Your Name: ______________________________

Teammates: ____

Physics 8, Fall 2023, Worksheet #4.

`http://positron.hep.upenn.edu/p8/files/ws04.pdf`

Upload PDF (smartphone scan or tablet edit) to Canvas at end of class on Wed, Sep 13, 2023.

Problems marked with (*) must include your own drawing or graph representing the problem and at least one complete sentence describing your reasoning.

Discuss each problem with your teammates (usually groups of 3), then write up your own solution. Be sure to compare final results with your teammates, as a way to catch mistakes. It can also be very interesting when you and a teammate use different methods to arrive at a result. Do not hesitate to ask for help from other students or from the instructors — but don't just copy down other people's results!

1*. During a blackout (a non-fire event, advises Prof Farley), you are trapped in a tall building. You want to call rescuers on your cell phone but can't remember which floor you're on. You pry open the doors to the elevator shaft, stoop down to floor level, drop your keys down the shaft, and hear them hit bottom at ground level 3.67 s later. (a) Making a simple calculation and remembering that the ground floor is numbered floor 1 (conventional in the USA), you determine which floor you're on. What floor is that? (Take the distance between flights to be 3.0 m.) (b) Before you make that phone call, however, you realize you've forgotten that the sound of the impact at the bottom travels up the shaft at 343 m/s, and so you redo your calculation. What floor number do you tell the rescuers? (The challenge here is explaining your reasoning for part (b)!)

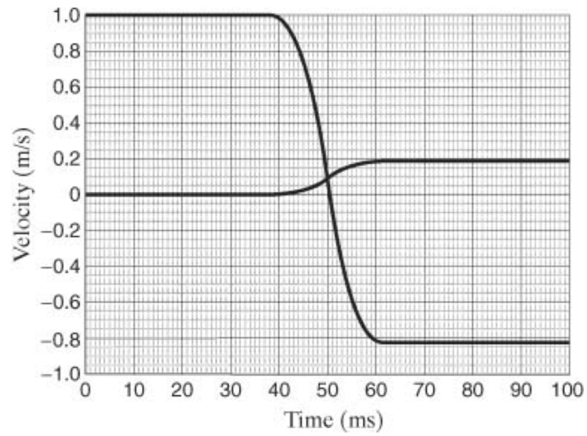
(Chapter 4 problems)

2*. Two male moose charge head-on at each other with the same speed and meet on an icy patch of tundra. As they collide, their antlers lock together and the two slide together with one-half of their original speed. (a) What is the ratio of their inertias (i.e. the ratio of their masses)? (b) In which direction do they slide after colliding? [It completely made my day when, one year, at a sort of Physics-for-Architects reunion, I overheard two students recalling: “Do you remember that homework problem about the two male moose?”]

3*. A load of coal is dropped vertically from a bunker into a railroad hopper car of inertia $2.7 \times 10^4\,\mathrm{kg}$ coasting at $0.51\,\mathrm{m/s}$ on a level track. The car’s speed is $0.23\,\mathrm{m/s}$ after the coal falls. What is the inertia (i.e. the mass) of the load of coal? (Since we are analyzing only the horizontal motion, we can consider the coal+car system to be isolated.)

[Prof Farley wonders if Q2 can be reworded to feature a robot in an automated warehouse. I’ll give a bonus point to anyone who emails me a physically realistic Amazon-warehouse-robot rewording of this problem. The numbers and the scenario should make sense as a physics problem (analogous to Q3), and the wording should make the situation easy for future students to grasp. Maybe a stationary robot drops a box onto a moving trolley?]

4. In some collisions, the velocity of one participant changes little while that of the other changes a lot, as the figure below illustrates. (a) In which direction (positive or negative) are the objects moving before the collision? (b) After the collision? (c) What is the ratio of the inertia (ie mass) of the larger object to the inertia (ie mass) of the smaller object? (d) Does friction play an important role in this collision? (Explain what feature of the graph would indicate whether or not friction is negligible here. Hint: non-negligible friction would cause moving objects to slow down, before, during, and after the collision.)



5*. In the process of moving out of your house, you are dropping stuff out a second-floor window to a friend 6.8 m below. You are about to drop a 13 kg stereo speaker when you remember that your friend cannot catch anything that has a momentum greater than 140. kg·m/s. Should you drop the speaker?

6. At an amusement park, a 130 kg bumper car traveling east at 2.5 m/s collides head-on with a 170 kg bumper car traveling at 1.9 m/s in the opposite direction. The bumper cars do not have brakes. You do not know anything about the type of material used in the bumper cars' bumpers, e.g. how well it regains its initial shape after being deformed. So the cars may stick together, may recoil, or something in between. (a) From the given information, is it possible to predict the velocities of the two cars after the collision? Explain your answer. (b) Is it possible to predict the value that any pertinent physical quantity has after the collision? If so, state that quantity and its final value. (Hint: think of a quantity whose units are kg·m/s.)

If you have extra time, feel free to revisit the XC problems from last time, ws03.

***** Please check in with one of the instructors before you leave, so that we can give you some quick feedback on your work and get your impressions of the appropriateness of today's assignment. *****