Problem **20-R-WE-DK-11**

In this video, there's a bar. And forces applied to this bar, it's starting stationary of forces applied and the bar slides along a, a and b along the surfaces and ends up vertical. And we are asked to find what is the final angular velocity of the bar given a force F. So we first have to analyze this problem. And we're going to define two states, the initial state and the final state. So the initial state, which we're going to call state one is going to be the state when the bar is slanted. So the bar is slanted, and it has an angle theta with the horizontal. And at this point, we can see that the eye sees that V of the bar is located over here, can this is because we have a velocity along the wall upwards over here, when it starts moving, and then to the right here, when it starts moving? This is right after it starts moving, that's the ICZV okay. So we can get some dimensions on this ICZV, so it's when we start off, we have on this length being 1.5 meters, and this angle, theta being 30 degrees. So this angle is also theta, which is equal to 30 degrees. So we can get the vertical distance as being three over four meters, and the top distance three root three over four meters. Okay. So this is essentially the initial geometry that starts off slanted, so we have the X the y and x components. So initially, at state in state one, we have zero kinetic energy, so T one is equal to zero because nothing is moving. And we have some potential energy that you want. Okay? So potential energy, we're going to define as our datum starting from B. Okay, so this is our datum. And this is going to be h, okay, the height off of here. So this is the data. And in this case, G will be halfway down. So again, G will be over here. And we need to find that height. So again, with our angle, we use the sign, and we find this height over here times half of this length. So v1 will be equal to m g, h one, which is equal to 30 kilograms times 9.81 meters per second squared. And then times h one, which is going to be three over four times sine of 30 degrees. And so v one is equal to 100 110.36 joules. Okay. So now we're done with state one, we found all the energies in state one, now we can move to the state two, which is the final state. Okay, so this is when the bar is perfectly vertical. All right, when the bars perfectly vertical, there's going to be the following velocities. So velocity at the bottom, like so. And velocity over here, like so. Okay, but since this can't detach from the bottom, we're going to have the iczv being up here on the top. Okay, so this and then G is going to be halfway. So this is G. Okay, and so this height is going to be 1.5 meters and we're going to have an Omega In this case, so an Omega rolling everything that way. Okay, so in this case, we're going to have some kinetic energy, or kinetic energy will not be zero. So T2 is going to be equal to its two terms, one half mVg squared plus one half Ig omega squared. Okay. Now we said there's going to be an Omega because it's rotating. And since it's pinned over here, it's acting pinned at a, so this is A, this is B, A, and this is B, it's acting as if it's pinned at a, we can, we don't know omega, we're trying to solve for omega. But we, we can relate to omega, we can relate VG to omega. So VG is just equal to m r v, one half m times v g squared, BG is going to be equal to this distance. So I'm going to draw BG and purple. So it's going to go to the right that way. Remember, omega cross r is V. In this case, since they're perpendicular, then they're perpendicular, or R and V, then we're going to have it going to the left, and it's just going to be the direct multiplication of the two. So we have omega, which we don't know we're still living as an unknown, times three quarters. And this is all squared. Okay, and three quarters is going to be half of this length, right? This is 1.53 quarters is just half of that length over there, plus one half times i g, now we need to calculate AG, IG is going to be 1/12 Ml squared. Okay, so and then l being the length of the bar, so l squared. And then we're going to multiply it by omega, which we don't know. Okay, so if we plug in values into this equation, we get the following. 112 times 30 kilograms times omega three over four meters squared plus one half of 1/12 times 30 kilograms, times 1.5 meters squared, omega squared, we can solve for T two, and we can find that T two is going to be equal to 11.25 omega squared. So we have to to in terms of omega, which is good, because that's what we're trying to solve for. Okay. Now, we need to find the potential energy in state two. So v two, v two is just going to be equal to mgh two, and m is 30 kilograms, G is 9.81 meters per second squared, and h two is just going to be equal to half the length again, so three quarters, meters, or 0.75 meters. And when we multiply everything, we get 220.73. jewels. So now we have the kinetic and potential energy of both states. But in this question, we're also applying a force and when we apply a force to a system, we're adding work into the system. So we're adding energy. So balancing these two states doesn't give us any information, because we've added energies to this system. So we have to account for that work. So this work is the work due to the force. And the work due to a constant force is the force times the distance that the location where the force has been applied has traveled. So we can just directly multiply those. So work due to force. We have you You know, that goes from one to two, go from state one to two is going to be equal to the work due to the forest, which is just the forests times the distance. Okay? In this case, the 466 150 Newtons, and the distance is just that x distance this thing has traveled, right, so it goes from here to the vertical position, or in the diagram, this distance here. So right, I'll draw that in over here. So this is deep. Okay. So that distance we already calculated is three root three over four. So we have three root three over four meters, which is equal to well, that's just a number that we plugged into the final equation. So now we have all of the components of the energy of the system that and we can add them up and equate them to each other and salt or omega, because everything depends on omega, okay, or is it constant, so we have state one, so T one plus v one, plus the work to go from one to two is going to be equal to T two plus v two. Okay, and this work, we're adding it on this side, because it's work we're adding to the system to get to state two. And since this is positive, we're adding work on this side. So watch for those for the sign convention. And we can plug everything in so we get zero plus 110.4 joules plus 650 Newtons times three root three over four meters is equal to 11.25 omega squared plus 220.7 joules. Okay. And when we solve this equation, it's a quadratic equation because omega is squared. We can solve for it and get that omega is equal to 8.1 radians per second. That is the final answer for this problem.