MATLAB HW2

ESC 202, Spring ‘25

Due on Blackboard by 11:59 pm on Feb. 19

Upload your solutions to Blackboard by 11:59pm on Feb. 19. Upload your Matlab code along with the .m (Matlab file). You will create a file called “YOURLASTNAMEmh2.m” and submit that file on Blackboard. Your file will do everything described in the problem statements on this page, and may do more. Do not submit any other .m files. There is a general pre-formated .m file on Blackboard that may be a useful start.

1 Sliding Crate

If a 150 lb. crate is released from rest on a ramp at a degree of $\theta = 30$ degrees, plot the speed of the create from 0 ft. – 50ft. The coefficient of friction is $\mu_k = 0.3$. Plot your results as velocity vs. position with appropriate axis labels, units, and a title.

2 Skateboarding

A 100 kg skateboarder drops into the half-pipe as shown in Figure 1 such that their velocity at $\theta = 0$ degrees is $v_o = 1\ m/s$. Make a plot of the normal force acting on them from $\theta = 0$ to $\theta = 60$ degrees. Hint: use $v\,dv = a_t\,ds = a_t\rho\,d\theta$ (where θ is in radians) to find an equation for velocity in terms of theta $v(\theta)$ (integration limits of v_o, v, 0, and θ might be helpful).

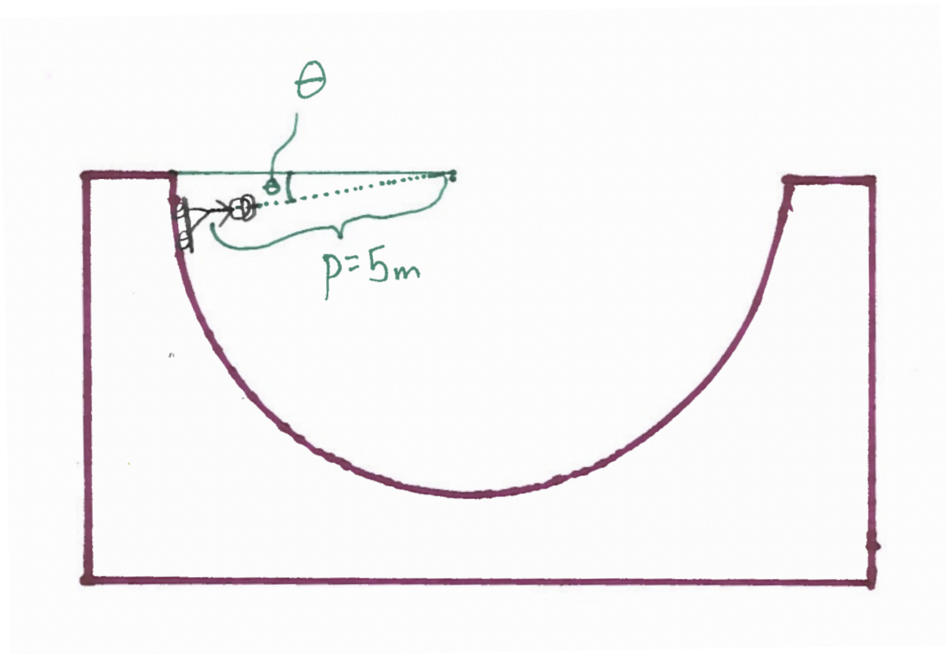

Figure 1: A skateboarder absolutely shredding.

3 Challenge: Dropping a Bowling Ball to Show Terminal Velocity

A 10 lb bowling ball typically has a diameter of 8.5 inches. In this problem you'll be asked to animate it in free fall when dropped from a height of 100 feet.

The force of drag acting on this bowling ball at any instant can be determined by

$$F_D = 0.018 * A * v^2 \tag{1}$$

where A is the cross-sectional area of the sphere and v is the velocity of the sphere at the moment of interest. This means that the forces acting on the bowling ball as it falls are changing as it falls. A common method for integrating acceleration to find velocity and position using a computer is with a technique called Euler integration:

$$v_{k+1} = v_k + a_k * \Delta t \tag{2}$$

$$s_{k+1} = s_k + v_k * \Delta t \tag{3}$$

In plainer English, this says that you can find the velocity at the next step $(k + 1)$ by adding the velocity at the current step (v_k) and the acceleration at the current step a_k multiplied by the change in time (Δt) between the steps. Similarly, you can find the position at the next step by adding the position at the current step (s_k) and the velocity at the current step multiplied by the change in time between steps.

Using a time-step of $\Delta t = 0.01$, a loop, the subplot function, and the "drawnow" function (among other tools), animate a falling bowling ball above a line plot. The plot should have the force of drag acting on the bowling ball and the force of gravity acting on the bowling ball, both plotted vs. time. An example at $t = 1.34$ seconds is shown in Figure 2.

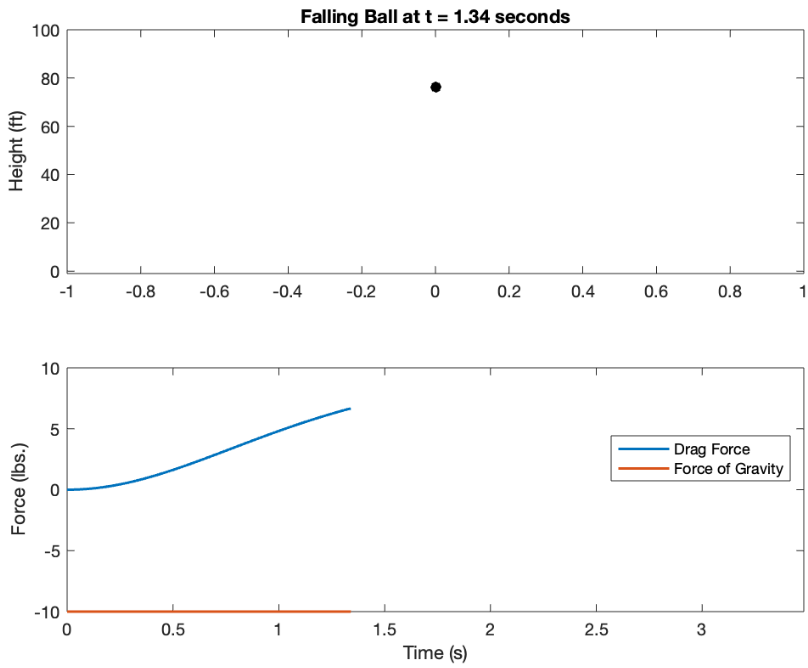

Figure 2: A screenshot of the animation.