Your Name: ____________________

Teammates: ______________________________

Physics 8, Fall 2023, Worksheet #6.

`http://positron.hep.upenn.edu/p8/files/ws06.pdf`

Upload PDF (smartphone scan or tablet edit) to Canvas by end of day on Wed, Sep 20, 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!

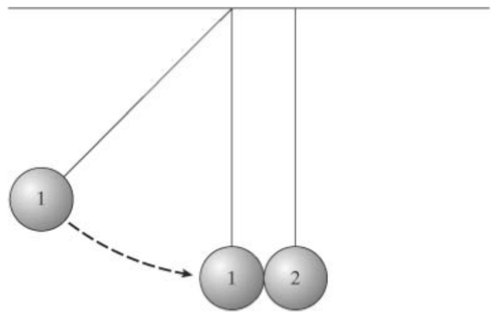
1*. An experienced bartender knows just how fast to push a glass of beer to get it to come to a stop in front any customer sitting along the bar. Say the initial speed needed to move a glass all the way to the end of the bar is v_{end}. In terms of v_{end}, how fast (i.e. what fraction of v_{end}) does she have to push an identical glass of beer if it is to stop at a customer sitting halfway down the bar? (The **only thing** you need to know about friction at this stage is that the kinetic energy converted to thermal energy because of friction is **proportional to the distance** the glass skids. The glass of beer comes to a stop when all of its initial kinetic energy has been dissipated by friction into thermal energy.)

2*. Two carts, of inertias m_1 and m_2, collide head-on on a low-friction track. Before the collision, which is elastic, cart 1 is moving to the right at $6.0\,\mathrm{m/s}$ and cart 2 is at rest. After the collision, cart 1 is moving to the left at $2.0\,\mathrm{m/s}$. (a) What are the speed and direction of motion of cart 2 after the collision? (b) If $m_2 = 6.0\,\mathrm{kg}$, what is the value of m_1?

3. A 41.0 kg (including clothing and several 1.00 kg snowballs) ice skater is at rest on the ice. She throws a snowball to the right at 20.0 m/s. (a) What is her speed after the throw? Is her velocity to the left or to the right? (b) Calculate the coefficient of restitution for this event. [The result is a very special "number."] She next throws a second snowball but this time at a speed of 10.0 m/s to the left (10.0 m/s is the snowball's speed in the Earth frame after the throw). Note that before throwing the second snowball, she is still moving at the result of part (a). (c) What is her speed after this throw? Is her velocity to the left or to the right? (d) Calculate the change in kinetic energy in the **first** event (from part a). Where does the added kinetic energy come from? (e) If one food Calorie equals 4184 J, how many Calories does the skater burn when she throws the first snowball? (Assume, unrealistically, that all of the energy burned goes into motion of the snowball and of the skater.)

4. A system consists of a 2.00 kg cart and a 1.00 kg cart attached to each other by a compressed spring. Initially, the system is at rest on a low-friction track. When the spring is released, an explosive separation occurs at the expense of the internal energy of the compressed spring. If the decrease in the spring's internal energy during the separation is 10.0 J (that's 10.0 joules), what is the speed of each cart right after the separation?

5. Two solid spheres hung by thin threads from a horizontal support (figure below) are initially in contact with each other. Sphere 1 has inertia $m_1 = 1.00\,\mathrm{kg}$, and sphere 2 has inertia $m_2 = 2.00\,\mathrm{kg}$. When pulled to the left and then released, sphere 1 collides elastically with sphere 2. At the instant just before the collision takes place, sphere 1 has kinetic energy $K_1 = 0.500\,\mathrm{J}$. (a) What is the velocity of sphere 1 right before the collision? (b) What is the kinetic energy of the system before the collision? (c) What is the velocity of each sphere after the collision? (d) From part c, calculate the kinetic energy after the collision. Does the value you get equal the result from part b? Explain why or why not. (e) Calculate the coefficient of restitution of the collision. Is this the result you expect?



6. Let's redo the previous problem, but now with two spheres made of modeling clay. As before, sphere 1 has inertia $m_1 = 1.00\,\mathrm{kg}$, and sphere 2 has inertia $m_2 = 2.00\,\mathrm{kg}$. Again, sphere 1 is pulled left, is released, and collides with sphere 2. This time, though, the two spheres stick together. Assume that sphere 1 again has a kinetic energy of $0.500\,\mathrm{J}$ just before the collision. (a) What is the initial velocity of sphere 1? (b) What is the kinetic energy of the system before the collision? (c) What is the final velocity of each sphere? (d) What is the kinetic energy of the system after the collision? Is this the same value you calculated in part b? (e) Based on what you have calculated so far, what kind of collision is this? (f) Calculate the coefficient of restitution. Is the value you get consistent with your answer to part e?

***** 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. *****