Scene #	Description	Narration
1	The slide is titled “Machines and Work”. It has a white background. Across the top of the slide just underneath the title is an image of each type of simple machine: a lever, an inclined plane, a wheel and axle, a wedge, a pulley, and a screw. Underneath the pictures in blue the narrator writes the word “direction”. Below that in green he draws a pulley. Next to the pulley in black he draws a box on an inclined plane. He draws an arrow pointing up and an arrow pointing right going up the inclined plane.	Machines make doing work easier. But it's not always really obvious why that's the case. Well, they do this in one of two main ways. The first is machines allow us to change the direction in which a force needs to be applied. And the second is that they allow us to change the magnitude of the force that we apply. First, let's look at how they allow us to change direction. I think one of the simplest examples of machines changing direction is just a simple pulley. A single pulley doesn't actually provide any mechanical advantage. But rather than making you lift a load straight upwards, it allows you to pull downwards, which is just much easier than lifting something upwards. Another example that shows how machines allows to change direction is the idea of an inclined plane. If you want to move a box from the ground to a higher position, you can either apply a force directly upwards or you could put that box on an inclined plane. And rather than having to apply an upward force, you can apply a forward force, and the end result will be the same. Now while the change of direction of the applied force is convenient, it doesn't actually in and of itself provide any mechanical advantage. Mechanical advantage is due to the fact that machines allow us to apply a different force. Let's look at how that's achieved.
2	The narrator scrolls down so only the pulley and inclined plane are showing that he drew. Below the pictures in blue he writes the word Force. Below the word force he draws another inclined plane in black and marks the angle of the incline at 20 degrees. He marks the height of the plane as 1 meter. He draws a blue box at the bottom of the plane and labels it as	To see how machines allow us to apply a different force, let's again look at the example of the inclined plane. Let's imagine we have an inclined plane that looks like this at an angle of 20 degrees and that achieves a height of 1 meter. If we have a 100 newton load at the bottom, if we're using an inclined plane, then rather than having to apply a 100 Newton force to lift this box, we'll actually

	having 100 newtons. He draws a red arrow pointing up the inclined plane and writes 34.2 newtons. He then writes 2.92 meters on the incline of the plane. In green the narrator writes the equation for input work and writes the solution. Below that he writes the equation for output work and writes the solution. He says all the steps he is doing out loud as he writes.	only to need to apply about a 34.2 Newton force. But of course, there's no such thing as a free lunch. We have to pay the price somehow. And in the case of the inclined plane, we pay the price by having to apply that lower force over a much longer distance. If we were to just lift the box up, we'd be applying 100 Newton force over one meter. But in this case, we're going to be applying a 34.2 Newton force over a distance of about 2.92 meters. So the input work, work in, is equal to force times distance. And we're applying a 34.2 Newton force over a distance of 2.92 meters. And that gives us an input work of 100 joules. The output work, the work that the machine does, well, the machine lifted a 100 Newton load one meter. So that's 100 newtons times 1 meter, which is also 100 joules. So even though we applied a much smaller force, because it was over a larger distance, we actually didn't save any work. But it was still easier to push the box. Now, this ramp that we've drawn here, this is what's called an ideal machine. And an ideal machine is one where the work in is equal to the work out. Unfortunately, ideal machines do not exist in the real world because as you know from your previous study of physics, there's always going to be friction. There's going to be losses to heat. This is going to make sound, and that's going to be a loss of energy. And since no machine is an ideal machine, we can gauge how close it is to an ideal machine using a measure called efficiency.
3	Below the inclined plane drawing the narrator writes in blue the word “efficiency”. To his drawing of the inclined plane above he adds a red	So an ideal machine has an efficiency of 100%. But in the real world, every machine is going to have an efficiency less than 100%.

	arrow pointing down the incline from the box and writes 10 Newtons by it. He also crosses out 34.2 Newtons and writes 44.2 Newtons in its place. In green he writes the equation and steps to solve the problem as he says them.	So sticking with the example of the 100 Newton load on the 20 degree inclined plane, let's imagine that we have a frictional force pulling backwards of 10 newtons. That means in order to push this load up the ramp, rather than needing to apply a 34.2 Newton force, we're going to need to apply a 44.2 Newton force. The equation for efficiency is efficiency equals work out divided by work in. Well, in this case, the work output by the machine is still 100 joules if lifting a 100 Newton load one meter. So the output work is still 100 joules.