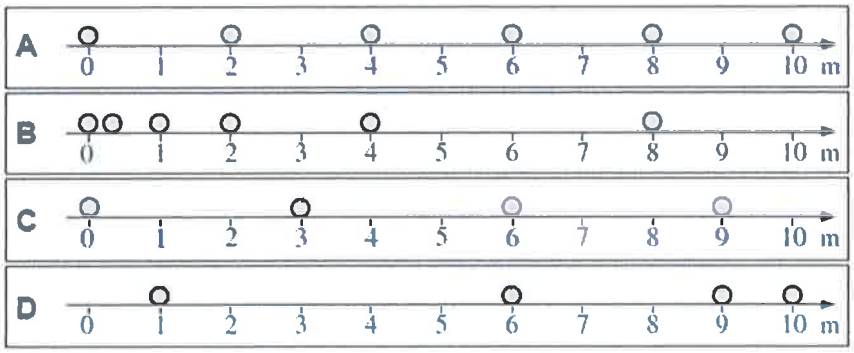
B1-RT03: Strobe Photographs of Spheres—Average Velocity I

In each case, a sphere is moving from left to right next to a tape marked in meters. A strobe (flash) photograph is taken every second, and the location of the sphere is recorded. The total time intervals shown are not the same for all spheres.

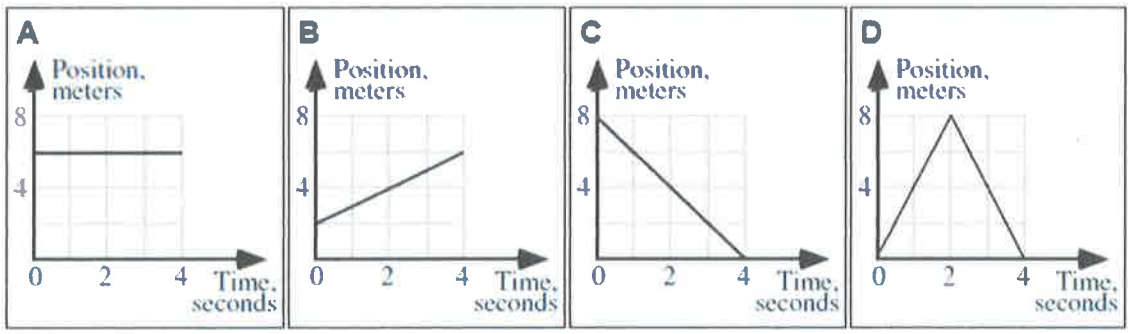


Rank the magnitude of the average velocity over the first 3 seconds.

Explain your reasoning.

B1-RT13: Position-Time Graphs—Displacement

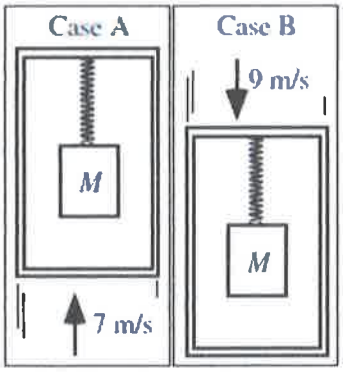
Each graph below shows the position of an object as a function of time.



Rank the magnitude of the displacement during the time interval from 0 to 4 seconds.

Explain your reasoning.

B3-CT09: Blocks in Moving Elevators—Stretch of Spring



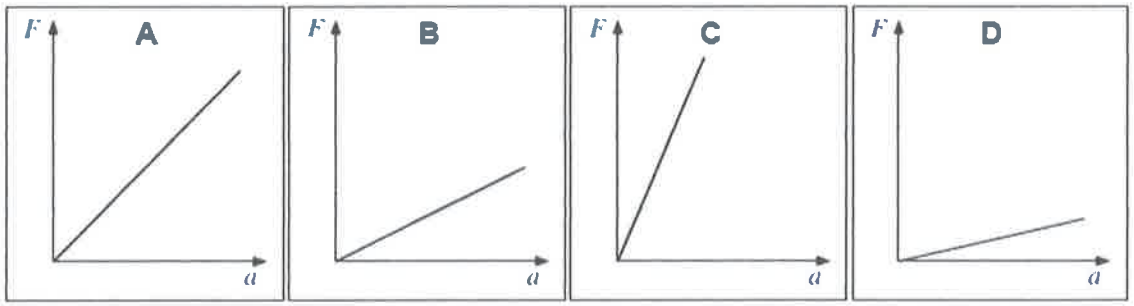
A spring is attached to the ceiling of an elevator, and a block of mass M is suspended from the spring. The cases are identical except that in Case A the elevator is moving upward with a constant speed of 7 m/s, while in Case B the elevator is moving downward with a constant speed of 9 m/s.

Will the spring be stretched (i) *more* in Case A, (ii) *more* in Case B, or (iii) *the same* in both cases? _____

Explain your reasoning.

B3-RT20: Net Force-Acceleration Graphs—Mass

These graphs are of net force versus acceleration for different objects. All graphs have the same scale for each respective axis.



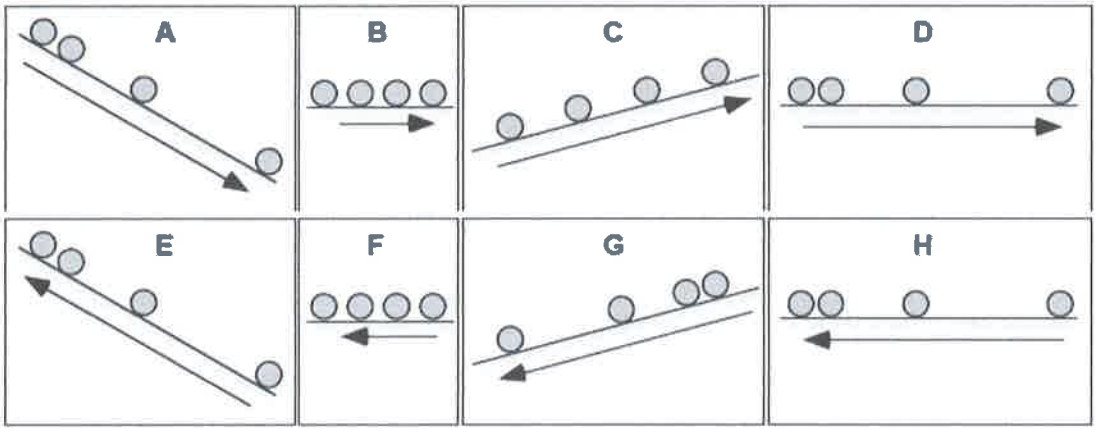
Rank the mass of the objects.

1	2	3	4	OR			
Greatest			Least		All the same	All zero	Cannot determine

Explain your reasoning.

B3-QRT19: Ball Strobe Motion—Net Force

The following drawings indicate the positions, using a strobe flash, of a ball moving from one side of the figure to the other as indicated by the direction of the arrow. Each circle represents the position of the ball at succeeding instants of time. Each time interval between successive positions is equal, and each ball has the same mass. Assume the acceleration, if any, for each situation to be constant.



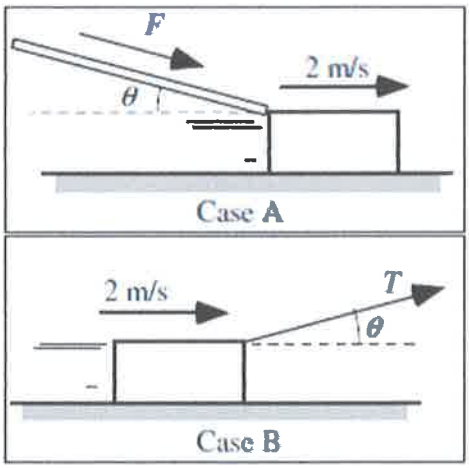
(a) In which of these cases, if any, is there a net force acting on the ball? _____
Explain your reasoning.

(b) In which of these cases, if any, is there a component of the net force directed to the right? _____
Explain your reasoning.

(c) In which of these cases, if any, is there a component of the net force on the ball directed upward? _____
Explain your reasoning.

B3-CT35: Blocks Moving at Constant Speed—Force on Block

A block is moving to the right across a rough table at a constant speed of 2 m/s. The tables and the blocks are identical in the two cases. In Case A, the block is pushed with a stick and in Case B, the block is pulled with a string. The angle that the applied force makes with the horizontal is the same in both cases.

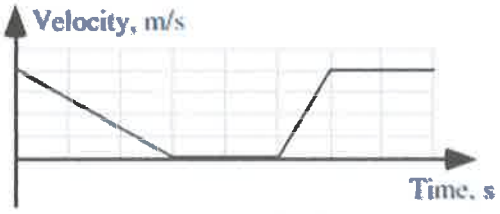


Will the magnitude of the force on the block by the stick in Case A be (i) *greater than*, (ii) *less than*, or (iii) *equal to* the tension on the block by the string in Case B? _____

Explain your reasoning.

B3-CRT37: Velocity-Time Graph—Force-Time Graph

Shown is the velocity versus time graph for an object that is moving in one dimension under the (perhaps intermittent) action of a single horizontal force.

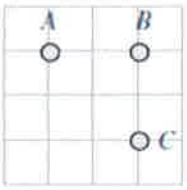


On the axes below, draw the horizontal force acting on this object as a function of time.

Explain your reasoning.

B3-QRT94: Three Objects Exerting Gravitational Forces—Net Force

Three objects each with a mass of *M* exert gravitational forces on each other. Which of the arrows below shows the direction of the net force on mass *B*?

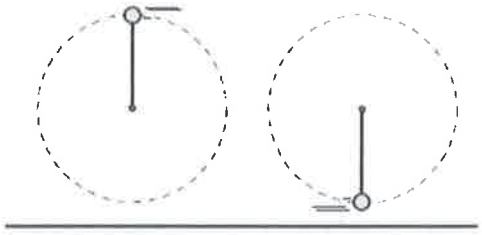


(i) ↙ (ii) ↗ (iii) ← (iv) ↑ (v) None of these

Explain your reasoning.

B3-SCT100: Ball Whirled in Vertical Circle—Net Force on Ball

A ball with a weight of 2 N is attached to the end of a cord of length 2 m. The ball is whirled in a vertical circle counterclockwise. The tension in the cord at the top of the circle is 7 N, and at the bottom it is 15 N. (The speed of the ball is not the same at these points.)



(a) Three students discuss the net force on the ball at the top.

Angelica: "The net force on the ball at the top position is 7 N since the net force is the same as the tension."

Bo: "The net force on the ball at the top position is 9 N. Both the tension and the weight are acting downward so you have to add them."

Charles: "No, you are both wrong. You need to figure out the centripetal force (mv^2/r) and include it in the net force."

With which, if any, of these students do you agree?

Angelica _____ Bo _____ *Charles* _____ None of them _____

Explain your reasoning.

(b) Now the students discuss the net force on the ball at the bottom.

Angelica: "The net force on the ball at the bottom position is 15 N since the net force is the same as the tension."

Bo: "The net force on the ball at the bottom position is 17 N, since you need to add the weight of 2 N to the tension of 15 N."

Charles: "The net force on the ball at the bottom position is 13 N. I agree that you need to take into account both the weight and the tension, but they are in different directions so they will subtract."

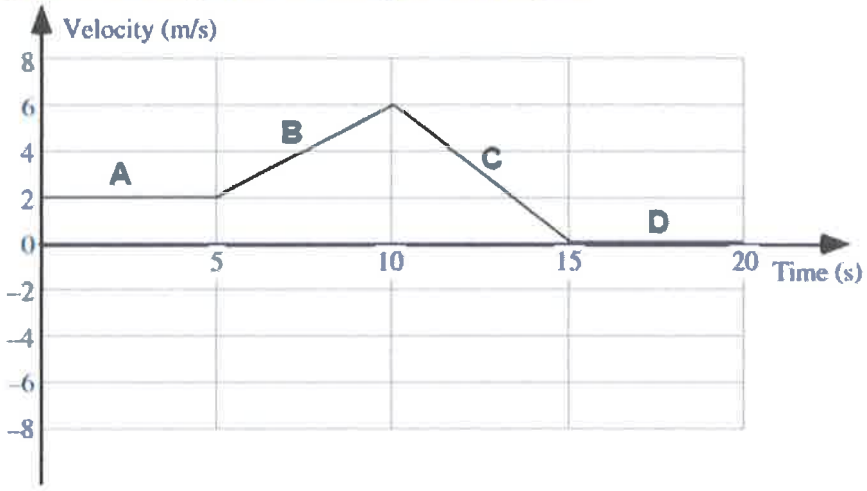
With which, if any, of these students do you agree?

Angelica _____ Bo _____ *Charles* _____ None of them _____

Explain your reasoning.

B4-RT09: Velocity-Time Graph I—Work Done on Box

Shown below is a graph of velocity versus time for an object that moves along a straight, horizontal line under the perhaps intermittent action of a single force exerted by an external agent.



Rank the work done on the box by the external agent for the 5-second intervals shown on the graph.

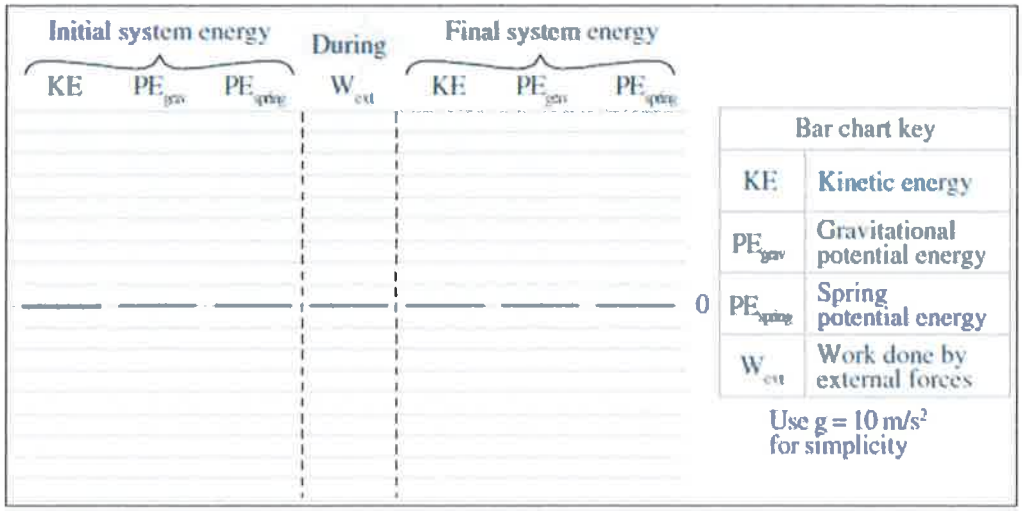
1	2	3	4	OR			
Greatest			Least		All the same	All zero	Cannot determine

Explain your reasoning.

B4-BCT35: Box Attached to Spring—Energy Bar Chart

A 40-N box is initially at rest on a smooth (frictionless) horizontal surface. An unstretched spring with spring constant 10 N/m connects the box to the wall. A 60 N force is applied horizontally to the right.

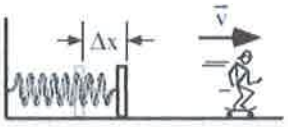
Complete the energy bar chart for the spring-block-earth system as the block moves a distance of 2 m. Label the column heights. Set the zero point for the gravitational potential energy at the center of the block.



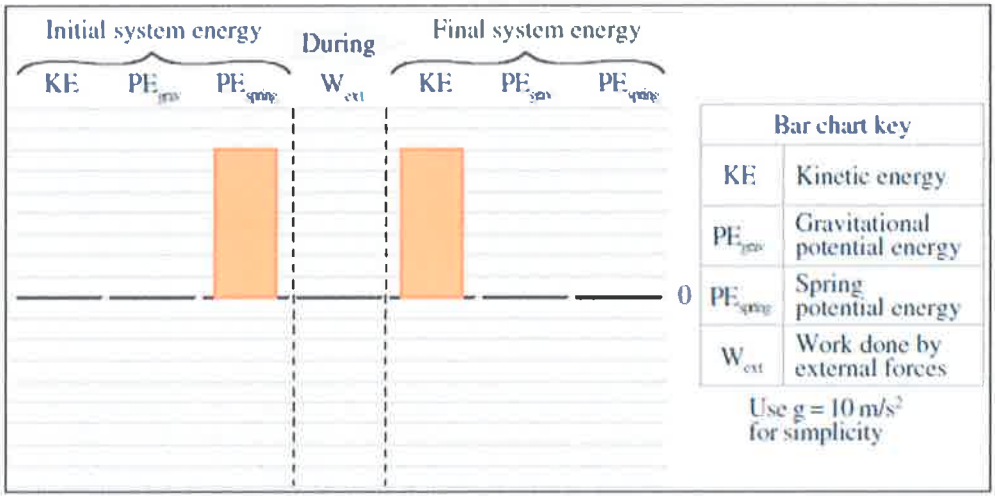
Explain your reasoning.

B4-BCT37: Skateboarder Launched by a Spring I—Energy Bar Chart

A performer on a skateboard is launched by a spring initially compressed a distance Δx. His speed on the horizontal portion of the ramp is v. Ignore friction effects.



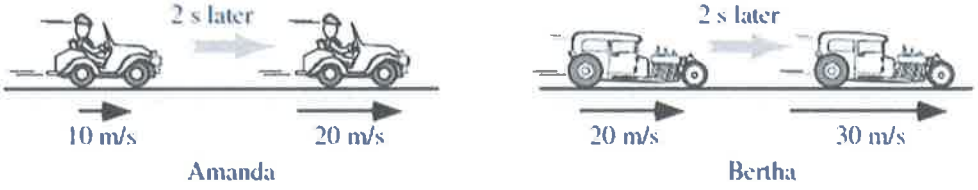
Draw an energy bar chart for the earth-skateboarder-spring system as the skateboarder goes from the compressed spring position at rest to where he moves free of the spring on the horizontal surface. Put the zero point for the gravitational potential energy at the height of the performer before launching.



Explain your reasoning.

B4-CT49: Car Race—Work and Power

Amanda and Bertha are in a car race. Their cars have the same mass. At one point in the race, they both change their speeds by 10 m/s in 2 seconds. Ignore air friction.



(a) Is the work that Amanda's car does while speeding up (i) *greater than*, (ii) *less than*, or (iii) *the same as* the work that Bertha's car does while speeding up? _____

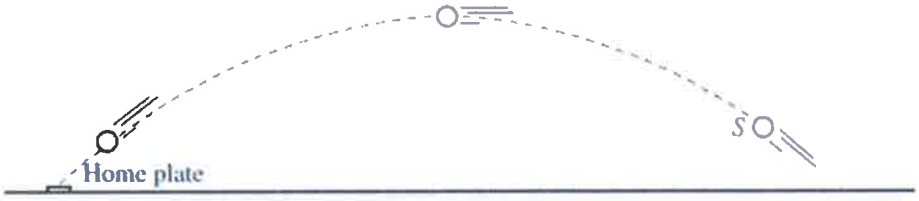
Explain your reasoning.

(b) Is the power generated by Amanda's car while speeding up (i) *greater than*, (ii) *less than*, or (iii) *the same as* the power generated by Bertha's car while speeding up? _____

Explain your reasoning.

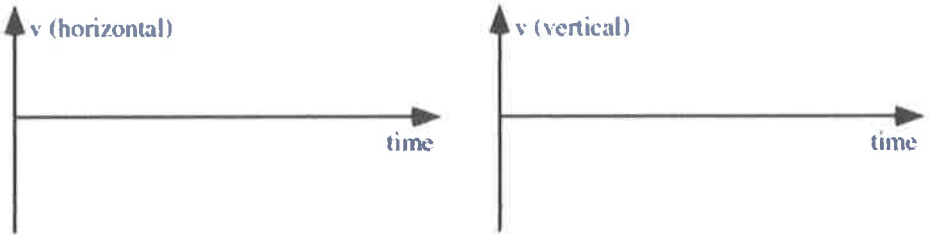
B2-QRT09: Projectile Motion—Velocity-Time and Acceleration-Time Graphs

A baseball is thrown from point *S* in right field to home plate. The dashed line in the diagram shows the path of the ball. Use a coordinate system with up as the positive vertical direction and to the right as the positive horizontal direction, with the origin at the point the ball was thrown from (point *S*).



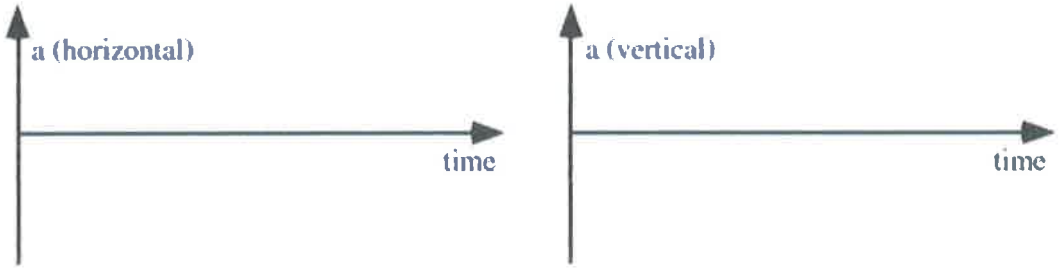
On the axes below, sketch graphs for the indicated quantities:

(a) The horizontal velocity versus time and the vertical velocity versus time.



Explain your reasoning.

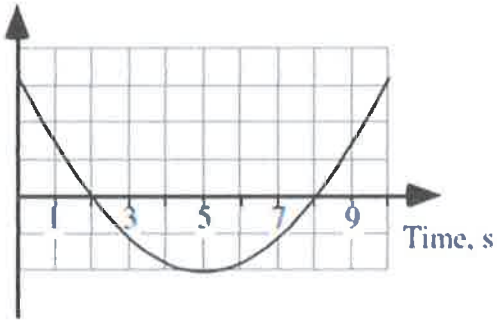
(b) The horizontal acceleration versus time and the vertical acceleration versus time.



Explain your reasoning.

B1-QRT38: Position or Velocity Graphs—Change Direction

The graph shown is for an object in one-dimensional motion. The vertical axis is not determined, so it is not labeled.



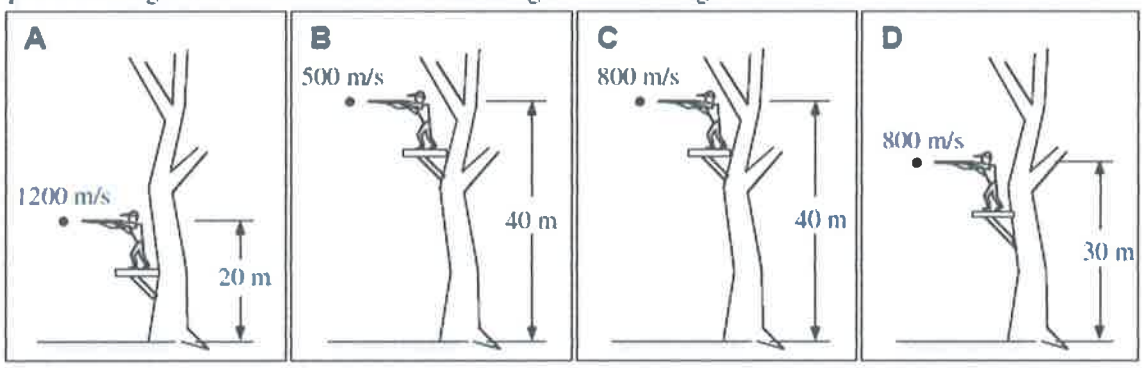
(a) If the vertical axis is position, does the object ever change direction?

If so, at what time or times does this change in direction occur?

Explain your reasoning.

B2-RT15: Rifle Shots—Time to Hit Ground

The rifles in the figures are being fired horizontally (straight outward, off platforms). The bullets fired from the rifles are all identical, but the rifles propel the bullets at different speeds. The speed of each bullet and the height of each platform are given. All of the bullets miss the targets and hit the ground.



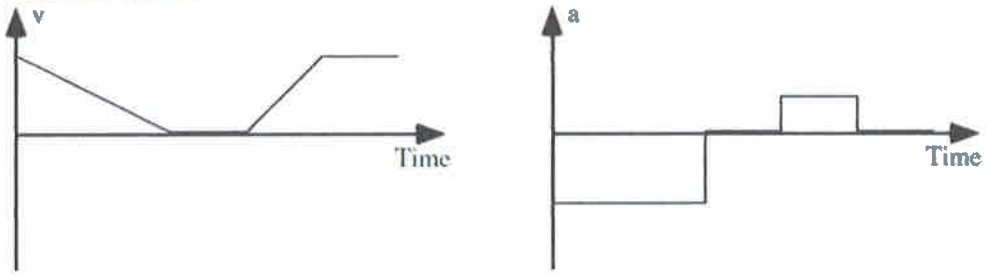
Rank the time it takes the bullets to hit the ground.

				OR			
1	2	3	4		All	All	Cannot
Greatest			Least		the same	zero	determine

Explain your reasoning.

B1-WWT20: Velocity-Time Graph—Acceleration-Time Graph

A student obtains a graph of an object's velocity versus time and then draws the graph of the acceleration versus time for the same time interval.

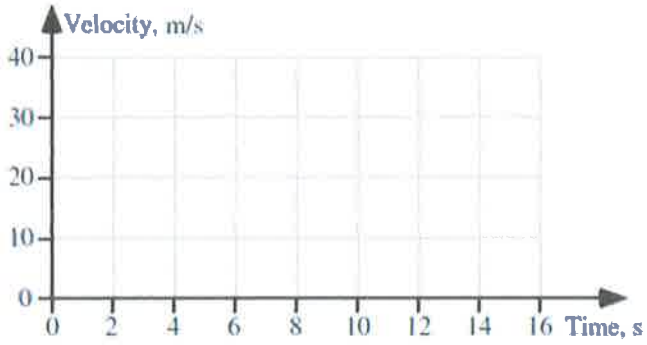


What, if anything, is wrong with the graph of the acceleration versus time? If something is wrong, identify it and explain how to correct it. If the graph is correct, explain why.

B1-CRT27: Traveling Students—Velocity-Time Graph

Carmela and Desi leave a parking lot separately and drive west. They both start from rest. Desi leaves first, traveling with an acceleration of 4 m/s^2 west for the first 6 seconds, and then driving at a constant velocity. Two seconds after Desi started, Carmela starts with an acceleration of 3 m/s^2 west for 10 seconds, and then she drives at a constant velocity.

Graph the velocity of both travelers as a function of time up to $t = 16$ seconds starting at time $t = 0$ when Desi leaves the classroom. Use a solid line for Desi's velocity and a dashed line for Carmela's velocity.



Explain your reasoning.

B2-QRT11: Baseball Projectile Motion—Velocity-Time and Acceleration-Time Graphs

A baseball is thrown from point *S* in right field to home plate. The dashed line shows the path of the ball.

Use a coordinate system with up as the positive vertical direction and to the left as the positive horizontal direction, and with the origin at home plate.

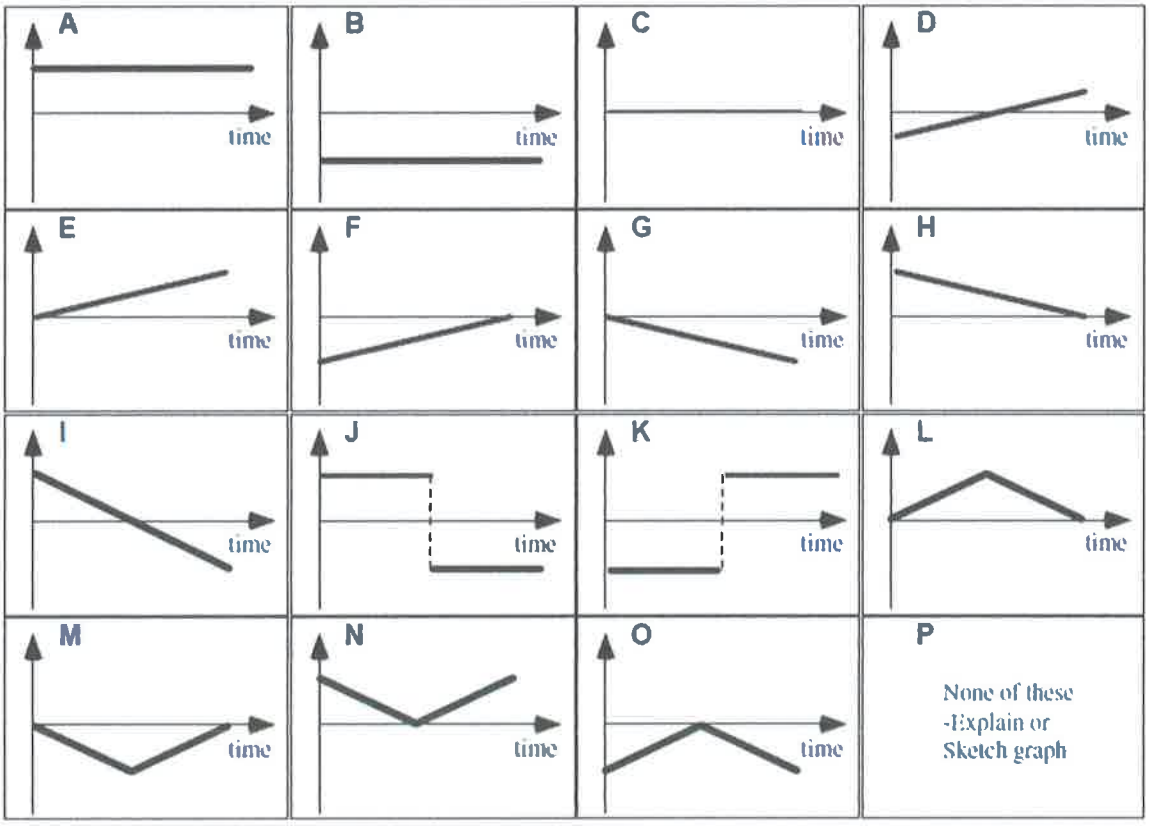
Select the graph from the choices below that best represents:

(i) horizontal velocity versus time graph ____ Explain your reasoning.

(ii) horizontal acceleration versus time graph ____ Explain your reasoning.

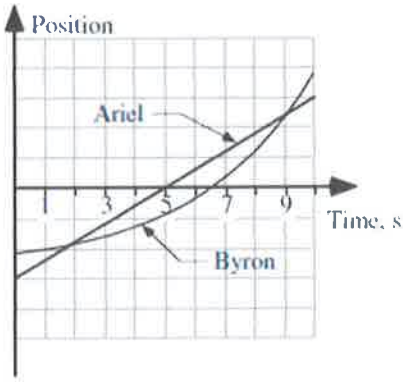
(iii) vertical velocity versus time graph ____ Explain your reasoning.

(iv) vertical acceleration versus time graph ____ Explain your reasoning.



You should be able to:

- Plot a velocity-time graph if given data. Then, draw the position-time graph and acceleration-time graph which correspond to the velocity-time graph and be able to answer questions about those graphs.
- Analyze any object using a free body diagram and Newton's Laws.
- Analyze any object using work and energy.
- Analyze the motion of any object in 1D or 2D motion with constant acceleration.



B1-QRT35: POSITION-TIME GRAPHS OF CHILDREN—KINEMATIC QUANTITIES

The position-time graph shown represents the motion of two children, Ariel and Byron, who are moving along a narrow, straight hallway.

(a) Do either of the children ever change direction?
If so, at what time or times does this change in direction occur?
Explain your reasoning.

(b) Are the two children ever at the same position along the hallway?
If so, at what time or times does this happen?
Explain your reasoning.

(c) Do the two children ever have the same speed?
If so, at what time or times does this happen?
Explain your reasoning.

(d) Do the two children ever have the same acceleration?
If so, at what time or times does this happen?
Explain your reasoning.