Name: _____

PHYS 1110-02 Quiz 4

You may use an 8.5"×11" note sheet written on both sides, a calculator of any type, and a rose hip. Please write your answers in the boxes provided. Show your work outside the boxes. If you wish to change an answer written in a box, thoroughly erase the unwanted answer and write the desired answer in its place. If a numerical answer is a physical quantity rather than a pure number, include the units with your answer.

"Multiple choice" questions, in which only one answer is correct, have circular bubbles (○): select exactly one choice. "Select all" questions, in which any number of the choices may be correct, have square bubbles (☐): select all correct answers. Select your choice by filling the circle or square: please do not "X", check, circle, or otherwise mark your choice. Do not mark bubbles for rejected options.

If the point value of a question is not indicated, it is worth one point.

Constants and equivalents

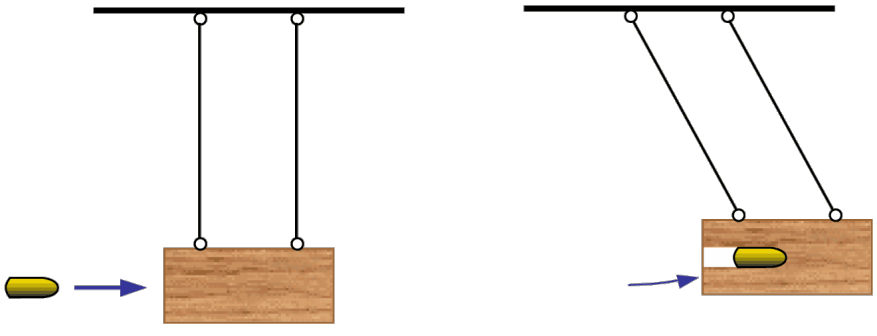
$g = 9.8\ \text{m/s}^2$	1 h = 60 min	1 min = 60 s	1 day = 24 h
1 in = 2.54 cm	1 ft = 12 in	1 m = 3.218 ft	1 mi = 5280 ft = 1609.3 m

Some metric prefixes

nano	n	$\times 10^{-9}$	deka	D	$\times 10^{1}$
micro	μ	$\times 10^{-6}$	hecta	h	$\times 10^{2}$
milli	m	$\times 10^{-3}$	kilo	k	$\times 10^{3}$
centi	c	$\times 10^{-2}$	mega	M	$\times 10^{6}$
deci	d	$\times 10^{-1}$	giga	G	$\times 10^{9}$

Questions

1. A 1.80-kilogram block of wood hangs motionless, suspended from two cables. A 12.0-gram (0.012 kg) bullet traveling horizontally at 360 meters per second is fired directly into the midline of the block, becoming embedded in the center of the block.



A. What is the kinetic energy of the bullet before it impacts the block?

B. What is the momentum of the bullet before it impacts the block?

C. (2 points) What is the total momentum of the bullet and block before their collision?

D. What sort of collision is this?

○ a. elastic ○ b. inelastic ○ c. totally inelastic

E. What is the total momentum of the combined bullet and block right after the bullet is embedded in the block?

F. What is the velocity of the combined bullet and block right after the bullet is embedded in the block?

G. What is the total kinetic energy of the combined bullet and block after the collision?

H. Is mechanical energy conserved in the interaction between the bullet and block?

○ a. Yes ○ b. No ○ c. We don't know without further information

I. After the collision, the combined bullet and block swings freely upward, still suspended from the cables. Is mechanical energy conserved as it swings upward?

○ a. Yes ○ b. No ○ c. We don't know without further information

J. What is the kinetic energy of the combined bullet and block at the top of its swing?

K. As the combined bullet and block swings upward, does its gravitational potential energy increase or decrease?

○ a. Its gravitational potential energy increases.

○ b. Its gravitational potential energy decreases.

○ c. Whether it increases depends on the specific choice of axes.

○ d. We cannot know without further information.

L. What is the gravitational potential energy of the combined bullet and block at the top of their swing?

M. How much higher is the top of the swing than the starting position of the block (hanging straight down)?

N. What is the momentum of the bullet right after embedding in the block?

O. What is the bullet's momentum *change* as it embeds in the block?

P. (3 points) The bullet traveled into the block for 5.00×10^{-4} seconds before becoming stuck inside. What was the magnitude of the average force on the bullet as it penetrated the block?

Q. (2 points) If the bullet had bounced off the block in an elastic collision, what would the block's velocity have been immediately after the collision? Use the direction of the bullet's initial velocity as the positive direction.

R. If the collision had been elastic, which quantities would have been conserved? Select all that apply.

☐ a. Total momentum.

☐ b. Total kinetic energy.

☐ c. Total mechanical energy.

☐ d. Relative speed.

S. Suppose that, instead of penetrating or violently rebounding from the block, the bullet had stopped dead and fallen straight to the ground after the collision. What quantities would have been conserved in that collision? Select all that apply.

☐ a. Total momentum.

☐ b. Total kinetic energy.

☐ c. Total mechanical energy.

☐ d. Relative speed.

2. A child rolls an old tire down a dirt path in rural Malawi at an initial speed of 1.20 m/s. The radius of the tire is 0.350 m. The path then slopes downhill, so that the tire accelerates at a rate of 0.800 m/s^2 for 4.00 m.

   A. What is the initial angular speed of the tire?

   B. What is the angular acceleration of the tire rolling downhill?

   C. Through what angle (how many radians) does the tire rotate in rolling 4.00 m?