

AE 252: Introduction to Aerospace Dynamics
Spring 2007

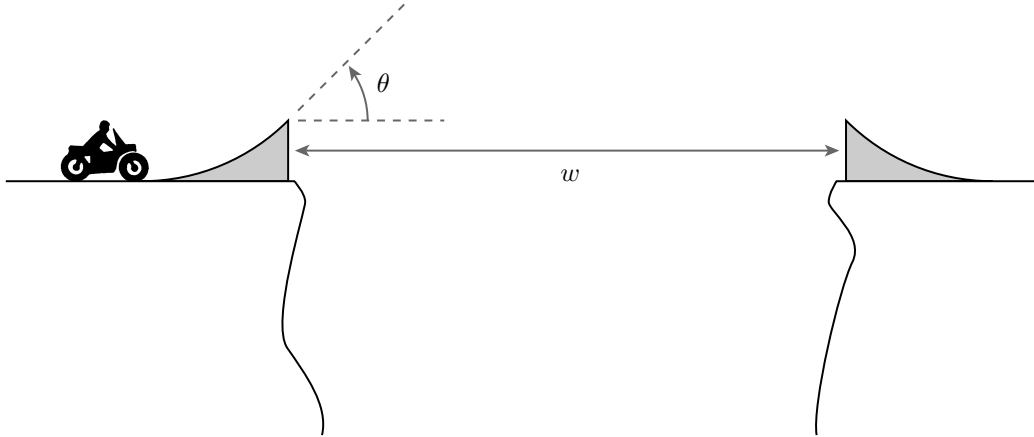
Homework #5

Due Thursday, February 22, at 5PM in the “AE252” box in the mailroom. Please start every problem on a new sheet of paper, and put your name on the *back* of each page.

1. Text problem 14.101 (solve twice: first, use Newton’s Laws; second, use the principle of work and energy).
2. Text problem 15.35
3. Text problem 15.61 (solve twice: first, use Newton’s Laws; second, use the principle of work and energy).
4. Do the “Motorcycle Jump” problem on the following page.
5. Pose a problem of your own. (A homework or exam problem, a design problem, a “real-world” problem, ...) Then, suggest a solution.

Problem 4. Motorcycle Jump

Inspired by problem 3.1.45, Tongue and Sheppard, *Dynamics: Analysis and Design of Systems in Motion*, Wiley, 2005



A daredevil motorcyclist wants to jump across a canyon. The takeoff ramp is sloped at $\theta = 45^\circ$. The width of the canyon is $w = 151\text{ft}$ (the same as what Evel Knievel jumped over at Caesar's Palace in Las Vegas, on New Year's Day, 1968). The motorcycle and its rider have a combined weight of 500lb.

- Model the cycle and rider together as a single point mass. Compute the initial speed v_0 coming off the ramp that just allows the rider to make the jump. Express your answer in miles per hour.
- Repeat part (a) but now include the effect of air drag. We model drag as a force

$$\vec{D} = -cv^2\hat{e}_t$$

where v is the rider's speed (which changes as a function of time) and $c = 0.24 \text{ lb} \cdot \text{s}^2/\text{ft}^2$. Recall that

$$\hat{e}_t = \frac{\vec{v}}{\|\vec{v}\|}$$

So the drag force always points in the direction opposite to the velocity vector. (*You may need to use numerical integration—ode45 in MATLAB—to solve this problem. You may also need to use some trial and error to find v_0 .*)

Finally, plot the trajectory of the rider for both parts in Cartesian coordinates on the same figure. When you solve this problem, remember to start by using Newton's Laws to write the equations of motion.

(You might be interested to know that Evel Knievel wanted to jump over the Grand Canyon, with a width of a quarter mile. I wonder how fast he would have had to be going then!)