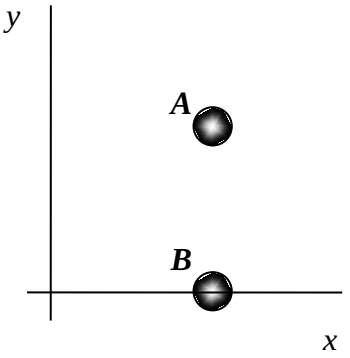
ES201 – HW Set 9 (Corrected 9/18/2014)

Problem 9.1 (10 points)

Two particles are shown in the figure. The following information is known about each particle:

Particle *A*	Particle *B*
m_A = 10 kg	m_B = 20 kg
x = [2 + (5/s)t] m	x = [2 – (5/s^2)t^2] m
y = [2 – (5/s)t] m	y = 0



Determine the following quantities** for a system consisting of *both* particles:

(a) the linear momentum ($\mathbf{P}_{sys}$) for this system, in kg-m/s.

(b) the time rate-of-change of the linear momentum ($d\mathbf{P}_{sys}/dt$) for this system, in kg-m/s^2

(c) the second derivative of the system linear momentum ($d\mathbf{P}_{sys}^2/dt^2$), in N/s. (This is called the "jerk.")

** Remember that when you are reporting a vector (any of the quantities above), you must specify both the *magnitude* and the *direction* of the quantity.

Problem 9.2 (10 points)

A large tank on rollers contains pressurized air which is exhausted from the tank through the nozzle on the right side of the tank. The tank has a constant mass (m_{tank}) and the mass of air in the tank ($m_{air\ in\ tank}$) changes with time. The velocity of the tank and its contents (V_{tank}) and the velocity of the air leaving the nozzle exit ($V_{air,nozzle,exit}$) are both constants and *measured* with respect to the ground. Other details about the masses and velocities are provided in the figure.

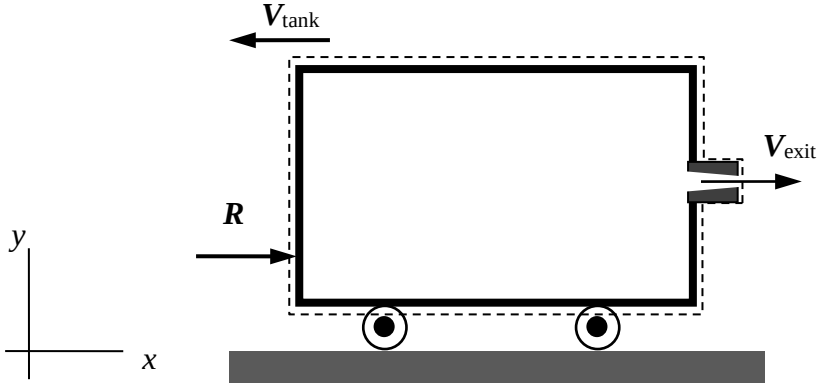
m_{tank} = 50 lbm

V_{tank} = (10 ft/s)

$m_{air\ in\ tank}$ = (20 lbm) exp[–t /(5 s)]

$V_{air,nozzle,exit}$ = 5 ft/s

Assume that the air inside the tank has the same velocity as the tank.



(a) Determine the linear momentum of the tank-air system, in lbm-ft/s, at t = 5 s.

(b) Determine the time rate-of-change of the linear momentum, in lbm-ft/s^2,
- … of just the tank (no air) at t = 5 s.
- … of just the air in the tank at t = 5 s.
- … of the combined tank-air system at t = 5 s.

(c) Determine the
- … the mass flow rate of air out of the tank-air system at time t = 5 s, in lbm/s.
- … the mass flow rate of linear momentum *out* of the tank-air system at time t = 5 s, in lbm-ft/s^2.