Problem Lab #1

"Lab" due Tuesday September 5, 1998. Clarity of presentation counts!

1 Basic Problem Practice

Practice using the steps given in the handout.

- A rock is thrown from the top of a tall cliff staight up.
  - Estimate the height of a "tall cliff" in meters.
  - Estimate the velocity.
  - Find the time when it reaches the bottom.
  - Plot position, velocity, acceleration, vs. time
- A plane needs a certain speed to take off.
  - Estimate that speed.
  - Estimate the maximum acceleration a person can comfortably take in meters/second.
  - Given the estimated acceleration what is the minimum length that the runway can be?
  - Plot position, velocity, acceleration, vs. time
- A motorcyle travels quickly along a road and sees a cat
  - Estimate his speed in meters per second.
  - Estimate how far away he will be from the cat before he sees it.
  - Estimate his maximum deceleration.
  - Using your estimates find the time it takes for him to stop.
  - Plot position, velocity, acceleration, vs. time

2 Dimension full reasoning

A ball is thrown straight up with speed v. The dimension full numbers in this problem are v and g

- What are the units of these variables
  - v
  - g
- Form all posible combinations of these variables which have time dimension of time?
- Form all possible combinations that have the dimenions of height?
- Find the balls maximum height in term of v and g.
- Find the time it takes for the ball to:
  - Reach its maximum height
  - Hit the ground again.
  - Reach 1/4 of its maximum height.
- Finally sketch the position and velocity as a function of time. Label your graph with what you know

Now substitue numbers.

- Suppose the ball is a bullet. Estimate the bullet speed. How high does the bullet go for this estimate?
- Suppose the initial speed is 1/2 or 1/3 or 1/5 or 1/10 of its initial speed. How high does the bullet go (in meters) for each of these initial speeds?

3 More Complicated Problems

To trucks are approaching each other each with a speed of 20 m/s (How fast is that?). They see each other when they are 200 m apart. Each truck steps on the breaks applying $1g$ of deceleration to avoid a collision

1. Draw vectors of the two trucks and agree on a coordinate sysem

2. Sketch the trucks position as a function of time on the same graph. For the numbers I have chosen the trucks will crash.

3. Sketch the position of the trucks if they were to just miss a crash.

4. Write down the equations of motion for the two trucks

5. Find when the two trucks crash. This will involve solving a quadratic equation. Only one of the solutions is physical. Which one is it? Use your graph?

4 More Problems

This is not part of the lab

A ball is thrown from the top of a cliff (with height h) staight straight down with speed v. The dimension-full numbers in this problem are h, v and g the acceleration do to gravity

1. What are the units of the three dimensionfull quantities?
   - h
   - v
   - g
2. Form all combinations h, v, g that have dimension of time.
3. First imagine that there is now gravity. Find the time it takes to reach the bottom in terms of the givens? Compare to your results in item #2
3. Next imagine that the ball is just dropped instead of the thrown. Find the time it takes to reach the bottom?
4. Now solve the full problem (Harder!). Express the time it takes to reach the bottom in terms of h, v, g. You will have to solve a quadratic equation symbollically.