AP PHYSICS

Name: _____

Period: _____ Date: _____

DEVIL PHYSICS

BADDEST CLASS ON CAMPUS

PHYSICS DAY AT BUSCH GARDENS
DATA COLLECTION WORKSHEET

General Guidelines:

1. **Data collection is a group effort among your lab team. Completion of the lab is an individual effort. I expect to see identical data between the members of each group. I do not expect to see identical data on the reports of others outside your group and I do not expect to see identical or paraphrased answers on the final report.**
2. **Your signature at the end of your report affirms that the work on your report is your own. Any instances of cheating will be referred to the IB administrator for disciplinary action.**
3. **You are expected to collect data for the three primary rides assigned to your group. If one of the assigned rides is closed, you can substitute the 4th ride for the closed ride. There is no excuse for completing the data collection on your assigned rides. Failure to collect the required data will result in a reduced grade on your final report. Once you have completed the data collection for your assigned rides, you are free to do whatever you want to do until departure time.**
4. **If you do not like to ride roller coasters, you may use the data collected from your teammates.**
5. **Save this Data Collection Worksheet and attach it to the back of your final report.**

AP Physics

#	Team Name	Team Members	Primary Rides	Backup Rides
1.			Scorpion	Kumba
			Montu	SheiKra
			Log Flume	Sand Serpent
2.			Kumba	Cheetah Hunt
			SheiKra	Scorpion
			Sand Serpent	Tidal Wave
3.			Cheetah Hunt	Montu
			Scorpion	Kumba
			Tidal Wave	Ubanga Banga (Bumper Cars)
4.			Montu	SheiKra
			Kumba	Cheetah Hunt
			Ubanga Banga (Bumper Cars)	Sand Serpent
5.			SheiKra	Scorpion
			Cheetah Hunt	Montu
			Sand Serpent	Log Flume

LOG FLUME

WHAT TO MEASURE AND NOTICE ON THE RIDE

1. At the splash at the bottom of the last hill, note whether you feel pressed back into your seat or you slide forward. Pay attention to your feelings on the last drop.
2. With the Horizontal G Force Meter, measure the largest angle to which the BBs in the tube will rise at the splash at the bottom of the last hill. Hold the meter parallel to the log, and brace it against the side.

WHAT TO MEASURE OFF THE RIDE

1. Measure the time for the log to go between point A (the light pole) and point B (the beginning of the splash).
2. Observe the splash of several logs. Do they all make the same splash, or does it depend upon how many people are in the log and where they are seated?

Data Table

	#1	#2	#3	Average
Angle of the BBs In G Force meter				
Time from A to B				

Questions

1. Did you ever feel close to weightless? If so, where?

2. Did you feel thrown forward or backward at the splash at the bottom of the hill?

3. How does this drop compare with the drop on the Scorpion?

4. What loading of the log produces the maximum splash? Why?
   a) Two in front
   b) Two in back
   c) Four in log
   d) Empty log

TIDAL WAVE

WHAT TO DO ON THE RIDE

1. With the Horizontal G Force Meter, measure the largest angle to which the BBs in the tube will rise at the splash at the bottom. Make sure to aim the horizontal accelerometer parallel to the motion and brace it against the side of the boat.
2. Notice whether you feel thrown forward or pushed backward at the splash.

WHAT TO MEASURE OFF THE RIDE

1. Time the boat from A to B at the bottom of the drop.
2. Time the splash.
3. Observe several boats splash at the bottom, and make a note of what kind of mass distribution of the boat corresponds to what kind of splash.

DATA TABLE

	#1	#2	#3	Average
Largest Angle of BBs in tube				
Time from A to B				
Time of the splash				

Questions

1. Did you feel thrown forward or pushed backward at the splash? Why?

2. Did all of the boats make the same size splash? If the splashes were different, describe which boat made the biggest splash and why?

SCORPION

WHAT TO MEASURE ON THE RIDE

1. Measure the G Force at the bottom of the first hill.
2. Measure the G Force at the top of the vertical loop.
3. Measure the G Force while moving through the top horizontal loop.
4. Notice whether you ever felt upside down.
5. Estimate the banking angle in the two horizontal loops near the end of the ride.

(Use your estimate along with estimates of two friends)

6. Do you feel pushed to the side in the two horizontal loops? If so, which way?

WHAT TO MEASURE OFF THE RIDE

1. Measure the time for the coaster to pass a point at the bottom of the first hill

DATA TABLE

	#1	#2	#3	Average
G Force at bottom of first hill				
G Force at the top of the vertical loop				
G Force in the top horizontal loop				
Time to pass a point at the bottom of the hill				
Banking angle				

Questions

1. The speed of Scorpion at the bottom of its first drop is about 10 m/s (22mph) slower than the speed of Kumba at the bottom of its first drop, but their G Forces at this point are very similar. Why?

2. As the coaster goes into the banked turns, do you feel pressed up against the sides of car or do you feel you're sitting upright? If you do feel pressed up against the sides, indicate whether you're pressed against the inside or outside of the car. Why is the banking angle so critical?

MONTU

WHAT TO NOTICE ON THE RIDE

1. Pay attention to your feelings when you are upside down. Do you ever leave your seat? Do you feel upside down?
2. Where on the ride do you feel the heaviest? Given that you experience approximately 3.5 g's at the bottom of the first hill, make an estimate of the g force at the heaviest point. Record your estimate and that of two friends. (On Physics Days only, sit in the second row, and check the G Force Meter to find the heaviest point. Record the actual G Force instead of just an estimate.)
3. Where on the ride do you feel heavy for the longest period of time? Where on the ride did you feel normal?
4. Ride once near the front of the coaster and once near the rear. Notice differences.

On the Ride Estimate

	#1	#2	#3	Average
Maximum G Force				

WHAT TO DO OFF THE RIDE

1. Measure the time for the coaster to pass the top of the second vertical loop (#9). (Start the stopwatch when the front of the front car reaches the top of the loop, and stop the stopwatch when the back of the last car reaches the top of the loop.)

DATA TABLE

	#1	#2	#3	Average Time
Time for the coaster to pass the top of the loop (#9)				Sec

Questions

1. Describe the places on the ride where you felt normal and explain why. Where did you feel the heaviest? Where did you feel the lightest?

2. Explain your experiences in the inversions. Which of them felt light? Did you ever leave your seat?

5. How is riding in the front car different from riding in the last?

UBANGA-BANGA BUMPER CARS

WHAT TO MEASURE ON THE RIDE

1. Using the Horizontal G Force Meter, measure the maximum angle to which the balls roll in a stationary collision. (Hold the Horizontal G Force Meter parallel to your direction of motion.) Note both the magnitude and direction of the motion of the balls in the tube. Pay attention to striking and also to being struck.
2. Using the Horizontal G Force Meter, measure the maximum angle to which the balls roll in a moving collision. (Hold the Horizontal G Force Meter parallel to your direction of motion.) Note both the magnitude and direction of the motion of the balls in the tube. Pay attention to striking and also to being struck
3. Pay attention to the motion of the balls when you are struck from the side. In that situation, you will need to hold your G Force Meter perpendicular to your car's original motion.

WHAT TO MEASURE OFF THE RIDE

1. Measure the time that it takes the cars going full speed to pass between two posts.

DATA TABLE

	#1	#2	#3	Average
Stationary collision angle				
Moving collision angle				
Time between posts				

KUMBA

WHAT TO NOTICE ON THE RIDE

1. Pay attention to your feelings during the carrousel section of the ride, near the end. Estimate how heavy you feel and whether you feel pushed to the left or right. Can you get your feet off the floor?
2. You will be inverted seven times. Pay attention to the similarities and differences in these inversions, i.e., do you feel heavy or light; do you ever leave your seat; etc.
3. The G Force at the bottom of the first hill is about 3.4. Where on the ride is the G Force greater than this? Where is the G Force the greatest, and what is that value? What is the value of the G Force in the carrousel?

On Physics Days only, sit in the second row in view of the mounted G Force Meter. Record the measured value instead of estimates.

WHAT TO MEASURE AND NOTICE OFF THE RIDE

1. Time the coaster from the point where the middle car passes the top of the first hill until the middle car reaches the top of the second corkscrew.
2. Measure the time for the coaster to pass the top of the first corkscrew. (Start the stopwatch when the front of the first car reaches the top of the corkscrew, and stop the stopwatch when the back of the last car reaches the top of the corkscrew.)
3. Watch the ride from the beginning to the end to determine where it moves the fastest and where it moves the slowest.

DATA TABLE

	Time #1	Time #2	Time #3	Average Time
Time it takes the coaster to go from the top of the first hill to the top of the second corkscrew				
Time it takes the coaster to pass the top of the first corkscrew				

On the Ride Estimates

	#1	#2	#3	Average
Heaviest point				
carrousel				

Questions

1. Describe the differences in the times that you were upside down. Did you ever leave your seat? Which time did you feel the lightest?

2. Where did you feel the heaviest during the ride? Where you able to pick up your feet in the carrousel? Were you thrown to the left or right or were you upright in the carrousel?

3. The Kumba has so many twists and turns that it can be disorienting. It is hard to tell where you are or whether you are upside down or not. This is especially true because your eyes will tell you that you are upside down, but you may not feel upside down. You also go from being light to being heavy many times. Where were your senses the most confused?

4. Give a general explanation for where on the ride you go fast and where slow.

SAND SERPENT

WHAT TO MEASURE AND NOTICE ON THE RIDE

1. With the Horizontal G Force Meter, measure the largest angle to which the BBs in the tube will rise on the third and fourth turns on the top level. Also note the direction that the BBs move. Indicate which seat you sat in: right or left. .NOTE: You must hold the accelerometer perpendicular to the motion.

2. With the Vertical G Force Meter, measure the maximum G Force experienced in the dips. Hold the Force Meter parallel to your spine.

	#1	#2	#3	Average
Angle: Turn 3				Direction: R or L
Angle: Turn 4				Direction: R or L
G Force: Dip				

Note: Ride the ride three times or get data from a friend.

SHEIKRA

WHAT TO NOTICE ON THE RIDE

1. Estimate the time that you are "weightless" on the big drop. Estimate to the nearest ½ second. (Practice counting: One thousand one, one thousand two, etc., or one-Mississippi, two-Mississippi, etc.) Use your count and that of two friends.

	#1	#2	#3	Average
Estimated time of big drop				

2. There are at least two other places on the ride where you feel weightless. Where are they?

WHAT TO DO OFF THE RIDE

1. Measure the time for the coaster to "free fall" down the first hill. Start your stopwatch at the instant the coaster begins to fall (it will hang at the edge for approximately 4 seconds before falling), and stop your stopwatch when the coaster arrives at the top of the blue post that supports the track. The track begins to curve after this point.

DATA TABLE

	#1	#2	#3	Average time
Time of fall				

CHEETAH HUNT

ELEMENTS OF THE RIDE:

1st Launch: Acceleration in the Station
Overbanked Turn: Immediately after 1st launch. Big looping turn.
2nd Launch: Acceleration before the Tower
Tower: You'll come down the tower and into a trench
Outbound Twister : Parabolic Hill with a twist up top. You're going over the skyride.
Heartline Roll: Upside down with the heart line as the pivot
Brake Block: Relatively flat, where the coaster can be stopped if needed
Serpentine turns: Like a snake, undulating back and forth
3rd Launch: Acceleration before Air Time Hill
Air Time Hill: Parabolic Hill with a weightless sensation
Inbound Twister: Sometimes called the over and under
Train Track Hill, and then **Sharp Left Turn** into the brakes at the end.

WHAT TO DO AND NOTICE ON THE RIDE

1. Note where you are when you feel pushed to the side. One easy way is to pay attention to your legs, especially if they are slightly raised off the ground.
2. Pay attention to where you feel the greatest periods of weightlessness.
3. Notice where on the ride you feel the heaviest.

WHAT TO MEASURE OFF THE RIDE

1. Time the coaster train between the highest two posts on the Air Time Hill. (This is just after the third launch and is easily visible behind the Pit Stop near the entrance to Rhino Rally.) Make three measurements and compute the average.
2. Watch the Cheetah Hunt coaster do its "serpentine" turns down the canyon.
3. Draw a sketch of the Air time hill, including the locations of the posts at the top.

AIR TIME HILL

	#1	#2	#3	Average
Time between Posts of Airtime Hill				

PARK INFORMATION

Busch Gardens® Tampa will open one hour early on December 4, 2015 exclusively for Physics Day students. Physics students will get one hour of exclusive park ride time, interactive physics stations located around the park, plus a live physics interactive show. Accelerometers are even mounted on select rides for student use. Students will have the opportunity to experience world-class roller coasters and make some of their physics calculations without having to wait in line.

Activity Stations:

- Station 1: This Bites - Students will learn the physics behind the bite force of some of the world's strongest carnivores.
- Station 2: I Feel the Need for Speed - Students will learn how to clock an animal's speed by measuring it's body and stride lengths.
- Station 3: The Physics of Superman - Students will take a closer look at the biomechanics of animal movement and discover what it would take for humans to have the same physical abilities, particularly the ability of flight.

Demonstration Stations:

- Station 4: The Power of Oobleck - Students gain "hands-in" knowledge of this and other mysterious non-Newtonian fluids to learn about their unique properties that seem to defy Newton's Laws.
- Station 5: That's How We Roll - Explore conservation of energy and magnetic braking through hands-on challenges at this SheiKra® station.

General Guidelines:

- Students should work in groups. Each group should have a Vertical G Force Meter, a Horizontal G Force Meter, and a Stopwatch. **These instruments cannot be taken on the Montu, Kumba, Phoenix, Gwazi or SheiKra.**
- Vertical Force Meters are used on the following Basic rides: **Scorpion and Sand Serpent**
- Horizontal Force Meters are used on the following Basic rides: **Log Flume, Tidal Wave, Bumper Cars, and Sand Serpent**
- **Hand-held instruments are not allowed on the Kumba, Montu, Phoenix, Gwazi or SheiKra.**
- On Physics Days there also will be G-Force Meters mounted on the Montu, Kumba, Phoenix, and Gwazi.