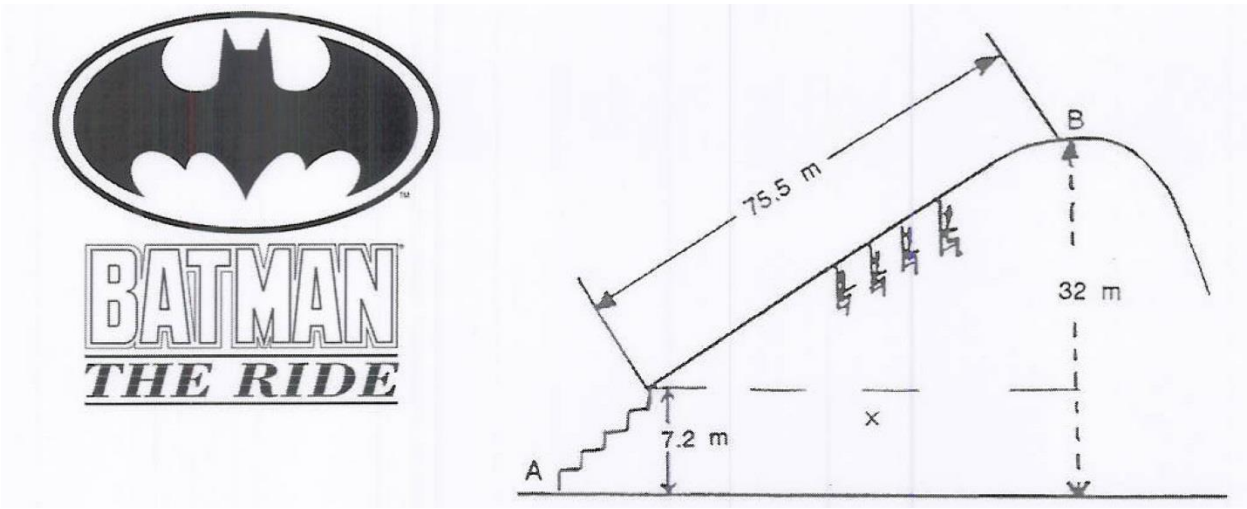
4. The Maximum speed of the Ninja is 65 mph. Why is the average speed so much slower?

5. The Ninja has one closed loop as pictured on the right. From point Q to point R, the radius of the loop decreases. From point R to point S, the radius remains the same. And from point S to T, the radius of the loop increases. If the radius at points R & S is 15 feet, what is the minimum length of the track in the loop?



6. A clockwise revolution has a negative magnitude and a counter clockwise has a positive magnitude. Assuming that your car enters the loop from the left, estimate the magnitude of one complete revolution.

Batman the Ride



1. There is 1,738,733 pounds of steel used to build BATMAN. Estimate the number of pounds of steel in each foot of track?

2. Using the Pythagorean Theorem, find x.

3. Find the slope of the first hill.

4. Joker has successfully blockaded the entrance to the BAT CAVE with a large cylinder of soil. If the cylinder's capacity is 50,000 cubic feet, and a cubic foot of soil weighs 90 pounds, calculate the weight that BATMAN needs to remove from the entrance.