

## Hot Air Balloons

A hot air balloon has three main parts:

- The balloon (usually a huge silk sack)
- The heater (basically a huge propane torch), and
- The basket (where the passengers and pilot stay)

It also has many other smaller parts including fuel tanks(s), cables, ballast (usually sand bags) and sometimes, an anchor.



The pilot and crew inflate the balloon by stretching it out flat and blowing hot air into the balloon. During inflation, the balloon is kept in place by several ropes tied to stakes in the ground.



Since hot air rises, the balloon slowly stands up. The crew then finishes the inflation to the point where the balloon is straining against the anchor ropes.



The hot air causes the balloon to rise; the weight of the ballast, passengers, and equipment pulls it down.

Once the balloon is in the air, its motion is controlled by several factors. The wind controls its horizontal movement. At different altitudes, the wind shifts direction. An experienced pilot knows how to find the level which will take the balloon in the desired direction.



The vertical movement is what we are interested in, for math's sake. To go up, the pilot pulls a lever and sends flames into the balloon to add more hot air – so we will assign a rise of one foot for each second of flame. In an emergency, the pilot can reduce the weight by dropping ballast – we will assign a downward force of -1 foot for each sandbag. Dropping one sandbag is therefore equivalent to subtracting a negative one. We rise!

To go down, the pilot can pull a cord which is attached to a flap in the top of the balloon. This works exactly like the flat rubber disk sometimes used as a bathtub plug. When it is open, hot air flows out, so we are subtracting hot air. We will assign a drop of one foot for each second the flap is open. Theoretically, we can also go down by adding more weight. If you have accepted all our other assignments, you should have little trouble with accepting that we could build a machine which will fling sandbags into the balloon basket (ouch!). Each sandbag (-1) added to the balloon will cause a drop of one foot.



We assign zero on our vertical number line to a point we'll call "safe cruising altitude." In this case, that will be the top of the tallest obstacle around, such as a power-line pole. Above this point is positive; below it is negative – very, very negative...Zzzzzzt!

Happy Sailing!