The Law of Conservation of Momentum

Pre-Class Questions

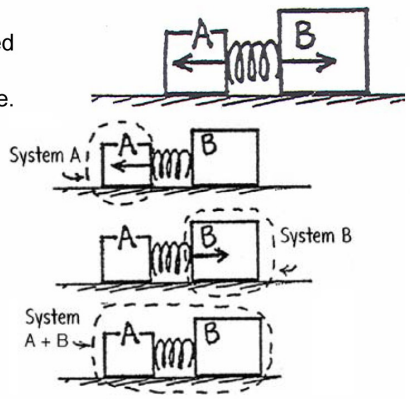
Problem Set (due next time)
Ch 8 - 8, 11, 14, 17

Lecture Outline

1. Developing the Law of Conservation of Linear Momentum
2. Applying the Law of Conservation of Linear Momentum

CONCEPTUAL Physics PRACTICE PAGE

1. When the compressed spring is released, Blocks A and B will slide apart. There are three systems to consider, indicated by the closed dashed lines below—A, B, and A + B. Ignore the vertical forces of gravity and the support force of the table.



a. Does an external force act on System A? [Y] [N]

Will the momentum of System A change? [Y] [N]

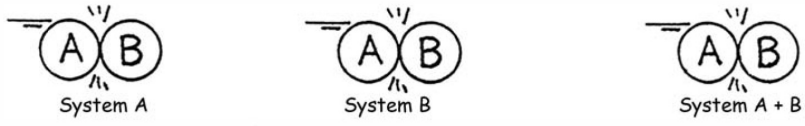
b. Does an external force act on System B? [Y] [N]

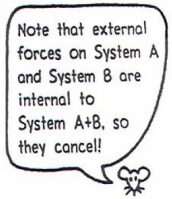
Will the momentum of System B change? [Y] [N]

c. Does an external force act on System A + B? [Y] [N]

Will the momentum of System A + B change? [Y] [N]

2. Billiard ball A collides with billiard ball B at rest. Isolate each system with a closed dashed line. Draw only the external force vectors that act on each system.

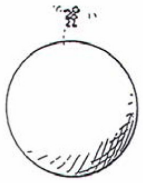




a. Upon collision, the momentum of System A [increases] [decreases] [remains unchanged].

b. Upon collision, the momentum of System B [increases] [decreases] [remains unchanged].

c. Upon collision, the momentum of System A + B [increases] [decreases] [remains unchanged].

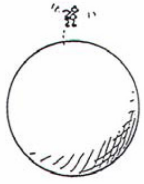


3. a. A girl jumps upward. In the left sketch, draw a closed dashed line to indicate the system of the girl.

Is there an external force acting on her? [Y] [N]

Does her momentum change? [Y] [N]

Is the girl's momentum conserved? [Y] [N]



b. In the right sketch, draw a closed dashed line to indicate the system (girl + Earth). Is there an external force acting on the system due to the interaction between the girl and Earth? [Y] [N]

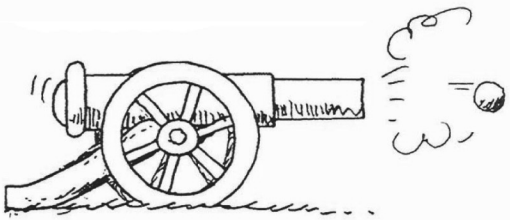
Hewitt Drew It!

CONCEPTUAL Physics PRACTICE PAGE

1. The recoil momentum of a cannon that kicks is

   [more than] [less than] [the same as]

   the momentum of the cannonball it fires. (Here we neglect friction and the momentum of the gases.)



2. Suppose you are traveling in a bus at highway speed on a nice summer day and the momentum of an unlucky bug is suddenly changed as it splatters onto the windshield.

   a. Compared to the force that acts on the bug, how much force acts on the bus?

      [More] [Less] [The same]

   b. The time of impact is the same for both the bug and the bus. Compared to the impulse on the bug, this means the impulse on the bus is

      [more] [less] [the same].

   c. Although the momentum of the bus is very large compared to the momentum of the bug, the *change* in momentum of the bus, compared to the *change* of momentum of the bug is

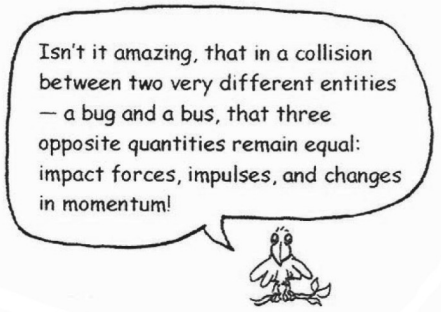
      [more] [less] [the same].

   d. Which undergoes the greater acceleration?

      [Bus] [Both the same] [Bug]

   e. Which therefore, suffers the greater damage?

      [Bus] [Both the same] [The bug of course!]



Hewitt Drew it!

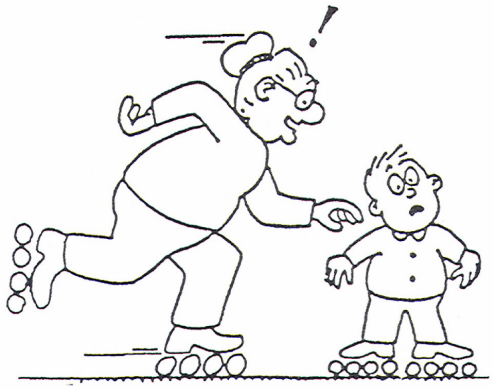
Example 1: A 100kg astronaut throws a 1.00kg wrench at 25.0m/s. Find the recoil velocity of the astronaut.

CONCEPTUAL Physics PRACTICE PAGE

Granny whizzes around the rink and is suddenly confronted with Ambrose at rest directly in her path. Rather than knock him over, she picks him up and continues in motion without "braking."

Consider both Granny and Ambrose as two parts of one system. Since no outside forces act on the system, the momentum of the system before collision equals the momentum of the system after collision.

a. Complete the before-collision data in the table below.



BEFORE COLLISION	
Granny's mass	80 kg
Granny's speed	3 m/s
Granny's momentum	_____
Ambrose's mass	40 kg
Ambrose's speed	0 m/s
Ambrose's momentum	_____
Total momentum	_____

b. After collision, Granny's speed [increases] [decreases].

c. After collision, Ambrose's speed [increases] [decreases].

d. After collision, the total mass of Granny + Ambrose is _____.

e. After collision, the total momentum of Granny + Ambrose is _____.

f. Use the conservation of momentum law to find the speed of Granny and Ambrose together after collision. (Show your work in the space below.)

New speed _____

Hewitt Drew it!

Example 2: A pumpkin dropped from the top of Butte Hall strikes the ground below and breaks into three pieces of equal mass that fly off horizontally. The first piece heads off northeastward at 20.0m/s. The second piece heads off at 60° south of east at 16.3m/s. Find the speed and direction of the third piece.

Lecture 20 - Summary

The Law of Conservation of Linear Momentum

"The total linear momentum of an isolated systems of objects remains constant."