

## Ballistic Pendulum

### *Conservation of Momentum in an Inelastic Collision*

*Physics 109, Class Period 15  
Experiment Number 7 in the  
Physics 121 Lab Manual (page 51)  
27 November 2007*

## Outline

- Description of the experiment
- Background information from the text
- Questions based on homework
- Questions related to the topic

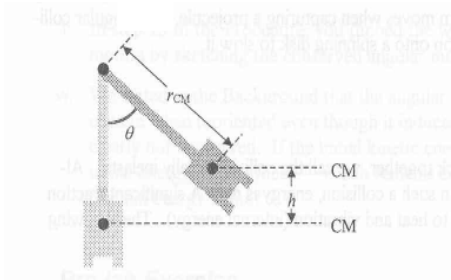
## Description of the Experiment

- We will do only the ballistic pendulum portion
- A ball is fired into the ballistic pendulum, and the resulting swing angle is measured.
- Knowing the mass of the ball, mass of the pendulum, the radius of the center of mass of the ball+pendulum combination and the angle the pendulum reaches, the ball velocity can be calculated.
- Three trials of three different velocities will be performed.
- Note: Momentum is conserved, Energy is not!
  - However, we use an energy calculation after the ball sticks in the pendulum!

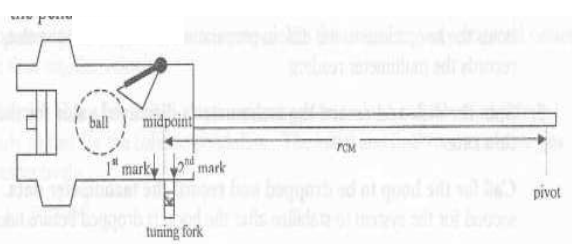
## Important Equations:

- $p(\text{initial}) = p(\text{final})$
- $M(\text{ball}) v(\text{ball}) = (M(\text{ball}) + M(\text{pend})) v(\text{pend})$
- $\frac{1}{2} (M(\text{b}) + M(\text{p})) v(\text{p})^2 = (M(\text{b}) + M(\text{p}))gh$  where  $h$  is the maximum vertical displacement of the center of mass (pendulum + captured ball)
- Put these two equations together and solve for  $v(\text{ball})$  [This is part of your assignment]

## Diagram

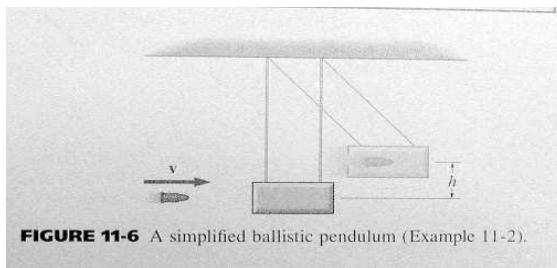


## Finding the Center of Mass



## Discussion in the Text

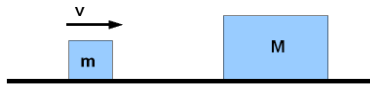
- Ballistic Pendulum can be found on page 267, Chapter 11.



## Questions

- Questions based on homework
- A car on an icy road is hit by a truck
- A totally inelastic collision
- A collisions question
- Impulse
- Conservation
- The apple
- The ping pong ball

An Inelastic Collision on a frictionless surface



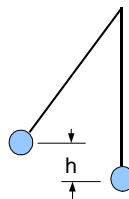
What happens?

- A. Block m rebounds.
- B. Blocks m and M stick together **C**
- C. Blocks m and M proceed with different velocities
- D. None of the above.

What principle applies?

- A. Conservation of Energy.
- B. Conservation of mass.
- C. Conservation of Momentum **C**
- D. None of the above

Two Pendulum bobs, suspended from the same point. The masses are equal?. One is raised to a height, h.

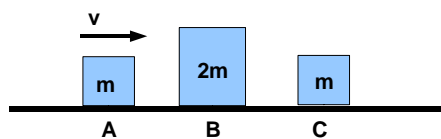


$$mv_1 = 2mv_2, K_1 = 1/2 mv_1^2$$

$$K_2 = 1/2 (2m)(v_1^2/4) = 1/2 K_1 = 2mgh_2 = 1/2 mgh_1 \text{ so } h_2 = 1/4 h_1$$

- If the masses stick together, to what height will they rise?
- A. h B. h/2 C. h/4 **C** D. h/8

Block A is moving on a frictionless surface with velocity, v. After striking block B, what is its velocity?



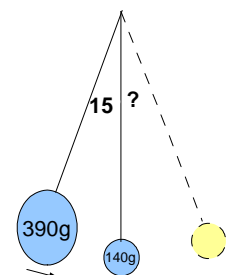
- A. v/3. B. 2v/3 C. -2v/3 D. -v/3 **C**

$$v_f = ((m_1 - m_2)/(m_1 + m_2))v_i$$

For an ELASTIC collision, what is your best estimate of what the angle of the 140g ball will be?

- A. 11 deg.
- B. 13 deg.
- C. 15 deg.
- D. 22 deg. **C**

- What principle do we use?
- A. Momentum conservation
- B. Mass conservation
- C. Energy conservation **C**



A 950 Kg car is stopped on an icy road at the bottom of a hill. It is hit from behind by a 7600 Kg truck moving at 50 Km/hr. The wreckage sticks together.

- The Collision is:
  - A. Elastic
  - B. Partially Elastic
  - C. Totally Inelastic **C**
  - D. None of the above

A 950 Kg car is stopped on an icy road at the bottom of a hill. It is hit from behind by a 7600 Kg truck moving at 50 Km/hr. The wreckage sticks together.

- We want to know how high (vertical distance) up the hill the wreckage travels. (Assume no friction.) The equation to use is:
  - A.  $M(\text{truck})v(\text{in}) = [M(\text{truck}) + m(\text{car})]v(\text{out})$
  - B.  $1/2(M+m)(v(\text{out}))^2 = (M+m)gh$
  - C. Neither of the above
  - D. Both of the above **C**

- A Totally Inelastic Collision is Governed By?

- A. Conservation of momentum **C**
- B. Conservation of energy
- C. Both of the above
- D. Neither of the above

- Which of the following qualify as collisions?

- A. A basketball rebounds off the backboard
- B. Two magnets approach each other with their north poles facing. They repel and reverse direction without touching
- C. A basketball flies through the air on a parabolic trajectory
- D. All of the above
- E. A. and B. **C**

- Why can we state that momentum is conserved in collisions?

- A. The velocity does not change
- B. There are no external forces acting **C**
- C. Both of the above
- D. Neither of the above

### An Extreme Case:

- A ping pong ball strikes a bowling ball with velocity,  $v$ . Obviously,  $M \gg m$ . What happens?
  - A. The ping pong ball rebounds with velocity  $-v$  **C**
  - B. The ping pong ball stops, and the bowling ball rolls on slowly.
  - C. Neither of the above.

### Next Week (last week of classes)

- Tuesday, 4 December Both Sections meet in 115 Workman. Course Evaluation and Re-test of the Force Concept Inventory, Final Exam handed out.
- Final Exam due back to me by Wednesday, December 12.