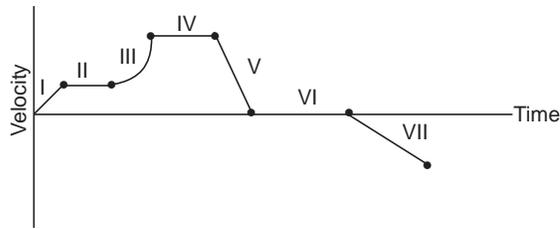
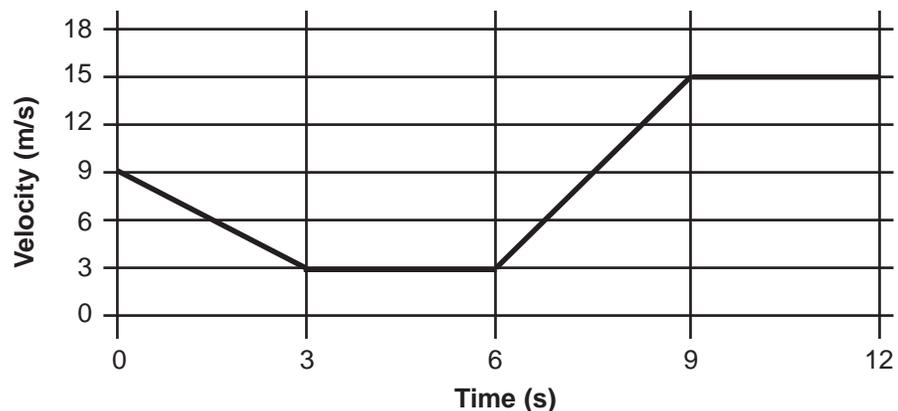


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Activity**Appendix 3.13: Kinematics Sampler: Graphs, Equations, and Problem Solving**

1. The graph above represents the velocity as a function of time for an object that is moving back and forth along a straight line.
 - a) For each interval:
 - i) indicate whether the velocity is positive, negative, or zero.
 - ii) indicate whether the velocity is steady, increasing at a steady rate, increasing at a rate that is not steady, decreasing at a steady rate, decreasing at a rate that is not steady.
 - iii) indicate whether the acceleration is positive, negative, or zero.
 - b) Over which interval would the object travel through the greatest distance? Assume that each segment of the graph lasts for the same amount of time. Explain your answer.



2. The graph above represents velocity as a function of time for an object moving back and forth along a straight line.
 - a) Plot a graph of acceleration versus time for this object.
 - b) Plot a graph of position versus time for this object.



3. A ball is thrown to the floor, bounces, and returns to the thrower's hand. Sketch graphs showing the position of the ball as a function of time, the velocity of the ball as a function of time, and the acceleration of the ball as a function of time. Assume that the ball is in contact with the ground for a negligible time interval and that the ball rises off the ground with the same speed it had when it first hit the floor. Assume upward to be the positive direction and the ground to be the zero point.
4. The table below shows the velocity of a car at various times. By looking at the table, but without substituting into any formulas, determine the acceleration of the car. Explain your answer in words.

Time (seconds)	Velocity (m/s)
0.0	2.5
1.0	3.2
2.0	3.9
3.0	4.6
4.0	5.3
5.0	6.0

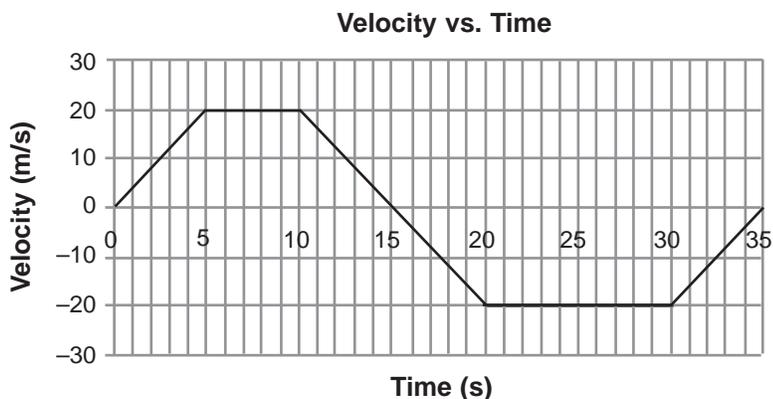
5. A car has an initial speed of 16.7 m/s and accelerates at 2.5 m/s² for another 8.1 seconds. What is the final speed of the car?
6. A car is initially moving at 28.4 m/s. In a panic stop, the car can decelerate (slow down) with an acceleration of -3.8 m/s². (The acceleration is negative because the car is slowing down.) What is the least amount of time it will take for this car to come to rest?
7. A car moving with a uniform (constant) acceleration takes 3.5 seconds to accelerate from 22 m/s to 34 m/s. Through what distance does the car move during this period of acceleration?
8. What acceleration must a car have if, starting from rest, it travels 30 metres in 3.5 seconds?
9. A rocket is blasting off with a constant upward acceleration of 18.7 m/s². Through what vertical height will the rocket rise as its speed changes from 3.6 m/s to 8.5 m/s?
10. A sprinter running at a speed of 12.5 m/s is approaching the finish line and, in a final burst of willpower, she forces herself to accelerate over the last 3.5 metres of the race. If this period of acceleration lasted for a time interval of 0.24 seconds, what was the sprinter's speed as she crossed the finish line?



11. A motorist is driving at a speed of 32 m/s on a stretch of highway where the speed limit is equivalent to 25 m/s. A truck coming in the opposite direction is flashing its headlights, which the speeding motorist interprets as a signal that a police cruiser is hiding just around a bend in the road 20 metres ahead of the motorist's current location. What must the car's acceleration be (assuming it is constant) if the car is to slow down to the speed limit just as it rounds the bend and passes the police cruiser?
12. A car initially moving at 17.1 m/s undergoes a 2.5-s period of constant acceleration during which it travels 63.5 metres. At what rate was the car accelerating?
13. A baseball pitcher throws a fastball at a speed of 47 m/s. When the catcher receives the ball, he pulls his hand back through a distance of 0.35 metres in the process of making the catch. What was the acceleration of the ball as it was being caught, assuming that the acceleration was constant?
14. A car is moving at 26.5 m/s when the driver sees a red light. If the driver takes 0.45 seconds to step on the brakes and the braking causes the car to accelerate at -8.5 m/s^2 , through what distance will the car travel as it comes to rest?
15. An elevator starts from rest at the ground floor of a building and rises to the top floor without stopping anywhere in-between. The elevator accelerates at 1.5 m/s^2 for 5 s, continues for an additional 15 s at the speed that it had after its initial period of acceleration, and then takes 1.8 s to come to rest with a uniform deceleration.
 - a) Through what vertical distance does the elevator rise during its initial period of acceleration?
 - b) What is the speed of the elevator after it stops accelerating?
 - c) Through what vertical height does the elevator rise during the period that it is moving at a constant speed?
 - d) Through what vertical height does the elevator rise during the time it takes to come to rest at the top of the building?
 - e) Through what total vertical height has the elevator risen?
16. The acceleration of an object due to gravity near the surface of the Moon is approximately 1.6 m/s^2 and there is no air friction on the Moon. An astronaut throws a rock vertically upward on the lunar surface. What is the acceleration of the rock when
 - a) it is still rising?
 - b) it is at its highest point?
 - c) it is falling back to the lunar surface again?



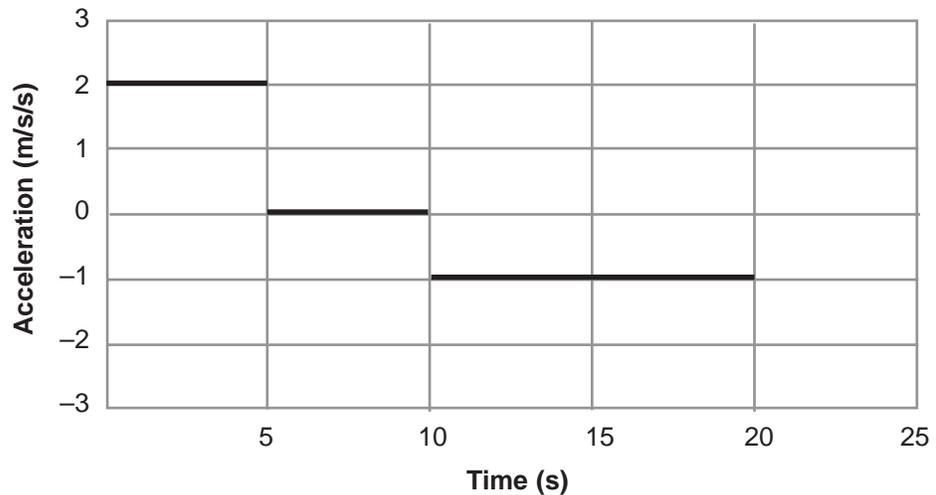
17. The graph below shows velocity versus time for a car that is initially moving northward along a straight north-south road. Answer the following questions based on this graph.



- At what time, after it starts out, does the car first reach its maximum speed in the northward direction?
- At what time, after it starts out, does the car first begin to slow down?
- At what time, after it starts out, does the car reach its maximum distance north of its starting point?
- At what time does the car first start heading back south again?
- Does the car ever come to rest after it has begun to head south again? If so, at what time?
- Is there any time interval during the 35 s shown on this graph during which the car begins to head back north again after it first began heading south? If so, what is the interval?
- At the 35-s mark, is the car at its starting point, north of its starting point, or south of its starting point? Explain how you reached your conclusion. (You should be able to arrive at the answer just by looking at the pattern of the graph and without doing a detailed numerical calculation.)
- What is the maximum distance the car goes north of its starting point?
- At what time, after it starts out, does the car first return to its starting point?
- Draw a graph of the car's displacement versus time.
- Draw a graph of the car's acceleration versus time.



18. The figure below is a graph of acceleration versus time for an object that is moving along a straight east-west path. At time $t = 0$ s the velocity of the object is also zero, and we are assuming east to be the positive direction.



- Use a piece of graph paper with carefully numbered and labelled axes to draw a graph of velocity versus time for this object.
- Find the displacement of the object (with respect to its starting point) at 20 s. Be sure that you give a direction as well as a magnitude. Use the area under a velocity-time graph method rather than the kinematic formulas.
- Now assume that, rather than starting from rest, the initial velocity of the object was 4 m/s. Redraw the velocity-versus-time graph under this new assumption.
- Based on the new graph, calculate how many additional metres are added to the magnitude of the displacement at 20 s because of this change in the initial velocity. Notice that you should be able to calculate the change in the displacement without first calculating the new displacement. Explain how you can do this.

