**Advanced Dynamics**
**Prof. Anirvan Dasgupta**
**Department of Mechanical Engineering**
**Indian Institute of Technology - Kharagpur**

**Module No # 03**
**Lecture No # 12**
**Work-Energy Relation – II**

Let us continue our discussion on the work energy relation.

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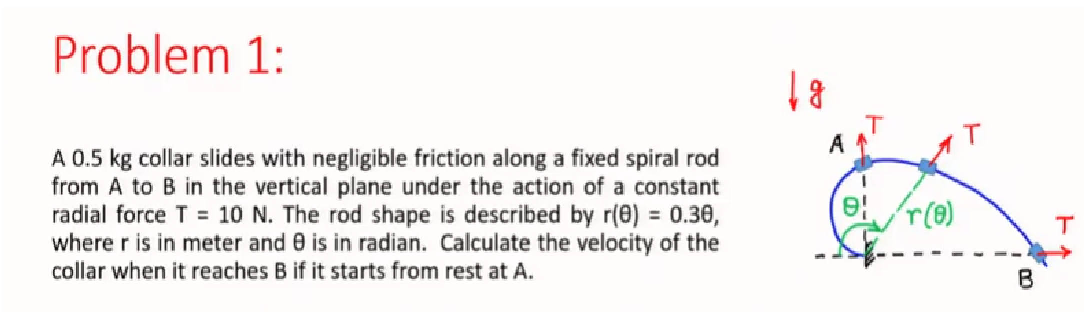


We are going to look at the application of work energy relation in certain problems. The problem statement is shown in the slide above.

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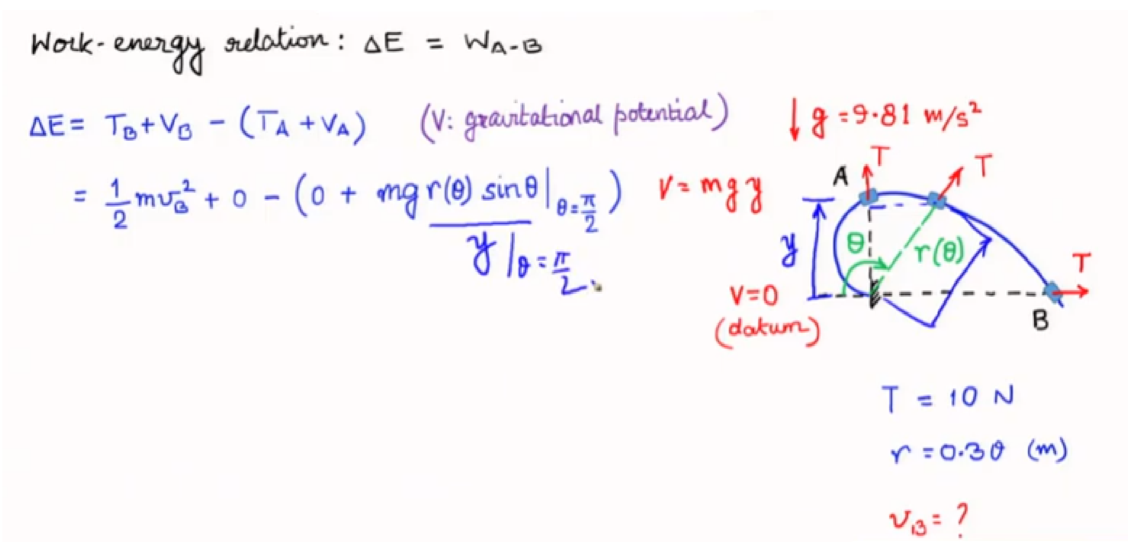


We solve the problem using the work energy relation as explained above. We define a datum where V = 0 in this problem, which is shown above.

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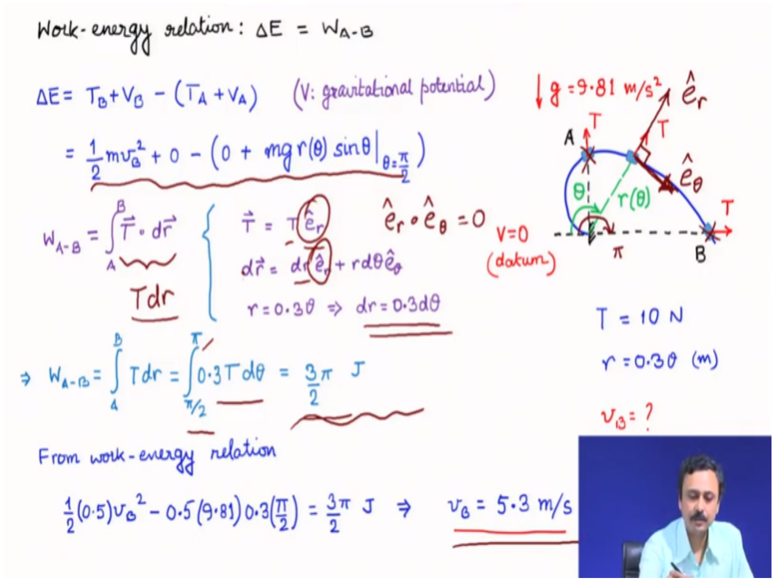



Now the work done by the external force T as the collar moves from A to B is T·dr. I have to now represent these vectors to find out the work done because the path is a spiral path. These vectors are given by

$$\vec{T} = T\hat{e}_r$$

$$d\vec{r} = dr\,\hat{e}_r + r\,d\theta\,\hat{e}_\theta$$

Hence, the work done is obtained as

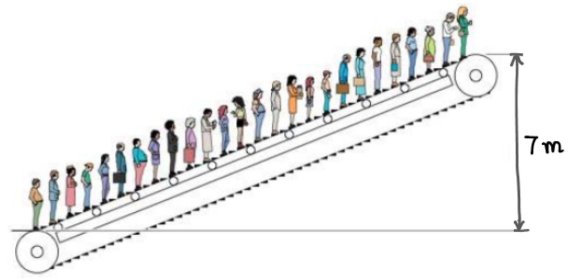
$$W_{A-B} = \int_A^B T\,dr = \int_{\pi/2}^{\pi} 0.3\,T\,d\theta = \frac{3}{2}\pi \quad J$$

Finally, from the work-energy relation

$$\frac{1}{2}(0.5)v_B^2 - 0.5(9.81)0.3\left(\frac{\pi}{2}\right) = \frac{3\pi}{2} \ J \quad \Rightarrow \quad v_B = 5.3 \ m/s$$

# Problem 2:

A department-store escalator handles a steady load of 30 people per minute in elevating them from the first floor to the second floor through a vertical rise of 7 m. The average person has a mass of 65 kg. If the motor that drives the unit delivers 3 kW, calculate the mechanical efficiency e.




Source: Dynamics, Meriam and Kraige

Next we consider the above problem.

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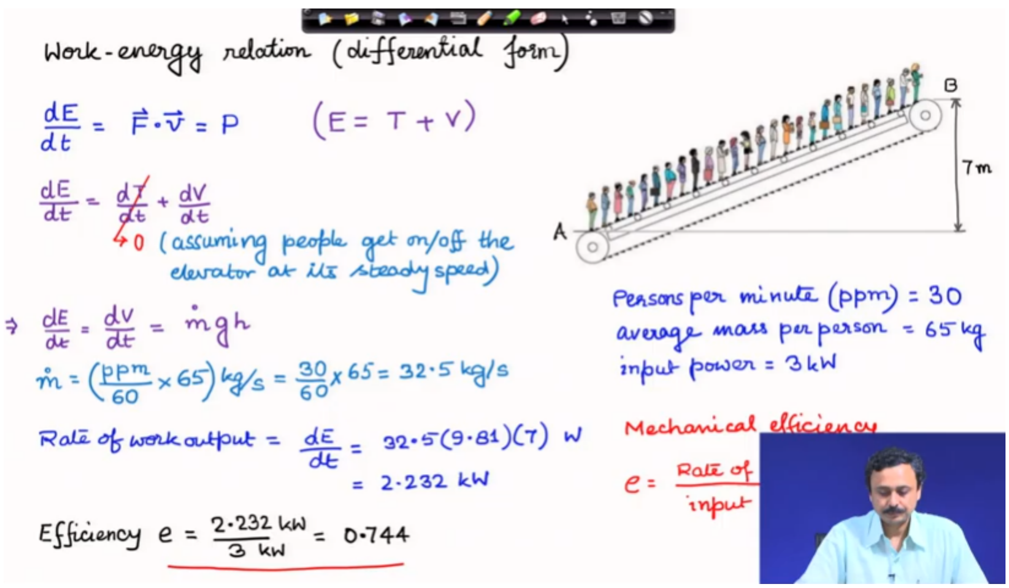


The solution is given in the slide above. The important step here is to realize that the rate of doing work by the escalator is the rate of change of potential energy, since the kinetic energy remains constant. Further, this rate of change of potential energy is given by

$$\frac{dE}{dt} = \frac{dV}{dt} = \dot{m}gh$$

where dm/dt is the rate at which mass is transported up, and not rate of change of mass. This is a mass flow problem.

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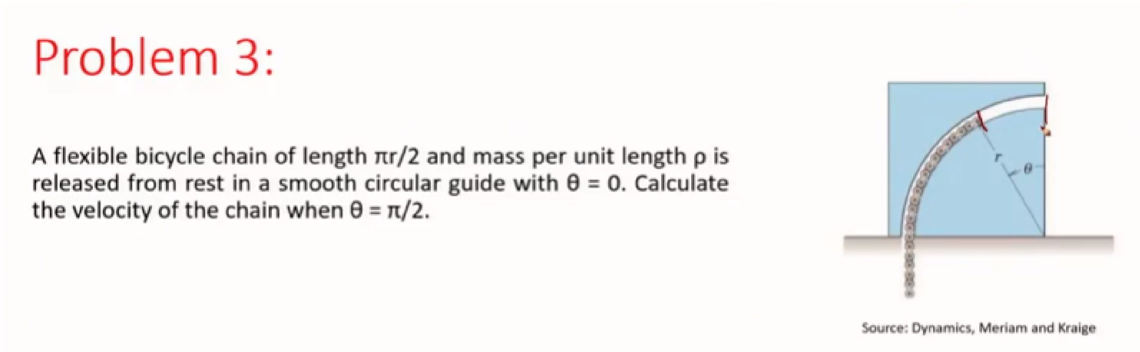


Next we look at the problem of a flexible chain like a bicycle chain. The problem statement is shown above.

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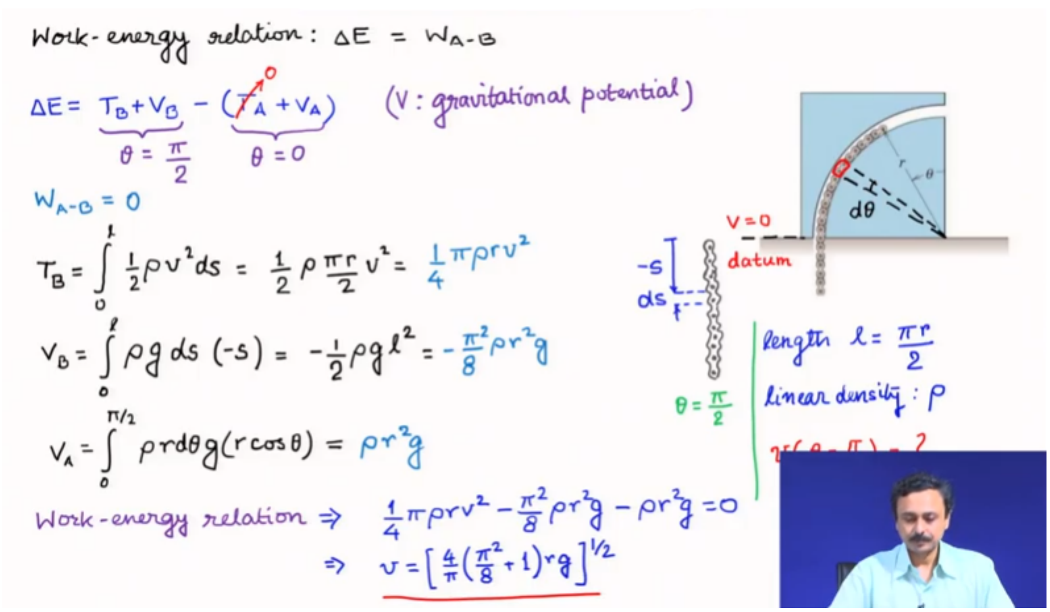


The solution is given in the slide above. It is important to note that the calculation of the potential energy has to be done carefully when the chain is inside the curved slot by assuming that the mass is distributed uniformly.

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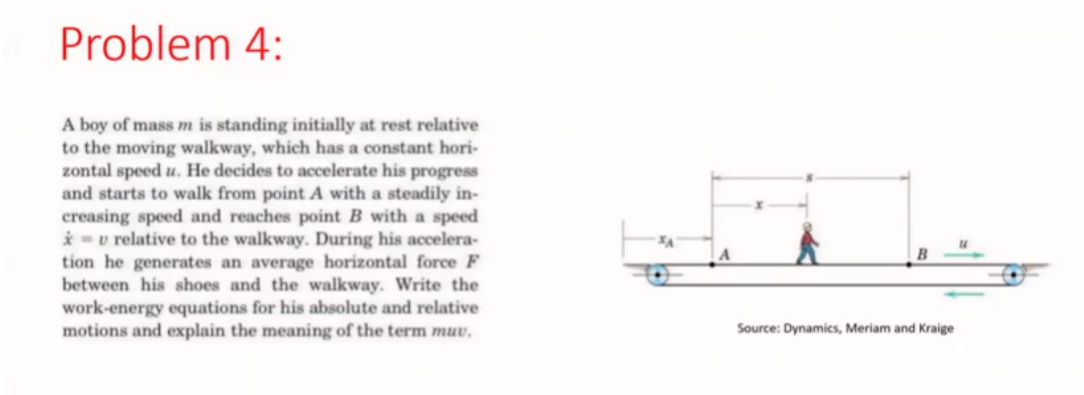


The next problem statement is shown above.

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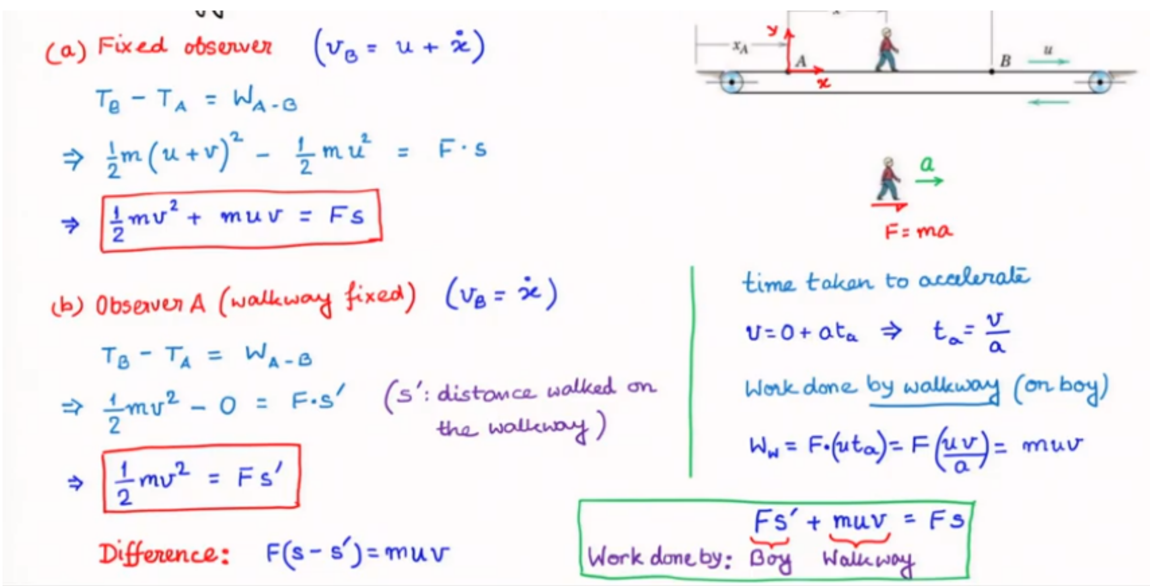


We look at this problem from the eyes of an observer who is fixed to the ground and watching this boy, and another observer who is fixed to the walkway. The solution is shown above.

It is noted that the net work done by the boy is measured by the walkway fixed observer. While, the ground-fixed inertial observer can see the work done by the boy and the work done by the walkway when the boy is accelerating on the walkway, and the walkway motor is is doing additional work in maintaining the speed of the walkway.

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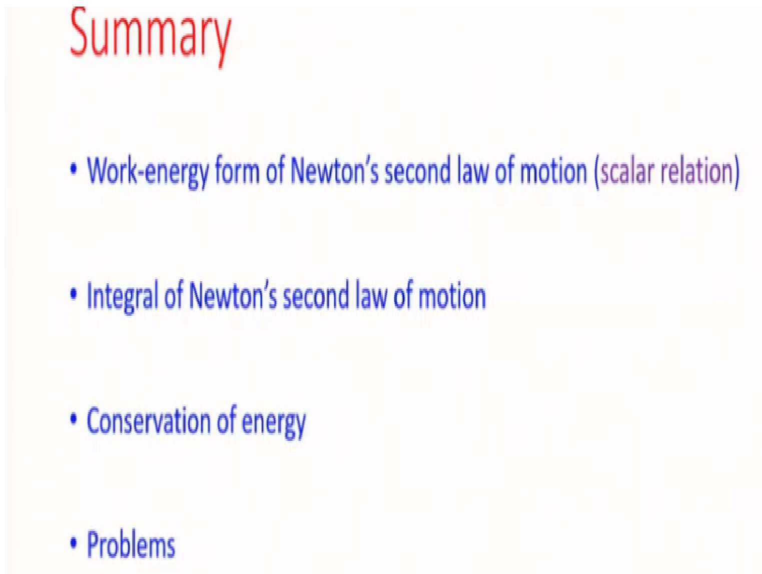


To summarize we have looked at the applications of work energy form of the Newton's second law.