

Evaluations for all courses will be conducted online for Spring 2009.

The course evaluation site will be active
from 9:00 am Monday, April 20
until midnight of Wednesday, May 6th.

The URL address to the evaluations will be provided through an email to the students.

Students will use their NJIT UCID and UCID password (same as "Highlander Pipeline") to login and go to a landing page which will have all their courses listed.

1

"Impulse" and "Momentum"

Last class...

Impulse

Momentum

Impulse-Momentum Theorem

Today...

System of particles

Conservation of Momentum

Elastic vs. Inelastic Collisions

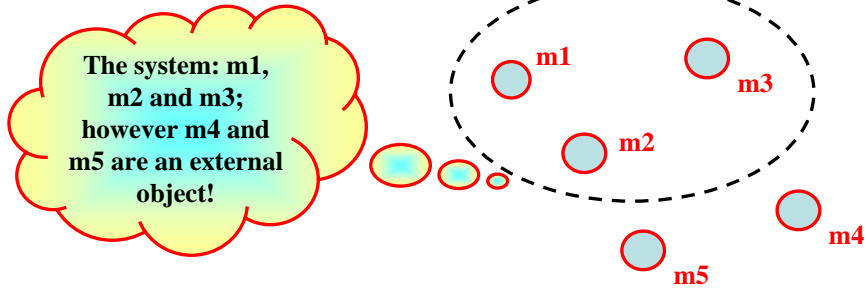
2

System of particles, or objects

So far, we mostly focused on the motion of "one" object.

We now consider system of "multiple" objects, which we can choose any way convenient for us.

For example,

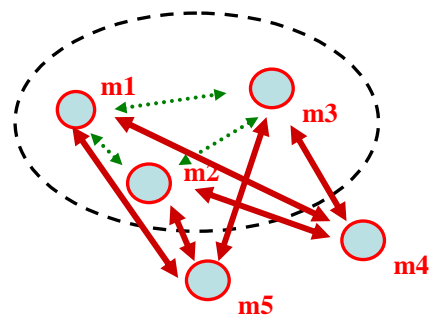


3

Internal vs. External Forces

Internal forces: Forces between objects within the system

External forces: Forces from outside the system



4

Net Momentum, Net external force, Net external impulse

Net Momentum of System of Particles (or, Objects)

$$\vec{P}_{net} = \vec{p}_1 + \vec{p}_2 + \dots = m_1\vec{v}_1 + m_2\vec{v}_2 + \dots$$

Net external force: $\vec{F}_{net,ext} = \vec{F}_{ext,1} + \vec{F}_{ext,2} + \dots$

sum of all "external" forces acting on the system

Net external impulse: $\vec{I}_{net,ext} = \vec{F}_{net,ext}\Delta t$

5

Impulse-Momentum Theorem for System of Particles

$$\vec{I}_{net,ext} = \vec{P}_{net,f} - \vec{P}_{net,i}$$

Net external impulse is equal to net momentum change.

Proof: use Newton's 3rd law (see textbook)

Note: Internal forces do not matter for net momentum change.

6

Conservation of momentum

If $\vec{I}_{net,ext} = 0$, for example, $\vec{F}_{net,ext} = 0$ (isolated system)

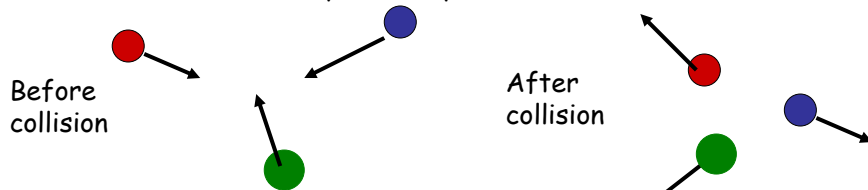
$$\rightarrow \vec{P}_{net,f} = \vec{P}_{net,i}$$

If the net external impulse is zero, for example,
if the net external force is zero,
the net momentum of a system is conserved.

7

Elastic vs. Inelastic Collisions

In a collision within a system of particles



Net kinetic energy: $K_{net} = K_1 + K_2 + \dots = \frac{1}{2}mv_1^2 + \frac{1}{2}mv_2^2 + \dots$

If $K_{net,i} = K_{net,f}$ \rightarrow elastic collision.

If $K_{net,i} \neq K_{net,f}$ \rightarrow inelastic collision.

If $K_{net,i} \neq K_{net,f}$ and objects move together after collision
 \rightarrow perfectly inelastic collision.

8

Example 1: The archer

An archer stands at rest on frictionless ice and fires a 0.50 kg arrow horizontally at 50.0 m/s. The combined mass of the archer and bow is 60.0 kg. With what velocity does the archer move across the ice after firing the arrow?



© 2008 Brooks/Cole - Thomson

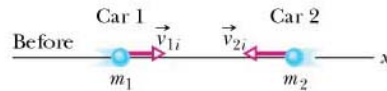
9

Data : Fatality of a driver in head-on collision

(With a passenger) < (Without a passenger)



Figure represents two identical cars about to collide head-on in a completely inelastic, one-dimensional collision along an x axis. Let's make the reasonable assumption that during the collision the impulse between the cars is so great that we can neglect the relatively minor impulses due to the frictional forces on the tires from the road. Then we can assume that there is no net external force on the two-car system. The x component of the initial velocity of car 1 along the x axis is $v_{1i} = +25$ m/s, and that of car 2 is $v_{2i} = -25$ m/s. During the collision, the force (and thus the impulse) on each car causes a change Δv in the car's velocity. The probability of a driver being killed depends on the magnitude of Δv for that driver's car. We want to calculate the changes Δv_1 and Δv_2 in the velocities of the two cars.



(1) First, let each car carry only a driver. The total mass of car 1 (including driver 1) is $m_1 = 1400$ kg, and the total mass of car 2 (including driver 2) is $m_2 = 1400$ kg.

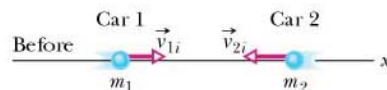
iClicker Quiz: Initial net momentum for the system of car 1 and car 2 is _____.
 (a) Positive (b) Zero (c) Negative

iClicker Quiz: Final velocity of the car 1 and car 2 is _____.
 (a) Positive (b) Zero (c) Negative

What are the changes Δv_1 and Δv_2 in the velocities of the cars?

11

....The x component of the initial velocity of car 1 along the x axis is $v_{1i} = +25$ m/s, and that of car 2 is $v_{2i} = -25$ m/s. During the collision, the force (and thus the impulse) on each car causes a change Δv in the car's velocity. The probability of a driver being killed depends on the magnitude of Δv for that driver's car. We want to calculate the changes Δv_1 and Δv_2 in the velocities of the two cars.



(1) First, let each car carry only a driver. The total mass of car 1 (including driver 1) is $m_1 = 1400$ kg, and the total mass of car 2 (including driver 2) is $m_2 = 1400$ kg.

(2) Next, we reconsider the collision, but this time with an 80 kg passenger in car 1.

iClicker Quiz: Initial net momentum for the system of car 1 and 2 is _____.
 (a) Positive (b) Zero (c) Negative

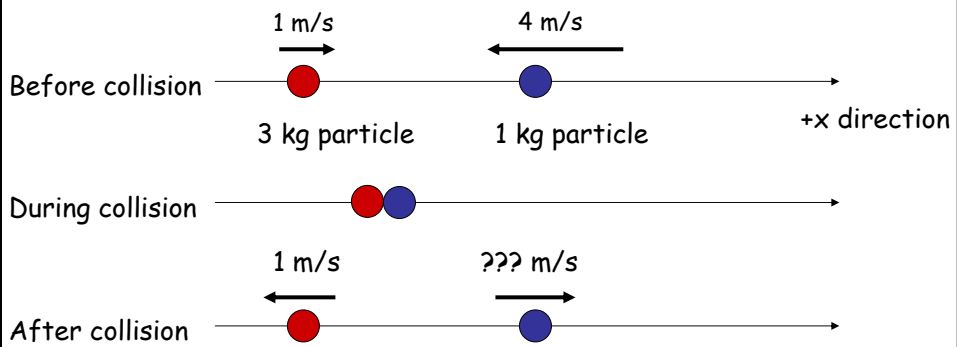
iClicker Quiz: Final velocity of the car 1 and car 2 is _____.
 (a) Positive (b) Zero (c) Negative

What are Δv_1 and Δv_2 now?

(3) If there's a passenger, does the collision become less fatal, or more fatal?

12

Example



Two objects on a frictionless horizontal surface collide as shown above.

iClicker Quiz: Net initial momentum is _____.

(a) positive, (b) zero, (c) negative

Find the velocity of the 1 kg object.