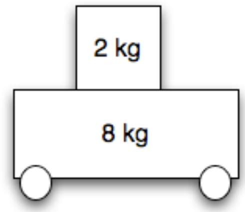
Physics 11 — Problem Set 8
Hammer — Due March 28 at 11:00

Problem set 8

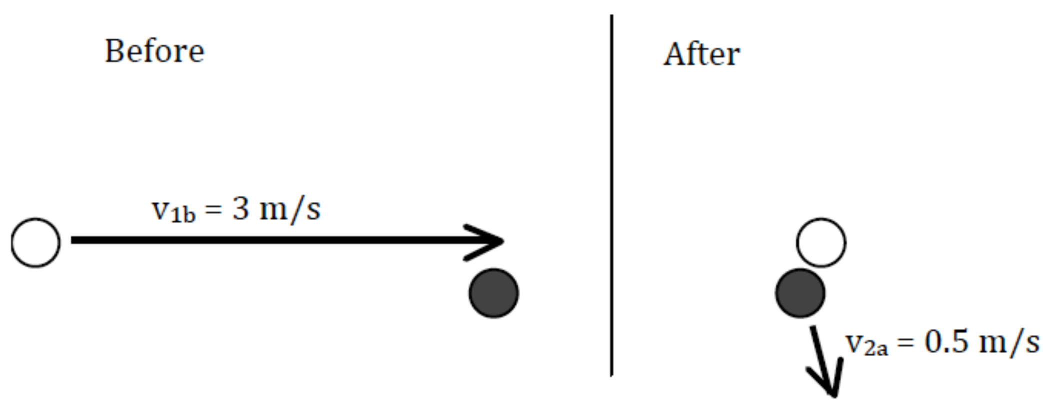
Only four problems this time, in honor of the exam, scheduled for Thursday March 31.

1) Another look at this situation: A 2 kg block sits on on a cart of mass 8 kg. The coefficient of static friction between the block and cart is μ_S=0.3. The cart's friction with the floor is negligible.



   a) Explain again what would happen if you push the cart with a force of 40 N (PS 4, #5).
   b) Suppose you push the cart with a force of 10 Newtons, for 2 seconds. Find the velocity of the cart.
   c) Now give the cart the same impulse as in part b, but much more suddenly: Suppose now that you kick the cart, so that the force by your foot on the cart lasts 0.1 seconds. Can you find the velocity of the cart?

2) I owe you a problem about collisions in 2-d. This one gives an interesting result. Curling is winter sport that it involves players sending "stones" (big pucks) gliding across the ice. A white stone with a mass of 10 kg is moving 3 m/s as shown, when it glances off a second, black curling stone of about the same mass. The black stone wasn't moving at first, but after the collision it moves off as shown, at a speed of 0.5 m/s. Assume the collision is elastic, and assume friction is negligible.[1]



   a) Write the expressions for conservation of momentum and conservation of energy. (The point of this is to be clear about what they say, so that you can figure out what they imply.)

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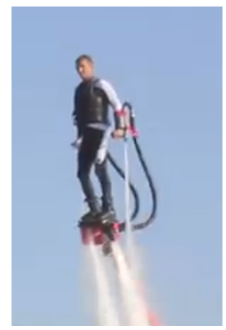
[1] It's a reasonable approximation at the collision, when the magnitude of the force by one puck on the other is much greater than the magnitude of friction by the ice. But the sport more generally is all about friction by the ice.

b) Show the velocity of the white stone, graphically, after the collision, if the black stone moves as I've shown. (I've drawn the vectors to scale.)

c) Find the speed of the white stone after the collision.

d) Find the angle between the velocity of the white stone and the velocity of the black ball, after the collision.

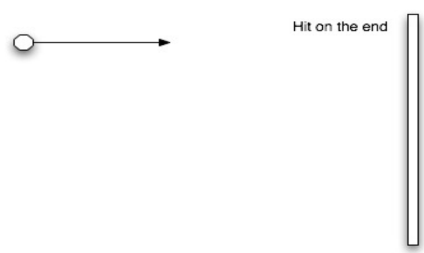
3) This one might be hard — see what you can do with it, and we can talk more on Piazza. This picture is of a man using a water jet device, from a company called Zapata Racing. It's a screen grab from a [a youtube video]() a student sent me a couple of years ago, and at this moment of the video, the man is hovering.



a) Try to explain how this is possible.

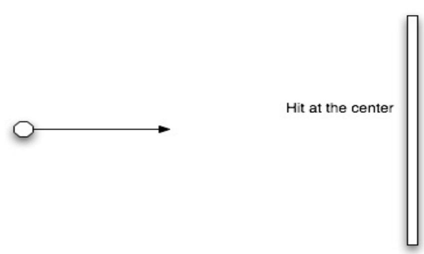
b) Try to come up with plausible estimates of the volume and speed of water shooting down from the jets.

4) Soon we're going to get into rotational motion, but it would be good for you to start now, based on the physics we've done and on what you've experienced in the world. No need to watch/read ahead!



A stone slides across the ice collides with a stick. Compare two ways the stone could hit the stick. One way, the stone hits the end of the stick; the other way, the stone hits the center of the stick. Suppose the stone has the same velocity in each case.

Just qualitatively — this is about getting a physical sense of what happens — compare what happens as a result of the two collisions with respect to



a) The *angular velocity* of the stick — that is, how quickly the stick *spins around its center of mass*.

b) The velocity of the stick, d**x**/dt — that is, of its center of mass.

c) The possibility of damage to the stick — does the stone dent it?

Try it! No need to find an ice rink: Use a pencil and a penny on a smooth table.