Explanation of Activity and Example

For each object described below, state whether or not the object is accelerating and explain your answer.

> **Example.** A ball rolls down a steep hill.
>
> *Answer: Yes; the ball is accelerating because it speeds up as it rolls down the hill. (Its direction of motion might also be changing, but we don't have enough information to know for sure.)*

A1. A ball is attached to a string and swung in a horizontal circle.

A2. A baseball is thrown straight up into the air.

A3. A bullet is fired horizontally into a block of wood.

A4. A football is kicked off.

A5. A race car speeds around a track at constant speed.

A6. A truck drives down a straight highway at 55 mph.

A7. A bicyclist slows down to stop at a crosswalk.

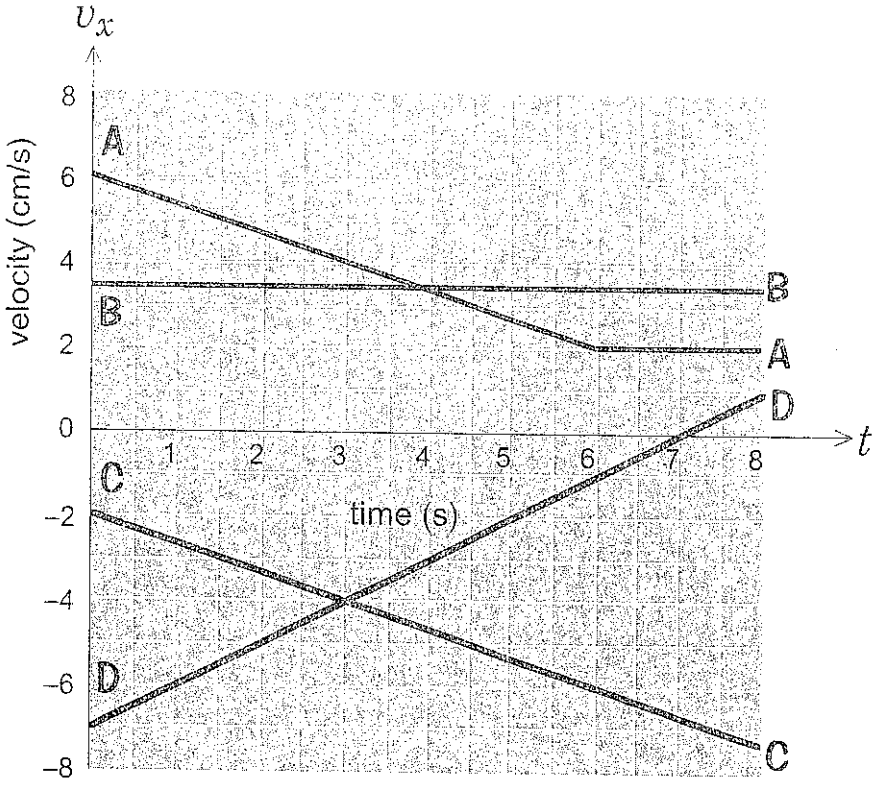
Reflection

R1. The term *acceleration* is often used in our everyday language, and now you have seen how the same term is used in physics. Under what conditions is the meaning of the term the same in physics as it is in everyday use? Under what conditions is the meaning different? Explain.

R2. Consider a ball being thrown straight up into the air. As it travels up, the speed is getting smaller and smaller until it stops at the top. Therefore, on its way up, the ball is accelerating. The ball then starts to fall, traveling faster and faster until it hits something. On its way down, it is also accelerating. At the top, the ball is at rest. Imagine the instant just before it reaches the top and the instant just afterwards. Does the velocity change during that time interval? What must be true about the acceleration of the ball at its topmost point (when the ball is at rest)? Explain.

Explanation of Activity

In this activity you will calculate the average acceleration from the velocity vs. time plots for four different objects and then make comparisons among them. The velocity vs. time graphs for all four objects, A, B, C and D, are shown below using the same set of axes for each object.



A1. What is the average acceleration over the interval 0 to 3 seconds for Object A?

A2. What is the average acceleration over the interval 2 to 4 seconds for Object A?

A3. What is the average acceleration over the interval 0 to 8 seconds for Object A?

A4. Is your answer to A1 the same as or different from the answer to A2? Explain.

A5. Is your answer to A1 the same as or different from the answer to A3? Explain.

continued

A6. What is the average acceleration over the interval 2 to 4 seconds for Object B?

A7. What is the average acceleration over the interval 4 to 6 seconds for Object C?

A8. Do any two objects ever have the same average acceleration? If so, which objects and for what time interval?

A9. Which object has the largest average acceleration over a very short time interval near $t = 3$s?

A10. Which object has the largest average acceleration over a very short time interval near $t = 7$s?

A11. What is the (instantaneous) acceleration of Object D at $t = 6$ seconds?

A12. Which objects have a smaller speed at $t = 6$ seconds than at $t = 0$s?

Reflection

R1. In question A12 you identified objects for which the speed was decreasing. What, if anything, can you say about the acceleration of an object when its speed is decreasing? Explain.

R2. For what kind of velocity vs. time graph is the average acceleration independent of the time interval used to calculate the average acceleration?

R3. From a velocity vs. time graph how can you tell at a glance if the object is speeding up? How can you tell if the object is slowing down?

R4. From a velocity vs. time graph how can you tell at a glance that the acceleration is positive? How can you tell that the acceleration is negative?