Problem **10**

In this problem, there is a flashlight with a handle that can be spun around to generate electricity in parallel light bulb. Lucy is spinning this handle for 30 seconds at a velocity of three radians per second, angular velocity three radians per second, with a constant moment of two Newton meters. And this is used to power a light bulb that uses three watts of power and we're keeping it on for one second. So, the 30 seconds of spinning powers the light for one second. We are asked to find what is the efficiency of the flashlight converting mechanical energy to usable electrical energy. So we know that efficiency is defined as the energy out divided by the energy in so this is essentially the useful part, the energy out usually is the useful part of the energy. So in this case, would be the energy that we produce as light. Whereas the energy and is how much energy we put into the system to get this energy out. And usually the energy out is less than the energy in because we do not have 100% efficiency, if this ratio was one, so 100% efficiency, then the energy and an energy out would be equal, right. But usually, the useful work is smaller than that, because there are some losses in the system. And energy cannot be created. So it's it can never be more than one or more than 100%. So we need to determine what the energy out and energy in of the system are. So the energy into the system is provided through spinning this handle, right. So we are given how long we spin the handle for, we're also given the velocity, and the moment with which we turn the handle. For the energy out, this is just specific to the flashlight, right, we're given how many watts the flashlight requires. And we're also given the time that the light is on. So we can recall that the energy E is equal to power times the time that you are using this power. So if for example, we have our three watt light bulb, if we use a three watt light bulb for one second, that will be an equal an equivalent of three joules of energy that we have pulled out of the system. So we can rewrite the equation for efficiency as P out times t out. And then the bottom is p in times t in. Okay. So again, this is what we pull out of the system in the form of light bulb, this at the bottom here is what we put into the system in the form of rotating that handle. Let's work on the out first. So P out. We said is equal to three watts. And then T out is equal to one second. This is just given in the question over here. One second three watts. The bottom quantity we have p in which is not given in the question, but we can determine P in right? So we are given the velocity, the angular velocity with which we spin the wheel and the moment, right. With this we can find the power with which we are we're putting into the system through this rotation. And that is done by simply multiplying the moment and the angular velocity. So this is going to be equal to m times omega. And this is going to be equal to two Newton meter times three radians per second. And again, T in is equal to 30 seconds. Because again, this is given in the question over here. So now that we have all of these quantities, we can plug everything into this equation and get a value for the efficiency. So let's do that. So efficiency is equal to three watts times one second. So this would be the Three Jewels that we require that we pull out of the system divided by all the energy that we put into the system. And this energy is the two Newton meters times three radians per second in 30 seconds. And this is equal to 0.017, which is equal to an efficiency of 1.7%. Usually we express efficiency in the form of a percentage, but you can also leave it as a decimal. But this is our final answer for the efficiency