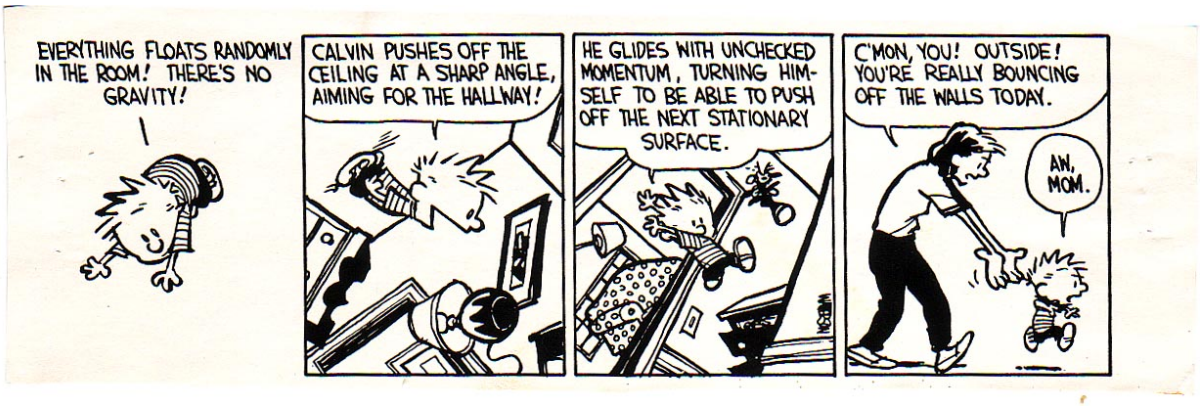
Momentum and Impulse Problems
AP Physics C

Name _____

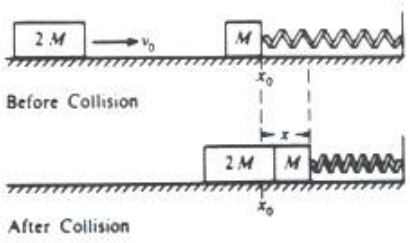


1. Two ice dancers, one of mass m_1 and the other of mass m_2, are heading towards each other with speeds of v_1 and v_2, respectively.
   a. Use the Law of Conservation of Momentum to derive an expression for the speed of their center of mass.

$$v_{cm} = \frac{v_1 m_1 - v_2 m_2}{m_1 + m_2}$$

   b. After they collide and stick together, what is their final speed?

4. A block of mass ***M*** is resting on a horizontal, frictionless table and is attached as shown to a relaxed spring of spring constant ***k***. A second block of mass ***2M*** and initial speed v_0 collides with and sticks to the first block. Develop expressions for the following quantities in terms of ***M***, ***k***, ***and*** v_0.



   (a) ***v***, the speed of the blocks immediately after impact

$v = 2/3v_0$

   (b) ***x***, the maximum distance the spring is compressed

$$x = \sqrt{\frac{4M}{3k}}$$

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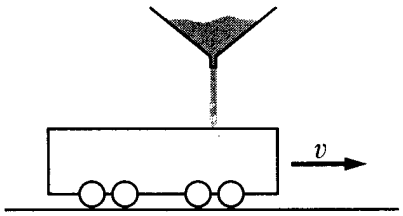

1997M2. An open-top railroad car (initially empty and of mass M_o) rolls with negligible friction along a straight horizontal track and passes under the spout of a sand conveyor. When the car is under the conveyor, sand is dispensed from the conveyor in a narrow stream at a steady rate $\Delta M/\Delta t = C$ and falls vertically from an average height h above the floor of the railroad car. The car has initial speed v_o and sand is filling it from time t = 0 to t = T. Express your answers to the following in terms of the given quantities and g.

a. Determine the mass M of the car plus the sand that it catches as a function of time t for $0 < t < T$.

b. Determine the speed v of the car as a function of time t for $0 < t < T$.

c. i. Determine the initial kinetic energy K_i of the empty car.

ii. Determine the final kinetic energy K_f of the car and its load.

iii. Is kinetic energy conserved? Explain why or why not.

d. Determine expressions for the normal force exerted on the car by the tracks at the following times.

i. Before t = 0

ii. For 0 < t < T

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5. Two eggs of mass m=.15 kg are traveling at a speed v=3 m/s. One hits a trampoline and bounces **BACKWARDS** with a speed of 1 m/s. The other hits a wall and breaks.

a. What is the impulse imparted by the trampoline on the egg?

b. If the other egg breaks because the average stopping force exerted on it is 36 Newtons, how long does it take to break?

6. A steel ball strikes a wall as shown. It bounces off with the same speed and angle. What is the direction of the average force exerted by the wall? What is the name of this force?

Direction of Force _____

Name of Force _____