Module 3: Motion in Two Dimensions

Topic 2 Content: Horizontal Projectiles Practice Solution Explanations

Click next to begin your practice of horizontal projectile problems.

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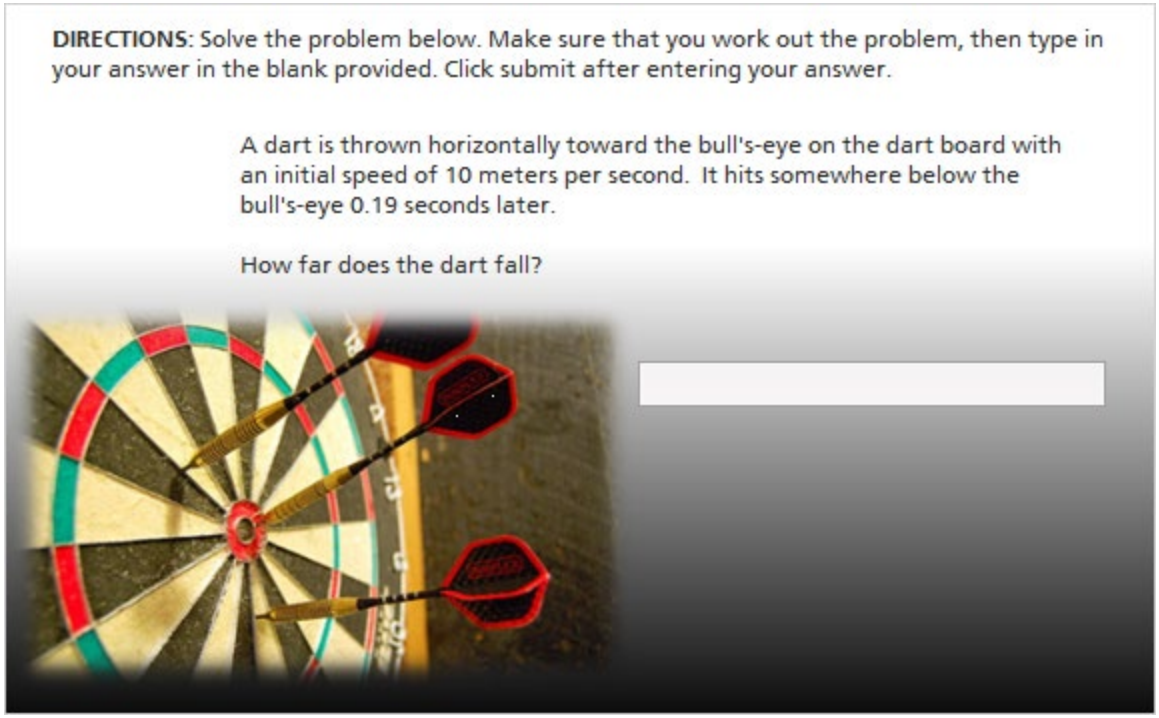
Question 1



A dart is thrown horizontally toward the bull's-eye on the dart board with an initial speed of 10 meters per second. It hits somewhere below the bull's-eye 0.19 seconds later. How far does the dart fall?

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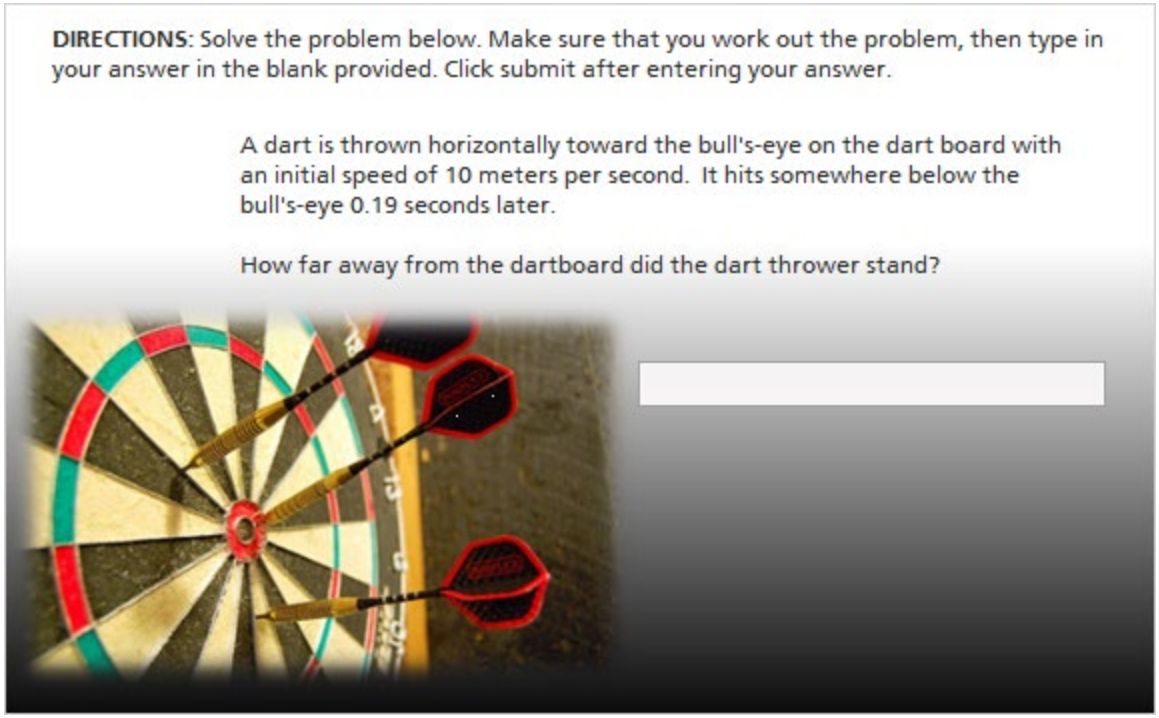
Question 2



A dart is thrown horizontally toward the bull's-eye on the dart board with an initial speed of 10 meters per second. It hits somewhere below the bull's-eye 0.19 seconds later. How far away from the dartboard did the dart thrower stand?

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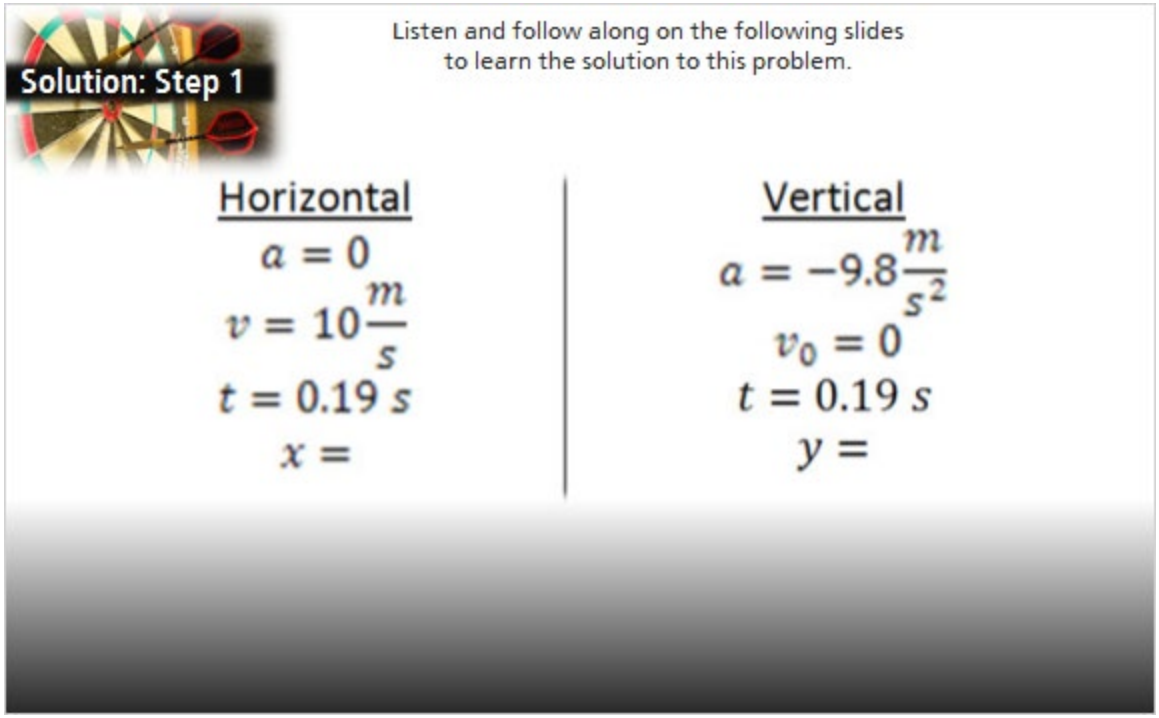

Since this is a horizontal projectile problem, we need to separate the horizontal and vertical analyses of motion. In the horizontal direction, we know, as always, that the acceleration is zero. The velocity is given as ten meters per second, and the time of flight is given as zero point one nine seconds. We do not yet know the horizontal displacement. Vertically, we know that the acceleration is nine point eight meters per second squared in a negative direction. We know the initial velocity is zero, since the dart is thrown horizontally. We know the time of flight is zero point one nine seconds. We do not yet know the vertical displacement.

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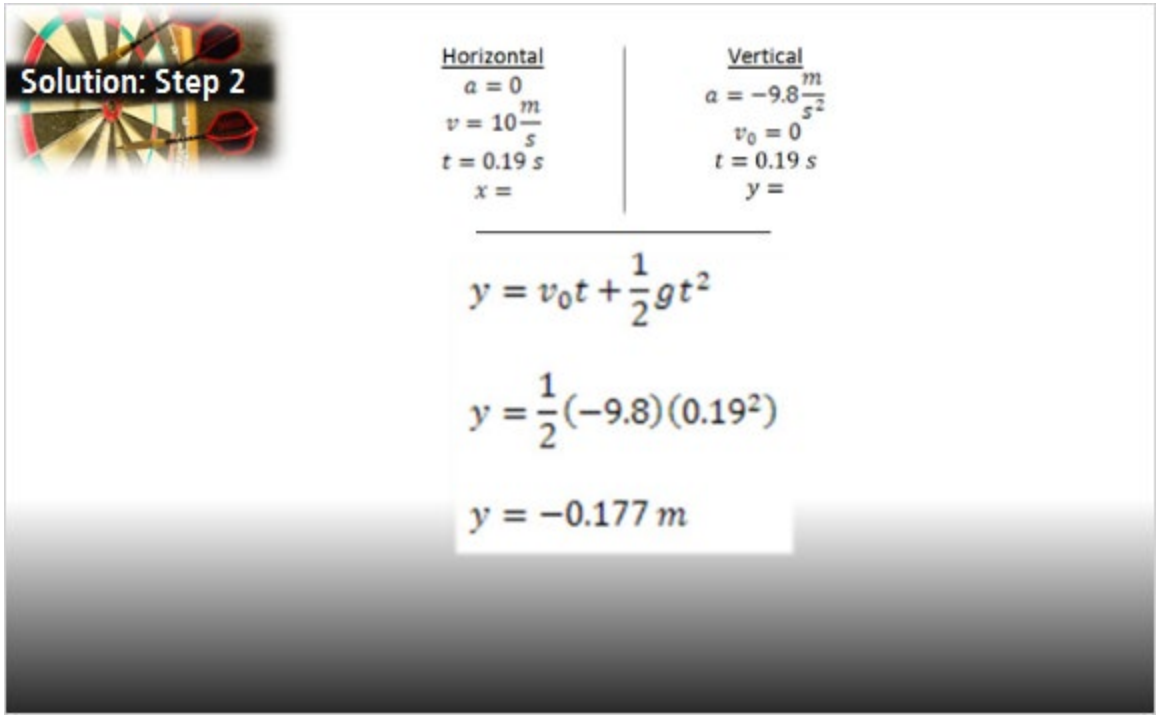

To answer the question of how far the dart falls, we look to the vertical analysis and see how to solve for displacement. We can use the kinematics equation y equals v zero t plus one half g t squared. Substituting and solving we see that the vertical displacement is negative zero point one seven seven meters.

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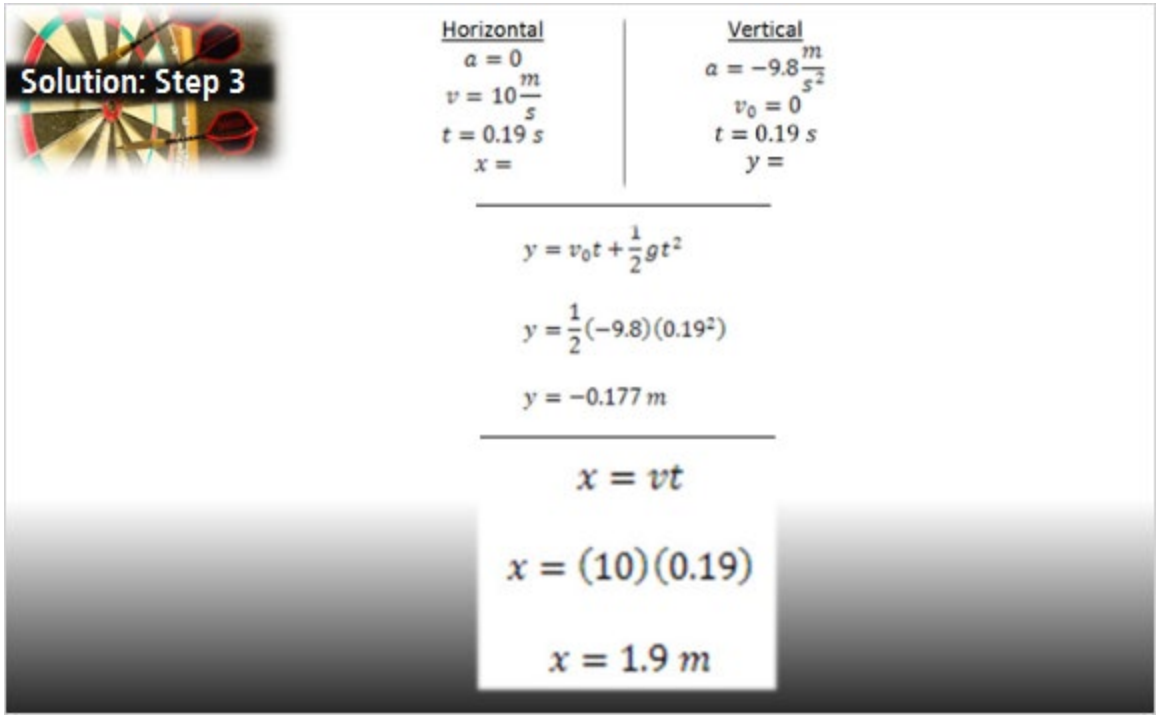

To determine how far from the dartboard the dart thrower stood, we look to the horizontal direction. We can use the constant-velocity equation x equals v t. Substituting and solving, we see that the horizontal distance equals one point nine meters.

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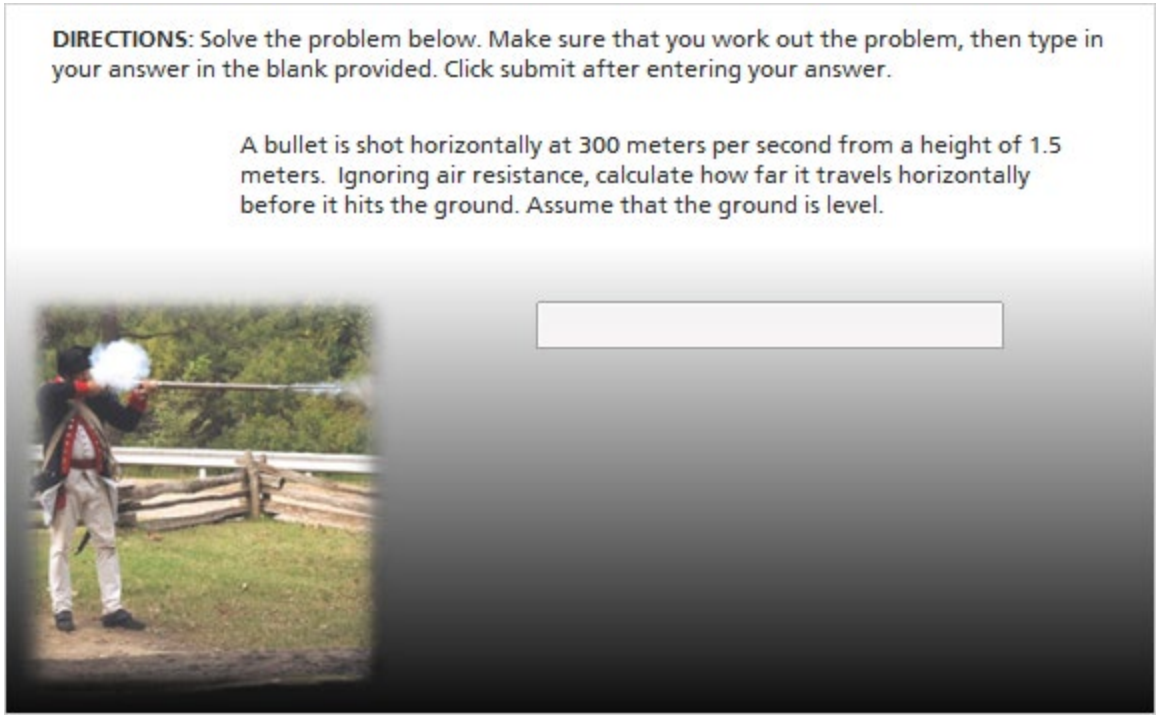
Question 3



A bullet is shot horizontally at 300 meters per second from a height of 1.5 meters. Ignoring air resistance, calculate how far it travels horizontally before it hits the ground. Assume that the ground is level.

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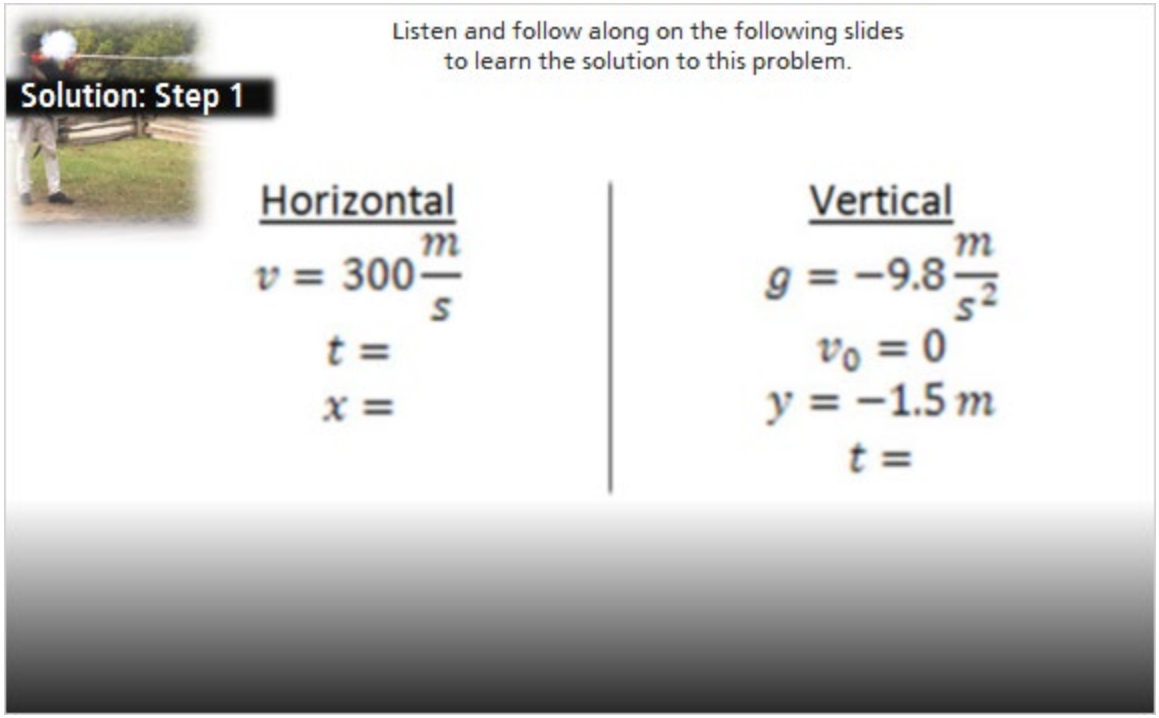
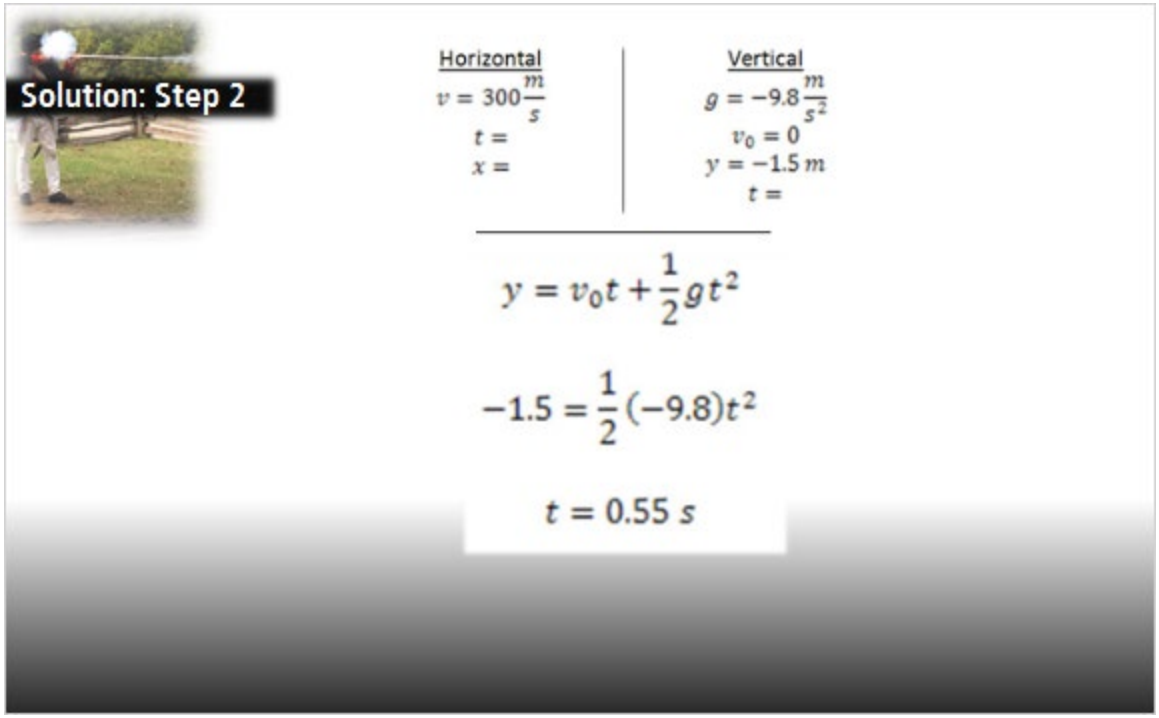
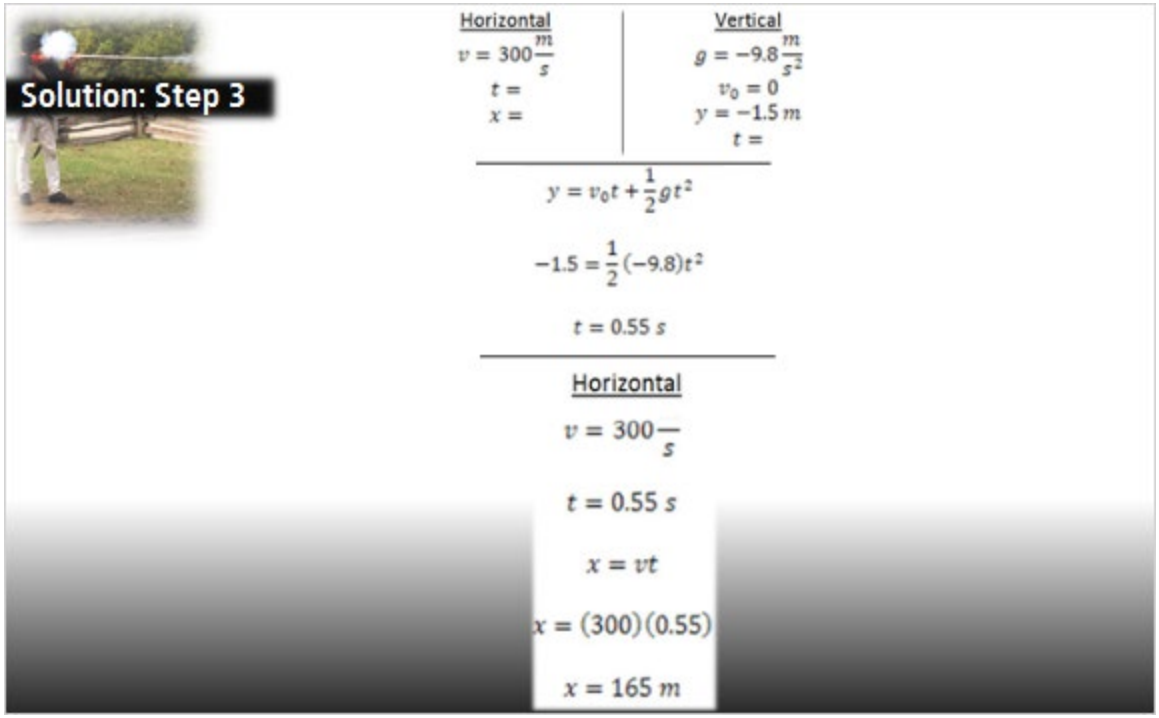


With projectile motion problems, we need to analyze horizontal and vertical motion separately. Horizontally, we know the initial velocity is three hundred meters per second. We do not know the time of flight or the horizontal range. Vertically, we know the acceleration is nine point eight meters per second squared in a negative direction, the the initial velocity is zero meters per second, and the vertical displacement will be negative one point five meters. We do not know the time of flight.



In order to determine the horizontal displacement, we need to know the time of flight, but there is not enough information to determine this solely from a horizontal analysis. So we must see if we can determine the time of flight in the vertical analysis. Knowing acceleration, initial velocity and displacement, we can find the time using the equation y equals v zero t plus one half g t squared. Substituting and solving, we see that the time of flight is zero point five five seconds.



We can move this value to the horizontal analysis and now can use the equation x equals v to to determine the horizontal range. Substituting and solving, we see that the horizontal range is one hundred sixty five meters.

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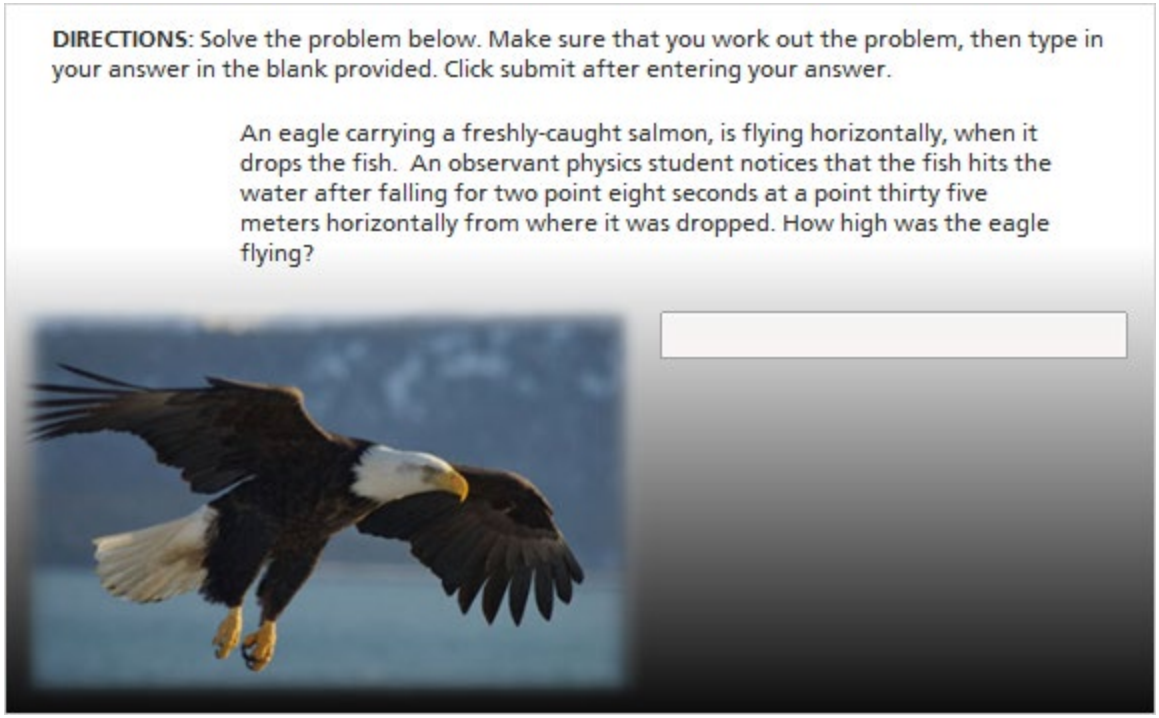
Question 4



An eagle carrying a freshly-caught salmon, is flying horizontally, when it drops the fish. An observant physics student notices that the fish hits the water after falling for two point eight seconds at a point thirty five meters horizontally from where it was dropped. How high was the eagle flying?

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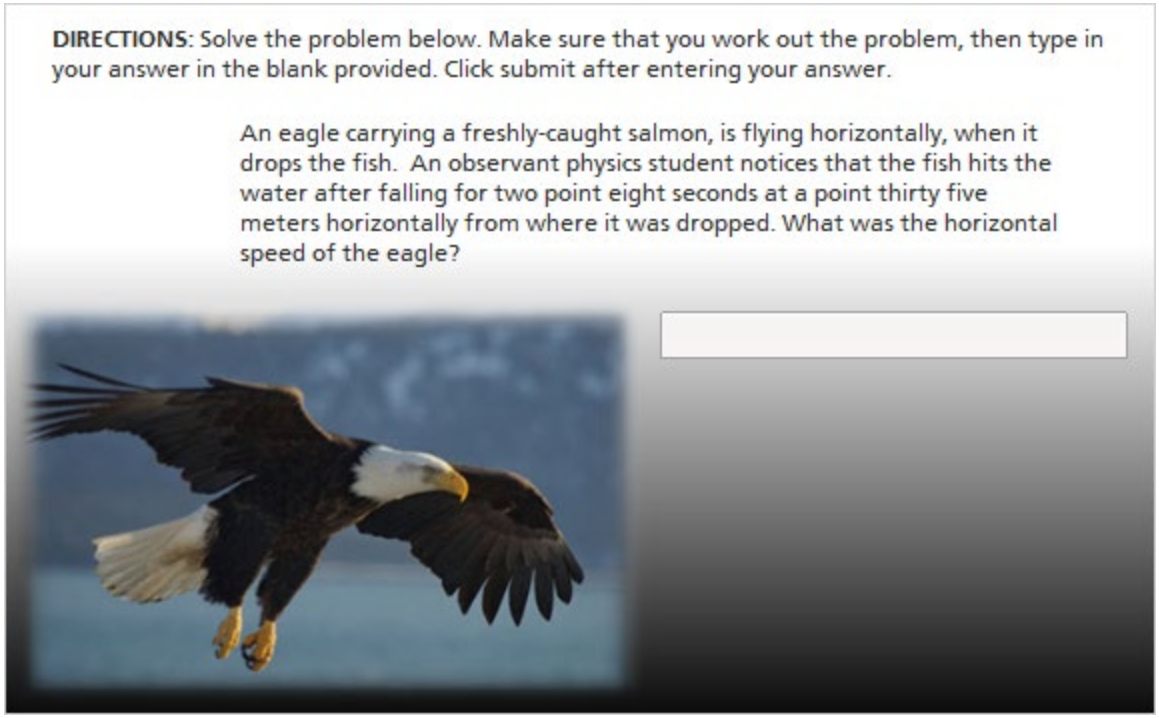
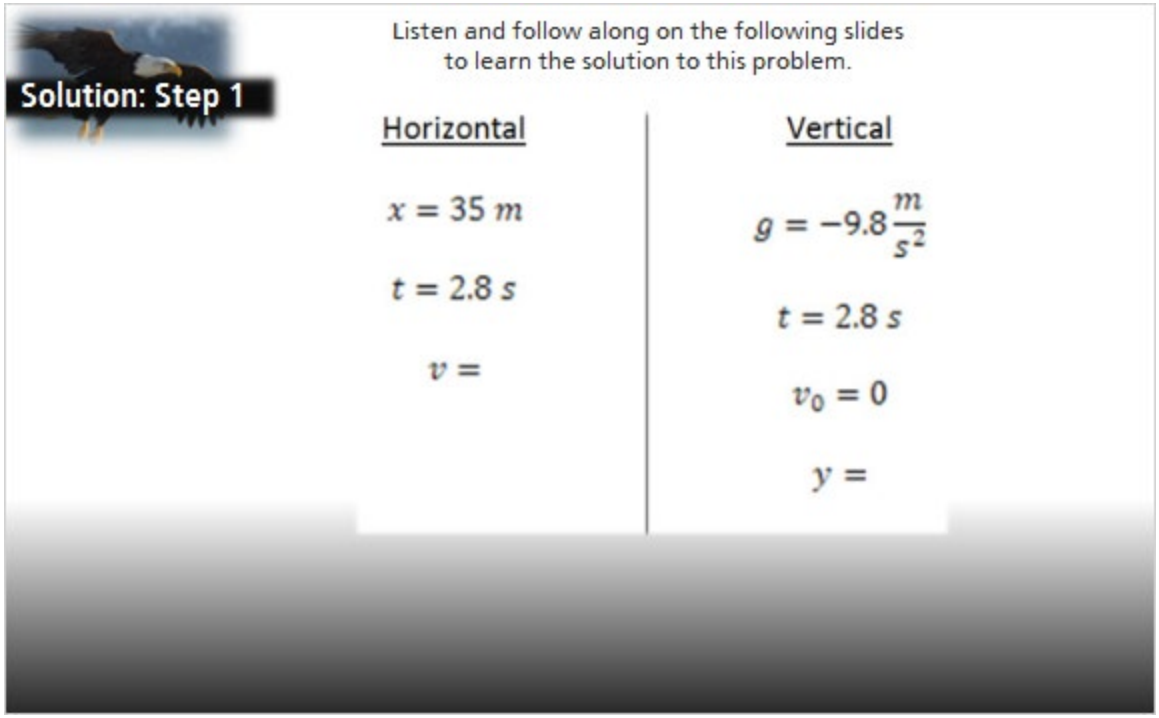
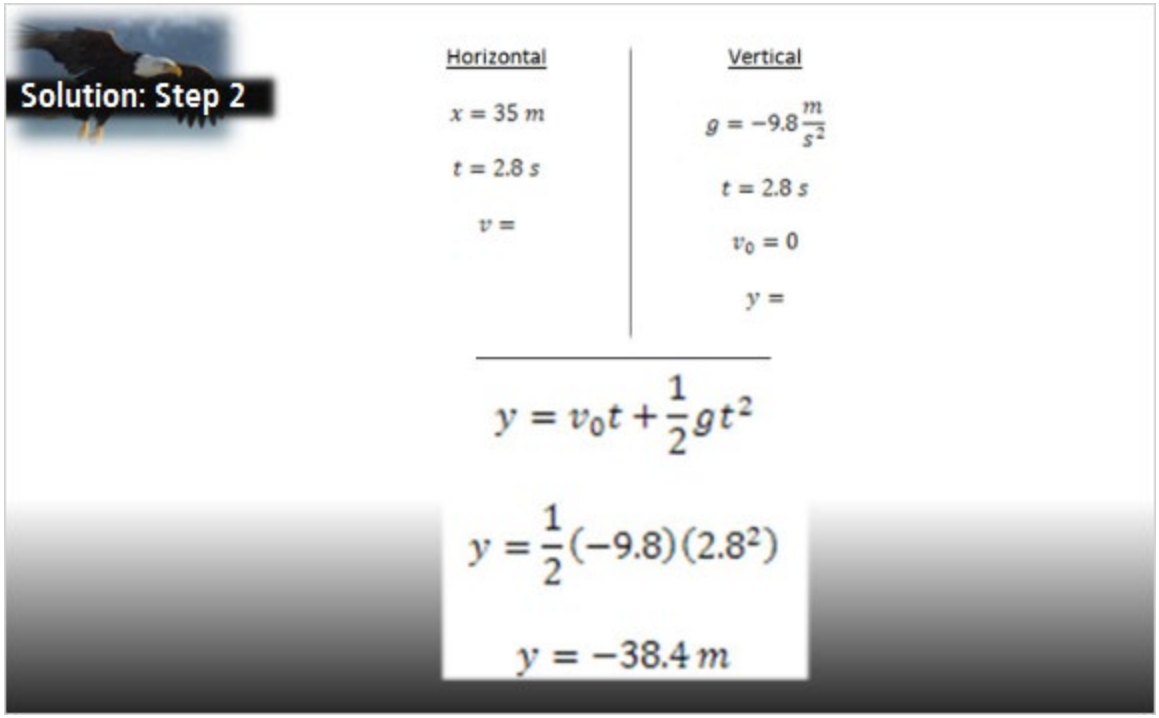
Question 5



An eagle carrying a freshly-caught salmon, is flying horizontally, when it drops the fish. An observant physics student notices that the fish hits the water after falling for two point eight seconds at a point thirty five meters horizontally from where it was dropped. What was the horizontal speed of the eagle?



Again, we must set up our horizontal and vertical analyses. Horizontally, we know that the displacement is thirty five meters, and we know the time of flight is two point eight seconds. We do not yet know the horizontal velocity. Vertically, we know the acceleration is nine point eight meters per second squared in a negative direction, and the time of flight is two point eight seconds. We also know the initial velocity is zero. We do not yet know the vertical displacement.



To determine how high the eagle was flying, we need to look at the vertical analysis and determine the vertical displacement. We can use the equation y equals v zero t plus one half g t squared. Substituting and solving we see that the fish falls down thirty eight point four meters. So the eagle was flying at a height of thirty eight point four meters.

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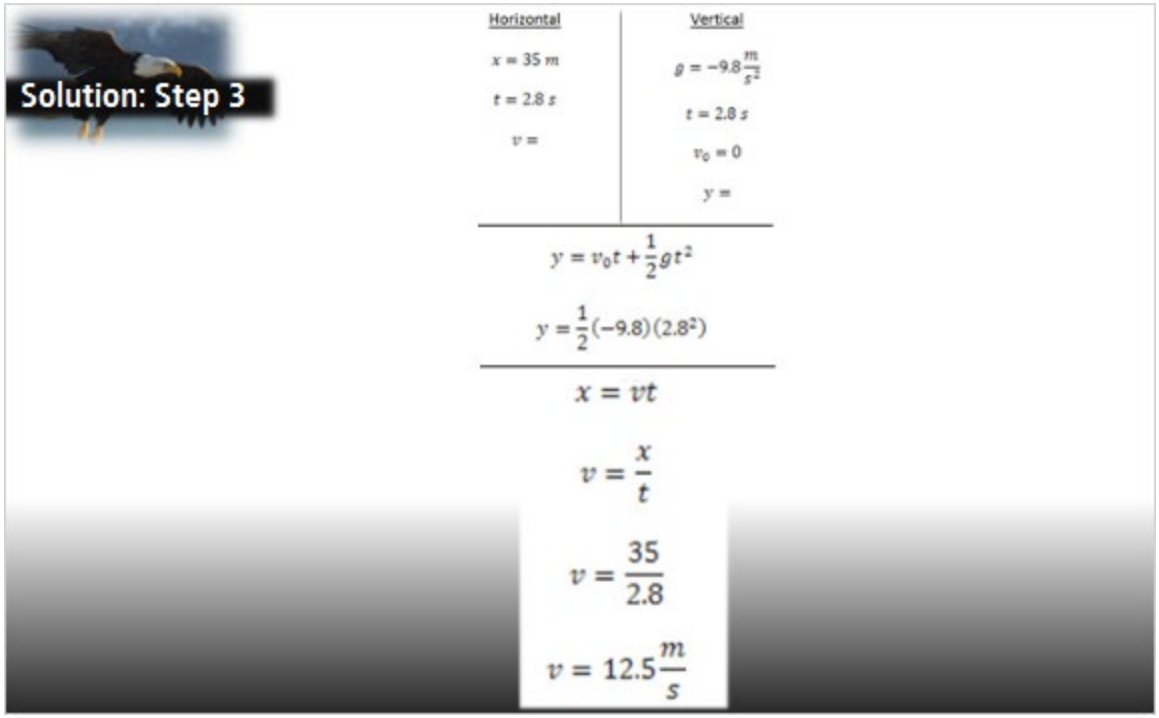

To determine the initial horizontal velocity of the eagle, we need to look at the horizontal analysis. We can solve the equation x equals v times t for v and see that v equals x over t. Substituting and solving we find that the eagle was traveling at a horizontal speed of twelve point five meters per second.