Physics of Amusement Parks

...being a collection of tricks, tools, and techniques that you will find of near-infinite value.

Note that the iPhone app that measures acceleration is called "Accel Pro."

Details, first...

- Meet in Physics room (Mudd 203) at 8am. We'll be back to school by 7pm...
- unless you need to get back early. I need to know who you are if this is you. See me.
- Physics stuff to bring: calculator, problem, pen/ pencil, stopwatch, horizontal or vertical accelerometer, your problem!
- Other stuff to bring: $$$, sweater or jacket, clothes that dry easily, sunglasses, sunscreen, camera, cellphone
- You will work in groups of two. Each student will have his or her problem. You can choose which of the two your group of two will do. EACH INDIVIDUAL WILL BE EXPECTED TO TURN IN THEIR OWN WRITE-UP by Friday, April 16.

Your Problem!

When you get it...

- Read through the gory details
- Your problem statement is at the bottom
- Take a moment to think about what strategies you'll need to help you solve your particular problem
- You'll have time later in the class to discuss your problem with your partners, make a data table, set up some preliminary equations...
- General techniques: kinematics, F_{net}=ma, conservation of energy, conservation of momentum...
- Panic at the park? Call me...

Measuring Time

- Having some means of measuring time is *vital* to your success: bring a stopwatch of some sort to the park.
- If the object you're trying to measure has some periodic movement, you can reduce error by timing a series of movements, then dividing by the number of movements to get the time for a single motion.

Measuring Length/Height/Distance

Measuring length is best accomplished by using one of two techniques:

1. If the object is physically accessible, pace alongside it and use your known pace distance to calculate the length.

This fountain has a width of 5.5 of my paces:

$$\frac{5.5\,paces}{1} \times \frac{0.85m}{1\,pace} = 4.7m$$

Measuring Length/Height/Distance

2. If the object is located near something else that you can use as a reference, *estimate* its length/height, and justify your estimation.

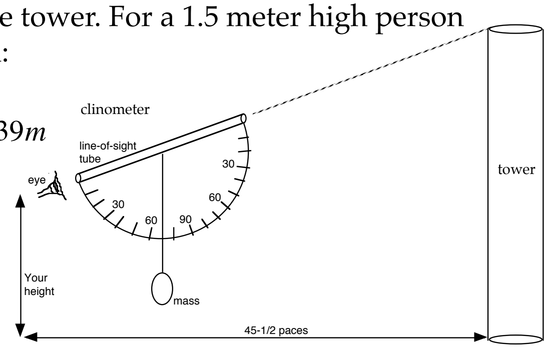
$$\frac{\sim 2meters}{1guy} \times \frac{4\,guys}{1\,parachute} \approx 8m$$

$$\frac{\sim 2meters}{1car} \times \frac{20cars}{1wheel} \approx 40m$$

Measuring Length/Height/Distance

3. Another way involves using an angle measurement to get the total height of the tower. For a 1.5 meter high person with a pace of 0.85m:

$$\frac{45.5\,paces}{1} \times \frac{0.85m}{1\,pace} \approx 39m$$



$$\theta = 20°$$

$$\frac{h}{39m} = \tan\theta$$

$$h = 39m(\tan 20°) = 14m$$

$$h_{total} = 14m + 1.5m \approx 16m$$

Calculating Velocity

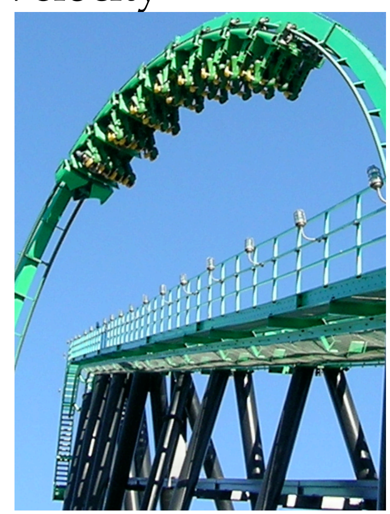
Again, there are several techniques that may be used:

1. A slow moving object of a known length can be timed as it passes a fixed point. Knowing the *distance* traveled in a measured *time*, the *average velocity* at that point can be calculated. (Remember the air glider cart?)

$$t = 2.78s$$

$$l\ \ of\ \ train\ \ (estimated) = 12m$$

$$v = \frac{l}{t} = \frac{12m}{2.78s} = 4.32m/s$$



Calculating Velocity

2. If you are able to consider friction negligible, you might consider using conservation of energy...

Clearly, some of your measurements will be approximations, which is okay, as long as you:

a. Make sure that they're *good* approximations, and

b. Make sure that you *explain* how you approximated, by

  i. showing calculations, and

  ii. blurbing well

Measuring Horizontal Acceleration

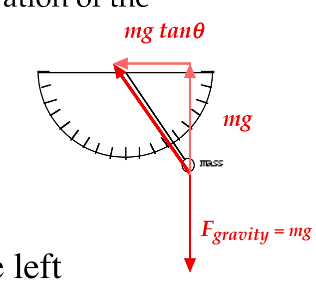
Use a *horizontal accelerometer* as shown. What is the magnitude and direction of the acceleration of the accelerometer shown here?

$$F_{net} = ma$$

$$mg\tan\theta = ma$$

$$g\tan\theta = a$$

$$a = 9.8\tan 35° = 6.86 m/s^2, \text{ to the left}$$



Measuring Vertical Acceleration

Use a *vertical accelerometer* as shown. What is the magnitude and direction of the acceleration of the accelerometer shown here?

$$F_{net} = ma$$

$$F_s - F_g = ma$$

$$11.5 - 4.9 = (.5kg)a$$

$$a = 13.2 m/s^2, \text{ up}$$