

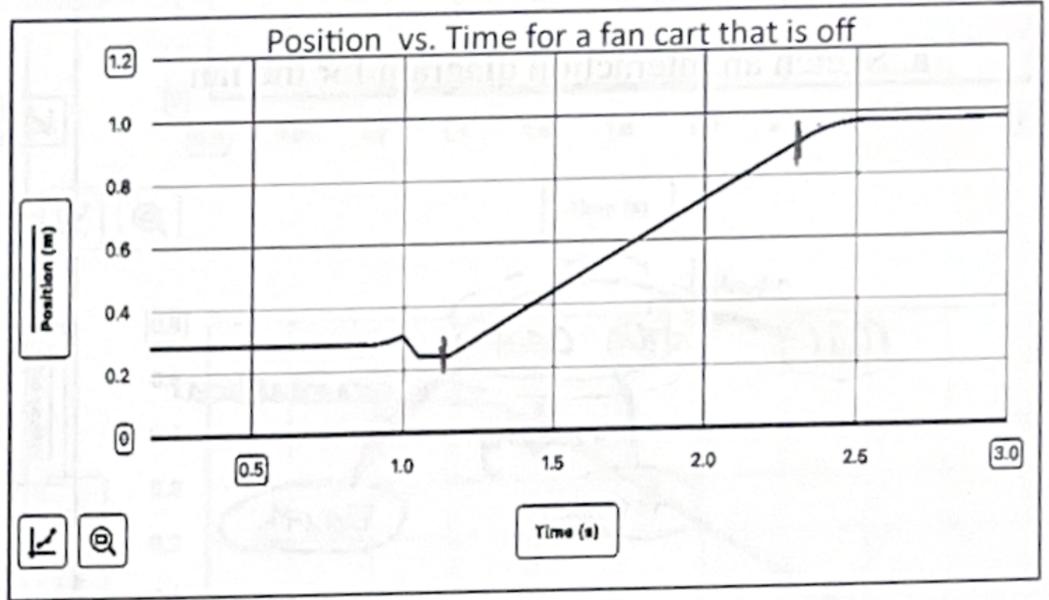
Fan Carts: Forces and Motion

In the first unit, we analyzed interactions between objects and the forces that arise from the interactions. In the second unit, we learned to describe motion. In this unit, we are going to make connections between the forces on a system and the motion of the system. Let's begin by looking at the forces on three fan carts and their motions. Assume friction is negligible.

1. A fan cart is on a horizontal track and the fan stays off. I gave the fan cart a quick push to the right. I let go around 1.2 s, let it coast, and then caught it around 2.3 s.

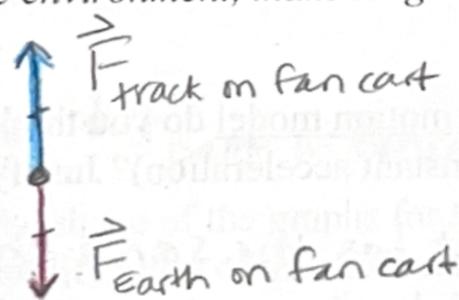
For the time interval from $t = 1.2 \text{ s}$ to $t = 2.3 \text{ s}$:

a. Sketch an interaction diagram for the fan cart. (Remember: object names in ovals, colored lines for each interaction with labels, dashed circle around the object of interest.)



object model: point particle
system: fan cart

b. Sketch a force diagram for this fan cart. (Remember: choose object model for the system, draw a force vector for every force exerted on the system by the environment, make lengths qualitatively correct as much as possible.)

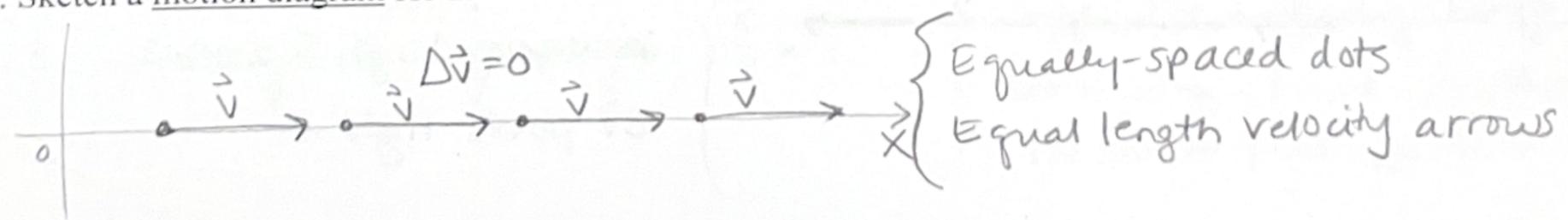


c. Consider the shape of the position-time graph for this time interval. What motion model do you think is a reasonable simplification of the motion (constant velocity or constant acceleration). Justify with a fact. To determine how fast an object is moving, look at the slope of the position-time graph. The slope is the velocity. Since in this case, the slope is constant, the velocity must be constant. Therefore, the constant velocity model is reasonable.

d. Describe the motion in words for this time interval. To "describe the motion" of a moving object in words, first state the direction it is moving and then describe its speed. Examples: "It is moving in the positive direction with increasing speed." "It is moving in the negative direction with constant speed."

The fan cart is moving in the positive direction with constant speed.

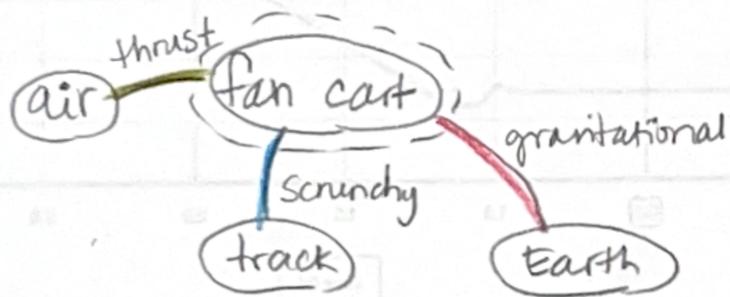
e. Sketch a motion diagram for this time interval.



2. A fan cart is on a horizontal track and the fan is off at $t = 0$ s. Around 5.45 s the fan started turning, and it reached its steady rotating speed around 5.7 s. I caught it around 7.0 s.

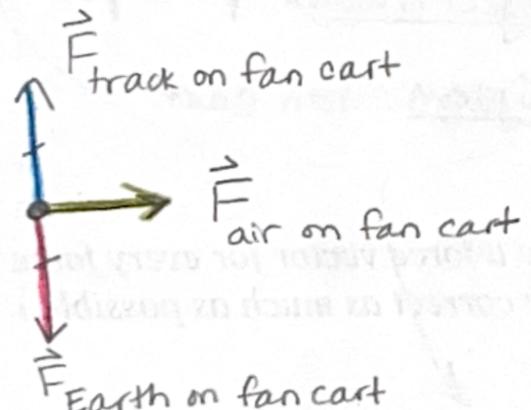
For the time interval from $t = 5.7$ s to $t = 7.0$ s:

a. Sketch an interaction diagram for the fan cart.



b. Sketch a force diagram for this fan cart.

object model:
point particle
System: fan cart



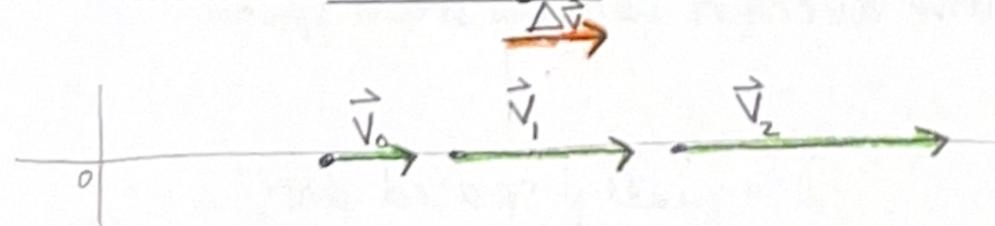
c. Consider the shape of the graphs for this time interval. What motion model do you think is a reasonable simplification of the motion (constant velocity or constant acceleration)? Justify with a fact.

Constant acceleration means the object has the same change in velocity in every unit of time. The straight line on the v-t graph has a constant slope, and slope of a v-t graph is $\frac{\Delta v}{\Delta t}$. Therefore, Δv is the same in every equal Δt , and the constant acceleration model is reasonable.

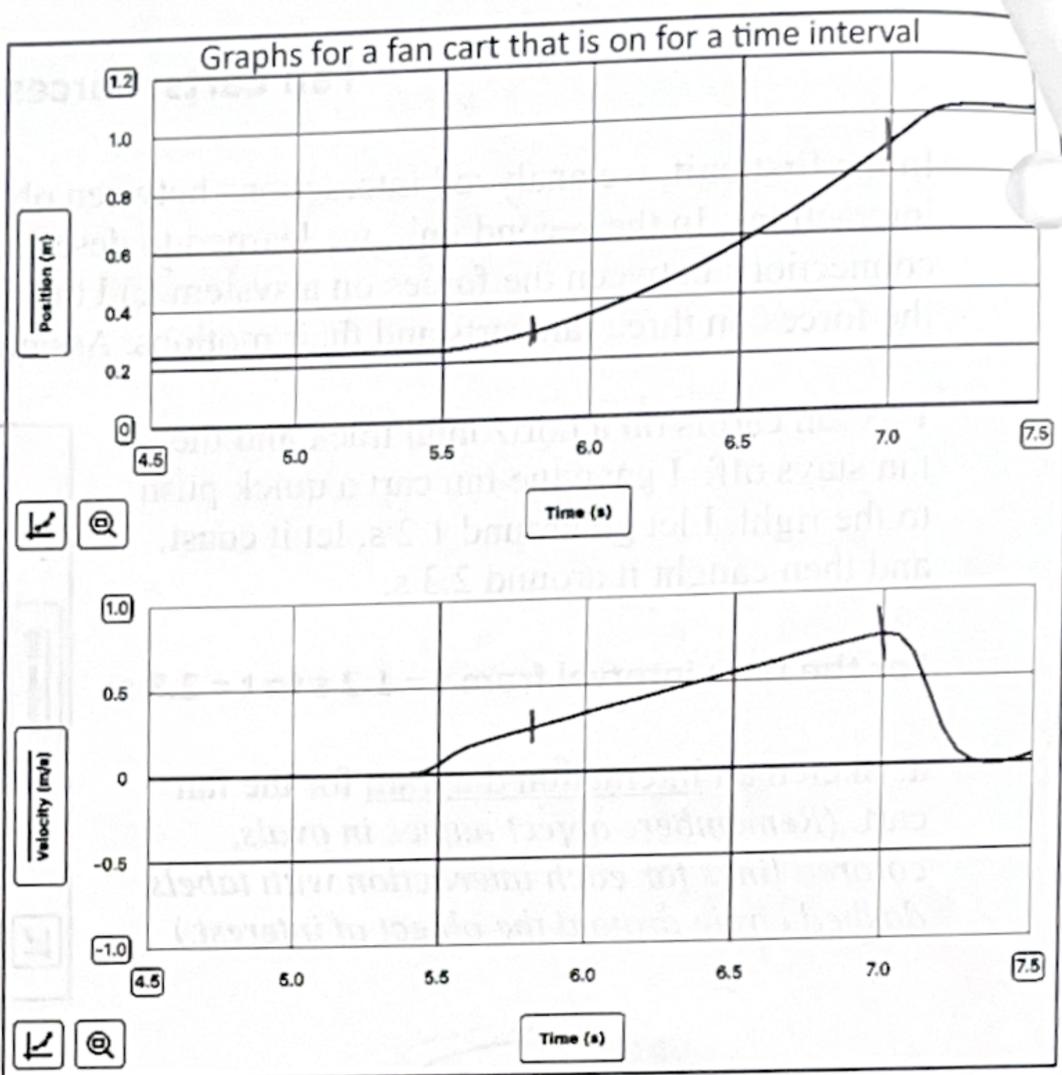
d. Describe the motion in words for this time interval.

The fan cart is moving in the positive direction with increasing speed.

e. Sketch a motion diagram for this time interval.



increasing spacing for dots
increasing length \vec{v} arrows
 $\Delta \vec{v}$ points right



3. I turned the fan cart from #2 around so the fan was facing the other way. I gave the cart a quick push to the right while the fan was off, so the fan cart was already moving at 0.8s. Around 1.3 s the fan started turning, and it reached its steady rotating speed around 1.6 s. I caught the fan cart around 2.3 s.

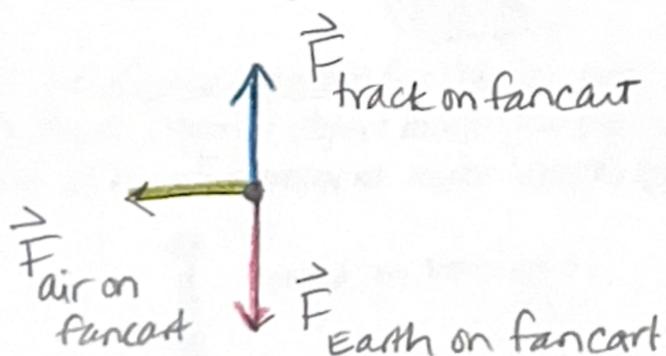
For the time interval from $t = 1.6 \text{ s}$ to $t = 2.3 \text{ s}$:

a. Sketch an interaction diagram for the fan cart.

(If it is the same as your diagram in #2, you do not need to draw it again.)

It is the same!

b. Sketch a force diagram for this fan cart.

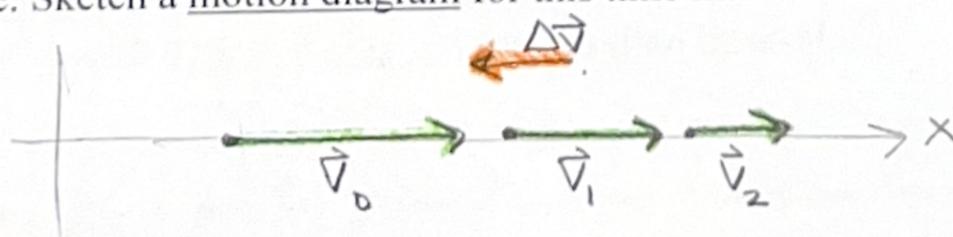


c. Consider the shape of the graphs for this time interval. What motion model do you think is a reasonable simplification of the motion (constant velocity or constant acceleration). Justify with a fact. Same exact answer as #2c.

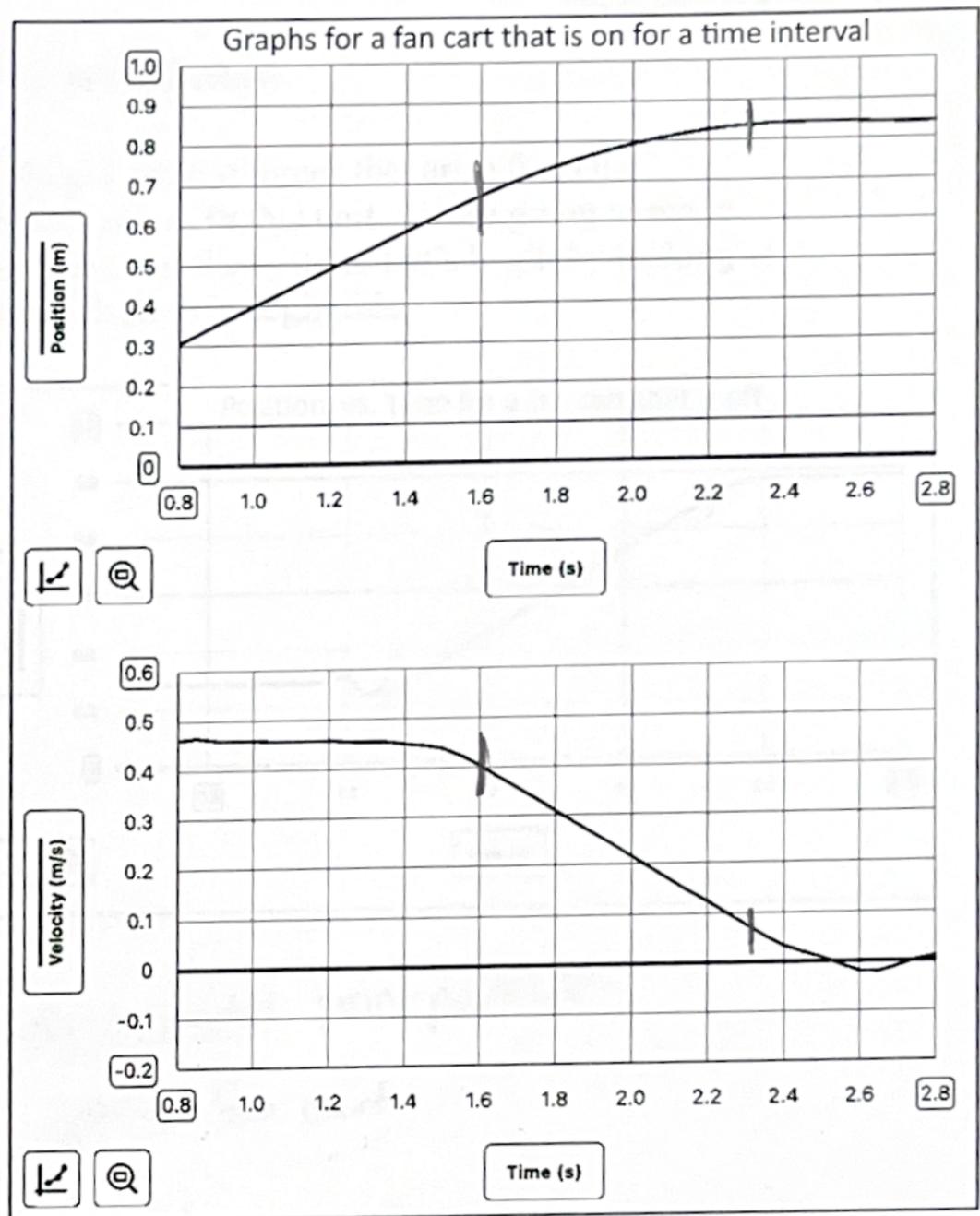
d. Describe the motion in words for this time interval.

The fan cart is moving in the positive direction with decreasing speed.

e. Sketch a motion diagram for this time interval.



Your \vec{v} arrows should point right and be getting shorter
Dot spacing should decrease
 $\Delta \vec{v}$ should point opposite \vec{v}



object model: point particle
system: fan cart