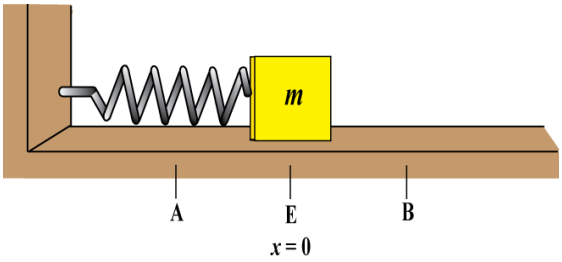
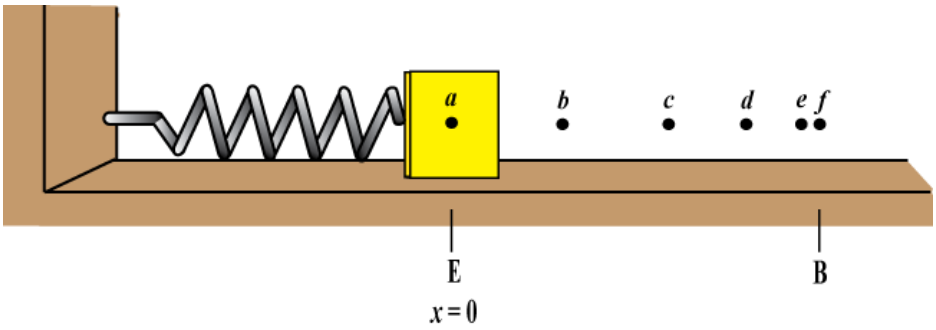
I. Position versus time from Position B to Equilibrium

Consider a compression spring mounted horizontally attached to a block of mass *m* positioned on a frictionless surface. When the spring is at its natural length, the block is said to be at its "equilibrium position", E.

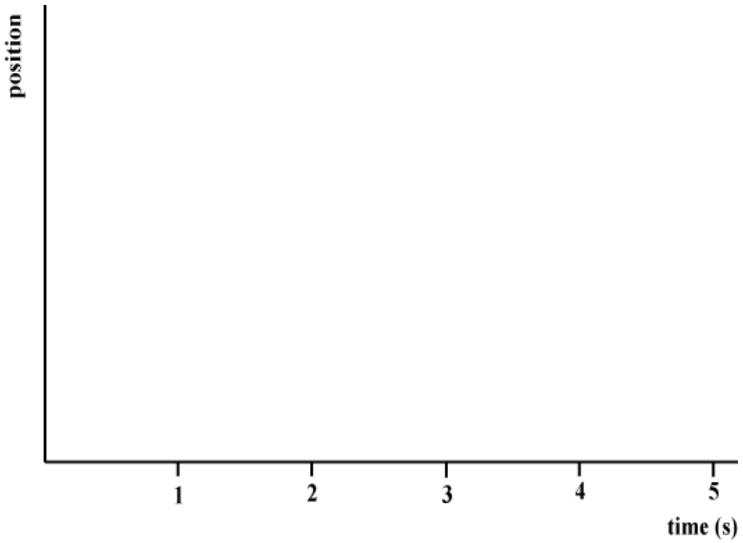


Positions A and B are both the same distance from the equilibrium position. When the spring is compressed to position A, and then released, the block will go back through the equilibrium position to position B. The block then returns through the equilibrium position to position A. This motion will continue indefinitely.

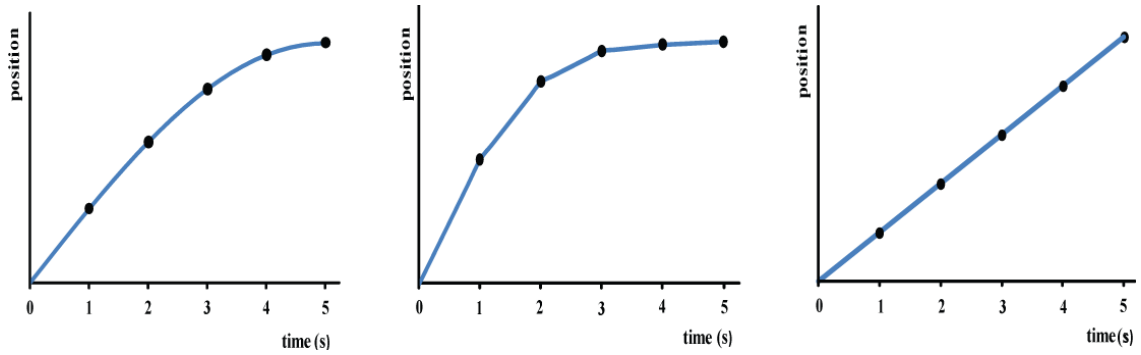
A. The diagram below shows the position of the block after it leaves position B returning to the equilibrium position at instants separated by equal time intervals. Point *a* is at the position B and point *f* is at the equilibrium position ($x = 0$).



On the axis given below, plot position (distance from equilibrium position) versus time for the points *a* to *f* (Points *a, b, c, d, e,* and *f* are taken at 0s, 1s, 2s, 3s, 4s, and 5s respectively).



B. Describe what the following three line shapes represent about the motion of the block.



Which of the line shapes do you think correctly fits the data points you have drawn for position versus time? Explain.

II. Position versus time for all intervals

A. Consider the following statements made by two students regarding the sign of the position when the block is moving from position A to equilibrium.

Student 1: *When the block was moving from equilibrium to position B the position was positive. When it moves from B to equilibrium it is moving in the opposite direction, therefore position must be negative.*

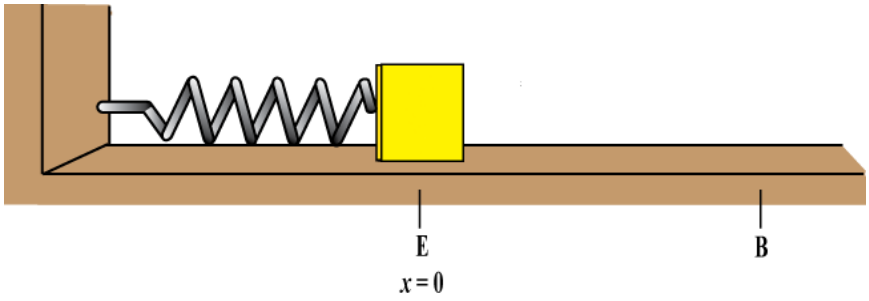
Student 2: *We are just looking at position, not a change in position or displacement. At equilibrium the position is zero. I think that when the block is at a position anywhere to the right of equilibrium it is a positive position.*

Which of the students do you agree with?

What will the sign for position be when the block is moving from equilibrium to position A, and when it is moving from position A to equilibrium? Explain brielfly.

B. Again consider the block moving from position B to equilibrium. Is the magnitude of the position increasing or decreasing? Explain.

On the diagram below indicate the position of the block at equal time intervals as it moves from position B to equilibrium (label the points *g*-*l*).

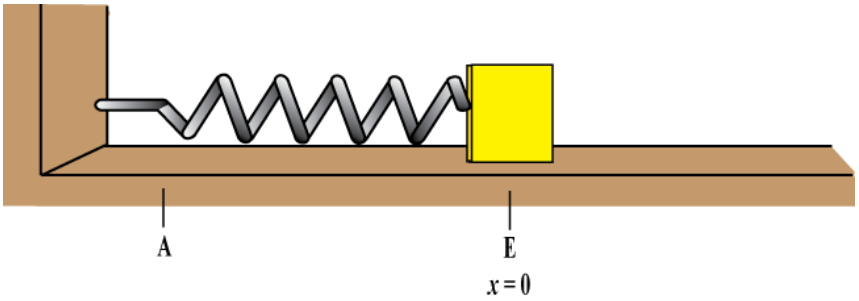


Will the graph of position versus time for B to equilibrium start at the origin? Explain.

Draw an axis and sketch the line shape for position versus time from B to equilibrium. Explain briefly.

C. Now consider the block moving from equilibrium to position A. Is the magnitude of the position increasing or decreasing? Explain briefly.

On the diagram below indicate the position of the block at equal time intervals as it moves from equilibrium to position A (label the points *m*-*r*).



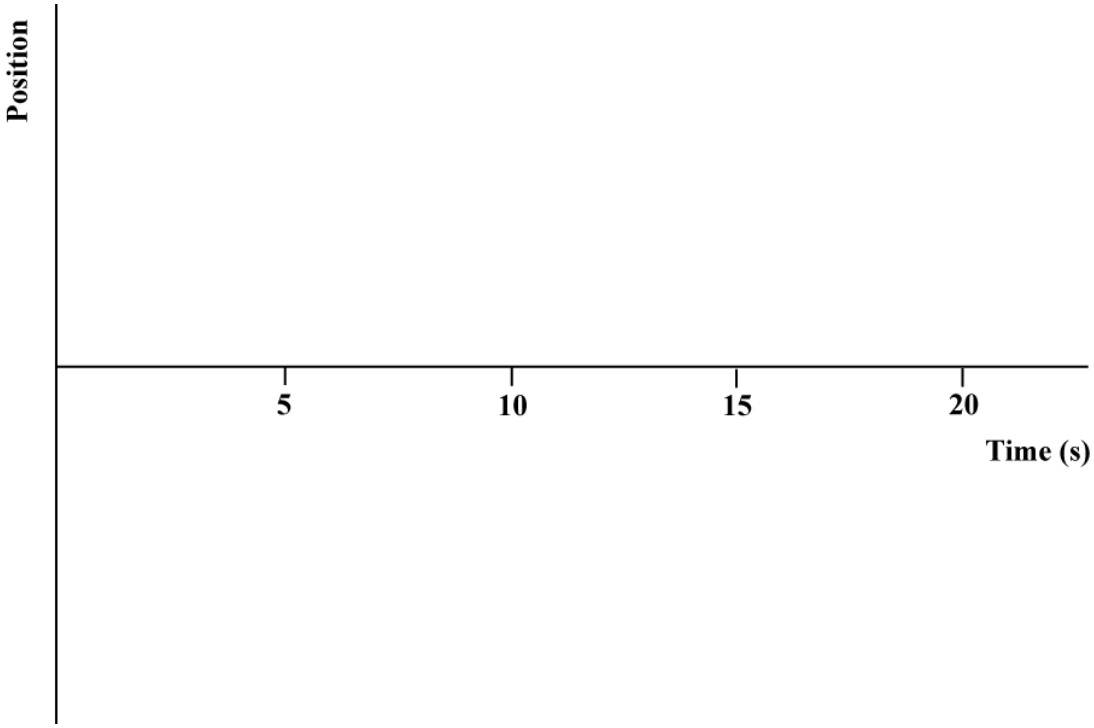
Compare the positions at points a-f when the block moves from equilibrium to position B to the positions at points *m-r* when the block moves from equilibrium to position A.

Draw an axis and sketch the line shape for position versus time from equilibrium to position A. Explain briefly.

D. In the table below, state the sign for position and whether its magnitude is increasing or decreasing for each interval.

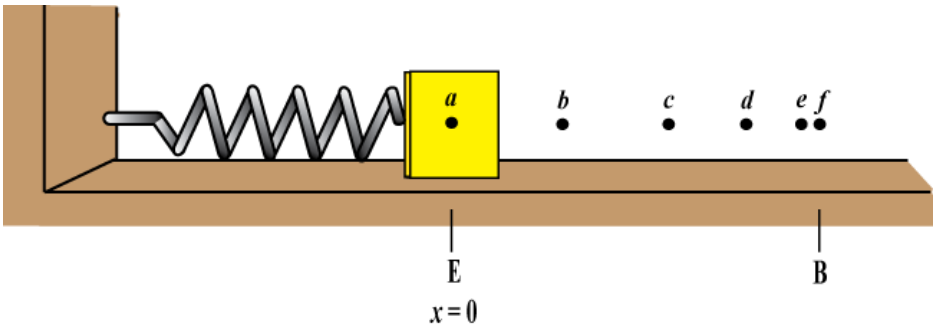
Interval	**Sign**	**Magnitude**
E-B	Positive	Increasing
B-E		
E-A		
A-E		

E. Use the information from the table to draw the graph of position versus time for one full cycle of motion starting from position A.



I. Velocity versus time from equilibrium to position B

A. The diagram below shows the position of the block after it passes the equilibrium position going to position B at instants separated by equal time intervals. Position B is 40mm from the equilibrium position.



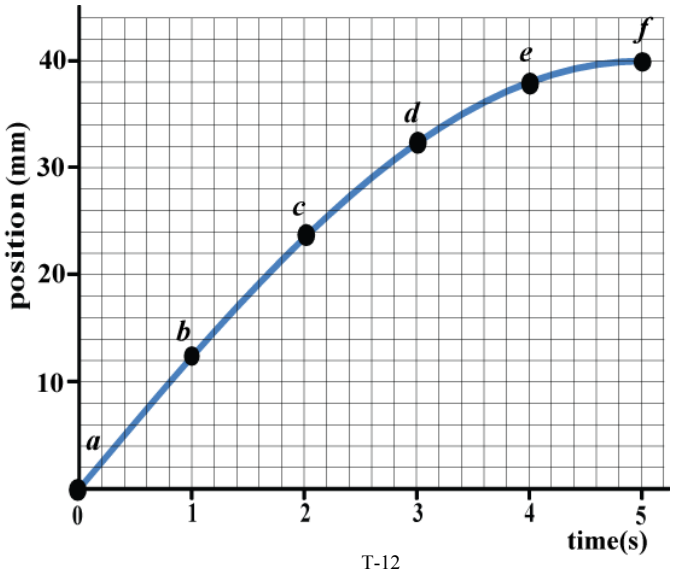
Between which consecutive points *a-b, b-c*, etc. is the change in position greatest and least?

Between which consecutive points *a-b, b-c*, etc. will the velocity be greatest? Where will it be least? Explain briefly.

Is the magnitude of the block's velocity increasing or decreasing as it moves from equilibrium to position B?

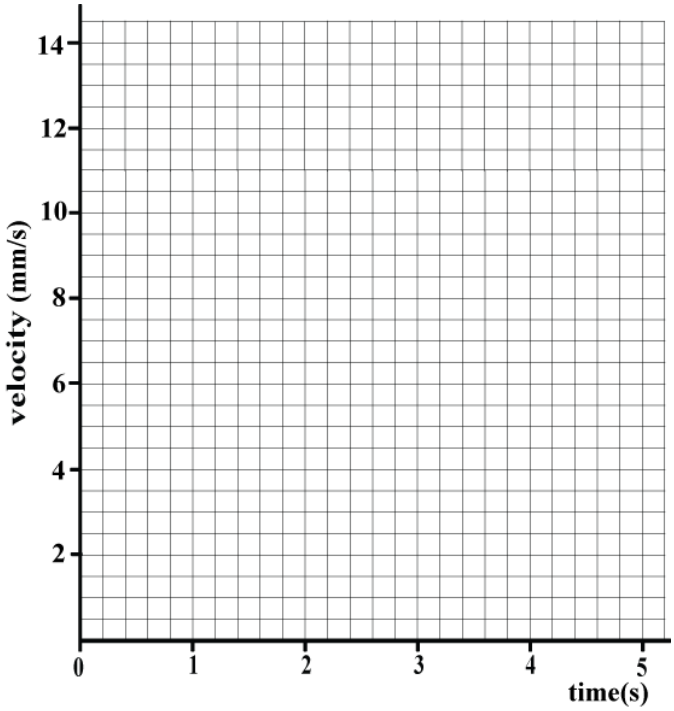
Draw vectors on the diagram that represent the instantaneous velocity of the block at each of the points *a-f*. If the velocity is zero at any point, state so explicitly.

B. In the *Position in Simple Harmonic Motion Tutorial* you obtained the following graph for position versus time for the block when it moves from equilibrium to position B.

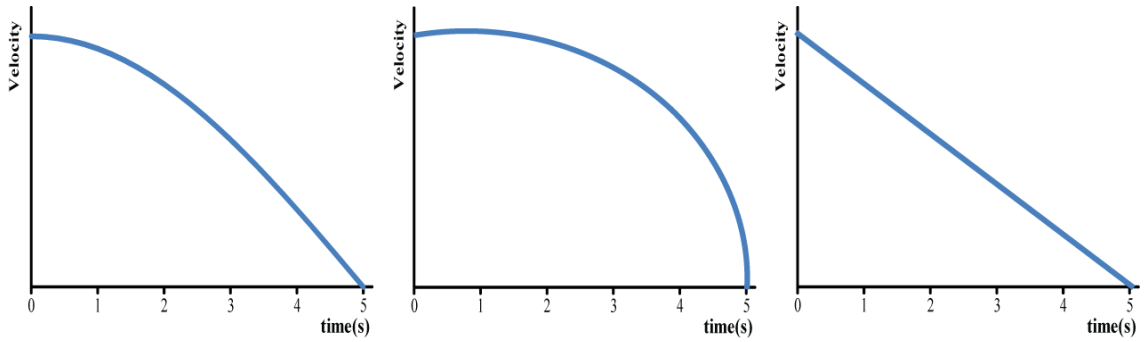


VELOCITY IN SIMPLE HARMONIC MOTION

Determine the velocity of the block at points *a, c* and *f.* Hence plot these points on the velocity versus time graph below.

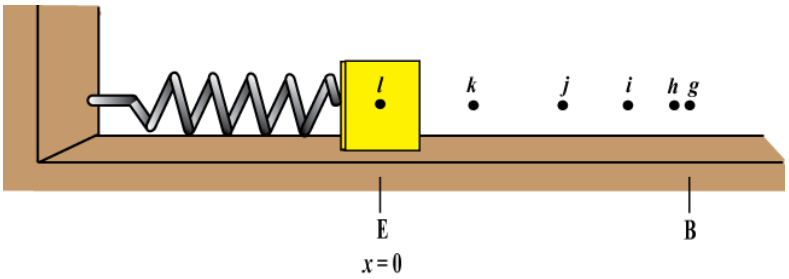


Explain what the following line shapes suggest about velocity versus time from equilibrium to position B. Which one is correct?



II. Velocity versus time for all intervals

A. The diagram below shows the position of the block as it moves from position B to equilibrium.



Is the magnitude of the block's velocity increasing or decreasing as it moves from position B to equilibrium?

Draw vectors on the diagram that represent the instantaneous velocity of the block at each of the points *g-l*. If the velocity is zero at any point, state so explicitly.

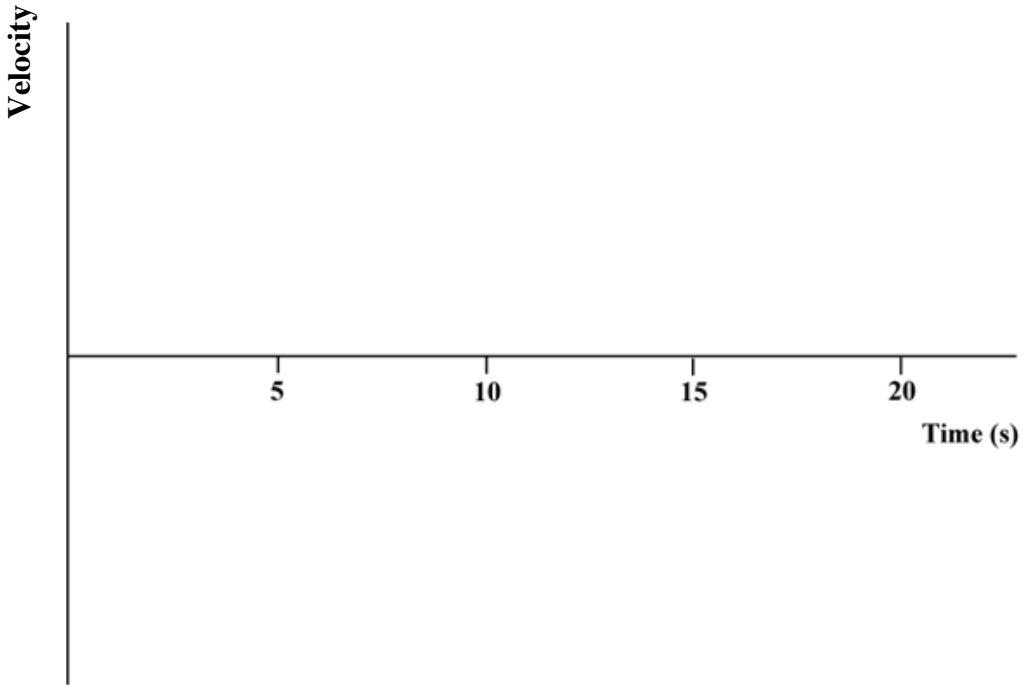
Based on the change of position is the velocity of the block positive or negative as it moves from position B to equilibrium?

Draw an axis and sketch the line shape for velocity versus time from position B to equilibrium. Explain briefly.

B. In the table below, state the sign for velocity and whether its magnitude is increasing or decreasing for each interval.

Interval	**Sign**	**Magnitude**
E-B	Positive	Decreasing
B-E		
E-A		
A-E		

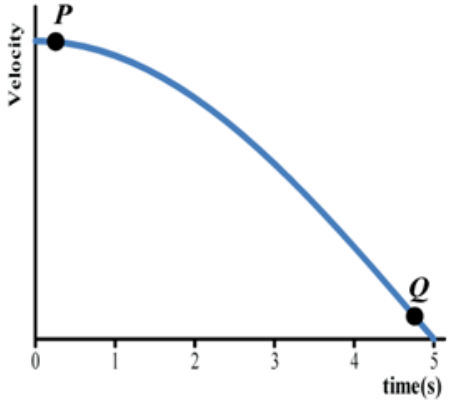
C. Use the information from the table to draw the graph of velocity versus time for one full cycle of motion starting from position A.



D. Compare position and velocity versus time for one full cycle of the blocks motion.

I. Acceleration versus time from equilibrium to position B

A. The graph at right shows velocity versus time for the block as it moves from equilibrium to position B. Point *P* is close to equilibrium and *Q* is close to position B.



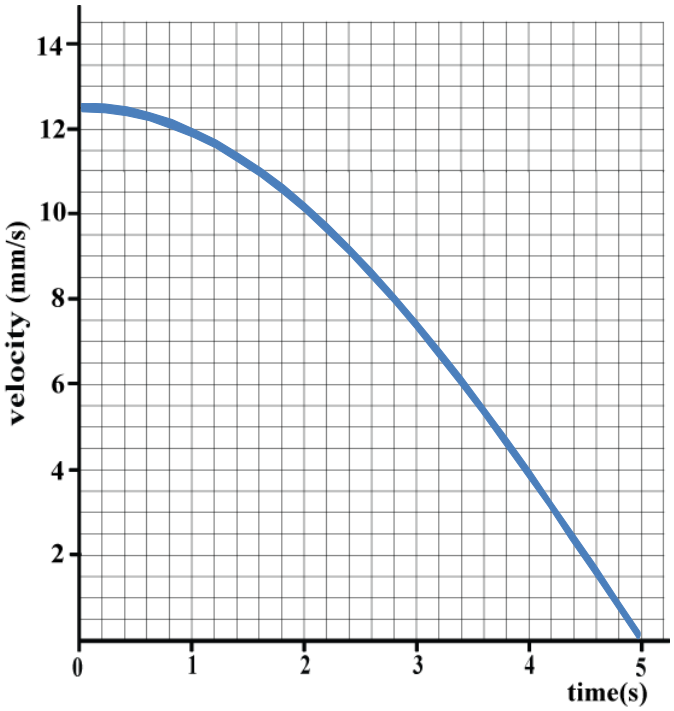
Is the change in velocity at *P* greater than or less than the change in velocity at *Q*? How can you tell from the graph?

Is the magnitude of the acceleration at *P* greater than or less than the magnitude of the acceleration at *Q*? Explain briefly.

Is the magnitude of the acceleration increasing or decreasing as the block moves from equilibrium to position B?

Is the change in velocity between point *P* and *Q* positive or negative? Hence is the acceleration positive or negative as it moves from equilibrium to position B?

B. In the *Velocity in Simple Harmonic Motion Tutorial* you obtained the following graph for velocity versus time for the block when it moves from equilibrium to position B.



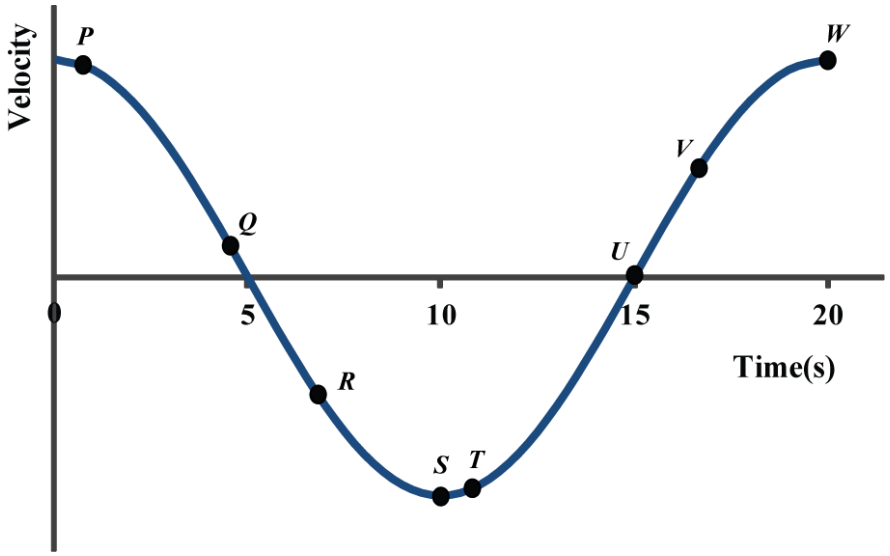
ACCELERATION IN SIMPLE HARMONIC MOTION

Determine the acceleration of the block at various points that will allow you determine the line shape of the acceleration versus time graph. Create an axis on the grid provided below and draw the graph of acceleration versus time for the block as it moves from equilibrium to position B.

C. Compare the magnitude and the sign of the blocks velocity and acceleration as it moves from equilibrium to position B.

II. Acceleration versus time for all intervals

A. The following graph shows velocity versus time for one full cycle of the blocks motion from equilibrium to position B, back through equilibrium to position A and again back to equilibrium.



Rank the magnitude of the acceleration at points *P*-*W* from greatest to least. Explain briefly.

At which points is the acceleration positive? At which points is the acceleration negative? If it is zero at any of the points state so explicitly. Explain.

B. In the table below, state the sign for acceleration and whether its magnitude is increasing or decreasing for each interval.

Interval	Sign	Magnitude
E-B	Negative	Increasing
B-E		
E-A		
A-E		

C. Use the information from the table to draw the graph of acceleration versus time for one full cycle of motion starting from position A.