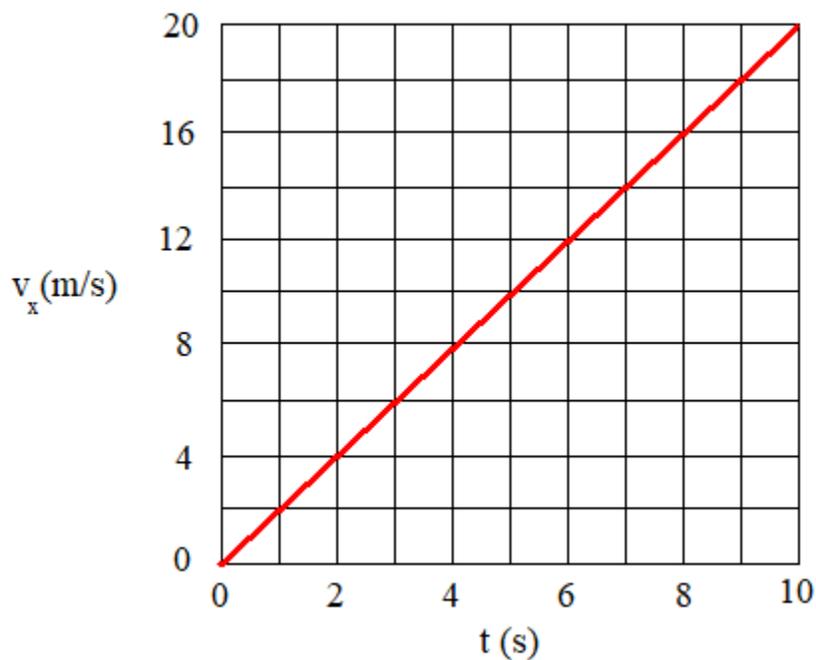


AP Physics 1 – Summer Tutorial 4

Velocity and time graphs



The graph above shows something new, a velocity that changes with time. See if you can answer the following questions. The answers will be on the next page.

1. What is the velocity at 6s?
2. At what time is the velocity 14m/s?
3. What is the change in velocity between 3s and 5s?
4. What is the speed at 9s?
5. Is the motion to the left or right?
6. Is the motion speeding up, slowing down, or remaining at a constant speed?
7. What is the slope of the graph, including units, and what does the slope represent?

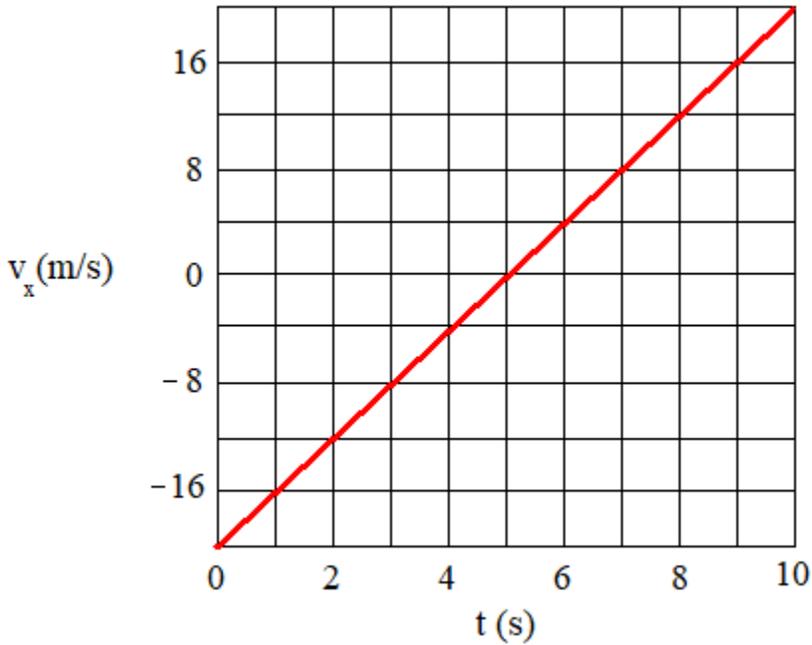
1. The velocity is 12m/s; you can read this right off the y-axis.
2. The time is 7s; you can read this off the x-axis.
3. At 3s, the velocity is 6m/s and at 5s, the velocity is 10m/s, so the change in velocity is 4m/s.
4. The velocity at 9s is 18m/s and the absolute value (or magnitude) of 18m/s is also 18m/s.
5. The velocity is positive throughout the graph which indicates rightward motion.
6. The motion is speeding-up because the speed is gradually increasing from 0m/s to 2m/s to 4m/s, etc.
7. The slope of the line is $\frac{20m/s}{10s} = 2 \frac{m/s}{s}$. This slope represents the rate at which the velocity changes:

For every second of time that passes, velocity changes by 2m/s.

This ratio of $\frac{\text{change in velocity}}{\text{change in time}}$ is defined to be the *acceleration*.

The units of $\frac{m/s}{s}$ are commonly written as $\frac{m}{s^2}$, but avoid thinking of that as “change in meters per change in seconds-squared”. It’s just a convenient way to collapse $\frac{m/s}{s}$, which is “change in meters per second of velocity per change in seconds of time.”

Try similar questions on the next page, thinking carefully about what is happening along the y-axis.



1. What is the velocity at 4s?
2. At what time is the velocity 12m/s?
3. What is the change in velocity between 2s and 8s?
4. What is the speed at 1s?
5. From 0s to 5s, is the motion to the left or right?
6. From 0s to 5s, is the motion speeding up, slowing down, or remaining at a constant speed?
7. From 5s to 10s, is the motion to the left or right?
8. From 5s to 10s, is the motion speeding-up, slowing-down, or remaining at a constant speed?
9. What is the acceleration, including units?

Answers are provided on the next page.

1. The velocity is -4m/s , which can be read off the y-axis.
2. The time is 8s , which can be read off the x-axis.
3. The velocity at 2s is -12m/s and the velocity at 8s is $+12\text{m/s}$, so the change in velocity is 24m/s .
4. The velocity at 1s is -16m/s , so the speed is 16m/s .
5. From 0s to 5s , the velocity is always negative, so the motion is to the left.
6. From 0s to 5s , the speed transitions from 20m/s to 0m/s , so the motion is slowing-down.
7. From 5s to 10s , the velocity is positive, so the motion is to the right.
8. From 5s to 10s , the speed transitions from 0m/s to 20m/s , so the motion is speeding-up.
9. The acceleration is the slope of the graph which is $4 \frac{\text{m/s}}{\text{s}}$ or $4 \frac{\text{m}}{\text{s}^2}$.

It's probably not intuitive that a single, straight line can represent an object moving left and slowing-down, pausing for an instant (at 5s), then moving right and speeding-up, but that is what the graph represents.

Also, if you would like a challenge, you could try to guess what the position versus time graph would look like if translated from the velocity versus time graph on the previous page.