Final Exam
8:30-11:00 am, May 8th, 2007, Tuesday
208 Kupfrian Hall (*Different from the room for the previous exams*)
From Chapter 1 to Chapter 9
Bring your scientific calculators.

Lecture notes at **http://www.geocities.com/kenahn7**

Today: Last lecture (HW#13 due May 4th,Friday)

Review session : **May 4th, Friday, 5:45-6:45 pm** (after Math exam) at **Cullimore Lecture Hall 1**

Bring your old common exams.

Today…

- Return Quiz #13
- Chapter 9
- HW13 hints
- Brief Review for Final Exam

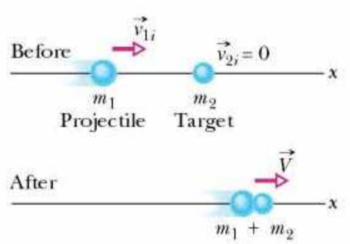
Last class, we learned…

Section 9-9, Inelastic Collisions in One Dimension

The total momentum is conserved,
but the total kinetic energy is NOT conserved.

Complete (fully, or perfectly) inelastic collision

→ Two objects move together after collision.



$$m_1 \cdot \vec{v}_1 + m_2 \cdot \vec{v}_2 = (m_1 + m_2) \cdot \vec{V}$$

Velocity of the center of mass

If no external force, $\vec{V}_{CM}$ is constant.

Chapter 9. Center of Mass and Linear Momentum

From Section 9-1 to Section 9-9

Center of Mass

Linear Momentum

Impulse

Conservation of Linear Momentum

Inelastic Collisions

Section 9-10, Elastic Collisions in One Dimension

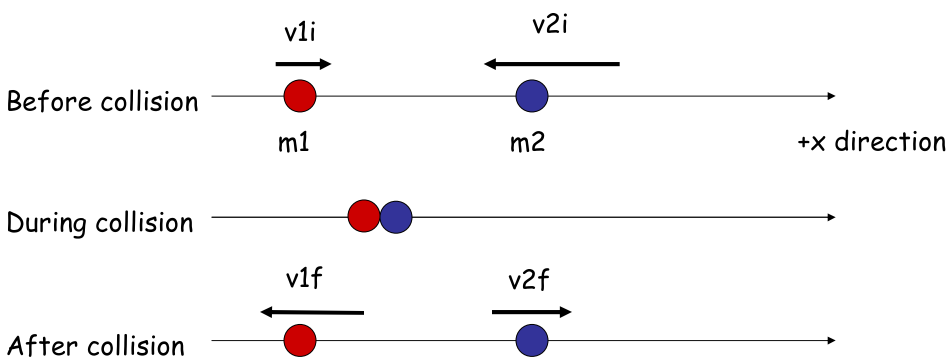
Section 9-11, Collisions in Two Dimensions

Section 9-10, Elastic Collisions in One Dimension

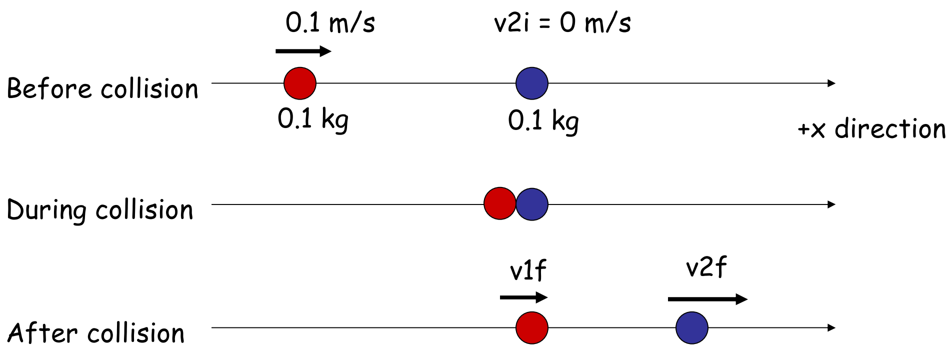
The total momentum is conserved,
and the total kinetic energy **is** conserved.

$$m_1\vec{v}_{1,i} + m_2\vec{v}_{2,i} = m_1\vec{v}_{1,f} + m_2\vec{v}_{2,f}$$

$$\frac{1}{2}m_1v_{1i}^2 + \frac{1}{2}m_2v_{2i}^2 = \frac{1}{2}m_1v_{1f}^2 + \frac{1}{2}m_2v_{2f}^2$$

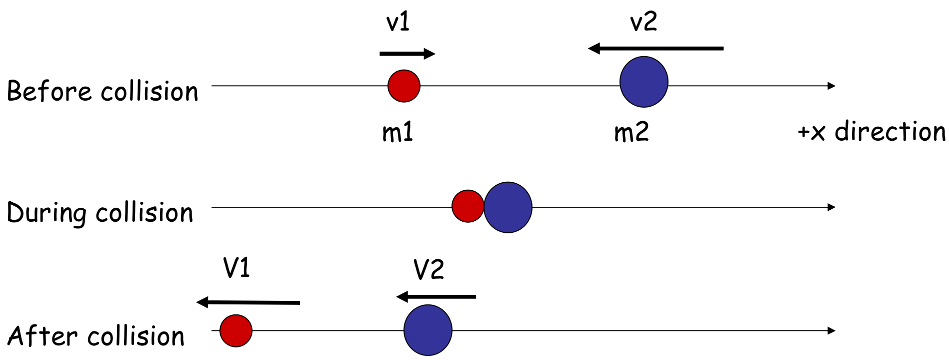


Example: A head-on collision of a cue ball with an object ball in a game of pool



The cue ball and the object ball have the same mass, 0.1 kg.
Assume that the collision is elastic. Find the final velocities, v1f and v2f.

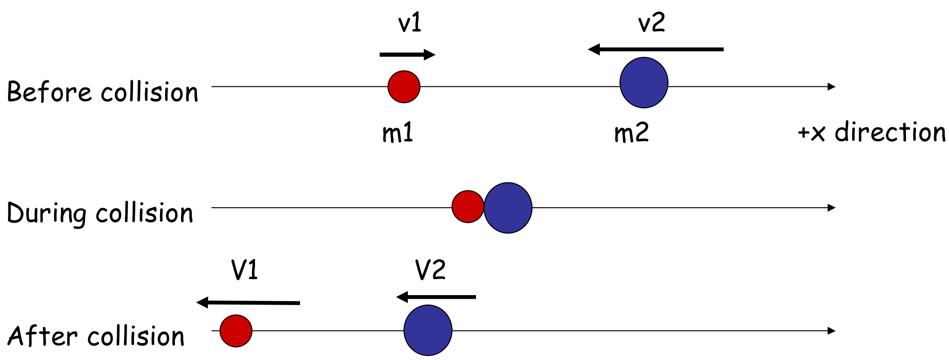
Example: Elastic collision of two balls in one dimension



Suppose the collision is elastic, m1=0.5 kg, m2=1 kg, v1=1 m/s, v2=-3 m/s.

Find the final velocities, V1 and V2.

Generally, for elastic collision of two objects in one dimension



$$V_1 = \frac{m_1 - m_2}{m_1 + m_2} \cdot v_1 + \frac{2 \cdot m_2}{m_1 + m_2} \cdot v_2 \quad \text{and} \quad V_2 = \frac{2 \cdot m_1}{m_1 + m_2} \cdot v_1 + \frac{m_2 - m_1}{m_1 + m_2} \cdot v_2$$

Section 9-11, Collisions in Two Dimensions

If no external force, then the **total** momentum is conserved.

→ $m_1\vec{v}_1 + m_2\vec{v}_2 = m_1\vec{V}_1 + m_2\vec{V}_2$

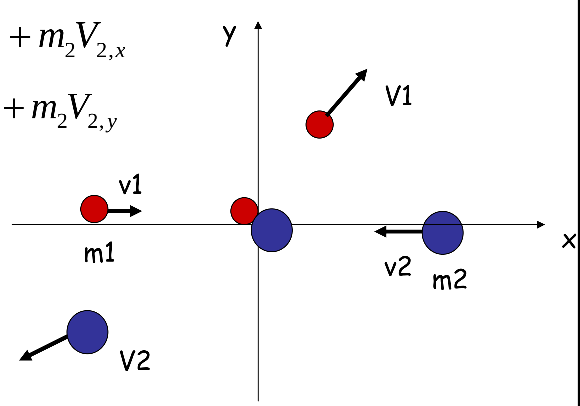
Or

$$m_1 v_{1,x} + m_2 v_{2,x} = m_1 V_{1,x} + m_2 V_{2,x}$$

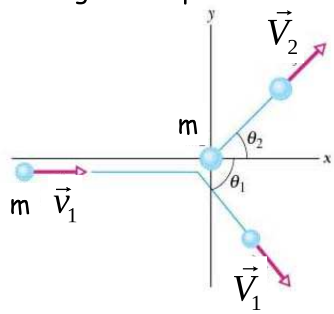
$$m_1 v_{1,y} + m_2 v_{2,y} = m_1 V_{1,y} + m_2 V_{2,y}$$

If kinetic energy is conserved,
→ Elastic collision

If K.E. not conserved,
→ Inelastic collision



Example: 90 degree deflection rule in a game of pool



Assume that the collision is elastic.

The two balls have the same mass.

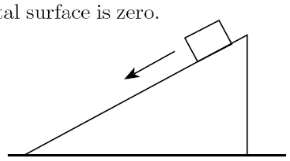
Show that the angle between the outgoing balls is 90 degree.

(No forward, back or side spin is in effect.)

HW#13 hints

001 (part 1 of 1) 10 points

A large wedge (with a rough inclined surface and a smooth lower surface) rests on a horizontal frictionless surface. A block with a rough bottom starts from rest and slides down the inclined surface of the wedge. The coefficient for friction between the block and inclined wedge surface is $.1 < \mu_{block\ incline} < .5$ and that between the lower wedge surface and horizontal surface is zero.



While the block is sliding down the inclined surface, the combined center of mass of the block and wedge

Consider "wedge+block" as a system.

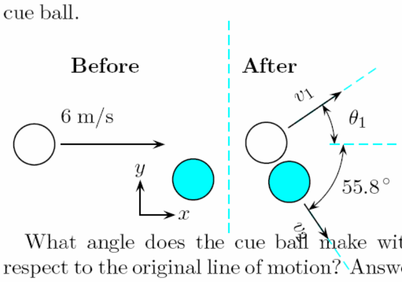
What are the external forces?

Is the net external force horizontal or vertical?

$$\vec{F}_{net} = M\vec{a}_{com}$$

002 (part 1 of 3) 10 points

In a pool game, the cue ball, which has an initial speed of 6 m/s, makes an elastic collision with the eight ball, which is initially at rest. The two balls have equal masses of 2 kg. After the collision, the eight ball moves at an an angle of 55.8° to the original direction of the cue ball.



What angle does the cue ball make with respect to the original line of motion? Answer in units of °.

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003 (part 2 of 3) 10 points

Find the speed of the cue ball. Answer in units of m/s.

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004 (part 3 of 3) 10 points

Find the speed of the eight ball. Answer in units of m/s.

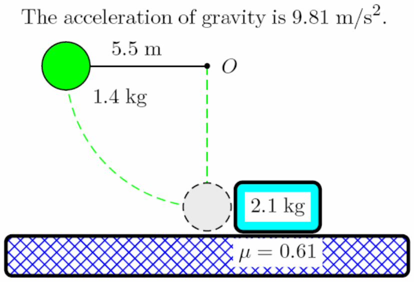
Elastic Collision in 2D

We learned this in the example today

005 (part 1 of 1) 10 points

A 1.4 kg steel ball and 5.5 m cord of negligible mass make up a simple pendulum that can pivot without friction about the point O. This pendulum is released from rest in a horizontal position and when the ball is at its lowest point it strikes a 2.1 kg block sitting at rest on a shelf. Assume that the collision is perfectly elastic and take the coefficient of friction between the block and shelf to be 0.61.

The acceleration of gravity is 9.81 m/s^2.



How far does the block move before coming to rest? Answer in units of m.

Three step problem

First, conservation of energy till the ball hits the block.

Second, conservation of momentum and energy, *right before and right after* the ball hits the block.

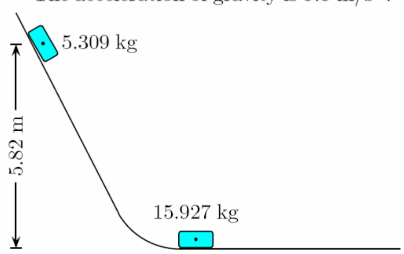
Third, kinetic friction.

006 (part 1 of 1) 10 points

Consider a frictionless track as shown in the figure.

A block of mass 5.309 kg is released on the track at a height 5.82 m above the level surface. It slides down the track and makes a head-on elastic collision with a block of mass 15.927 kg, initially at rest.

The acceleration of gravity is 9.8 m/s^2.



Calculate the height to which the block with mass 5.309 kg rises after rebounding from the collision. Answer in units of m.

Three step problem

First, conservation of energy till the first block hits the second block.

Second, conservation of momentum and energy, *right before and right after* the collision.

Third, conservation of energy for the first block.

<u>Review for final exam</u>

Ch1 Measurement

Ch2 Motion along a straight line
Ch3 Vectors
Ch4 Motion in two and three dimensions

Ch5 Force and motion – I
Ch6 Force and motion – II

Ch7 Kinetic energy and work
Ch8 Potential energy and conservation of energy

Ch9 Center of mass and linear momentum

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