Problem Set 6 – Dynamics

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Problem 1

Box A and box B are sliding towards each other on a frictionless surface. Box A, with a mass of 5kg, moves with a velocity 5m/s east, and Box B, with a mass of 10kg, moves with a velocity 3m/s east.
a) Calculate the momentum and kinetic energy of Box A
b) Calculate the momentum and kinetic energy of Box B
c) If the collision is elastic, find the speed of the two boxes after the collision.

Problem 2

A child is sliding out of control with velocity v_c across a frozen lake. He runs head-on into another child, initially at rest, with 3 times the mass of the first child, who holds on so that the two now slide together. What is the velocity of the couple after the collision in terms of v_c? Keep in mind that in an inelastic collision, only momentum is conserved.

Problem 3

An object of mass 1kg which is originally at rest is subjected to a constant force of 10N for a duration of 5 seconds. Find the object's final velocity.

Problem 4

In deep space (thus, ignoring gravity), an apple and an orange are thrown at each other across a space shuttle. The apple has a mass of 136g, and is thrown with an initial speed of 1m/s. The orange has a mass of 205g, and is thrown with an initial speed of 1.6m/s. Their original velocities are straight towards each other. The fruits collide, sending the orange downwards at a speed of 0.75m/s. Find the final velocity (magnitude and direction) of the apple, with direction given as an angle counter-clockwise from the apple's original direction of motion.
(In a 2 or 3 dimensional elastic collision, the conservation of kinetic energy and momentum still hold. However, think of momentum as 2D or 3D vectors instead of 1D values.)

Problem 5

You are on a 20 meter long boat. The boat weighs 1000 kg and has uniform density, and you weigh 100 kg. Consider the system of you and the boat together. (Assume the boat slides on the water without friction, the boat's center of mass is at its center, and your center of mass is the same height as the boat's center of mass.)
a) If you are at one end of the boat, how far from the boat's center is the system's center of mass?
b) How far does the system's center of mass move (with respect to the water) if you walk from one end of the boat to the other?

Problem 6

Little 35-kg Taqwaan is sitting in a stationary 10kg wagon on level ground; the wagon can roll freely without friction. Taqwaan wants to propel the wagon forward without touching the ground. Conveniently, he is carrying a 10kg stone in the wagon.
He throws the stone horizontally off the back of the wagon. The stone flies out of his hand with a

speed of 8 m/s relative to Taqwaan. **How fast is the wagon moving forward immediately afterwards?** (Conservation of momentum)