

# Where Learning is Fun!



# Science in the Park



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Dear Classroom Teachers,

We would like to thank all of the Teachers who are leading our young people down the path of science and math. You are the people who will make a positive influence in the lives of our best and brightest young people. For that reason alone America has a great future.

Thank you so much for using Dollywood as your classroom. We hope that this latest addition to our Science in the Park lesson plan for Wild Eagle will be a good challenge for your 7<sup>th</sup> through 9<sup>th</sup> grade math and science students. This lesson plan can also be adapted for 10<sup>th</sup> through 12<sup>th</sup> grade. We also would like to let you know that there are lesson plans for many of the other rides at the park.

Thank You,

Gary Joines Author *Science in the Park* 



# **Coming out of the Sun is an Advantage**

# For the Teacher:

8.11.spi. Recognize that forces cause changes in speed and/or the direction of motion.
Website - <u>http://www.grc.nasa.gov/WWW/K-12/BGA/Dan/airplane\_parts\_act.htm</u>
Print the questions for airplane parts for the above website.

Mystery Mine

Bernoulli's Principle Immelmann Turn Hammerhead Stall Turns Chandelle Power on Stall Roll Pitch Yaw





#### **Definitions:**

Bernoulli's Principle

A fluid in motion creates less pressure than the surrounding fluid. (This definition is adequate for this lesson.)

#### Immelmann Turn

1/2 looping up followed by half a roll. There should be no pause between the end of the looping section and the start of the roll to erect flight. If you do this maneuver in reverse you execute a Split S.

#### Hammerhead Stall Turn

Pull up to vertical. Then the aircraft moves to the left and drops back into the vertical.

#### Chandelle

Consists of a maximum climb, maximum bank combinations to obtain the greatest altitude gain for a given airspeed and at the same time making a 180 degree course reversal.

#### Power on stall

Climb vertically to a stall and then the airplane rotates over to drop vertically into a power dive.

Roll

Roll is the rotation around the longitudinal axis-an axis drawn through the body of the vehicle from tail to nose in the normal direction of flight, or the direction the pilot faces.

Pitch

Pitch is the rotation around the lateral or transverse axis. The nose pitches up and the tail down, or vice-versa.

Yaw

 $\overline{\text{Yaw}}$  is the rotation about the vertical axis.

#### **Classroom Exercises:**

Have students make paper airplanes with control surfaces. Then have them predict airplane movement and test their predictions for different combinations of elevator, rudder and aileron positions. For other paper airplane activities, go to the following sites:

Paper Airplane Activity – <u>http://www.grc.nasa.gov/WWW/K-</u>12/aerosim/LessonHS97/paperairplaneac.html.
 How to Build a Paper Jet Model – <u>http://www.grc.nasa.gov/WWW/K-</u>12/WindTunnel/Activities/foldairplane.html.





Using the picture above and a little imagination, answer the following questions. The motion of all airplane parts is as if you were looking at the airplane from the front.

- 1.) What are the names of the parts of the airplane picture above?
  - a.
    b.
    c.
    d.
    e.
    f.
    g.
    h.
    i.



- 2.) Describe the following aircraft motions.
  - a. Pitch:
  - b. Roll:
  - c. Yaw:
  - d. Loop:
  - e. Dive:
  - f. Climb:
  - g. Lift:

3.) What are the functions of the parts of the plane pictured on page 4?

a.
b.
c.
d.
e.
f.
g.
h.
i.
j.
k.
l.



4.) Which parts are used to control lift at low speed for takeoff and landing?

5.) Which parts, installed one to each wing, operate in opposite directions (i.e., one up and one down)?

6.) If the part in Problem 4 on the right wing is up and the one on the left wing is down, what will the airplane do?

7.) If the pilot lowers the elevator, what will the airplane's tail do? What will this in turn cause the airplane's nose to do?

8.) If the pilot moves the rudder to the left, what will the airplane's tail do? What will this in turn cause the airplane's nose to do?

9.) What motion will occur in an airplane with the elevator deflected up and the rudder deflected to the right?

10.) Define a spoiler and describe its function.



# For the Student:

1.) Google: All about aerobatics - Figures: loop, roll, spin, Cuban eight, tailslides ....

Aircraft Proving Grounds. Click on the various maneuvers. Focus on Hammerhead and Immelmann maneuvers.

2.) <u>http://www.grc.nasa.gov/WWW/K-12/airplane/rotations.html</u>

Click on 6-8 grade Click on Airplane Parts Definitions (with text)

- 3.) <u>http://www.zurqui.co.cr/crinfocus/paper/air-bld.html</u>
- 4.) <u>http://hyperphysics.phy-astr.gsu.edu/hbase/pber.html</u>

Scroll down to airfoil

### Please observe the diagram



Dolly food

#### **Materials:**

1.) Standard writing paper-rectangular

#### **Procedure:**

- 1.) Use your paper airplane to demonstrate roll, pitch and yaw.
- 2.) Use your airplane to demonstrate the following maneuvers:
  - Immelmann Turn
  - Hammerhead Stall
  - Power Stall
  - Chandelle

3.) Place about an inch of the end of a piece of paper in the end of your textbook so the rest of the paper falls outside the book. Hold the book so the paper faces away from you. Then blow across the paper and observe the motion of the paper. (See the website at number 4 on the previous page.)

#### Your Day at Dollywood:

1.) When riding Mystery Mine, be able to recognize the rolls, pitch and yaw movements that you will experience.

2.) Identify the Immelmann Turn, Hammerhead, Chandelle and Power on Stall.





### Post Lab Questions:

1.) Answer the questions on the handout provided by your teacher.



# Thunderhead

# For the Teacher:

8.11.spi.7 Solve problems pertaining to distance, speed, velocity and time, given illustrations, diagrams, graphs or scenarios.

8.11.spi.1 Recognize that forces cause changes in speed and/or the direction of motion.

8.1.spi.8 Use estimated strategies to select a reasonable solution to a real-world problem involving computing with rational numbers.

4.11.spi.3 Recognize simple machines (i.e., incline plane, pulley).

Use the units of measure that is appropriate for your class.

#### **Introduction:**

The students know the relationship between distance, time, speed and velocity and the students know that forces cause changes in speed and/or the direction of motion.

### For the Student:

#### Materials:

1.) Stopwatch

#### **Mathematical Formulas:**

1.) Speed = distance divided by time



Dolly food

#### **Thunderhead Fact Sheet:**

- Length of Track: 3,230 feet
- Turns: 22
- Tallest Drop: 100 feet
- Top Speed: 55 mph
- Your speed at the beginning of the first drop: 2 feet/second
- Distance of the drop to the photo cameras: 65 feet
- The time it takes to travel the 65 feet: .4 seconds
- The electronic flash of the camera: one five thousandth of a second

#### **Procedure:**

1.) Using the information provided in the fact sheet section. How far will the roller coaster travel in the time it takes for your picture to be taken?

2.) Using your stopwatch. Do you have enough information to determine your speed down the first 100 foot drop?

3.) If your answer to question to number one of this section is no, then what additional information would you need?

4.) If your answer to number one of this section is yes, then solve the problem.

5.) What is your average speed over the distance of the entire ride?



### **Physics Questions for the Student:**

- 1.) What is the force that drives this roller coaster?
- 2.) Where along the track would you expect to experience the highest G forces?
- 3.) Where along the track would you expect to experience negative G forces?
- 4.) How is the experience of positive and negative G forces on a rider different?
- 5.) Which G force experience is your favorite and why?
- 6.) Where on this ride would you expect to find an incline plane?
- 7.) Where would you expect to find a pulley system?



# Wild Eagle

**Note:** This lesson plan was prepared from a virtual Wild Eagle ride experience. While the distances will remain the same the times will vary. Possible reasons for these differences are temperature and weight variances, etc.

### Wild Eagle Fact Sheet:

- Type: Steel Wing Coaster
- Track Length: 2,863 feet
- Top Speed: 61 miles per hour
- Top of the Lift Height: 190 feet
- Top of Loop Height: 110 feet
- First Drop: 135 feet
- Length of Zero-G-Roll: 379.6 feet



- The length of the left wing from the center of the track to the outside passenger car: approximately 7.19 feet
- The length of the left wing from the center of the track to the inside passenger car: approximately 5 feet
- The time to travel through the zero-g-roll: 6 seconds
- The time it takes for the first drop: 5.2 seconds
- There are 60 seconds in a minute
- There are 60 minutes in an hour
- The time to travel from the load in to the top of the lift: 52 seconds
- The approximate velocity at the end of the first drop: 60 mi./hr.

d = distance	t = time
a = acceleration	vf = final velocity
vi = initial velocity	v = velocity (speed in a directin)
v = d/t	a = vf - vi/t
mile = $5,280$ ft.	diameter = two times the radius
circumference = diameter times 3.14 (pi)	



### **Questions for the Student:**

- 1.) What is the estimated velocity when the Wild Eagle reaches the top of the lift?
- 2.) What is the average velocity through the first drop?
- 3.) What is the rate of acceleration through the first drop?
- 4.) What are the velocity/velocities of the passengers that are riding in the outside cars going through the zero-G-roll? **Hint:** There are two answers.





#### Answers for the Teachers:

- 1.) Question 1 190 ft./52 sec. = 3.65 ft./sec.
- 2.) Question 2 135 ft./5.2 sec. = 25 ft./sec.
- 3.) Question 3 vf = 61 mi./hr.vi = 3.65 ft./sec.

Convert 3.65 ft./sec. to mi./hr. 3600 sec. in an hour 3600 sec. x 3.65 ft./sec. = 13,140 ft./5,240 ft. = 2.4mi./hr.

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