Name clé

Unit 4: Homework Questions #3

*Conservation of Momentum*

1. In a football game, a 89.7 kg fullback running east with a speed of 4.96 m/s is tackled by a 94.9 kg linebacker running north with a speed of 3.09 m/s.

a. Calculate the speed and direction of the players just after the tackle.

y-direction

$(94.9)(3.09) = (184.6)(v)$

$v = 1.588$

2.89 m/s at 33.4°

Solve the triangle → $V_f$, 33.4°, 1.558, 2.41

x-direction

$(89.7)(4.96) = (184.6)(v)$

$v = 2.41$ m/s

$(89.7)(4.96)$ →

↑ $(94.9)(3.09)$

$V_f = 2.887$ m/s

$\theta = 33.389°$

b. Determine the mechanical energy lost as a result of the collision.

785.5 J

$E_{before} = \frac{1}{2}(89.7)(4.96)^2 + \frac{1}{2}(94.9)(3.09)^2 = 1556.44$ J

$E_{After} = \frac{1}{2}(184.6)(2.887^2) = 769.299$ J

Subtract: 787.140 J loss

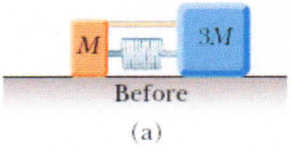
2. Two blocks of masses $M$ and $3M$ are placed on a horizontal, frictionless surface. A light spring is attached to ~~one of~~ them, and the blocks are pushed together with the spring between them as shown in the figure below. A cord initially holding the blocks together is burned; after that happens, the block of mass $3M$ moves to the right with a speed of 2.05 m/s.

(a) What is the velocity of the block of mass $M$?

-6.15 m/s

$0 = (3M)(2.05) + (M)(v)$

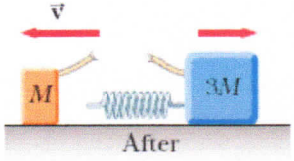
$v = -6.15$ m/s




(b) Assuming that the collision was perfectly elastic, find the system's original potential energy taking $M = 0.390$ kg.

9.83 J

$\frac{1}{2}(3M)(2.05^2) + \frac{1}{2}(M)(6.15)^2 = 9.834$ J




3. A ball of mass 0.120 kg is dropped from rest from a height of 1.25 m. It rebounds from the floor to reach a height of 0.800 m. What impulse was given to the ball by the floor?

1.07 kg m/s

$mgh = \frac{1}{2}mv^2$

$v = 4.950$ m/s

$p = (.12)(4.95) =$

$0.594 \frac{kgm}{s}$

$mgh = \frac{1}{2}mv^2$

$g(.8m) = \frac{1}{2}v^2$

$v = 3.960$ m/s

$p = 0.475 \frac{kgm}{s}$

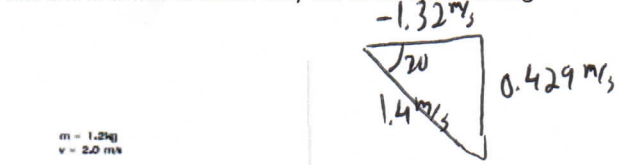
opposite signs

$p_f - p_i$

$-0.47 - 0.594 = -1.07 \frac{kgm}{s}$

4. A small black disc (1.2kg) travels with a constant velocity of 2.0 m/s due east. A second larger, gray disc (m= 3.0kg) travels with its own constant velocity of 1.4 m/s in a direction of 20 degrees north of west. If the two discs have a Velcro ring around them and stick together, determine how fast and in which direction they will travel upon sticking together.

0.503 m/s at 47 °




X-momentum

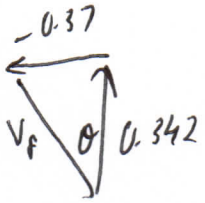
$(1.2\,kg)(2\,m/s) + (3\,kg)(-1.32\,m/s) = (4.2\,kg)(v_{fx})$

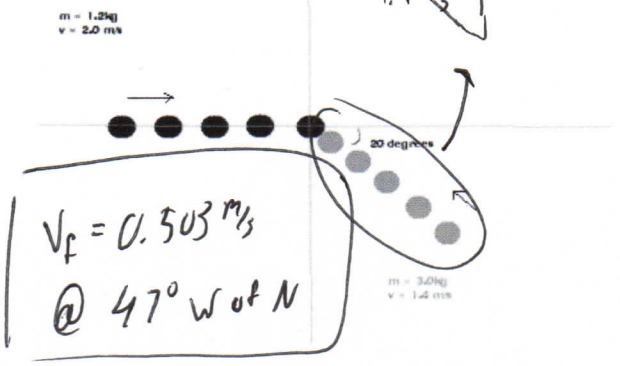
$v_{fx} = -0.37\,m/s$

Y-momentum

$(3\,kg)(0.429\,m/s) = (4.2\,kg)(v_{fy})$

$v_{fy} = 0.342$



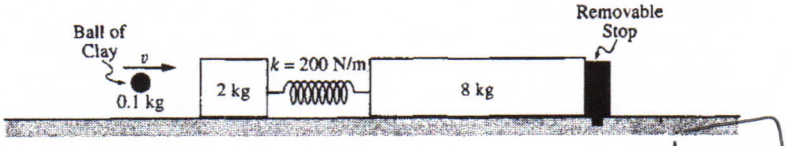




$v_f = 0.503\,m/s$ @ 47° W of N

5. A 2-kilogram block and an 8-kilogram block are both attached to an ideal spring ( for which k = 200 N/m) and both are initially at rest on a horizontal frictionless surface, as shown in the diagram above.

In an initial experiment, a 100-gram (0.1 kg) ball of clay is thrown at the 2-kilogram block. The clay is moving horizontally with speed v when it hits and sticks to the block. The 8-kilogram block is held still by a removable stop. As a result, the spring compresses a maximum distance of 0.4 meters.

***NO ANSWERS GIVEN***




a. Calculate the energy stored in the spring at maximum compression. $U = \frac{1}{2}(200\,N/m)(0.4\,m)^2 = 16\,J$

b. Calculate the speed of the clay ball and 2-kilogram block immediately after the clay sticks to the block but before the spring compresses significantly. $\frac{1}{2}mv^2 = U$ $v = \sqrt{2U/m} = \sqrt{32\,J/2.1\,kg} = 3.9\,m/s$

c. Calculate the initial speed v of the clay. $mv = Mv_i$ $v = \frac{Mv_i}{m}$ $v = (2.1\,kg)(3.9\,m/s)/(0.1\,kg) = 81.9\,m/s$

*In a second experiment, an identical ball of clay is thrown at another identical 2-kilogram block, but this time the stop is removed so that the 8-kilogram block is free to move.*

d. State whether the maximum compression of the spring will be greater than, equal to, or less than 0.4 meter. Explain briefly.

Less than. 8 kg will begin to move before spring can compress as much