**Problem 9.1 (10 points)**

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

<table>
<thead>
<tr>
<th>Particle A</th>
<th>Particle B</th>
</tr>
</thead>
<tbody>
<tr>
<td>$m_A = 10$ kg</td>
<td>$m_B = 20$ kg</td>
</tr>
<tr>
<td>$x = [2 + (5/s)t]$ m</td>
<td>$x = [2 - (5/s^2)t^2]$ m</td>
</tr>
<tr>
<td>$y = [2 - (5/s)t]$ m</td>
<td>$y = 0$ m</td>
</tr>
</tbody>
</table>

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

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

(b) the time rate-of-change of the linear momentum ($dP_{sys}/dt$) for this system, in kg-m/s²

(c) the second derivative of the system linear momentum ($dP_{sys}^2/dt^2$), 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/s²,

… 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/s².