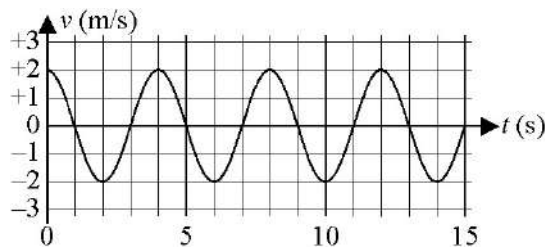
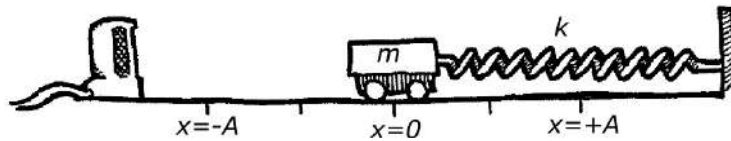


NAME \_\_\_\_\_

DATE \_\_\_\_\_

## Scenario

A cart of mass  $m$  is connected to a spring of spring constant  $k$  and displaced to position  $x = +A$ . The cart is released and oscillates about the position  $x = 0$ . At time  $t = 0$ , the cart passes through the origin having rightward velocity. For the 15 seconds after this time, Angela and Blake use motion-sensing equipment to measure the cart's velocity (where right is positive). The graph below shows this velocity as a function of time.



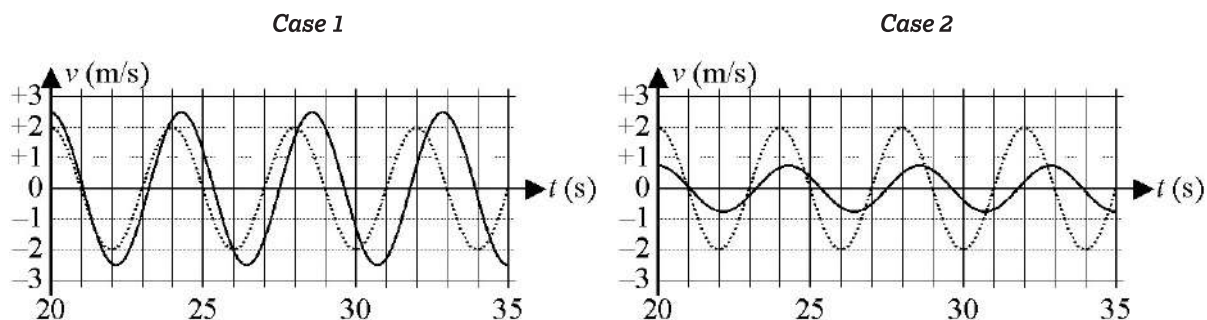
## Quantitative Analysis

**PART A:** The spring-cart system has  $10\text{ J}$  of total energy. Calculate the values of  $m$ ,  $k$ , and  $A$ . Explain your methods with words as you show calculations.

[illegible]

## 6.I Changing Mass and Period of a Mass-Spring System

A dart is shot to the right into the cart at a moment in time when the cart's momentum has greater magnitude than the dart's momentum. In Case 1, the dart is shot into the cart at time  $t = 12$  s. In Case 2, the experiment is repeated exactly as before, but the dart is shot into the cart at time  $t = 14$  seconds. The dart embeds itself into the cart in both cases. The graphs below show the velocity of the cart as a function of time for both cases for the interval  $20 \text{ s} < t < 35 \text{ s}$ . The dotted graph in each case is the graph of the cart's velocity vs. time had the dart not been shot into the cart.



## Argumentation

**PART B:** In a clear, coherent, paragraph-length response, explain how and why the maximum speed and period shown in each case is different from the maximum speed and period had the dart not been shot into the cart. Discuss specific physical principles as appropriate.

	I connected the law or concept of physics to the specific circumstances of the situation.
	I compared the situation to what was the same in a previous situation.
	I contrasted the situation to what was different in a previous situation.
	I used physics vocabulary (period, mass, spring constant, force, velocity, displacement, equilibrium, momentum).

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 compared the situation (stated what was the same in all cases).
- \_\_\_\_\_ I contrasted the situations (stated what was different in all cases).
- \_\_\_\_\_ I used physics vocabulary (period, mass, spring constant, force, velocity, displacement, equilibrium, momentum, energy).