

In this quiz, you will be required to analyze **stepwise motion** using the kinematic equations.

In stepwise motion, the acceleration is not constant for the entire interval, but it is constant within each step of the motion.

--For each interval in which an object is speeding up or slowing down, you need to use one of the kinematic equations.

$v_f = v_i + a \cdot \Delta t$	$\Delta x = \left(\frac{v_i + v_f}{2} \right) \Delta t$
$\Delta x = v_i \cdot \Delta t + \frac{1}{2} a (\Delta t)^2$	$v_f^2 = v_i^2 + 2a \cdot \Delta x$

--However, there are also many intervals in these problems in which an object is moving at a *constant velocity*. For these problems, use the much simpler formula:

$$\Delta x = vt$$

-- There may also be steps in which an object is not moving at all. In these portions, of course, $\Delta x = 0$.

These problems take a long time! I included several here for practice, but don't feel you need to do them all. Work until you feel confident you can figure out the problems relatively quickly and accurately. Then you are ready for the quiz!

Note that the four kinematic equations will NOT be written on the quiz! You must memorize the four kinematic equations in order to pass the quiz.

1. The Red Light

You are driving towards a green light at a speed of 25 m/s. But after 3 seconds, the light ahead of you turns red, and you begin slowing to a stop. You stop at the light after 4 seconds. You wait for 10 seconds. Then, the light turns green, and you begin accelerating at a rate of 4 m/s^2 , until you reach 25 m/s again. You then travel another 3 seconds.

For this entire trip, what is your *average speed*?

Hints for Solving this problem:

Average Speed = Total Distance / Total Time

- You need to first find the total distance the total time to find the final answer
- Break the motion into several Steps. For each step, find the distance traveled in that step and the time of that step:

<p>Step 1: You are driving towards a green light at a speed of 25 m/s. But after 3 seconds, the light ahead of you turns red, and you begin slowing to a stop. You stop at the light after 4 seconds.</p>	<p>Step 2: You wait for 10 seconds.</p>
<p>Step 3: Then, the light turns green, and you begin accelerating at a rate of 4 m/s^2, until you reach 25 m/s again.</p>	<p>Step 4: You then travel another 3 seconds. [at a constant speed]</p>

2. [3 steps] A super hero is flying briskly down the street at a constant speed of 4 m/s. She travels a distance of 100 meters. Suddenly, she sees an ice cream truck and start accelerating forward at a rate of 2 m/s^2 for 10 seconds. But a super villain comes up behind her and she must stop suddenly, decelerating at a rate of -8 m/s^2 until she is stopped.

Determine the super hero's average speed.

3. [2 steps] The great hero is fighting a demon. The demon unfortunately wins the fight and pushes him off a cliff that is 100 meters tall. (Neglect air resistance.) Fortunately, when the hero is 20 meters above the ground, a wizard appears and decides to save his life, by causing him to decelerate so that he strikes the ground with a speed of precisely 2 m/s.

Determine the great hero's average speed during his fall.

4. The Bike Race [quite hard, tougher than questions that will be on the quiz!]

Jonny and Joey are in a bicycle race.

Joey is biking consistently forward at a rate of 15 m/s. Jonny is moving at the same speed as Joey but is behind by 60 meters. This persists for 30 seconds.

Then, Jonny decides to catch up. He accelerates at a constant rate for a time of 10 seconds, after which he is moving 5 m/s faster than Joey.

Then, he bikes at this speed until he is 20 m ahead of Joey.

Over the course of the next 40 m, Jonny decelerates to 15 m/s, his original speed.

Fortunately, Joey is completely exhausted and unable to catch up! Jonny easily wins moving at a constant velocity for the final 200 m of the race.

For the entire time described in the passage, what is Jonny's *average speed*?

Answer:

#1 The Red Light

10.6 m/s