Ch 8.3, Ch 8.4

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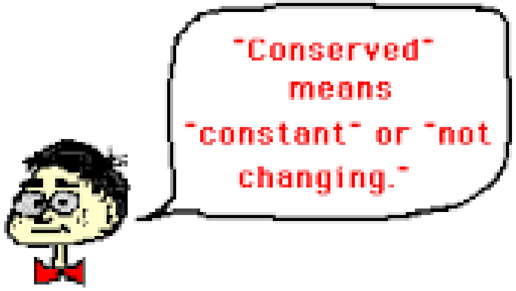
Conservation of Momentum Principle

The conservation of momentum principle is written

ptot=constant

principle of conservation of momentum states that when you have an isolated system with no external forces, the initial total momentum of objects before a collision equals the final total momentum of the objects after the collision.

Pinitial=Pfinal



Isolated systems

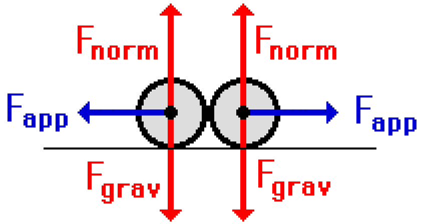
Equation:

$$\sum \vec{F} = 0.$$

ptot = **p′**tot

ptot is the initial total momentum and **p′**tot is the total momentum some time later.

In an isolated system the net force <u>must</u> be 0 (**F**net=0).



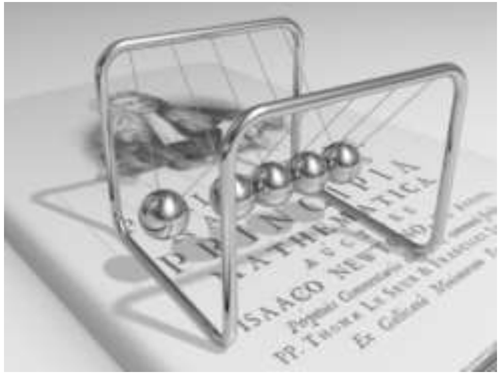
The collision between two billiard balls on a friction-free surface occurs in an isolated system; the only unbalanced forces occur from within the system.

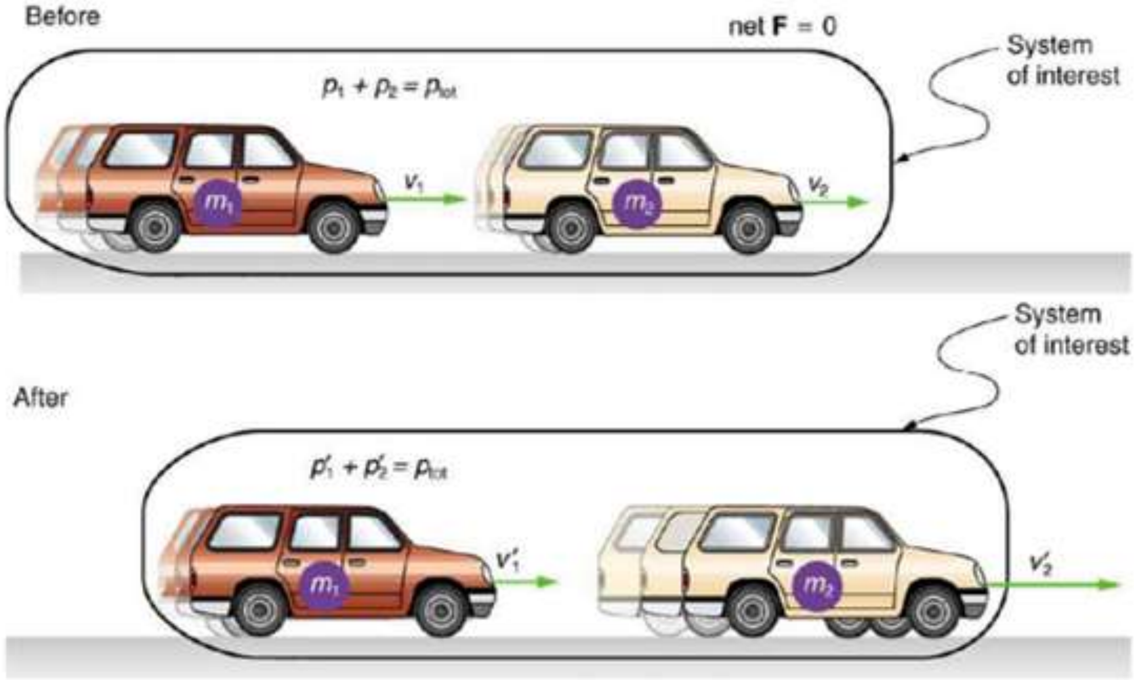
Conservation of Momentum

m1v1 + m2v2 = m1v'1 + m2v'2

P1 + P2 = P'1 + P'2

P(total) = P'(total)





Conservation of Momentum

$m_1v_1' - m_1v_1 = - F\Delta t$

$m_2v_2' - m_2v_2 = F\Delta t$

$- (m_1v_1' - m_1v_1) = m_2v_2' - m_2v_2$

$\therefore \quad m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'$

Examples (from Textbook)/Lab

https://www.youtube.com/watch?v=2UHS883_P60

Hold a tennis ball side by side and in contact with a basketball. Drop the balls together. (Be careful!) What happens? Explain your observations. Now hold the tennis ball above and in contact with the basketball. What happened? Explain your observations. What do you think will happen if the basketball ball is held above and in contact with the tennis ball?

Hypothesis (stacked)
The tennis ball will take the force from the basketballs potential energy as it hits the ground causing it to launch way higher.

Elastic Collisions (in one Dimension)

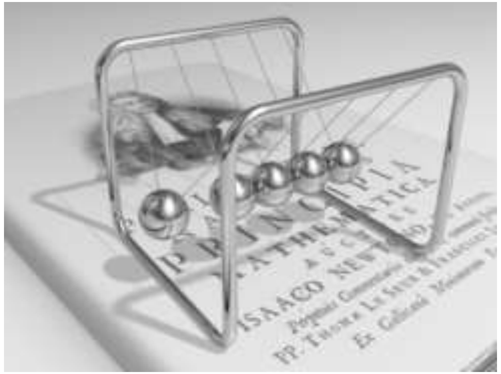
A collision conserving internal kinetic energy

Conservation of momentum and kinetic energy can be used to allow final velocities to be calculated in terms of initial velocities and masses in one dimensional, two body collisions.

Under what circumstances is momentum conserved?

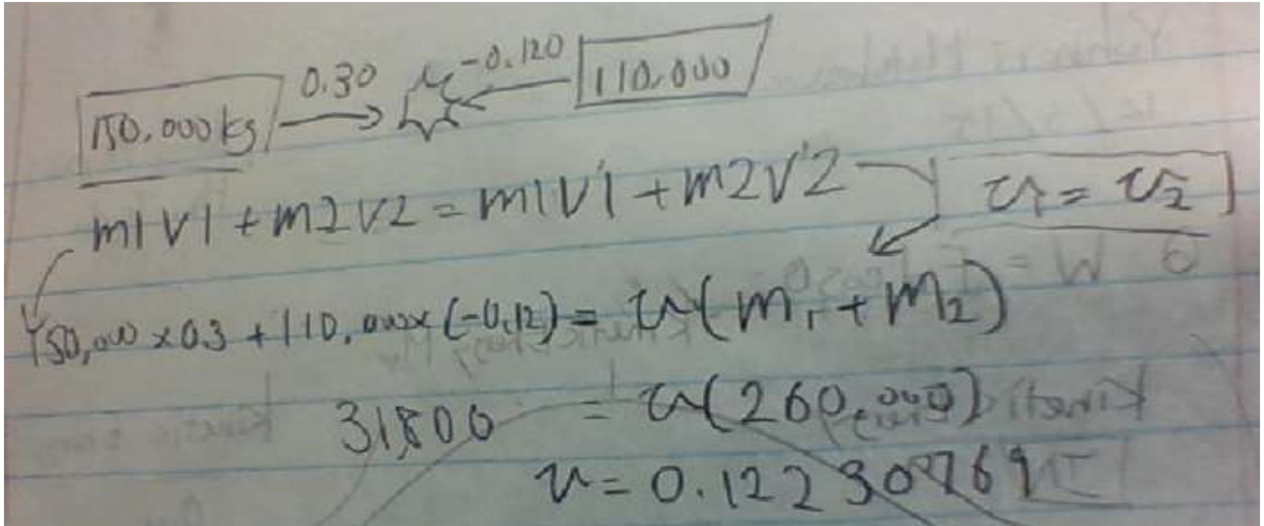
The Conservation of momentum can only take place when the net forces in the problem are 0

Isolated systems



Textbook Problems

Train cars are coupled together by being bumped into one another. Suppose two loaded train cars are moving toward one another, the first having a mass of 150,000 kg and a velocity of 0.300 m/s, and the second having a mass of 110,000 kg and a velocity of −0.120 m/s. (The minus indicates direction of motion.) What is their final velocity?



Answer:

0.122 m/s

Textbook problems (continued...)

Two cars (A and B) of mass 1.5 kg collide. Car A is initially moving at 12 m/s, and car B is initially moving in the same direction with a speed of 6 m/s. The two cars are moving along a straight line before and after the collision. What will be the change in momentum of this system after the collision?

a) −27 kg • m/s

b) zero

c) +27 kg • m/s

d) It depends on whether the collision is elastic or inelastic.

B) Momentum is conserved/ carried on from car A and will just continue as both cars were headed in the same direction.

SOLVE EACH VEROCITY (M1= 0.5KG, M2=3.5KG, V1=4M/S, V2=0)

$$\frac{1}{2}m_1 v_1^2 = \frac{1}{2}m_1 v'^2_1 + \frac{1}{2}m_2 v'^2_2.$$

Solving the first equation (momentum equation) for v'_2, we obtain

$$v'_2 = \frac{m_1}{m_2}(v_1 - v'_1). \quad (8.40)$$

Substituting this expression into the second equation (internal kinetic energy equation) eliminates the variable v'_2, leaving only v'_1 as an unknown (the algebra is left as an exercise for the reader). There are two solutions to any quadratic equation; in this example, they are

$$v'_1 = 4.00 \text{ m/s} \quad (8.41)$$

and

$$v'_1 = -3.00 \text{ m/s}. \quad (8.42)$$

As noted when quadratic equations were encountered in earlier chapters, both solutions may or may not be meaningful. In this case, the first solution is the same as the initial condition. The first solution thus represents the situation before the collision and is discarded. The second solution ($v'_1 = -3.00$ m/s) is negative, meaning that the first object bounces backward. When this negative value of v'_1 is used to find the velocity of the second object after the collision, we get

$$v'_2 = \frac{m_1}{m_2}(v_1 - v'_1) = \frac{0.500 \text{ kg}}{3.50 \text{ kg}}[4.00 - (-3.00)] \text{ m/s} \quad (8.43)$$

or

$$v'_2 = 1.00 \text{ m/s}. \quad (8.44)$$

Chapter 8.3-8.4

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