



State Fair Field Trip



Each student must complete this and three of the other activities at the fair to receive credit.

Student Name _____

On The Way

As you ride to the fair grounds discover some of the PHYSICS on the way. Show all work!

Questions - Quantitative

1. As you pull away from the school or from a stoplight, find the time it takes to go from stopped 0 mph (v_i) to 20 mph (v_f). You may have to get someone up front to help on this.

$t =$ _____ sec.

2. Convert 20 mph to m/s. (1.0 mph = 0.44 m/s) Velocity (v) = _____

3. Find the average acceleration of the bus in m/s^2 .

$$\text{Ave. acceleration} = \frac{\Delta \text{velocity}}{\text{time}} = \frac{v_f - v_i}{t}$$

$a =$ _____

4. Using your mass in kilograms (1 kg of mass weighs 2.2 lbs), calculate the average force on you as the bus starts up. $F = ma$ (Multiply your mass times the answer in #3) $F =$ _____ N

5. How does this compare to the force gravity exerts on you (your weight in Newtons)? (Force calculated in #4) divided by (Force gravity normally exerts - 9.8m/s) = _____ more or less? (Circle one)

Questions - Qualitative

1. As you start up, which way do you FEEL thrown, forward or backward?

2. If someone were watching from the side of the road, what would that person see happening to you in relation to the bus?

What would that person see happening to you in relation to the ground underneath you?

3. Describe the sensation of going at a constant speed. Do you feel as if you are moving? Why or why not? (Try to ignore the effects of road noise.)

4. If your eyes are closed, how can you tell when the bus is going around a curve? Try it and report what you notice. (Do NOT fall asleep!)

Investigation #1: The Wild Cat Roller Coaster



Questions - Qualitative

1. Did you sit in the front or back of the car? _____ Do you think your position in the car affect your ride? (Ask a friend who sat in a different part of the car to share their opinion on this.)
2. Where on the ride did you experience the greatest acceleration? In which direction was it? Why there and not another place?
3. Was there a place on this ride where you felt like you were being lifted out of your seat? Where was it? How did the ride create that feeling?
4. Why do you think the second hill was smaller than the first?

Questions- Quantitative (Show your work!)

1. Calculate the average rate of speed for the whole ride. Round to the nearest tenth.

Length of the Track	560m
Length of the Ride	95 sec
Average Speed for the Whole Ride	_____ m/s

2. Calculate your average speed going down the first hill. ($d / t = s$) Round to the nearest tenth.

Length of first drop	77 feet
Time of first drop	_____ sec.
Average speed	_____ ft./s

Investigation #2: The Dopple Looping

Questions – Qualitative

1. Draw and label the key parts of the ride: Lift, Initial Descent, Loop(s), etc.

Put a mark on your profile to indicate the position of the train every 1 seconds.

2. Is there a place where the riders go at a constant speed? Where? How did you determine they were going at a constant speed there? (Be specific)

Questions- Quantitative

1. List 2 places where the riders are speeding up. Are there any energy changes going on in each of these sections? Describe. Do the riders feel any net forces or accelerations in each of these sections? Describe the direction of any net forces (mechanical, kinetic, etc.) and indicate why they feel the net force in this direction.

Location on Ride	Energy Changes	Net Forces/Direction
(a)	KE PE	
(b)	KE PE	

2. List 2 places where the riders are slowing down. Are there any energy changes going on in each of these sections? Describe. Do the riders feel any net forces or accelerations in each of these sections? Describe the direction of any net forces and indicate why they feel the net force in this direction.

Location on Ride	Energy Changes	Net Forces/Accelerations
(c)	PE KE	
(d)	PE KE	

3. For the whole ride, where does the largest force or acceleration occur? In which direction is that force? Why do you think the largest value occurs here and why is it in the direction you indicate?

Investigation #3 The Drop of Fear



Questions - Quantitative:

CALCULATING 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 one or another of the following methods. They will give you a reasonable estimate. Consistently use one basic unit of distance - meters or feet.

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, giving you the average distance per step. Knowing this, you can pace off horizontal distances.

I walk at a rate of _____ paces per _____....or....My pace = _____

Triangulation: For measuring height by triangulation, a horizontal accelerometer can be used. Suppose the height h of a ride must be determined. First the distance L is estimated by pacing it off (or some other suitable method). Sight along the accelerometer to the top of the ride and read the angle. Add in the height of your eye to get the total height.

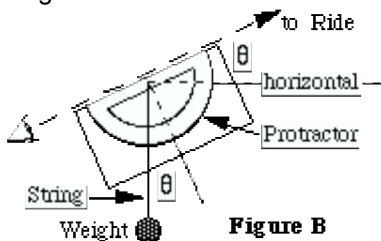


Figure B

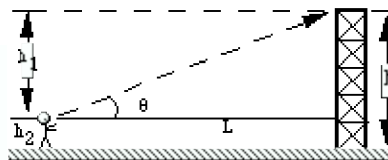


Figure B:

$$\tan \theta = h_1 / L, \quad h_1 = L \tan \theta, \quad h_2 = \text{height of eye from ground}$$

$$h = \text{total height of ride} = h_1 + h_2$$

1. Use the triangulation instrument to determine the height of this ride. _____.
2. How many seconds did it take for the seat take to drop? _____ sec.
3. What, then, is the rate of speed for this ride. _____ (Show your work!)
4. At what point of the ride did you experience a feeling of being weightless?

Investigation #4 – The Wave Swinger

Questions – Qualitative:

1. How do you feel when the ride is moving, but not tilted?
2. How do you feel when the ride is going down when tilted?
3. How do you feel when the ride is going up when tilted?
4. Which goes higher----an empty swing or one with someone in it?
5. What do you feel as the speed increases?
6. What happens to the seats as the speed increases?

Questions – Quantitative:

1. Estimate the angle of the swings at full speed (at rest = 0°). _____ $^\circ$
2. Estimate the angle of the top of the ride as it begins to tilt. _____ $^\circ$
3. How long does it take the ride to make one complete rotation? _____ sec.
4. Estimate the radius of the path of the riders in the outer chairs. _____
5. Compute the circumference of the rider's path in meters. _____m
6. Now calculate the approximate speed of the ride by dividing the answer you got for #5 (distance) by the answer you got for #3 (time). _____m/s
7. Now calculate the centripetal acceleration a of the riders from the relation $a = v^2/r$, where v is the speed and r is the radius.
8. How does this acceleration compare to g ? _____ .



Investigation #5 - The Merry Go Round

Questions – Qualitative

1. Draw a simple drawing as if you were above the merry go round showing the direction of its spin.
2. Do you think that those who are on the outside row of animals experience the ride in a different way than those in the inner row? Explain.
3. If you were to carry a pendulum onto the merry go round, would you expect its time-of-swing (period) to be different than that on the ground?

Questions- Quantitative (*Show your work!*)

Time to complete one revolution		sec.
Number of horses or other animals along the outer edge of ride		
Estimated distance nose to nose between two adjacent animals along the outer edge of ride		m

1. Use the number of animals and the spacing between them to calculate the circumference of the ride (show method clearly)
2. Use the circumference and the time to determine the speed of an outside rider (show your method).
3. Use the circumference to determine the radius of the ride (or use another method). Show your work.



Investigation #6 - The Sizzler

Questions – Qualitative

1. Add two arrows to the drawing to show the difference in directions of spin in this ride.

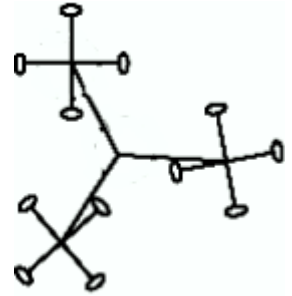


Figure B8

2. Which side of the car experiences the greatest amount of pressure? Explain how and why you know this.

Questions- Quantitative (Show your work!)

Notice that the riders are brought to a momentary stop at one edge of the ride and then moved quickly to the other side of the ride in a motion that is approximated by a straight line that is the diameter of the circle defined by the extreme positions.

1. Estimate the diameter of the extreme path in meters. _____ m

2 Find the time to move from one extreme edge to the other: _____ s

3. Compute the average speed along that path by dividing the distance by the time: _____ m/s

4. The speed goes rapidly from 0 to a maximum and back to 0 as the car is swung from one side to the other. To a good approximation the maximum speed is twice the average speed.

Compute the maximum speed: _____ m/s.

5. Can you calculate the acceleration during the time in which the car is being accelerated from 0 to the maximum speed? _____ m/s^2

Extra Credit

Many interesting observations about science can be made while enjoying the State Fair, not all of them requiring calculations. Here's a few ideas you can get extra credit for answering.

- Could you figure out the height of the rocket at the front gate using only its shadow and a yardstick?
- As a Ferris wheel turns, a mark on the side moves in a circular path. Why is this so? As you sit in the moving seat of the Ferris wheel, sometime your feet are "inside" the wheel and sometimes they are "outside" Draw a diagram to represent the path of the mark and the path of your feet. Do your feet move in a circular path?
- Try to diagram the paths of the more complicated rides. Mark where they are going fastest. Mark where the change in direction is sharpest and mark where the change in speed is greatest.
- If you carry a scale on the Ferris Wheel, do you expect things to weigh the same all around the trip? What would you expect at the top, bottom, and the two sides? Assume the wheel turns smoothly. Can you think of a way to test your ideas using a simpler method than riding a Ferris Wheel?
- If you carry a pendulum onto a merry-go-round would you expect its time-of-swing (period) to be different from that on the ground? How about other rides — such as the Ferris wheel or a roller coaster?
- What factors make it hard to toss a ring over a peg to win a prize? Look carefully at what happens, and see if you get some ideas.
- Look in the mirror at the fun house. Is there a connection between the way the mirror is shaped and the way your image is shaped? Try your ideas for differently shaped mirrors.
- What will happen if a skinny driver in a bumper car runs head-on into a heavy driver in a bumper car? What happens if one or the other car is not moving?
- Why does the bumper car ride have a ceiling? Can you draw an electrical circuit diagram for the bumper car ride?
- Are the rides and Midway illuminated primarily by incandescent or by florescent lamp bulbs? Why?