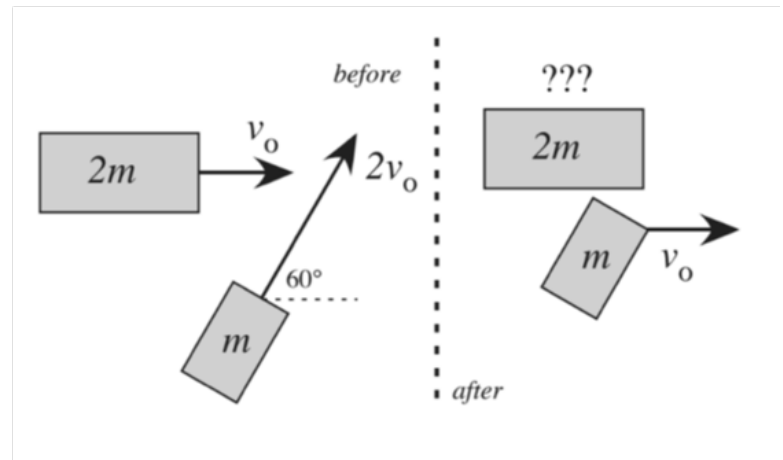


## Physics 2211 – Summer GPS Week 9

### Problem #1

A cruise ship is moving due east with some speed  $v_0$  when it collides with a boat moving  $60^\circ$  north of east with a speed  $2v_0$ . The boat's mass is  $m$  and the cruise ship's mass is  $2m$ . Immediately after the collision, the boat is observed to be floating due east with a speed  $v_0$ .

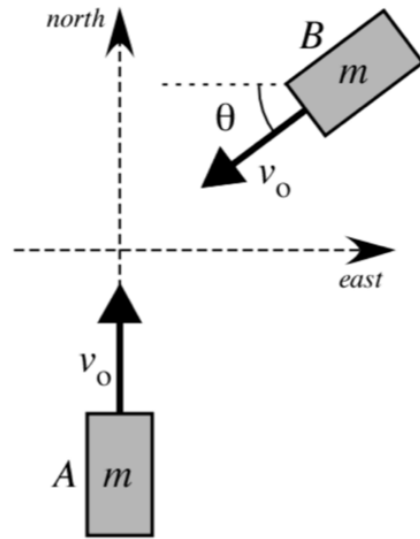


(a) Determine the velocity of the cruise ship just after the collision. You need to express your answer in terms of the parameter  $v_0$ .

(b) What percentage of the original kinetic energy was lost in the collision?

## Problem #2

Two cars of identical mass  $m$  are involved in a collision. Both cars are moving at the same speed  $v_0$ . One of the cars is initially moving due north, and the other is initially moving south of west at an angle  $\theta$  (where  $45^\circ < \theta < 90^\circ$ ). The collision between the two vehicles is maximally inelastic; in other words, the vehicles stick together after the collision.



- (a) Determine the magnitude of the final velocity of each car after the collision, in terms of the quantities  $m$ ,  $v_0$ , and  $\theta$ .

### Problem #3

A person of mass  $m_1$  is walking at constant velocity  $\vec{v}_1 = \langle v_1, 0, 0 \rangle$  along the sidewalk towards an intersection, looking down at their phone. At the same time, another person riding a scooter (total mass  $m_2$ ) approaches the intersection with unknown velocity  $\vec{v}_2 = \langle 0, v_2, 0 \rangle$ . Neither the person walking nor the person on the scooter notice each other, and so they crash.

The two people and the scooter stick together after the crash, moving together with an **unknown final speed** at an angle  $\theta$  above the x-axis.

(a) How fast was the scooter moving before the crash? I.e., what was the initial speed  $v_2$ ? Your answer must use **ONLY** variables that represent known quantities ( $m_1, m_2, v_1, \theta$ ). Hint: drawing a diagram may help.

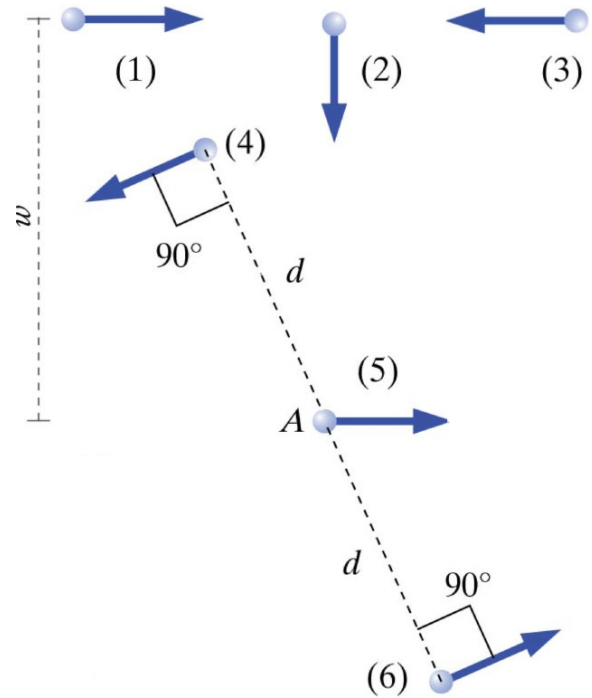
(b) What was the change in internal energy of the system during the crash? Again, your answer must only use variables that represent known quantities in the problem.

#### Problem #4

In the diagram on the right, six identical particles of mass  $m$  and speed  $v$  are moving relative to a point  $A$ , the current location of particle (5). The distance of these particles from point  $A$  is indicated in the diagram. The arrows indicate the directions of the particle's velocities.

As usual,  $+x$  is to the right,  $+y$  is up and  $+z$  is out of the page, towards you.

In the following calculations, remember that angular momentum is a vector.



- (a) Calculate the angular momentum of particle 1 with respect to  $A$ .
- (b) Calculate the angular momentum of particle 2 with respect to  $A$ .
- (c) Calculate the angular momentum of particle 3 with respect to  $A$ .
- (d) Calculate the angular momentum of particle 4 with respect to  $A$ .
- (e) Calculate the angular momentum of particle 5 with respect to  $A$ .
- (f) Calculate the angular momentum of particle 6 with respect to  $A$ .
- (g) Calculate the total angular momentum of the system of particles with respect to  $A$ .