Problem **4**

In this problem, we have a rod A B, that is rotating about C with an angular velocity of two radians per second. And given the angle theta 60 degrees, and l is one meter, we're asked to find the velocities of point A and point B. So we start with our kinematic diagram. So we draw our rod A B. And we draw the velocities. Since we're told that is rotating about C, we know that c over here will be our instantaneous center of zero velocity, I see Z v. So all the velocities will be with respect to this point, or just due to the angular velocity, as this point does not have any translation. So if we draw the radius between A and C, and if we draw the radius, between B and C, you know that the velocities will be perpendicular to this radius. So since the system is rotating, in the positive k hat direction, meaning it is rotating, rotating counterclockwise, so everything will be rotating, like this, we say that is the positive k direction, we're going to have the following velocities, va downwards and vB slanted downwards, but also to the right. So again, these two are right angles because the velocity is perpendicular to that radius vector. So let's go ahead and calculate the magnitudes of these velocities. So we have velocity of A is equal to V c plus omega cross r of a with respect to C. So from here, we can instantly cross out this, because we said that vc is a instantaneous center of zero velocity, so that has a velocity of zero. And we're left with the term omega cross r of a with respect to c. Now, our A with respect to c is the following vector over here that I just drew in red. So this is our of A with respect to c. And we have that is based on the geometry. And we know omega, so we can find VA. So VA is equal to omega, which is two radians per second in the k hat direction, notice I put positive k hat and this is cross. This radius is very simple. It's just along the negative x direction, so and the length is going to be proportional to the angle. So it's one meter over tan of theta, which is 60 degrees. And again, this is going to be in the negative i hat direction, because it points to the left, we can do this cross product easily. And it yields the following results: negative 1.15 j hat meters per second. And this is going to be our value for VA. And this is our final answer for velocity of A. Moving on to VB we use the same technique, same equation. But this time, we're going to have a bit of a more complex cross product because the radius vector is actually in two dimensions. So vb is equal to Vc plus omega crossed to r of v with respect to c. So again, our V with respect to c in our kinetic diagram is this vector over here. And we know we can see that and so we're given this data here. And we're given this length of the beam here. We can find this length over here, but we actually just split it into two components, the y component and the x component. So let's go ahead and do that. So first of all, let's get rid of the C because we know the C is the instantaneous center of zero velocity, so it has no velocity. And let's move on to the cross product. So Omega has the same exact expression. So v b is equal to two radians per second, the k hat direction crossed to a bit of a more involved factor, because we have the x and y component. So along the x component, we have the same as previously, right? This is the x component over here. So it's the same as the previous equation, which is going to be one over tan of 60 degrees and this is going to be in the negative i hat direction. But we also have a y component now. So the y component is just the length right. So, this is the y component, and this is just the length and again, this is going to be in the negative j direction. So, we have plus one meter in the negative j hat direction. And this is our cross product. Now, we can easily compute this cross product and it gives the following results are condenses down to the following 2k crossed to negative 0.577 i hat minus one j hat and this is equal to negative 1.154 j hat plus two i hat meters per second. So a b is equal to two i minus 1.154 J meters per second. And this is our final answer for VB