

SI Physics - Full Discipline Demo

Kinematics

Final Report - Answer Guide

Institution	Science Interactive University
Session	SI Physics - Full Discipline Demo
Course	SI Physics - Full Discipline Demo
Instructor	Sales SI Demo

Test Your Knowledge

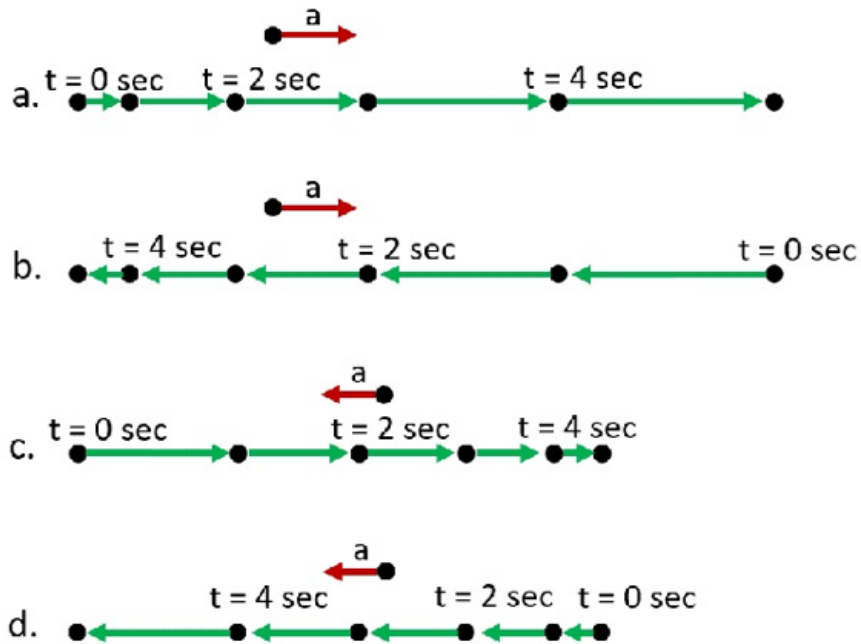
Categorize each variable as a scalar or vector quantity.

	Scalar	Vector
Acceleration		
Displacement		
Distance		
Speed		
Velocity		

Correct answers:

1 Speed Distance 2 Acceleration Velocity Displacement

Match each diagram to the best description.



☐ A	▶	Positive acceleration, slowing down	☐	1	
☐ B		Negative acceleration, speeding up	☐	2	
☐ C		Positive acceleration, speeding up	☐	3	
☐ D		Negative acceleration, slowing down	☐	4	

Correct answers:

1 B 2 D 3 A 4 C

Label the three related graphs.



Correct answers:

- 1 Position versus Time 2 Velocity versus Time
- 3 Acceleration versus Time

Categorize each statement as True or False.

⚡ Acceleration is the rate of change of position	
⚡ Acceleration is the rate of change of velocity	
⚡ Free fall acceleration is constant	⚡ Free fall velocity is constant
⚡ Free fall velocity is proportional to weight	
⚡ Velocity changes linearly for motion with constant acceleration	
True	False
1	2

Correct answers:

1 Velocity changes linearly for motion with constant acceleration

Free fall acceleration is constant

Acceleration is the rate of change of velocity

2 Acceleration is the rate of change of position

Free fall velocity is proportional to weight Free fall velocity is constant

Exploration

A displacement is positive if it points up or to the right in the Cartesian coordinate system.

☒ True	✓
☐ False	

The speed of an object moving in multiple directions is the same as the magnitude of the velocity.

- ☐ True
- ☒ False ✓

The dots in motion diagrams are always equally spaced in ____.

- ☐ space
- ☒ time ✓
- ☐ space and time
- ☐ None of the above

Velocity ____ when acceleration points in the ____ direction as the velocity.

- ☒ increases; same ✓
- ☐ increases; opposite
- ☐ decreases; same
- ☐ None of the above

$v = v_0 + at$ relates ____ and ____.

- ☐ position; time
- ☐ position; velocity
- ☒ velocity; time ✓
- ☐ velocity; acceleration

The velocity of an object at time t can be determined from the slope of the ____ versus time graph at that time.

- ☒ position ✓
- ☐ acceleration
- ☐ velocity
- ☐ None of the above

The magnitude of the velocity at time t is determined by calculating the area under the acceleration versus time graph and adding the initial velocity.

☒ True



☐ False

In free fall, acceleration is constant.

☒ True



☐ False

Exercise 1

Explain the mathematical and graphical relationship between velocity and acceleration using your own words.

Acceleration is the time rate of change of the velocity. The acceleration is the slope of the velocity-time graph. The velocity is the area under the acceleration-time graph.

Explain the mathematical and graphical relationship between velocity and position using your own words.

Velocity is the time rate of change of the position. The velocity is the slope of the position-time graph. The displacement is the area under the velocity-time graph.

How does the angle of inclination affect the velocity of the marble? The acceleration?

The velocity of the marble increases at the bottom of the ramp as the angle of incline increases. The acceleration of the marble at the bottom of the ramp increases as the angle of incline increases.

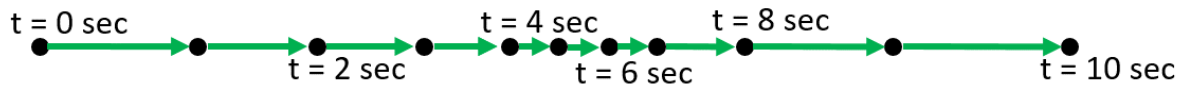
Compare calculated velocity and acceleration to velocity and acceleration determined from graphs. Do the values match? If not, which value is more accurate and why?

The values for acceleration and velocity do not match, although they are very similar. The values obtained from graphical means are likely more accurate because the best-fit trendline averages the data from each data point together, taking into account standard deviation and random error better than a simple average.

Describe the motion of an object with positive velocity and negative acceleration. Describe the motion of an object with negative velocity and positive acceleration. Describe the motion of an object with negative velocity and negative acceleration.

An object with positive velocity and negative acceleration will slow down while traveling to the right. An object with negative velocity and positive acceleration will slow down while traveling to the left. An object with negative velocity and negative acceleration will speed up to the left.

Describe the motion depicted by the following motion diagram. Then, sketch a velocity versus time graph for this motion diagram and insert the image into Graph 5:



At the starting time, the object is moving to the right with a positive velocity, slowing down. At $t = 4$ seconds the object continues to move to the right at a constant velocity. At $t = 7$ seconds the object starts to speed up as it continues to move to the right.

Relate the velocity and position versus time graphs you made in Part 2 and Part 3 to one another.

The velocity versus time graph in Part 2 is a straight line with a positive slope, while the velocity versus time graph in Part 3 has zero slope. The position versus time graph in Part 2 is a parabola, while in Part 3 it is a straight line with a positive slope.

How does the distance traveled with constant incline (Part 2) affect the velocity? What about the acceleration?

The velocity increases as the distance increases. The acceleration remains mostly constant as the distance increases.

Data Table 1: Changing Inclination Angle
(SAMPLE ANSWER BELOW)

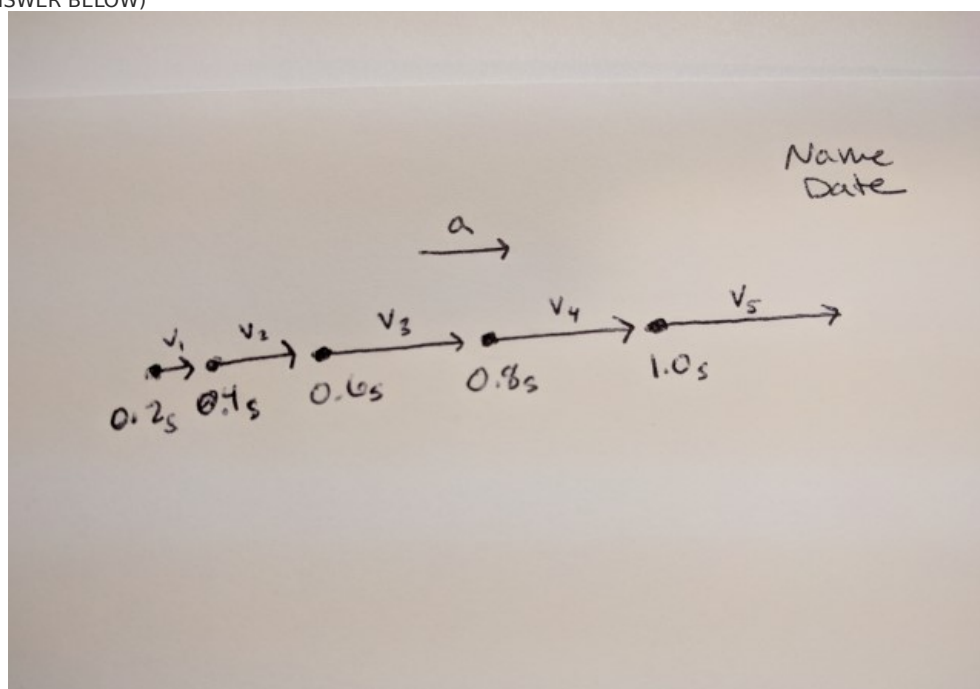
Board Length 0.355m	Angle 1	Angle 2	Angle 3
Angle of incline ($^{\circ}$)	3.0	6.0	7.5
Trial 1 time (s)	1.49	1.30	1.10

Trial 2 time (s)	1.47	1.33	1.05
Trial 3 time (s)	1.42	1.19	0.93
Trial 4 time (s)	1.39	1.29	1.03
Trial 5 time (s)	1.50	1.28	1.03
Average time (s)	1.45	1.28	1.03
Velocity (m/s)	0.49	0.56	0.69
Acceleration (m/s ²)	0.34	0.43	0.67

Data Table 2: Changing Distance on Incline
(SAMPLE ANSWER BELOW)

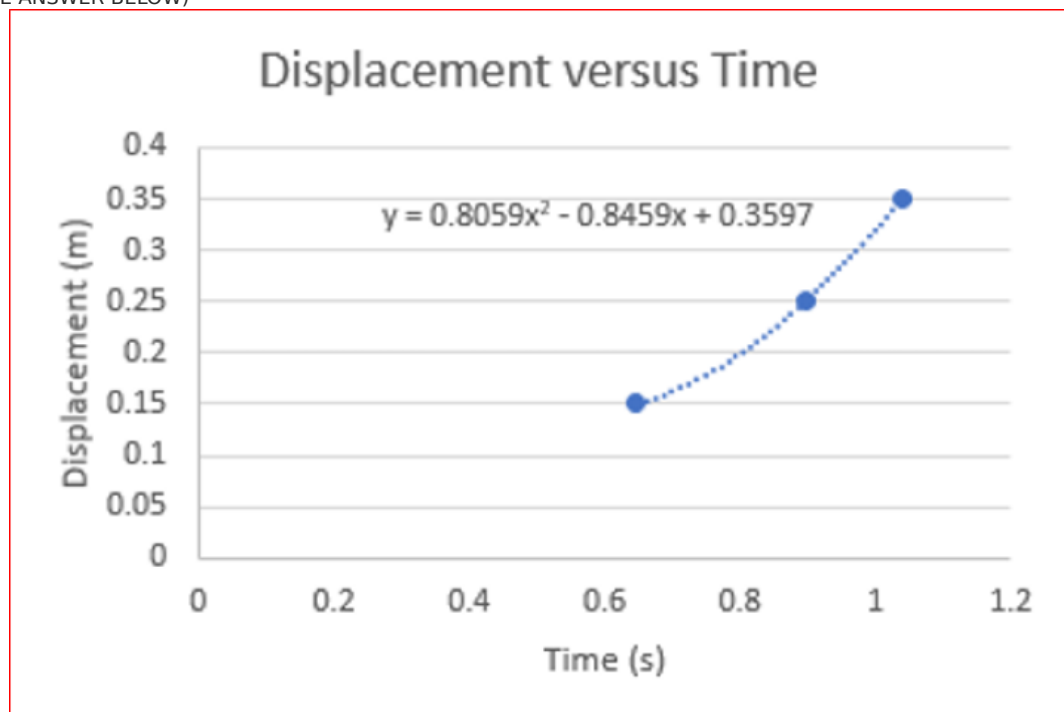
Angle of incline(°)	Distance 1	Distance 2	Distance 3
Distance (m)	0.15	0.25	0.35
Trial 1 time (s)	0.67	0.93	1.00
Trial 2 time (s)	0.66	0.87	1.01
Trial 3 time (s)	0.67	0.90	1.05
Trial 4 time (s)	0.57	0.89	1.07
Trial 5 time (s)	0.67	0.90	1.06
Average time (s)	0.65	0.90	1.04
Velocity (m/s)	0.46	0.56	0.67
Acceleration (m/s ²)	0.71	0.62	0.65
Trendline acceleration	0.52		

Photo 1: Motion Diagram
(SAMPLE ANSWER BELOW)

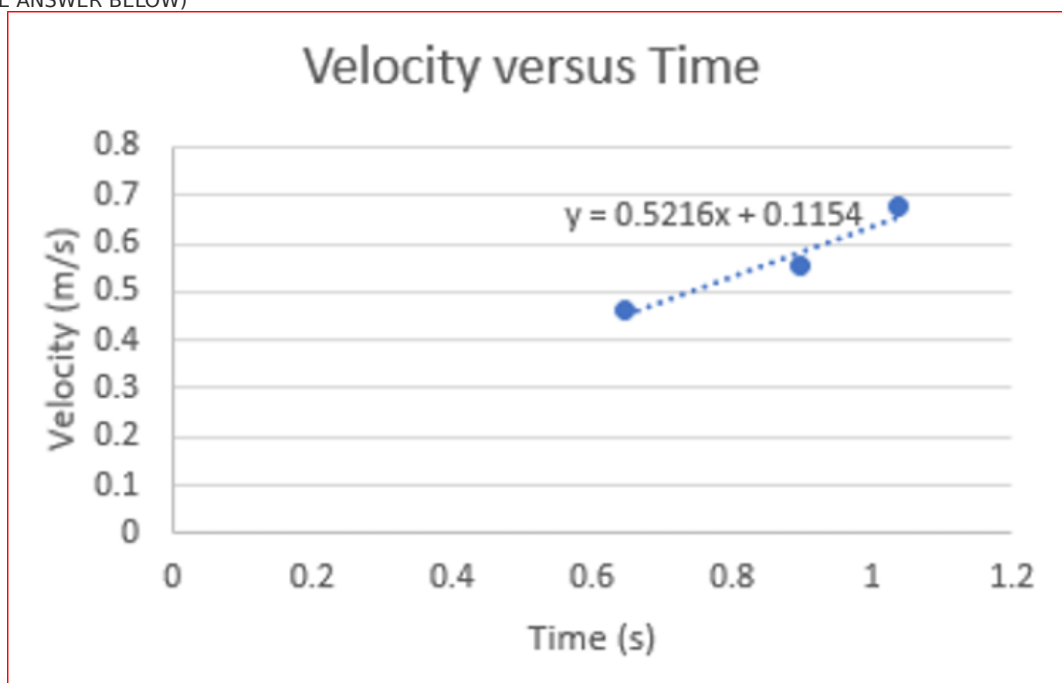




Graph 1: Distance vs. Time
(SAMPLE ANSWER BELOW)



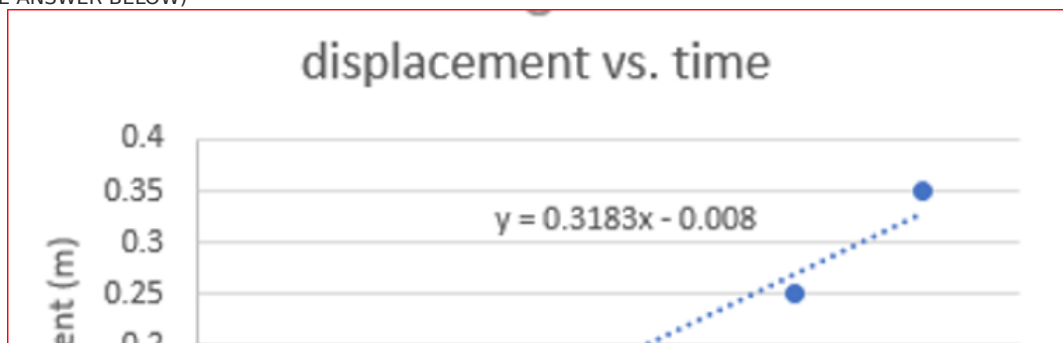
Graph 2: Velocity vs. Time
(SAMPLE ANSWER BELOW)

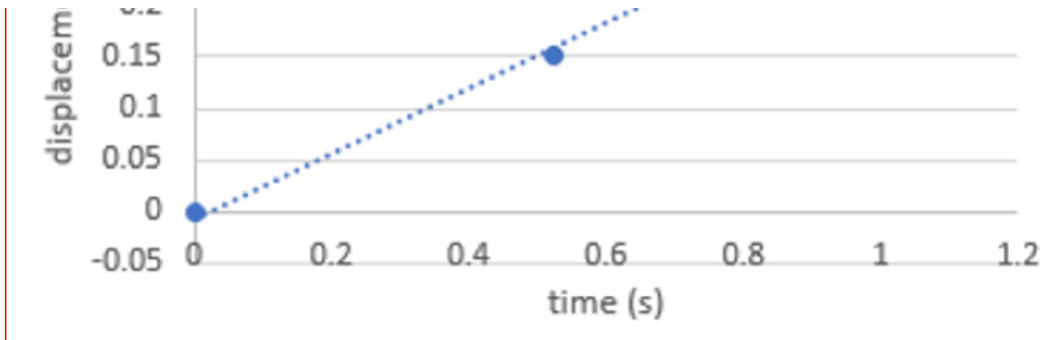


Data Table 3: Changing Distance on Flat Surface
(SAMPLE ANSWER BELOW)

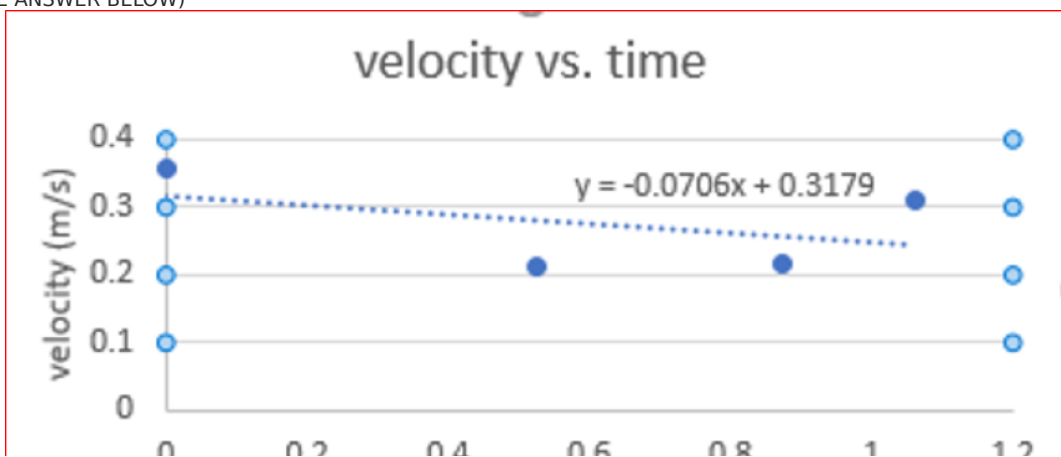
	Release Point	Distance 1	Distance 2	Distance 3
Distance (m)	0.090	0.15	0.25	0.35
Trial 1 time (s)	0.48	0.56	0.84	1.02
Trial 2 time (s)	0.53	0.52	0.85	1.08
Trial 3 time (s)	0.54	0.48	0.95	1.12
Trial 4 time (s)	0.44	0.51	0.91	1.05
Trial 5 time (s)	0.52	0.55	0.81	1.04
Average time (s)	0.50	0.52	0.87	1.06
Velocity (m/s)	0.36	0.21	0.22	0.31
Acceleration (m/s ²)		-0.28	-0.16	-0.05
Trendline velocity (m/s)		0.32		
Trendline acceleration (m/s ²)		-0.07		

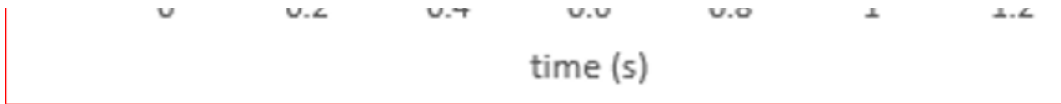
Graph 3: Displacement vs. Time
(SAMPLE ANSWER BELOW)



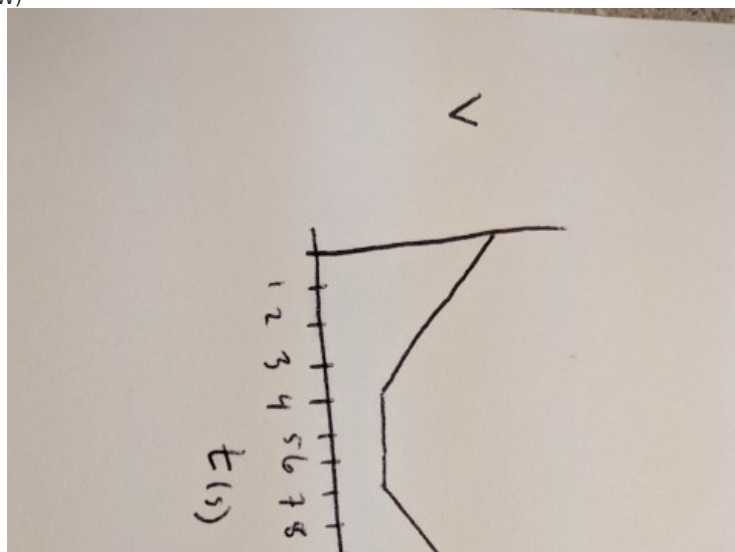


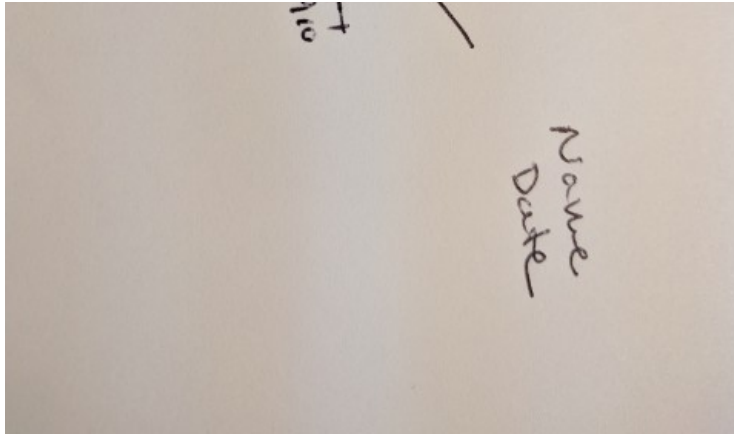
Graph 4: Velocity vs. Time
(SAMPLE ANSWER BELOW)





Graph 5: Question 6
(SAMPLE ANSWER BELOW)





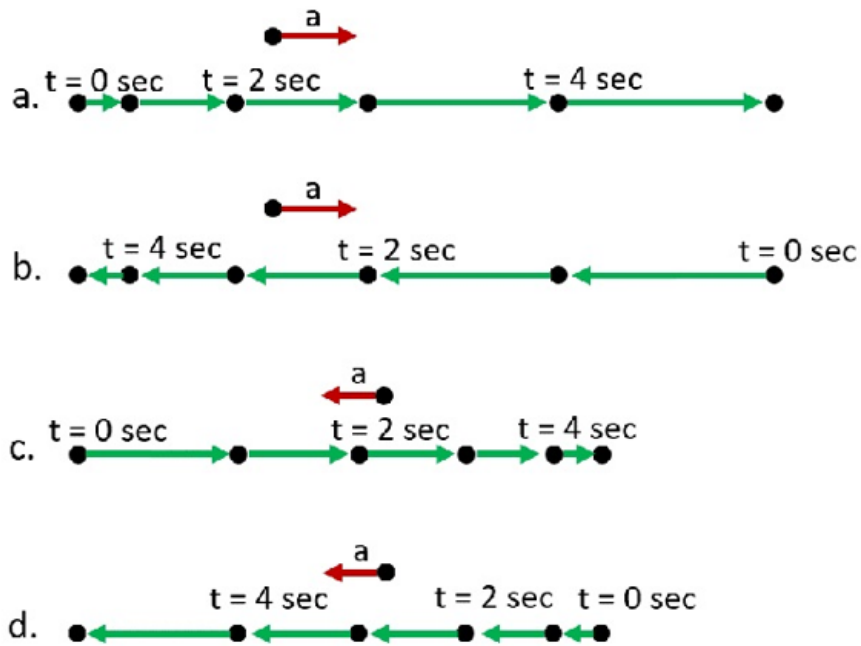
Competency Review

Velocity and displacement vectors must always point in the same direction.

- ☒ True
- ☐ False



Diagram ____ best matches the motion diagram of a car traveling to the right and slowing down to a stop at a stop sign.



- ☐ a
- ☐ b
- ☒ c
- ☐ d

✓

Acceleration is the time rate of change of the ____ of a moving object.

- ☐ position
- ☐ displacement
- ☒ velocity
- ☐ None of the above

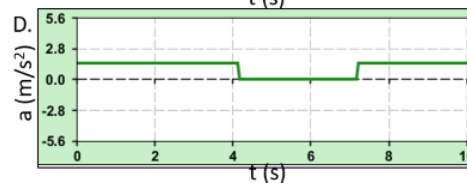
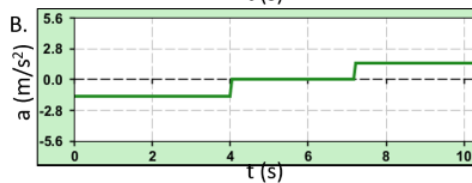
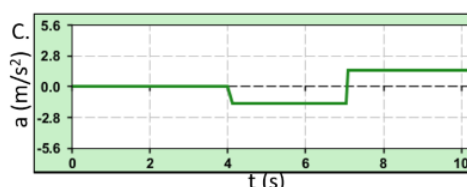
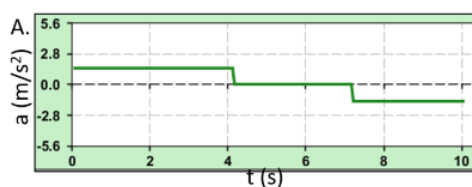
✓

An airplane with a takeoff speed requirement of 75 m/s and an average acceleration of 1.5 m/s^2 will require ____ seconds to become airborne.

- ☐ 75
- ☒ 50
- ☐ 35
- ☐ None of the above

✓

Graph ____ best represents the motion diagram below.



- ☐ A
- ☒ B
- ☐ C
- ☐ D

✓

As the angle of incline of a ramp increases towards 90° , the acceleration of a marble down the ramp ____.

- ☒ increases
- ☐ decreases
- ☐ remains constant
- ☐ All of the above

✓

As the distance a marble travels down a ramp at a constant incline increases, the acceleration of the marble ____.

- ☐ increases
- ☐ decreases
- ☒ remains constant ✓
- ☐ All of the above

The velocity versus time graph can be constructed by determining the slope of the acceleration versus time graph at each time.

- ☐ True
- ☒ False ✓

A marble rolled down an inclined ramp with an acceleration of 0.500 m/s^2 for 7.00 seconds will travel ____ meters from the point where it was released.

- ☒ 12.3 ✓
- ☐ 24.5
- ☐ 1.80
- ☐ None of the above

The ____ of a moving object is required when constructing a motion diagram.

- ☐ acceleration
- ☐ initial velocity
- ☐ initial position
- ☒ All of the above ✓

If an object starts at a positive position on the x-axis and undergoes a negative displacement, its final position must be negative.

☐ True

☒ False



Extension Questions

A basketball dropped from the roof of a three-story building falls to the ground. Ignoring air resistance, sketch the motion diagram for this motion, including approximate representations of the position versus time, velocity versus time, and acceleration versus time graphs for this motion. Include axes labels, appropriate numbers, and units for each graph. Upload an image of the sketches and explain your sketches in words in the panels below. (SAMPLE ANSWER BELOW)

The motion diagram starts with a very small velocity pointing downward, and for each successive time interval the velocity increases. The acceleration is constant in the downward direction. The position versus time graph shows a parabolic curve starting at a height of 10 m and decreasing slowly at first, then much faster toward 0 m after about 5 seconds. The velocity versus time graph shows a straight diagonal line starting at the origin and pointing down and to the right, indicating that the velocity is increasingly negative. The value of the velocity at each point along the graph is equal to the slope of the position versus time graph at that time. The acceleration versus time graph shows a straight horizontal line at the y-axis value of -9.8 m/s^2 , the acceleration due to gravity. The value of the acceleration is the same as the slope of the velocity versus time graph.

Create a motion diagram for the previous question. (SAMPLE ANSWER BELOW)

