REPRESENTATIONS OF MOTION

In this tutorial, you will use a motion detector to graph your motion and to investigate how motion can be described in terms of position, velocity, and acceleration. See your instructor for instructions on using the equipment.

General tips

When using a motion detector:

- Stay in line with the detector and do not swing your arms. For best results, take off bulky sweaters or other loose-fitting clothing. You may find it helpful to hold a large board in front of you in order to present a larger target for the detector.

- Do not stand closer than about 0.5 meter or farther than 4.0 meters from the detector.

- It is difficult to obtain good *a* versus *t* graphs with the motion detector. Discuss any questions about your *a* versus *t* graphs with an instructor.

Instructions

In each of the following problems, you will be given one of the following descriptions of a motion:

- a written description, or

- an *x* versus *t*, *v* versus *t*, or *a* versus *t* graph.

Predict the other three descriptions of the motion, then use the motion detector to check your answers. Check your predictions one-by-one, instead of checking several problems at once. In addition, answer the questions posed at the bottom of each page.
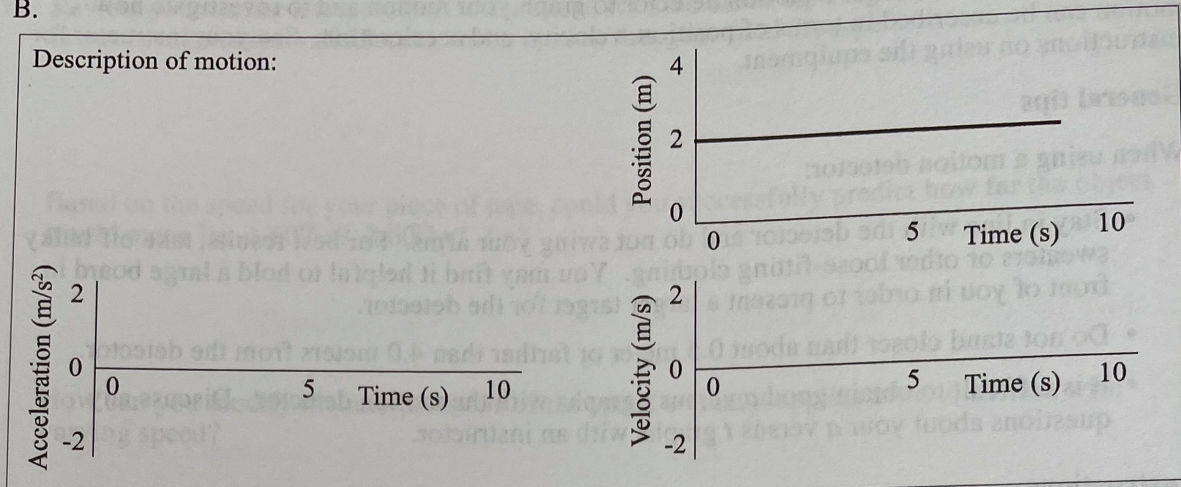
Note: So that your graphs emphasize important features, draw them in an idealized form rather than showing many small wiggles.

Example: The problem below has been worked as an example. Use the motion detector to verify the answers.
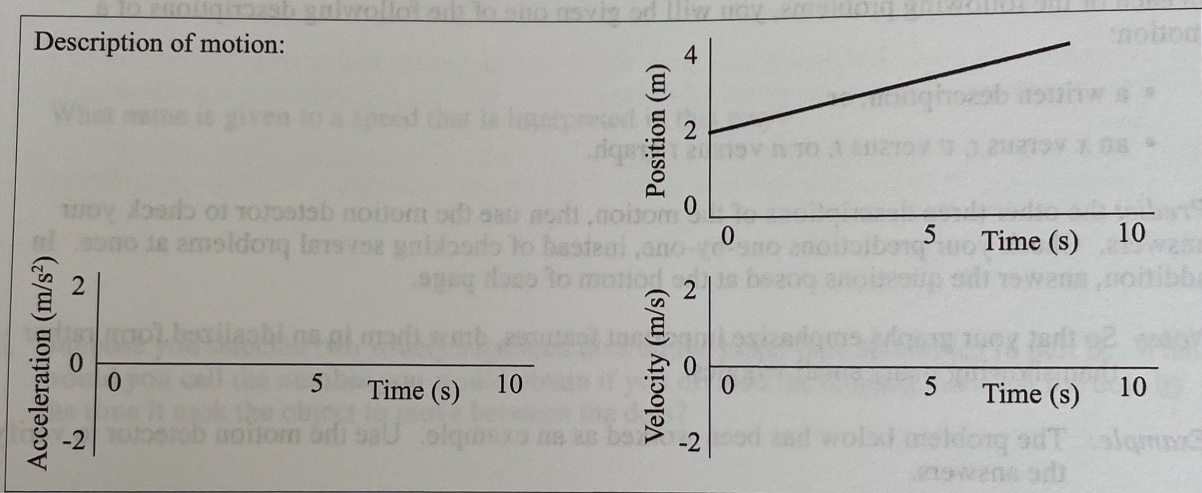
Description of motion:

Move toward the detector at constant speed.
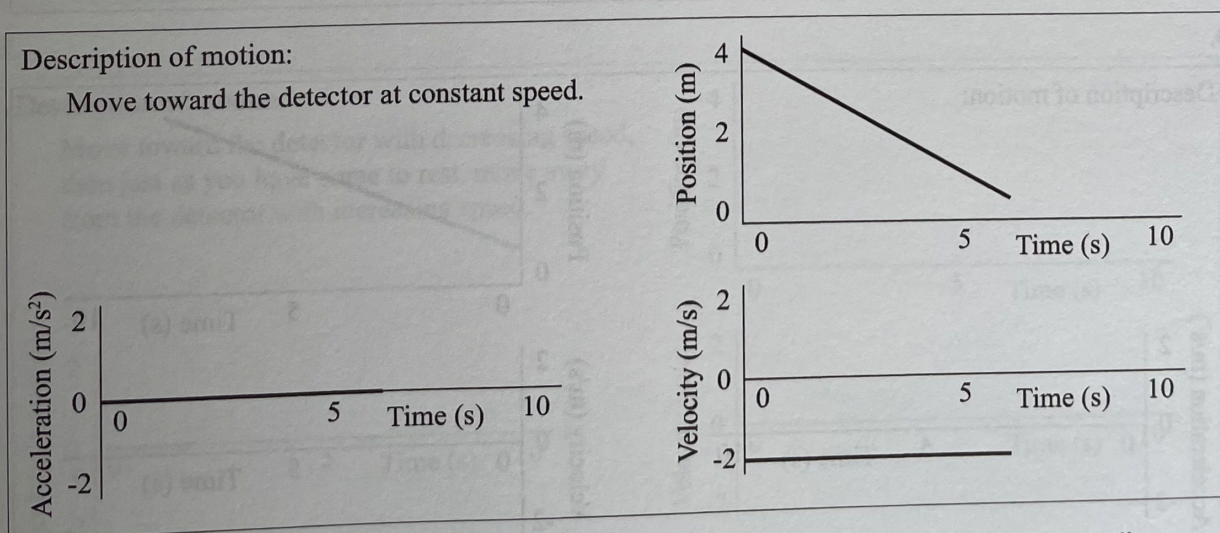
A. The computer program assumes a particular coordinate system. Describe this coordinate system.

B.

Description of motion:

Position (m) vs Time (s) graph — axis labels: Position (m) 0, 2, 4; Time (s) 0, 5, 10

Velocity (m/s) vs Time (s) graph — axis labels: Velocity (m/s) -2, 0, 2, 4; Time (s) 0, 5, 10

Acceleration (m/s²) vs Time (s) graph — axis labels: Acceleration (m/s²) -2, 0, 2; Time (s) 0, 5, 10

C.

Description of motion:

Position (m) vs Time (s) graph — axis labels: Position (m) 0, 2, 4; Time (s) 0, 5, 10

Velocity (m/s) vs Time (s) graph — axis labels: Velocity (m/s) -2, 0, 2, 4; Time (s) 0, 5, 10

Acceleration (m/s²) vs Time (s) graph — axis labels: Acceleration (m/s²) -2, 0, 2; Time (s) 0, 5, 10

D.

Description of motion:

Position (m) vs Time (s) graph — axis labels: Position (m) 0, 2, 4; Time (s) 0, 5, 10

Velocity (m/s) vs Time (s) graph — axis labels: Velocity (m/s) -2, 0, 2; Time (s) 0, 5, 10

Acceleration (m/s²) vs Time (s) graph — axis labels: Acceleration (m/s²) -2, 0, 2; Time (s) 0, 5, 10

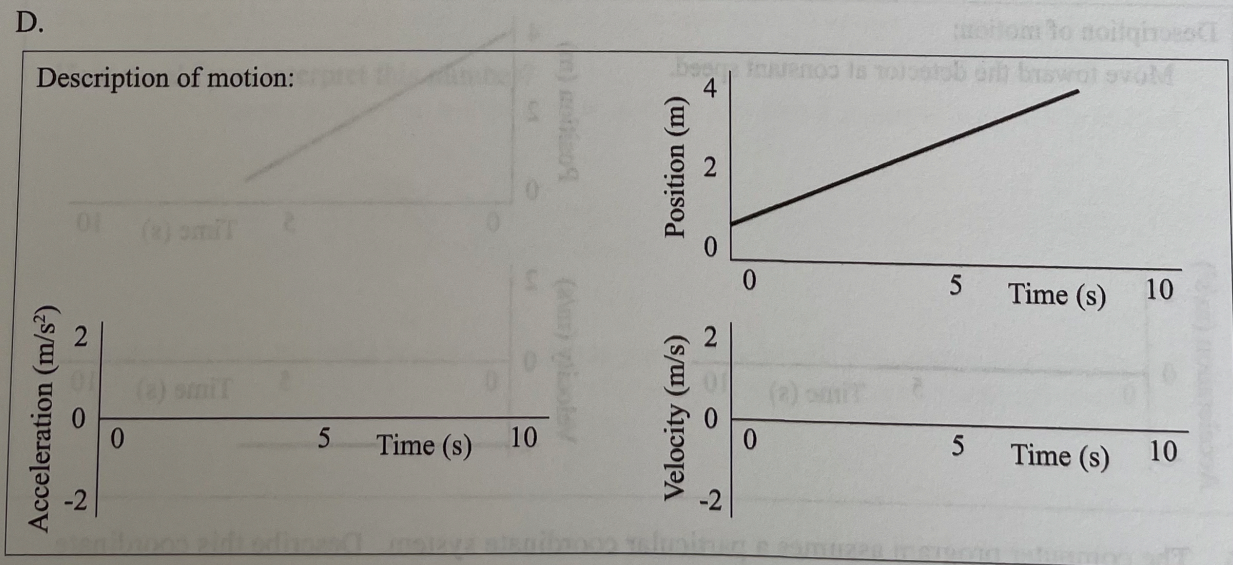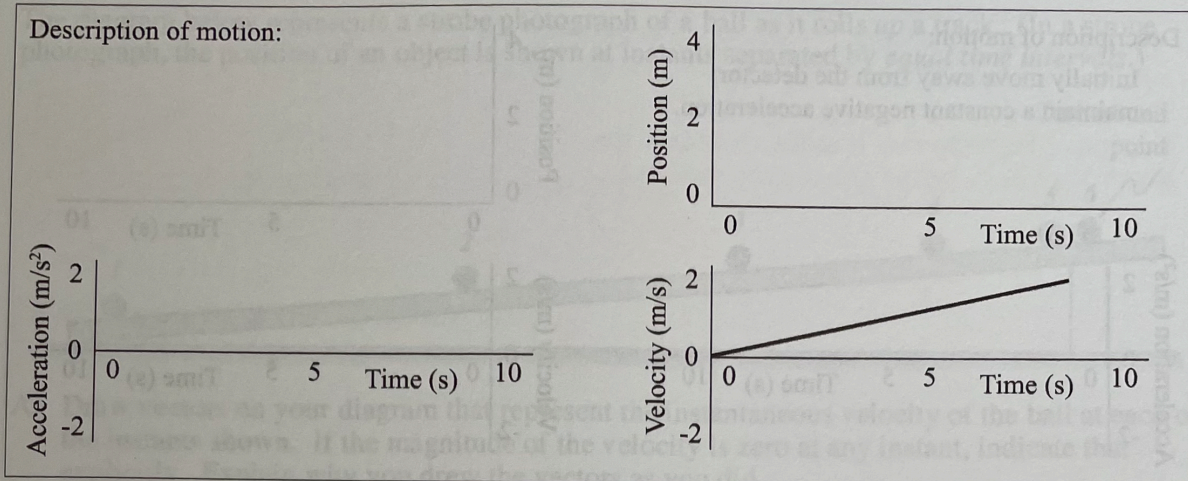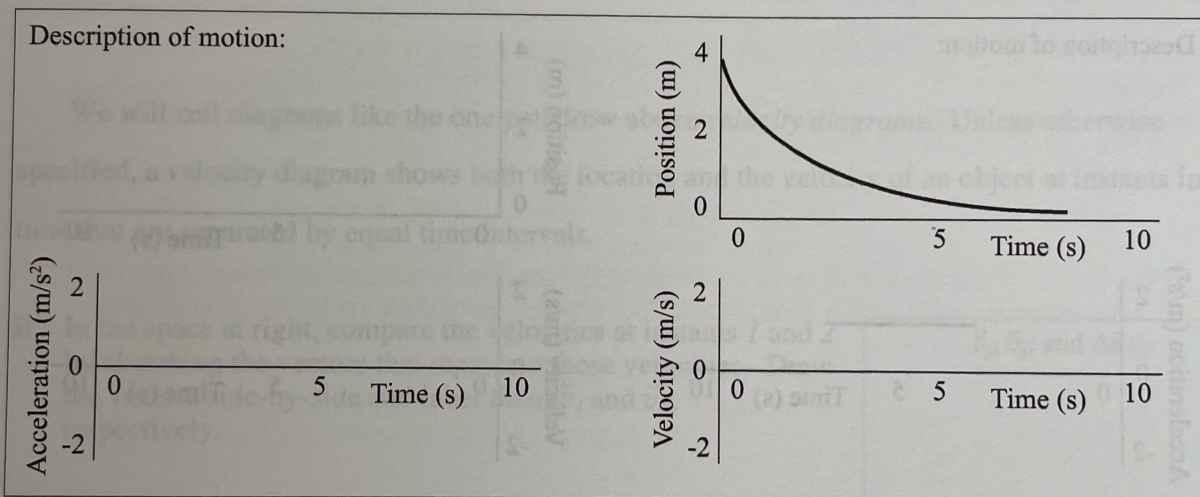**E.** How are the motions in parts C and D similar? How do they differ? How are the graphs similar? How do they differ?

F.

Description of motion:
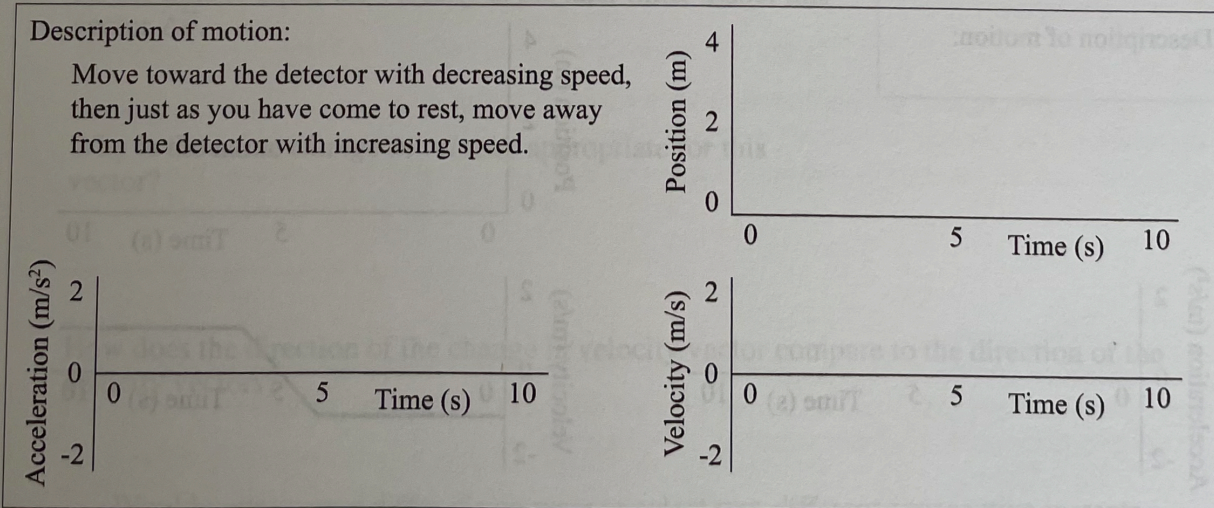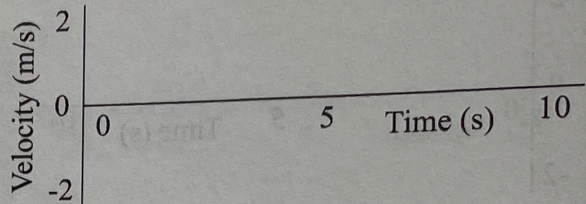
Acceleration (m/s²) graph: flat line slightly above 0, Time (s) axis 0 to 10, values 2, 0, -2.

Position (m) graph: Time (s) axis 0, 5, 10, values 0, 2, 4.

Velocity (m/s) graph: line increasing from 0, Time (s) axis 0, 5, 10, values -2, 0, 2.

G.

Description of motion:

Acceleration (m/s²) graph: Time (s) axis 0, 5, 10, values 2, 0, -2.

Position (m) graph: curve decreasing, Time (s) axis 0, 5, 10, values 0, 2, 4.

Velocity (m/s) graph: Time (s) axis 0, 5, 10, values -2, 0, 2.

H.

Description of motion:

Move toward the detector with decreasing speed, then just as you have come to rest, move away from the detector with increasing speed.

Acceleration (m/s²) graph: Time (s) axis 0, 5, 10, values 2, 0, -2.

Position (m) graph: Time (s) axis 0, 5, 10, values 0, 2, 4.

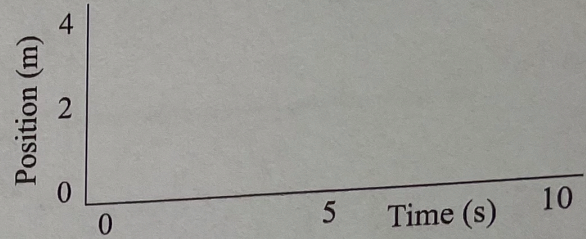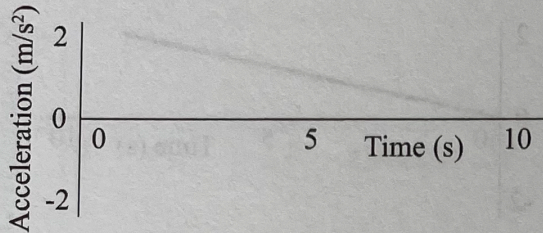Velocity (m/s) graph: Time (s) axis 0, 5, 10, values -2, 0, 2.

I. How do the acceleration graphs for F, G, and H compare? Is it possible to have: a positive acceleration and slow down? a negative acceleration and speed up?
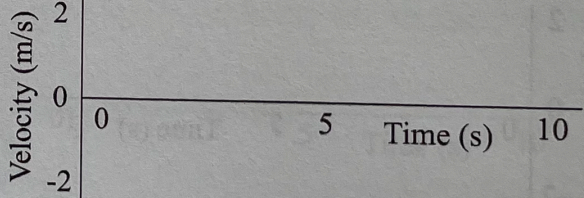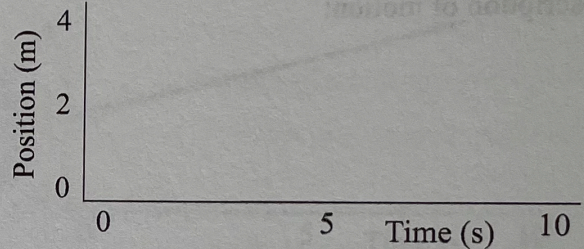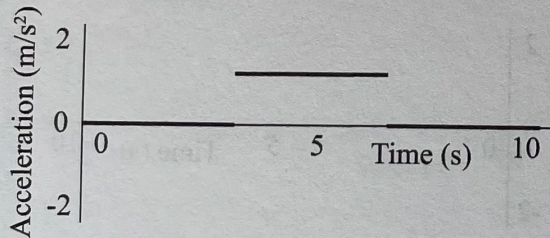
J.

Description of motion:

Initially move away from the detector;
maintain a constant negative acceleration.

Acceleration (m/s²) vs Time (s) graph

Position (m) vs Time (s) graph

Velocity (m/s) vs Time (s) graph

K.

Description of motion:

Acceleration (m/s²) vs Time (s) graph

Position (m) vs Time (s) graph

Velocity (m/s) vs Time (s) graph

L.

Description of motion:

Acceleration (m/s²) vs Time (s) graph

Position (m) vs Time (s) graph

Velocity (m/s) vs Time (s) graph
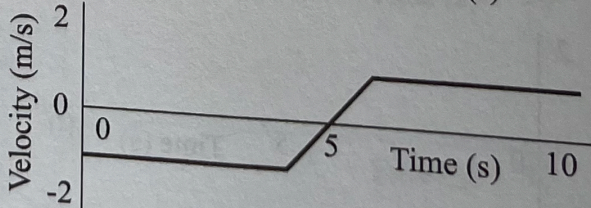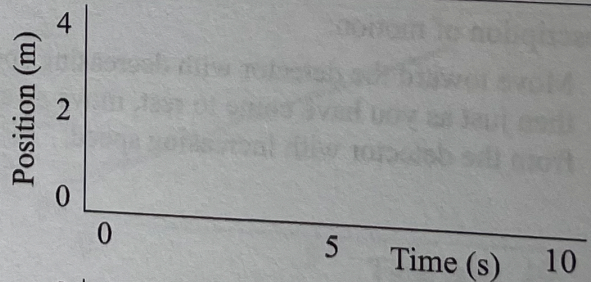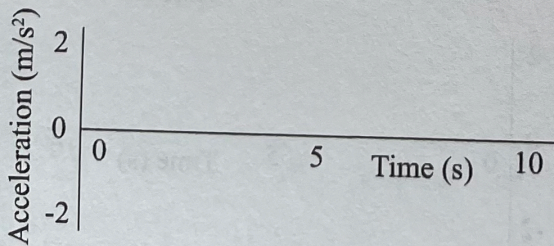
M. The term *decelerate* is often used to indicate that an object is slowing down. Does this term indicate the sign of the acceleration?