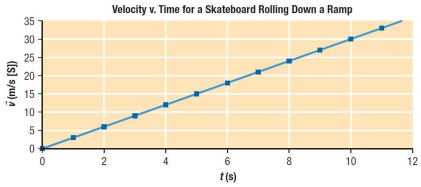
SPH3U UNIVERSITY PHYSICS

KINEMATICS

- Velocity-Time Graphs (P.22-26)

Velocity-Time Graphs

*A **velocity-time graph** is a graph that describes the velocity of an object over time (velocity on the y-axis and time on the x-axis). The following diagram shows a velocity-time graph for a skateboard rolling down a ramp. Notice that the line of the graph goes upward to the right and has x-intercept and y-intercept of zero.*

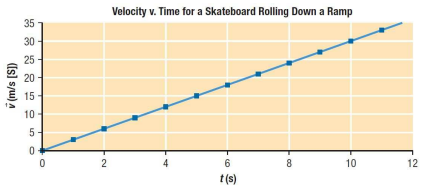


Velocity-Time Graphs

We can calculate the slope of the graph using the equation:

$$slope = \frac{rise}{run}$$

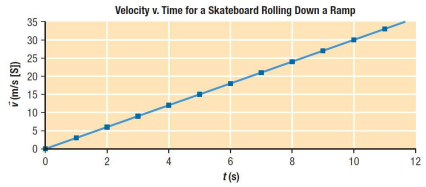
$$m = \frac{\Delta \vec{v}\ (m/s)}{\Delta t\ (s)}$$



Velocity-Time Graphs

And since acceleration describes the change in velocity over time, this means:

The slope of a velocity-time graph gives the acceleration of the object.

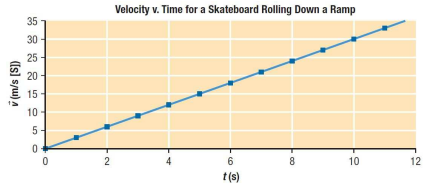


Velocity-Time Graphs

PRACTICE

1. What is the acceleration of the skateboard?

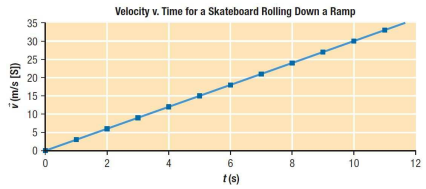
a = slope = 3.0 m/s^2[S] (slope = rise/run = 30 m/s[S]/10 s)



Velocity-Time Graphs

By further analyzing the velocity-time graph shown, we can determine even more information about the motion of the skateboard:

The area under a velocity-time graph gives the displacement of the object.

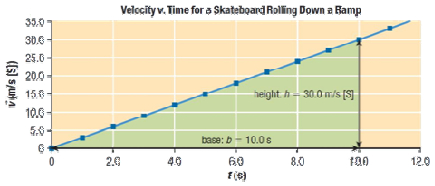


Velocity-Time Graphs

PRACTICE

2. What is the displacement of the skateboard between 0 and 10.0 s?

d = area = 150 m[S] (area = ½bh = ½(10.0 s)(30.0 m/s[S]))

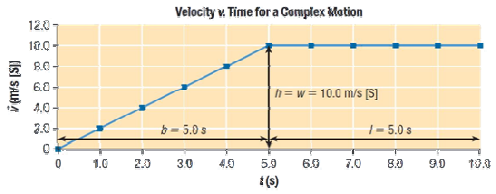


Velocity-Time Graphs

PRACTICE

3. What displacement is represented by the graph over the time interval:
   (a) 0.0 s to 5.0 s?

(a) d = area = 25 m[S] (area = ½bh)

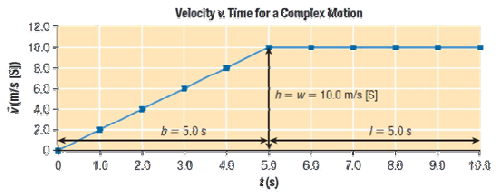


Velocity-Time Graphs

PRACTICE

3. What displacement is represented by the graph over the time interval:
   (b) 5.0 s to 10.0 s?

(b) d = area = 50 m[S] (area = lw)

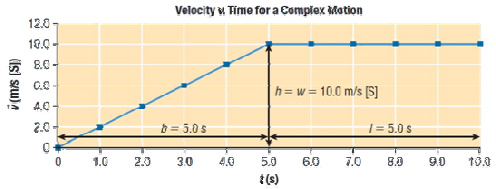


Velocity-Time Graphs

PRACTICE

3. What displacement is represented by the graph over the time interval:
   (c) 0.0 s to 10.0 s?

(c) d = area = 75 m[S] (area = (a) + (b))



Velocity-Time Graphs

VELOCITY-TIME GRAPH

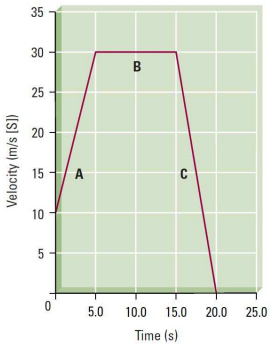
- graph that describes the velocity (y-axis) of an object wrt time (x-axis)
- slope = acceleration of object
- the steeper the slope, the greater its acceleration
- area under graph = displacement of object

Complex Velocity-Time Graphs

Sometimes the motion of an object is complex and so the velocity-time graph for the object is not a single straight line but several.

PRACTICE

4. Describe the motion of the object in segments A, B, and C of the graph shown.

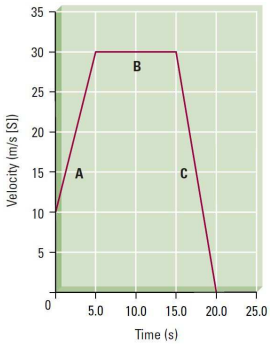


Complex Velocity-Time Graphs

A - accelerates from a velocity of 10 m/s[S] to a velocity of 30 m/s[S] in a time of 5.0 s

B - maintains a steady velocity of 30 m/s[S] for 10 s

C - decelerates from a velocity of 30 m/s[S] to a velocity of 0 in a time of 5.0 s

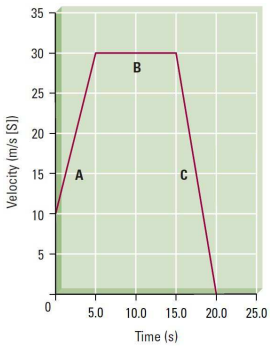


Complex Velocity-Time Graphs

PRACTICE

5. For each segment determine the average acceleration.

   A 4.0 m/s^2[S]
   B 0 m/s^2
   C -6.0 m/s^2 [S] or 6.0 m/s^2 [N]

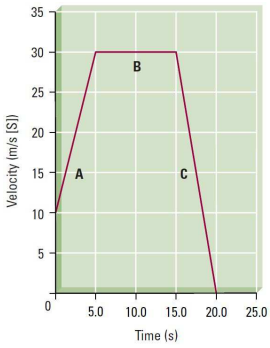


Complex Velocity-Time Graphs

PRACTICE

6. For each segment determine the displacement. Assuming the object starts from home, what is the object's final position?

   A 100 m[S]
   B 300 m[S]
   C 75 m[S]
   d_{final} = 475 m[S] of home



✔ Check Your Learning

TEXTBOOK

P.30 Q.6

WIKI (KINEMATICS)

- 3U1 - WS#2 (d-t Graphs)
- 3U1 - WS#3 (v-t Graphs)