

Physics I Midterm

Due 5:00pm, Thursday October 21, 2021

Important Directions—Please Read Carefully

- **You may not collaborate on this exam; do not work with others.**
- You may consult your notes, your textbook, or any other written material while doing this test. You may use calculators and computer programs.
- When you are done with the exam, upload it to google classroom.
- If you have clarifying questions, please ask me and not one of the TAs.
- To receive full credit on most of these problems you must show your work clearly.
- **If you need extra time, that's fine—just let me know.** I know that this is a busy week for some.
- **Time estimate:** It's hard to me to say how long this will take, but I think that a total three focused¹ hours should be enough. If you've spent more than three hours of quality time with this exam and aren't done, stop and check in with me.

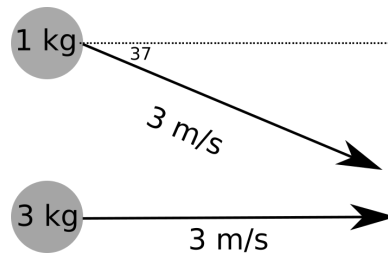


Figure 1: Yet again, two pucks are sliding, colliding, and sticking together.

1. Two pucks collide on a frictionless surface as shown in Fig. 1.
 - (a) Write the velocity for each of the two pucks in component form.
 - (b) After the pucks collide, they stick together. What is the velocity of the two stuck-together pucks? Answer in components and by giving the magnitude and angle of the pucks' velocity.
2. Steve Ressel has sent you on a mission to Pluto to look for lizards. You are hovering in a spacecraft 4 km above Pluto's surface. You need to get to the surface to begin your search. Would it be safe to jump off the spaceship at this altitude? The mass of Pluto is around 1.45×10^{22} kg. The radius of Pluto is 3500 km.

¹By this I mean three hours—not necessarily in a row—where you are focused on working through these problems with minimal distractions and multitasking.

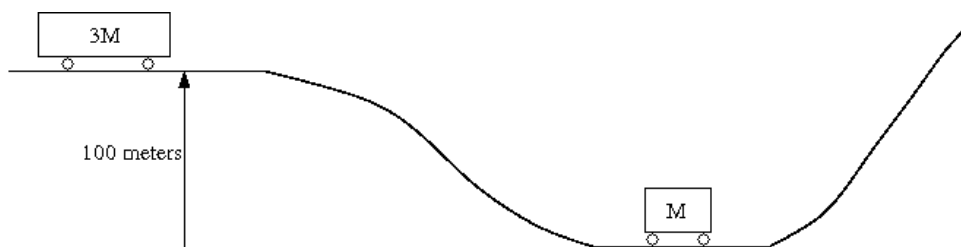


Figure 2: A train collision.

3. Consider the scenario in Fig 2. A train car starts at rest 100 meters above the ground. It rolls down and sticks to the smaller car. How high up the incline do the two trains go? The large car has a mass three times that of the smaller car.
4. A ball thrown by a professional baseball pitcher rotates at 2800 rotations per minute.
 - (a) Express the angular speed of the ball in radians per second.
 - (b) The radius of a baseball is about 230 mm. How fast is the surface of the baseball moving, in meters per second?
5. You are standing at the base of a building. On the second story of the building is a bowling alley owned by a friend of yours. It's time to take the bowling balls to get cleaned. Your friend has the following idea: Construct a ramp that goes out of the window and then onto the ground. The bowling balls can then be rolled down the ramp onto the level ground and you can stop them. This will be a lot easier than carrying the bowling balls down the stairs. Is this safe?
 - (a) Estimate the speed of the bowling balls when they reach you at ground level. State any assumptions you need to make to do the problem. (If something doesn't affect the final solution (perhaps the mass of the ball), you should state that, too.)
 - (b) Do you think the final speed poses a hazard?
 - (c) If the bowling balls slid² instead of rolled down, would they reach the bottom with a greater speed? Why or why not? (No calculations are necessary for this part of the question, but explain your answer.)

²Perhaps because you put oil on them. The need to get cleaned, anyway, so why not?