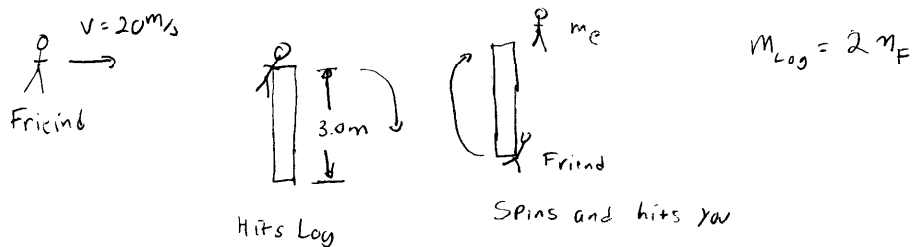


Assignment 12 Problem A

Context-Rich Problems: Solutions Outline

FOCUS the PROBLEM

Draw a picture of the situation including ALL the information given in the problem.



Question(s): What is the problem asking you to find?

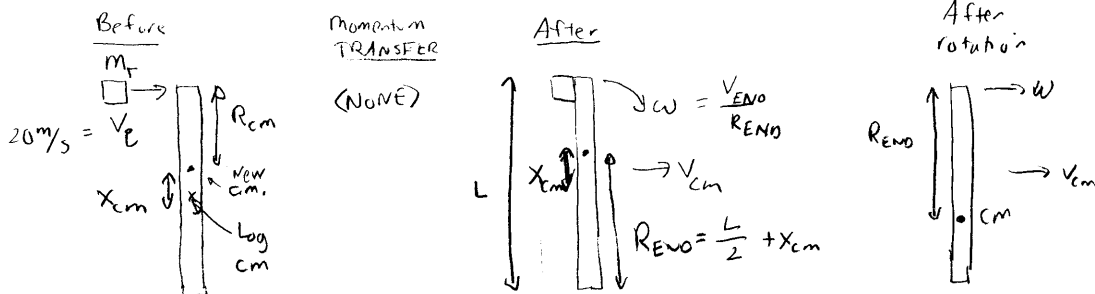
What is the tangential velocity of the log when it hits me?

Approach: Outline the approach you will use.

Use conservation of angular momentum around the center of mass of the log plus person and conservation of linear momentum.

DESCRIBE the PHYSICS

Draw physics diagram(s) and define ALL quantities uniquely.



Which of your defined quantities is your Target variable(s)?

$$v_T = v_E + v_{cm}$$

Quantitative Relationships: Write equations you will use to solve this problem.

$$\sum \vec{F} = \frac{d\vec{p}}{dt}$$

$$\sum \vec{\tau} = \frac{d\vec{L}}{dt}$$

$$x_{cm} = \frac{\sum x_i m_i}{\sum m_i}$$

PLAN the SOLUTION

Construct Specific Equations (Same Number as Unknowns)

$$V_T = V_{cm} + V_{EVO}$$

$$\textcircled{1} V_T = V_{cm} + \omega R_{EVO}$$

UNKNOWN
 V_{cm}, R_{EVO}
 ω

Find V_{cm} using cons. of momentum

$$P_i = P_f$$

$$m_F V_i = (m_F + m_{Log}) V_{cm} = 3 m_F V_{cm}$$

$$\textcircled{2} V_{cm} = \frac{1}{3} V_i$$

Find R_{EVO} by finding New Center of mass

$$x_{cm} = \frac{x_F m_F + x_{Log} m_{Log}}{m_F + m_{Log}} = \frac{\frac{L}{2} m_F}{3 m_F} = \frac{L}{6}$$

$$\textcircled{3} \therefore R_{EVO} = \frac{1}{2} L + \frac{L}{6} = \frac{2}{3} L$$

Find ω using cons of Angular momentum

$$L_i = L_f$$

$$R_{cm} = L - R_{EVO} = \frac{1}{3} L$$

$$R_{cm} \times m_F \vec{v}_i = (I_{Log} + I_F) \omega$$

$$\frac{1}{3} L m_F v_i = (I_{cm} + m_{Log} (\frac{L}{6})^2 + I_F) \omega$$

$$\frac{1}{3} L m_F v_i = (\frac{1}{12} L^2 m_{Log} + \frac{1}{36} L^2 m_{Log} + m_F (\frac{1}{3} L)^2) \omega$$

$$\frac{1}{3} m_F v_i = (\frac{2}{12} L m_F + \frac{1}{18} L m_F + \frac{1}{9} L m_F) \omega$$

$$\frac{1}{3} v_i = \frac{6}{18} L \omega = \frac{1}{3} L \omega$$

$$\omega = v_i L$$

$$\therefore V_T = \frac{1}{3} v_i + v_i L \frac{2}{3} L = (\frac{1}{3} + \frac{2}{3}) v_i = v_i$$

Check Units

(L)
(T)

EXECUTE the PLAN

Calculate Target Quantity(ies)

$$V_T = 20 \text{ m/s}$$

EVALUATE the ANSWER

Is Answer Properly Stated?

Yes

Is Answer Unreasonable?

Seems ok, The velocity should include translation plus rotation

Is Answer Complete?

Yes

(extra space if needed)