Answer on Question #83779, Physics / Mechanics | Relativity

Question:

After hitting a long fly ball that goes over the right fielder's head and lands in the outfield, a batter decides to keep going past second base and try for third base. The 67 kg player begins sliding 3.40 m from the base with a speed of 4.5 m/s.
If the player comes to rest at third base, how much work was done on the player by friction with the ground?
What was the coefficient of kinetic friction between the player and the ground?

Decision:

Work was done on the player by friction with the ground equals to kinetic energy of player

$$\mathrm{E} = \frac{m \cdot V^2}{2} = \frac{67 \cdot 4.5^2}{2} = 678.375\, J$$

Friction provides constant braking force $\mathrm{F}_{br} = \mu \cdot \mathrm{N} = \mu \cdot \mathrm{m} \cdot \mathrm{g}$

And $\mathrm{F}_{br} = m \cdot \mathrm{a}_{br}$

Where a_{br} is braking deceleration

So $\mathrm{a}_{br} = \mu \cdot \mathrm{g}$

System of equations for formulas for path and velocity when constant acceleration occurs:

$$\begin{cases} \mathrm{S} = \mathrm{V} \cdot \mathrm{t}_{br} + \dfrac{\mathrm{a}_{br} \cdot {\mathrm{t}_{br}}^2}{2} \\ 0 - \mathrm{V} = \mathrm{t}_{br} \cdot \mathrm{a}_{br} \end{cases}$$

Where t_{br} is time of braking

$$\begin{cases} \mathrm{S} = \mathrm{V} \cdot \mathrm{t}_{br} + \dfrac{\mathrm{a}_{br} \cdot {\mathrm{t}_{br}}^2}{2} \\ \mathrm{a}_{br} = -\dfrac{\mathrm{V}}{\mathrm{t}_{br}} \end{cases}$$

$$\begin{cases} S = V \cdot t_{br} - \dfrac{V}{t_{br}} \cdot \dfrac{{t_{br}}^2}{2} \\ a_{br} = -\dfrac{V}{t_{br}} \end{cases}$$

$$\begin{cases} S = \dfrac{1}{2} \cdot V \cdot t_{br} \\ a_{br} = -\dfrac{V}{t_{br}} \end{cases}$$

$$\begin{cases} t_{br} = 2 \cdot \dfrac{S}{V} \\ a_{br} = \dfrac{V}{t_{br}} \end{cases}$$

$$a_{br} = \frac{V}{2 \cdot \frac{S}{V}} = \frac{V^2}{2 \cdot S}$$

$$\mu = \frac{a_{br}}{g} = \frac{V^2}{2 \cdot S \cdot g} = \frac{4.5^2}{2 \cdot 3.4 \cdot 9.8} = 0.3$$

Answer:

Work was done on the player by friction with the ground is $678.375\ J$

Coefficient of kinetic friction between the player and the ground is 0.3