

## Final Project 1: Time of flight for a baseball

A pitcher is throwing the baseball from the height  $h = 1.8m$  straight up with the initial velocity  $v_0 = 20 \frac{m}{sec}$ . Another time, he throws the baseball in the direction making angle  $\alpha$  with the ground with the initial velocity  $v$  such that  $v \sin \theta = v_0$ . In the absence of air resistance, the time of flight will be the same for two throws, however, with air resistance it may be different. Find for which angle  $\alpha$  the time of flight (until it hits the ground) is minimal. Please assume that pitchers cannot throw with velocity  $v > 46 \frac{m}{sec}$  (this is an experimental fact).

Diameter of a baseball:  $d = 0.0732m$ ;

Mass of a baseball:  $m = 0.145kg$ ;

Drag coefficient:  $C = 0.30$ ;

Air density:  $p = 1.25 \frac{kg}{m^3}$ .

Here typical heights are small so you may assume that the air density does not depend on height.