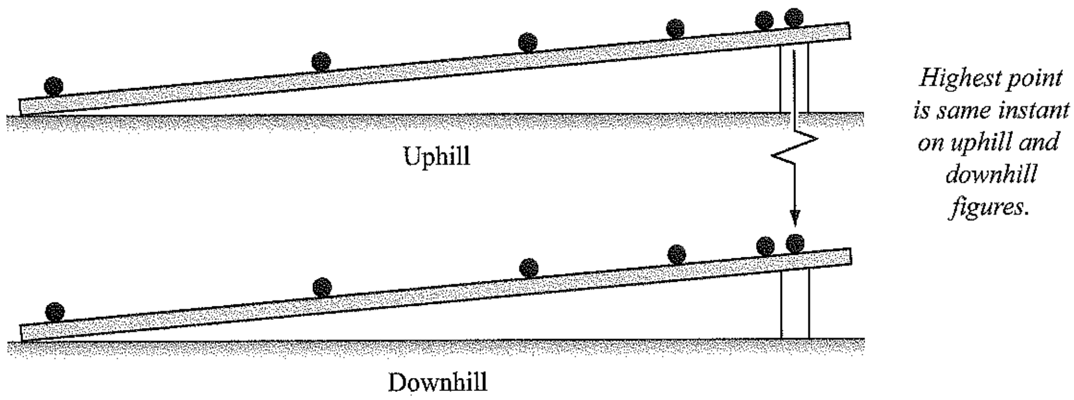
ACCELERATION IN ONE DIMENSION

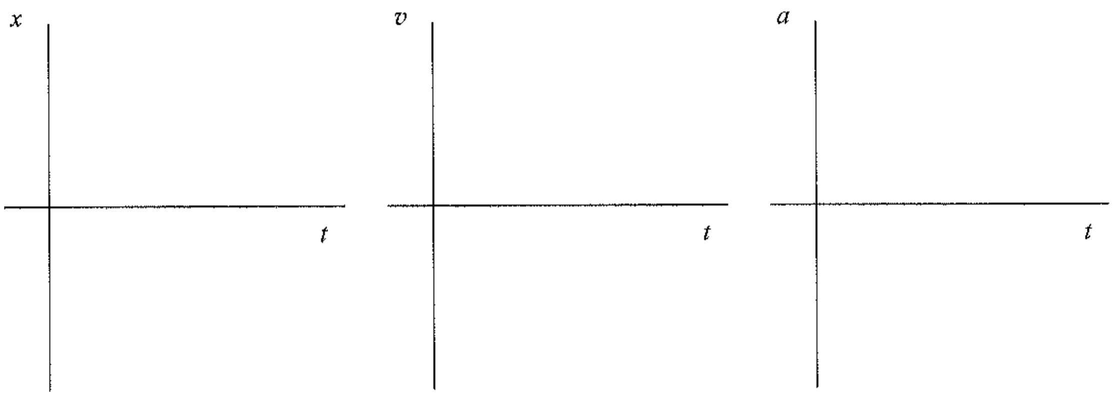
Name ______________________

1. A ball rolls up, then down an incline. Sketch an *acceleration diagram* for the entire motion. (An *acceleration diagram* is similar to a velocity diagram; however, the vectors on an acceleration diagram represent the *acceleration* rather than the velocity of an object.)

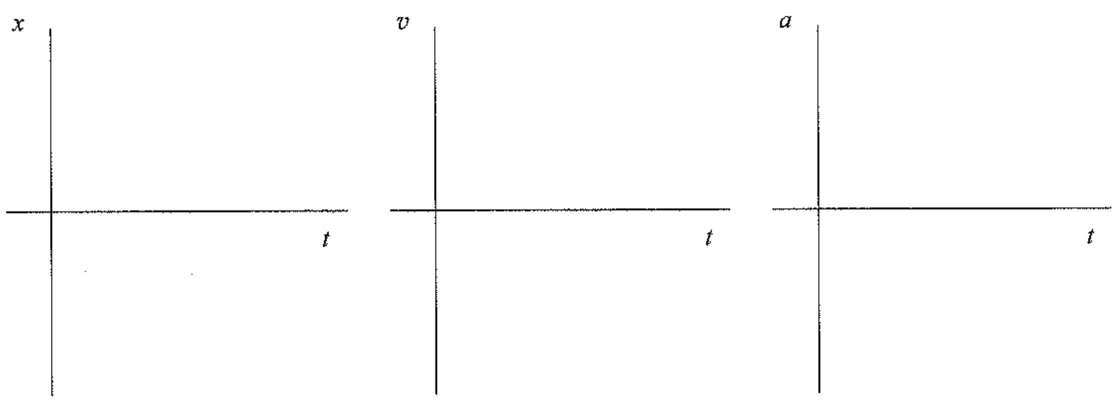


2. Sketch x versus t, v versus t, and a versus t graphs for the entire motion of a ball rolling up and then down an incline.

   a. Use a coordinate system in which the positive x-direction is *down* the track.



   b. Use a coordinate system in which the positive x-direction is *up* the track.



   c. Can an object have a negative acceleration while speeding up? If so, describe a possible physical situation and a corresponding coordinate system. If not, explain why not.

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3. Describe the motion of an object:

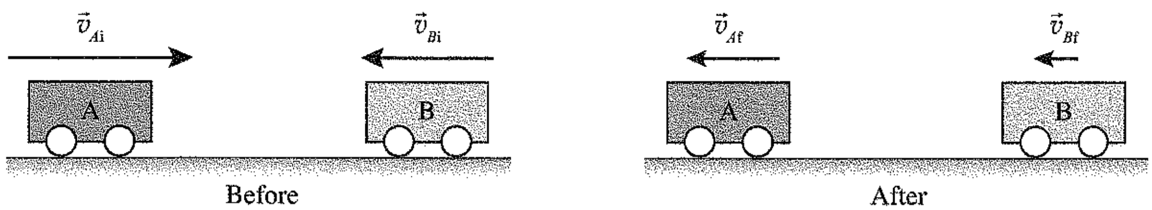
   a. for which the direction of the acceleration is the *same as* the direction of motion of the object.

   b. for which the direction of the acceleration is *opposite to* the direction of motion of the object.

   c. for which the change in velocity is zero.

   d. for which the initial velocity is zero but the acceleration is not zero.

4. Two carts roll toward each other on a level table. The vectors represent the velocities of the carts just before and just after they collide.



   a. Draw and label a vector for each cart to represent the *change in velocity* from before to after the collision. Make the magnitude and direction of your vectors consistent with the vectors drawn above.

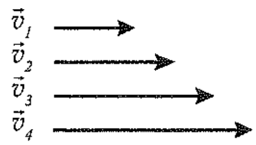
   b. How does the direction of the average acceleration of cart A compare to the direction of the average acceleration of cart B over the time interval shown? Explain.

   c. For the time interval shown, is the magnitude of the average acceleration of cart A *greater than, less than,* or *equal to* the magnitude of the average acceleration of cart B? Explain.

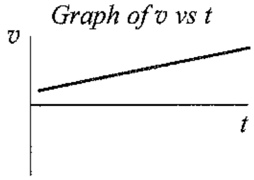
5. In this problem, a cart moves in various ways on a horizontal track. A coordinate system with the positive x-direction to the right is used to measure each motion. For each motion, one of five different representations is given: a strobe diagram, a velocity *versus* time graph, a set of instantaneous velocity vectors, a written description, or a pair of arrows representing the directions of the velocity and acceleration.

Give the remaining *four* representations for each motion. The first exercise has been worked as an example.

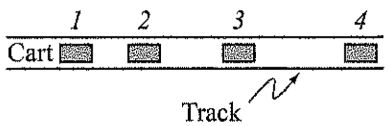
Example. ***Given:*** *velocity vectors*



Graph of v vs t



Top-view strobe diagram



Written description

The cart moves in the positive direction and speeds up.

Arrows

Direction of $\vec{v}$: →

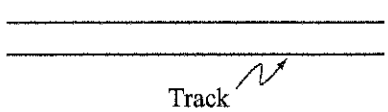
Direction of $\vec{a}$: →

a. ***Given:*** The cart moves in the negative direction with constant speed.

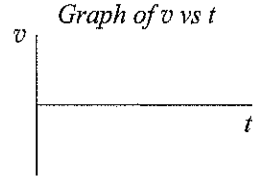
Velocity vectors

$\vec{v}_1$
$\vec{v}_2$
$\vec{v}_3$
$\vec{v}_4$

Top-view strobe diagram



Graph of v vs t

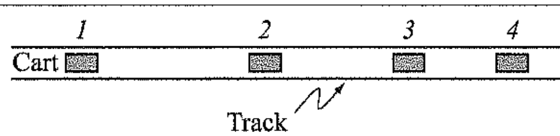


Arrows

Direction of $\vec{v}$:

Direction of $\vec{a}$:

b. ***Given:*** *top-view strobe diagram*

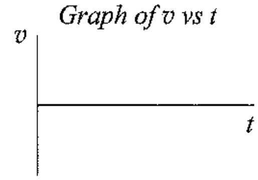


Velocity vectors

$\vec{v}_1$
$\vec{v}_2$
$\vec{v}_3$
$\vec{v}_4$

Written description

Graph of v vs t

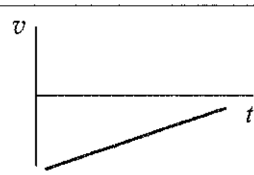


Arrows

Direction of $\vec{v}$:

Direction of $\vec{a}$:

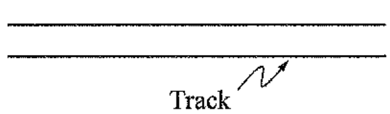
c. ***Given:*** *graph of v vs t*



Velocity vectors

$\vec{v}_1$
$\vec{v}_2$
$\vec{v}_3$
$\vec{v}_4$

Top-view strobe diagram



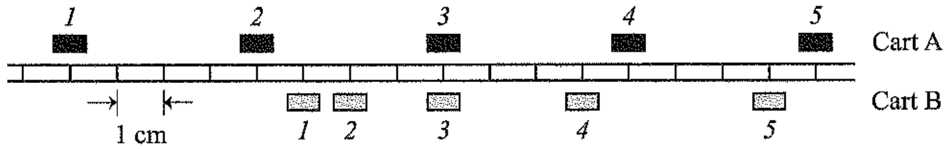
Written description

Arrows

Direction of $\vec{v}$:

Direction of $\vec{a}$:

6. Carts A and B move along a horizontal track. The top-view strobe diagram below shows the locations of the carts at instants *1–5*, separated by equal time intervals.



a. At instant *3:*

- is cart A *speeding up, slowing down,* or *moving with constant speed?* Explain.

- is cart B *speeding up, slowing down,* or *moving with constant speed?* Explain.

b. Is the speed of cart B *greater than, less than,* or *equal to* the speed of cart A:

- at instant *2?* Explain.

- at instant *3?* Explain.

c. During a small time interval from just before instant *2* until just after instant *2,* does the distance between cart A and cart B *increase, decrease,* or *remain the same?* Explain.

Consider the following response to the above question:

"For the small interval containing instant 2, cart B is ahead and speeding up, so the distance between the carts must be increasing."

Do you agree or disagree? Explain.

d. Is there any time interval during which cart A and cart B have the same average velocity? If so, identify the interval(s) and explain. If not, explain why not.

Is there any instant at which cart A and cart B have the same instantaneous velocity? If so, identify the instant(s) (*e.g.*, "at instant *1*," or "at an instant between *2* and *3*") and explain. If not, explain why not.

7. Two cars, C and D, travel in the same direction on a long, straight section of highway. During a particular time interval Δt_o, car D is ahead of car C and is speeding up while car C is slowing down.

   During the interval Δt_o it is observed that car C *gains* on car D (*i.e.*, the distance between the cars decreases). Explain how this is possible, and give a specific example of such a case.

8. Two cars, P and Q, travel in the same direction on a long, straight section of a highway. Car P passes car Q, and is adjacent to car Q at time t_o.

   a. Suppose that car P and car Q each move with constant speed. At time t_o, is the magnitude of the instantaneous velocity of car P *greater than, less than,* or *equal to* the magnitude of the instantaneous velocity of car Q? Explain.

   b. Suppose instead that car P is moving with constant speed but car Q is speeding up. At time t_o, is the magnitude of the instantaneous velocity of car P *greater than, less than,* or *equal to* the magnitude of the instantaneous velocity of car Q? Explain.