

## 1 Related Rates Problems

1. A tiger escapes from a truck, right in front of the Empire State Building. I start running west along 34th Street at 2.5 m/s, while my friend takes off north on Fifth Avenue at 3 m/s.

Draw a diagram of this situation.

How fast is the distance between my friend and I growing after 12 seconds?

After 12.8 minutes, I've hit the river; I stop to catch my breath. My friend is still running up Fifth Avenue. At what rate is the angle between my friend and I increasing at 13 minutes? How about at 15 minutes? (NB: Convert minutes to seconds before computing)

2. Huckleberry Finn is drifting down the Mississippi on a rectangular, flat-bottomed boat, 6 feet wide by 12 feet long. Suddenly, he hits a rock and gashes a hole in the boat. Water is now pouring into the boat at a rate of  $1/2$  cubic foot per minute. Huck is doing the best he can to bail out the boat, but he only has a tin cup to pitch the water, and can only remove  $1/3$  ft<sup>3</sup>/min.

Try to picture this dire situation in your mind, and draw a diagram or two to help you understand what's going on here.

At what rate is the volume of water inside the boat increasing?

At what rate is the depth of the water in the boat increasing?

If the boat is half a foot high, when will the boat completely fill with water?

3. Your esteemed professor has just finished teaching and needs to lift his spirits. He goes to the nearest bar and orders a gin martini, served up in a conical cocktail glass, and downs it. The bartender has filled it to the brim, though, so knowing his clumsiness he decides it's better to drink the first centimeter of it through a straw rather than move the glass and spill any of it. The straw is kind of narrow, so he can only drink at a rate of 10 ml/sec. The cocktail glass is a right angle cone, and it holds 133 ml.

Picture this situation, and then draw a diagram. A delicious, gin-and-vermouth-flavored diagram.

Given that its height and radius are the same, and its volume is 133 ml, what is its height in centimeters? (the volume of a cone is  $(1/3)\pi r^2 h$ , where  $r$  is the radius and  $h$  is the height)

At what rate is the depth of the liquid in the glass decreasing, as a function of time?

How long does it take for the depth of liquid to drop 1 centimeter, so he can safely pick up his glass?

## 2A Little Integration

Compute the following indefinite integrals:

1.  $\int (3x^2 + 5x - 2)dx$
2.  $\int e^{3x}dx$
3.  $\int \frac{1}{\sqrt{x}}dx$