Physics 180A Chapter 8 Problem 68

A rifle bullet with mass 8.00 g strikes and embeds itself in a block with a mass of 0.992 kg that rests on a frictionless, horizontal surface and is attached to a coil spring. The impact compresses the spring 15.0 cm. Calibration of the spring shows that a force of 0.750 N is required to compress the spring 0.250 cm. (20 pts)

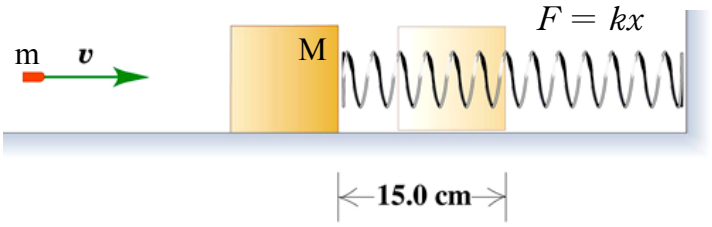
Momentum Before

mv_B

Ballistic Pendulum Problem

Momentum After

What kind of collision is this? (2 pts)



What is the value of the spring constant **k**? (2 pts)

Energy Before bullet enters block.

$\frac{1}{2}mv^2$

After bullet enters block

Energy Before $\frac{1}{2}(m+M)v_A^2$

Energy After spring is compressed.

Conservation of Momentum (2 pts)

$mv_B =$

Conservation of Energy (2 pts)

$\frac{1}{2}(m+M)v_A^2 =$

Solve for the initial speed of the bullet then plug in given values? (4 pts)

Solve for the magnitude of the bullet-block velocity just after impact then plug in the given values? (4 pts)

How much energy was lost in this collision? (2 pts)

$KE_{before} =$

$PE_{spring} =$

Energy Lost

Where did the lost energy go? (2 pts)

Physics 180A Chapter 8 Problem 68 *Solution*

A rifle bullet with mass 8.00 g strikes and embeds itself in a block with a mass of 0.992 kg that rests on a frictionless, horizontal surface and is attached to a coil spring. The impact compresses the spring 15.0 cm. Calibration of the spring shows that a force of 0.750 N is required to compress the spring 0.250 cm. (20 pts)

Momentum Before

mv_B

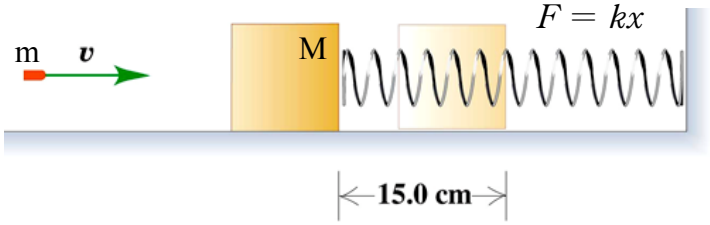
Ballistic Pendulum Problem

Momentum After

$(m + M)\,v_A$

What kind of collision is this?

Inelastic



What is the value of the spring constant **k**?

$$k = \frac{F}{x} = \frac{0.750N}{0.250m}$$

$$k = 300N/m$$

Energy Before bullet enters block.

$\frac{1}{2}mv^2$

After bullet enters block

Energy Before $\frac{1}{2}(m + M)\,v_A^2$

Energy After spring is compressed.

$\frac{1}{2}kx^2$

Conservation of Momentum

$$mv_B = (m + M)\,v_A$$

Conservation of Energy

$$\frac{1}{2}(m + M)\,v_A^2 = \frac{1}{2}kx^2$$

Solve for <u>the initial speed of the bullet</u> then plug in given values? (4 pts)

$$v_B = \frac{(m + M)\,v_A}{m}$$

$$v_B = \frac{(0.008kg + 0.992kg)\,2.60\,m/s}{0.008kg} = 325m/s$$

Solve for the <u>magnitude of the bullet-block velocity</u> just after impact then plug in the given values?

$$v_A = \sqrt{\frac{kx^2}{m + M}}$$

$$v_A = \sqrt{\frac{300N/m\,(0.150m)^2}{(0.008 + 0.992)\,kg}} = 2.60\frac{m}{s}$$

How much energy was lost in this collision?

$$KE_{before} = \frac{1}{2}mv^2 = \frac{1}{2}(0.008kg)\,(325m/s)^2 = 423\ Joules$$

$$PE_{spring} = \frac{1}{2}kx^2 = \frac{1}{2}300N/m\,(0.150m)^2 = 3.38\ Joules$$

Energy Lost

$420\ Joules$

Where did the lost energy go?

Bullet Deformation of the block, Massive Heat and Loud Sound