MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Department of Physics

Physics 8.01X Fall Term 2001

# PROBLEM SET 9

**Handed out: November 2**
**Due: November 9 at 5 pm in 4-339B.**

Please write your name, subject, **recitation number**, and the name of the recitation instructor on the top right corner of the first page of your homework solutions. The solutions should be placed in the appropriate box in room 4-339B.

**Problem 1:**

Suppose a ping-pong ball and a bowling ball are rolling toward you. Both have the same momentum, and you exert the same force to stop each.

a. Is the time interval to stop the ping-pong ball shorter, longer or the same as the time interval to stop the bowling ball? Explain your reasoning.

b. Is the distance needed to stop the ping-pong ball shorter, longer, or the same as the distance needed to stop the bowling ball? Explain your reasoning.

**Problem 2:**

The compressive force per area necessary to break the tibia in the lower leg is about $1.6\times10^3$ bars. The smallest cross-sectional area of the tibia, about 3.2 $cm^2$, is slightly above the ankle. Suppose a person of mass $m$ jumps to the ground from a height $h$ and absorbs the shock of hitting the ground by bending her knees. During the time of collision $\Delta t$ the person lowers her center of mass by an amount $\Delta h$.

a. Find the average force of the ground on the person exerted during the shock absorption, in terms of $m$, $g$, $h$ and $\Delta h$.

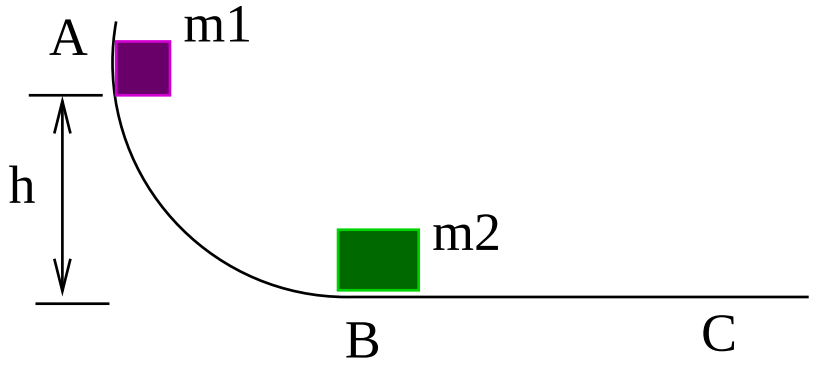
b. What is the average impulse of the ground on the person? Answer in terms of $m$, $g$, $h$ and $\Delta h$.

c. What is the maximum ratio $h/\Delta h$ that a person of mass $m = 60$ kg can sustain without breaking the tibia?

d. Assuming you bend your knees properly as you land, estimate the maximum height you can jump from without breaking your legs.

**Problem 3:**

Consider a frictionless track ABC as shown in the figure. A block of mass $m_1$=5.00 kg is released from A at height $h$ = 5.00 m. It makes a head-on elastic collision at B with a block of mass $m_2$=10.0 kg that is initially at rest.




Calculate the maximum height to which $m_1$ rises after the collision.

**Problem 4:**

A ballistic pendulum consists of a pumpkin of mass 1.5 kg suspended on a 1 m string. A bullet of mass 10 g has an initial speed of 400 m/s and passes through the pumpkin. After the collision, the pendulum swings up to a maximum angle of 24° between the string and the vertical. Find the final speed of the bullet after the collision and the energy lost in the collision.

**Problem 5:**

You have purchased a batch of defective baseballs. For some unknown reason, they tend to explode. You toss one of these balls straight up. While

in mid-air, it explodes into two fragments, one of which has mass $m_1 = 0.2\,\text{kg}$; the other has mass $m_2 = 0.10\,\text{kg}$. The two fragments land on the ground at the same time. The heavier fragment lands 3.0 m to your left. The lighter fragment lands to your right in some thick grass.

Where should you look for the fragment?