ME 230 - Dynamics	Your Name:
Tutorial 5	Section No.:
Partners:	

Impulse, Momentum, Impact, and Conservation of Linear Momentum

Relationships of Interest

Work:
$$U = \int_{r_1}^{r_2} \vec{F} \cdot d\vec{r} = \frac{1}{2} m v_2^2 - \frac{1}{2} m v_1^2$$

Potential Energy

For weight:
$$V = mgy$$
 For springs: $V = \frac{1}{2}kS^2$ ($S = \text{stretch}, s_2 - s_1$)

Kinetic Energy:
$$T = \frac{1}{2}mv^2$$

Conservation of Energy:
$$T + V = \text{Constant}$$
 or $T_1 + V_1 = T_2 + V_2$

Linear Impulse-Momentum::
$$\vec{H}_0 = \vec{r} \times m\vec{v}$$

Conservation of Linear Momentum:
$$\vec{L}_1 = \vec{L}_2$$
 or $(\sum m\vec{v})_1 = (\sum m\vec{v})_2$

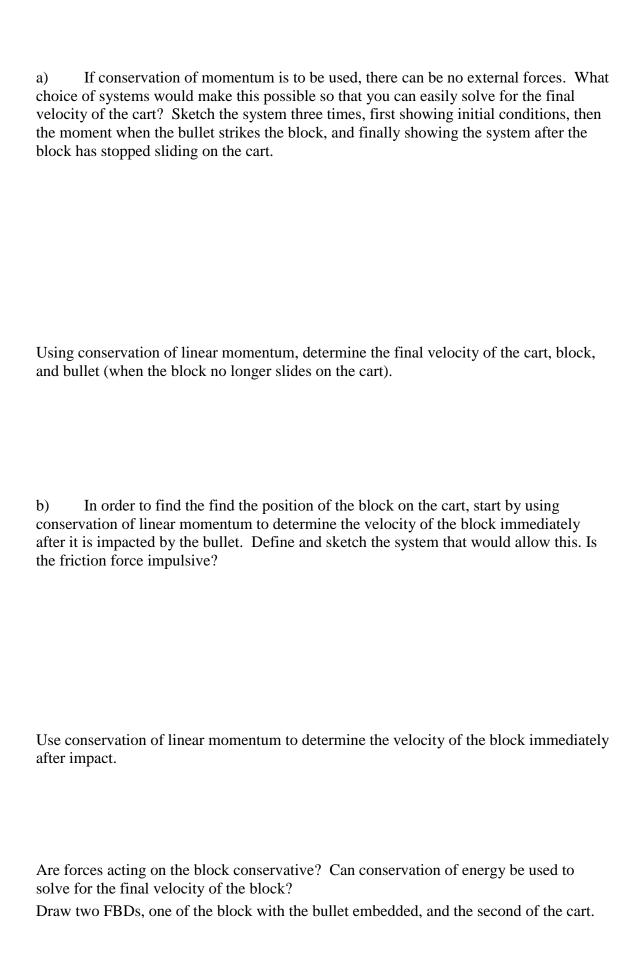
Impact
$$(\sum m\vec{v}) = (\sum m\vec{v})'$$

Coefficient of restitution:
$$e = \frac{\vec{v}_B' - \vec{v}_A'}{\vec{v}_A - \vec{v}_B}$$

Perfectly plastic:
$$e = 0$$
 Perfectly elastic: $e = 1$

- 1) A 1 oz. bullet is fired with velocity 1600 ft/sec into block A, which weighs 10 lb. The coefficient of kinetic friction between block A and the cart BC is 0.50. Knowing that the cart weighs 8 lb. and can roll freely (and that 1 lb. = 16 oz.), determine:
- a) the final velocity of the cart and block
- b) the final position of the block on the cart

This exercise will give you an opportunity to carefully define the system you are working with, and to see that analysis of more than one system is sometimes necessary.



Consider the block-bullet system. Using work and energy, solve for the distance moved by the block until it has no relative motion on the cart.
Now consider the cart. Using work and energy, solve for the distance moved by the cart until there is no relative velocity between the block and the cart.
Determine the distance moved by the block relative to the cart as it slides on the surface of the cart.

2) A lead ball weighing 5 lb. hanging from a string of length $l = 36$ in. is released from
rest at an angle of θ_A = 20 degrees with the vertical. As it swings past vertical, it strikes a block weighing 1 lb., which slides a distance d = 12.86 in., and then the ball continues to swing through an angle of 14.63 degrees. The kinetic coefficient of friction between the block and the ground is 0.3.
Using work and energy, symbolically determine the velocity of the ball just before striking the block and just after collision. Are the forces conservative? Can you use conservation of energy to do this?
Using work and energy, symbolically determine the velocity of the block just after the collision. Are the forces conservative? Can you use conservation of energy?
Using your equations determine the velocities just before and after the collision of the ball and the block.
Determine the coefficient of restitution for the collision.