

NAME _____

DATE _____

Scenario

A wooden cart of mass M is set on a horizontal section of track. The cart experiences negligible friction as it rolls.

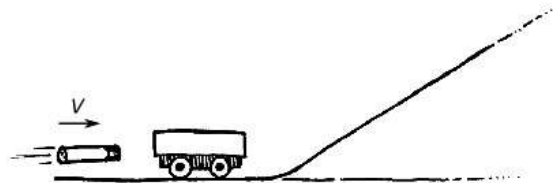
A dart of mass $m < M$ is fired with initial speed v toward the cart, which is initially at rest.

Consider the following cases:

Case 1: The dart embeds itself in the cart.

Case 2: The dart bounces backward off the cart.

Case 3: The dart passes through the cart.

**Using Representations**

PART A: For each case, create a pictorial representation of conservation of momentum during the collision.

<p>Dart's Initial Momentum</p> <p>\vec{v}_{1i}</p>	<p>Cart's Initial Momentum</p> <p>\vec{v}_{2i}</p>	<p>System's Final Momentum</p> <p>\vec{v}_f</p>
m_1	$+$	m_2
$=$		m_{total}

<p>Dart's Initial Momentum</p> <p>\vec{v}_{1i}</p>	<p>Cart's Initial Momentum</p> <p>\vec{v}_{2i}</p>	<p>Dart's Final Momentum</p> <p>\vec{v}_{1f}</p>	<p>Cart's Final Momentum</p> <p>\vec{v}_{2f}</p>
m_1	$+$	m_2	$=$
$=$		m_1	$+$
$=$		m_2	

<p>Dart's Initial Momentum</p> <p>\vec{v}_{1i}</p>	<p>Cart's Initial Momentum</p> <p>\vec{v}_{2i}</p>	<p>Dart's Final Momentum</p> <p>\vec{v}_{1f}</p>	<p>Cart's Final Momentum</p> <p>\vec{v}_{2f}</p>
m_1	$+$	m_2	$=$
$=$		$+$	
$=$		m_2	

Quantitative Analysis

PART B: Create a mathematical representation showing conservation of momentum for each of the three cases. Use each representation to derive the velocity v_{2f} of the cart after the collision.

<i>Case 1</i>	<i>Case 2</i>	<i>Case 3</i>

Argumentation

PART C: Rank the cases in terms of the distance up the incline that the cart travels after its interaction with the dart and explain your ranking in terms of conservation of momentum and conservation of energy.

Claim: Farthest up the incline _____, _____, _____ Least far up the incline _____

Evidence/Reasoning: (Use evidence and reasoning from Parts A and B to support your claim.)
