NAME _____ DATE _____

Scenario

Angela and Carlos have identical masses M *and stand on identical light carts with bearings with negligible friction. Carlos holds a heavy ball of mass* m. *At time* $t = 0$, *Carlos throws the ball so that it has a horizontal component of velocity* v *while a projectile. At time* $t = T$, *Angela catches the ball at the same height from which it was thrown.*

Argumentation

PART A: Which student moves with faster speed for time $t > T$? Explain your reasoning *qualitatively* without manipulating equations.

Quantitative Analysis

PART B: Derive expressions for v_{fA} and v_{fC}, Angela and Carlos's final speeds for time $t > T$ in terms of M, m, and v.

	System is Carlos and ball. There are no net horizontal external forces, so the momentum of the system is conserved.
	Initially, Carlos and the ball are at rest, so their initial momentum is zero, so their final momentum must also be zero.
	Equation for v_{fC} in terms of *M*, *m*, and *v*.
	For the second part of the problem, the system is the ball and Angela. There are no net horizontal external forces, so the momentum of the system is conserved.
	Initially, Angela is at rest and the ball has momentum *mv*, which means that the final momentum must also equal *mv*. After the collision, the ball and Angela have a new velocity v_{fA}.
	Equation for v_{fA} in terms of *M*, *m*, and *v*.

Data Analysis

PART C: Explain how your expressions in Part B support your reasoning in Part A.

PART D: Let E_1 be the mechanical energy of the Angela-Carlos-ball system for $t < 0$, let E_2 be the mechanical energy of this system for $0 < t < T$, and let E_3 be the mechanical energy of this system for $t > T$. Rank these energies from highest to lowest and explain your reasoning.

Highest energy _____ Lowest energy

Checklist

- _____ I answered the question directly.
- _____ I stated a law of physics that is always true.
- _____ I connected the law or laws of physics to the specific circumstances of the situation.
- _____ I used physics vocabulary (energy, mass, momentum, conservation, velocity, time).