Questions are largely from Taylor, Chapter 3. Please show all your work and write legibly for full credit! As always, if you have any questions please don't hesitate to ask.

- **Traincar Daredevils:** Two daredevils, each of mass m, are standing at one end of a stationary railroad flatcar with frictionless wheels and mass M. Ether daredevil can run to the other end of the flatcar and jump off with the same speed u (relative to the flatcar's speed after jump).

  (a) Use conservation of momentum to find the speed of the recoiling car if the two daredevils run and jump simultaneously.

  (b) What is the speed of the recoiling car if the second daredevil jumps only after the first has already jumped. Which procedure gives the greater speed to the car?

  Remember what we discussed in class about relative velocities and how they relate to one another. For part b, when you need to compare which is faster, feel free to just pick some numbers for your constants and then plug them in. It can be easier than doing the algebra to show which case is faster.

- **3.12** – Some multistage rocket antics

- **Getting Fragged:** A one kilogram grenade is thrown upwards at 22 m/s at an angle of 60° with the positive x-axis. Two seconds into its flight, while traveling at speed $\vec{\mathbf{v}}$, it explodes into three chunks. The first chunk is 600 g and leaves at speed $\vec{\mathbf{v}} + \Delta\vec{\mathbf{v}}_1$, where $\Delta\vec{\mathbf{v}}_1 = 10\hat{\mathbf{x}} + 5\hat{\mathbf{y}}$ m/s. The second is 250 g and leaves at speed $\vec{\mathbf{v}} + \Delta\vec{\mathbf{v}}_2$ where $\Delta\vec{\mathbf{v}}_2 = (-15, 10)$ m/s. You can assume no mass is lost in the explosion and that the axes are defined as per the below image.

  (a) What is $\Delta\vec{\mathbf{v}}_3$?

  (b) Plot the path of the original grenade and then all 3 projectiles on the same plot.

  (c) Include on your plot the trajectory of the center of mass of all three particles as well. How does the center of mass trajectory compare to the original grenade's trajectory? Is this what you would expect?

  (d) Determine how far from the launch point each of the 3 pieces lands.