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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.

   2.89 m/s at 33.4 °

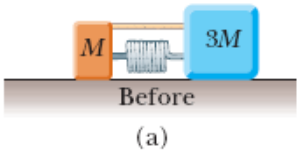
   b. Determine the mechanical energy lost as a result of the collision.

   785.5 J

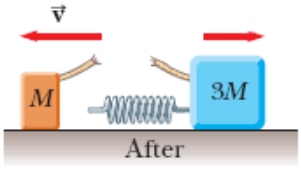
2. Two blocks of masses M and $3M$ are placed on a horizontal, frictionless surface. A light spring is attached to one of them, and the blocks are pushed together with the spring between them as shown in the figure below. A cord initially holding the blocks together is burned; after that happens, the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



(a)



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

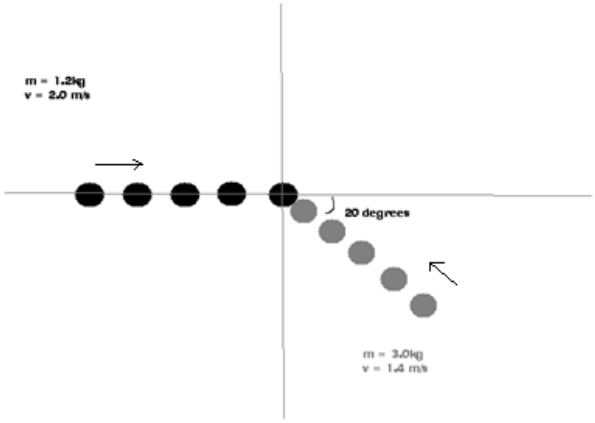
   9.83 J

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

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 °



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.

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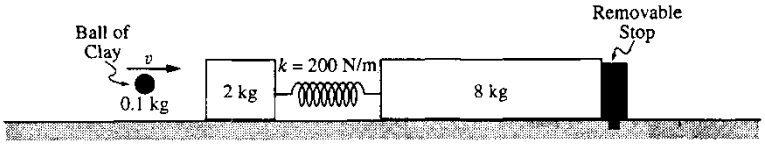

a. Calculate the energy stored in the spring at maximum compression.

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.

c. Calculate the initial speed v of the clay.

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.