Scene #	Description	Narration
1	A problem is showing on screen. The narrator reads the problem out loud.	Now let's look at a problem that requires us to combine our understanding of forces with our understanding of kinematics. A shopper in a supermarket pushes a 50 kilogram loaded cart with a horizontal force of 17.5 newtons. The floor provides a frictional force of 2.4 newtons. What is the acceleration of the shopping cart? If the cart starts from rest, how long does it take the cart to reach a speed of 3.4 meters per second? And how far does the cart roll as it accelerates from rest to 3.4 meters per second?
2	Below the problem the narrator begins to draw a free-body diagram. As he draws it he describes what he is drawing and why.	All right. Let's begin by drawing a free-body diagram of what's happening to this cart. We'll draw our cart as a dot. There's a 17.5 newton force, the force of the push. There is a much smaller 2.4 newton force. That's the force of friction. It acts in the opposite direction of motion. And those are the only two forces that we're really concerned with on this cart.
3	Next to the free-body diagram in red the narrator writes down and says the variables to be used to solve this problem.	So let's go ahead and write down the values that we know. We know that the mass of the cart m is equal to 50.0 kilograms. We know that the force of the push, what I'm going to call Fp, is equal to 17.5 newtons. And then the force of friction we will call Ff is equal to negative 2.4 newtons, negative because it's in the negative direction.
4	Next to the variables the narrator uses blue to write down the equation for finding net forces. As he talks he writes down the steps to the problem.	All right. Before we can solve for the acceleration, let's find the net forces on this cart. So we're going to write sigma F. And in this case, all of our forces are in the x direction. So I'm going to write sigma Fx is equal to, well, we have a positive 17.5 newton force. I'm going to write 17.5 newtons plus-- we have a negative 2.4 newton force-- negative 2.4 newtons. And those are the only two forces we have acting. So when we add those together, we find that the net force acting on this cart is

		15.1 newtons. And that's in the positive direction.
5	In green the narrator writes the equation F=ma to solve part a. As he walks through the steps to the solution he writes them down.	All right. Let's use that to solve part A. Part A asks, what is the acceleration of the shopping cart? And to find that, we can use Newton's second law, which says that force is equal to mass times acceleration. We know the net force acting on the cart is 15.1 newtons. That's equal to the mass of the cart, 50.0 kilograms, times the acceleration. If we divide both sides of this equation by 50 kilograms, we get the acceleration is equal to 0.302 meters per second squared.
6	In blue the narrator writes down the steps to solving part b of the problem. As he talks he writes the steps to the solution on the screen.	The next part of the question asks, if the cart starts from rest, how long does it take the cart to reach a speed of 3.4 meters per second? So starting from rest, we know that means the initial of 0 meters per second moving up to 3.4 meters per second. So that means v final equals 3.4 meters per second. So we know the initial velocity. We know the final velocity. And we know the rate of acceleration. So we can use the equation v final minus v initial is equal to acceleration times time. v final is 3.4 meters per second. v initial is 0 meters per second. And that's equal to our acceleration, which is 0.302 meters per second squared times time. If we divide both sides of this equation by 0.302, we find that the time it takes for the cart to reach 3.4 meters per second is 11.3 seconds.
7	To solve part c the narrator writes in red the variables they have, the equation to use and the steps to solving the problem. He says the steps out loud as he writes them.	The final part of this question asks, how far does the cart roll as it accelerates from rest to 3.4 meters per second? So we're trying to find the distance covered, d. But we already have acceleration. We already have v initial and v final. So if we're hoping to find distance, we can use the equation v final squared minus v initial squared is equal to 2 times the acceleration

		times the displacement. All right. Let's enter in the values we know and solve for displacement. We know that the final velocity is 3.4 meters per second. So that quantity squared minus the initial velocity, which is 0 meters per second, squared equals 2 times 0.302 meters per second squared times the displacement. All right. Simplifying this out, 3.4 meters per second squared gives us 11.56 meters squared per second squared. And that term just goes away. That's equal to 2 times 0.302. That's 0.604 meters per second squared times distance. If we divide both sides of this equation by 0.604 meters per second squared, we get distance is equal to 19.1 meters. So if the cart were pushed with the force that we calculated, it would take 19.1 meters over a period of 11.3 seconds accelerating at a rate of 0.302 meters per second squared to get up to a speed of 3.4 meters per second.