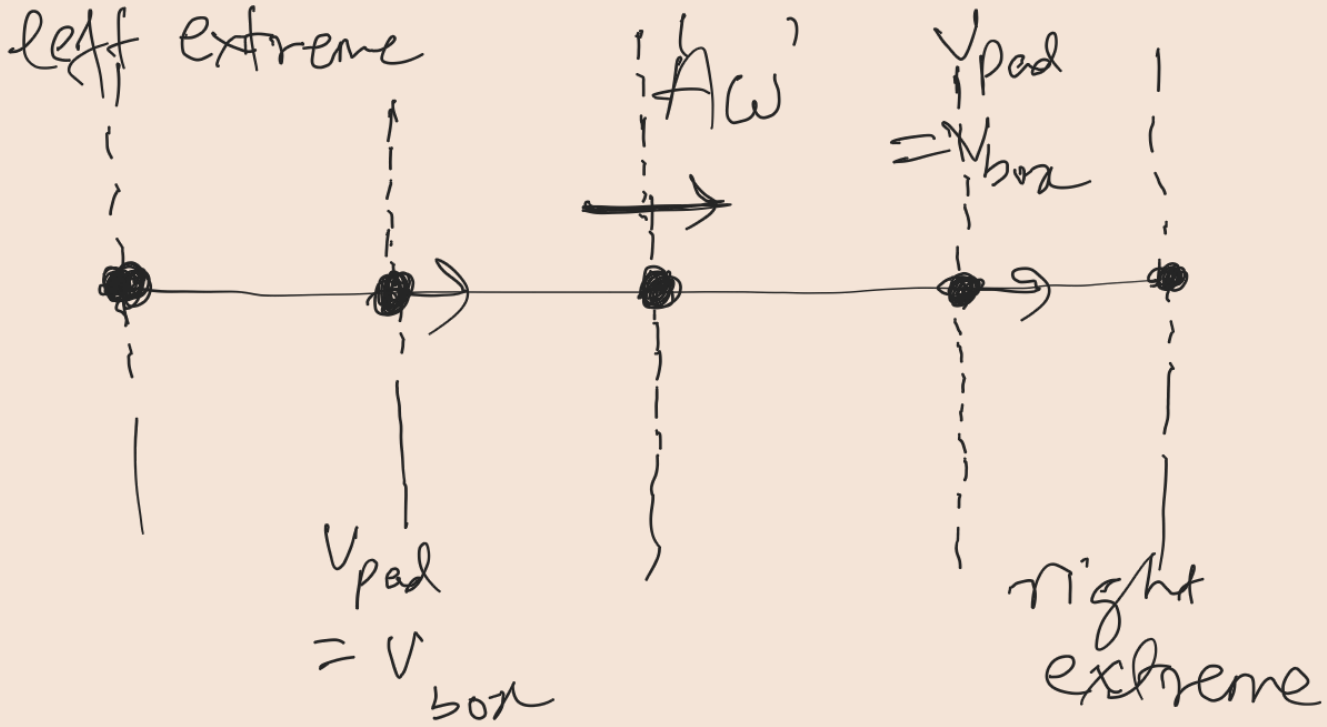
The entire mechanism of motion under steady state condition is already well described in the book hint. We have to formulise the mathematical part.

Let consider the motion of the box down the incline in steady state.



Friction force on the right pad is acting up the incline. Net velocity of left pad will be $V - V_{Pad/box}$. Now as long as velocity of pad wrt box exceed V_{box} friction will act on it downwards & net friction on (box + pad) system will be zero. Hence, we are interested to find the interval for

which velocity of pad stm is lesser than $V_{box} = V$.



For one journey of left pad from left extreme to right extreme, its velocity function can be expressed as $V_{pad} = (A\omega)\sin(\omega t)$.

The time instant when

$V_{pad} = v$ will be

$\sin^{-1}\left(\frac{v}{Aw}\right)$ / w. This will be executed twice in journey from one extreme to other.

So, total duration of friction force (net) activation $= \frac{2\sin^{-1}\left(\frac{v}{Aw}\right)}{w}$

$\approx \frac{2v}{Aw^2}$. Hence,

net impulse of friction is

$$\mu mg \times \frac{2v}{Aw^2} \quad (\cos\theta \approx 1).$$

Impulse of self weight

$$= (mg\theta) \times \left(\frac{\pi}{\omega}\right).$$ Since

$\vec{\Delta p}_{box} = 0$ in this interval,

$$(mg\theta)\frac{\pi}{\omega} = \frac{2v}{Aw^2}(\mu mg)$$

$$\boxed{v = \frac{\omega A \theta \pi}{2\mu g}}$$