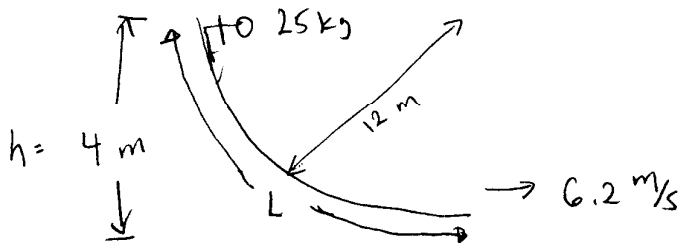
Group Problem

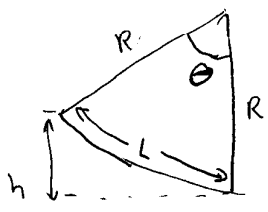
You have been hired as an intern at a company that makes playground equipment. You have been asked to help design a slide that will be shaped in the form of the arc of a circle with a maximum height of 4.0 m, and a radius of 12 m. The bottom of the slide at ground level is parallel to the ground. In order for the slide to be safe, a 25 kg child starting from rest at the top of the slide should exit the slide with a speed no greater than 6.2 m/s. Your job is to determine what material the slide should be made of so that friction will slow the child to this speed. The first step in choosing the correct material is to determine the average frictional force that acts on the child as he or she slides down the slide, so you decided to calculate that force.

Context-Rich Problems: Solutions Outline

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



Note the length of slide:



$\cos\theta = \frac{R-h}{R}$

$L = R\theta$

θ in radians

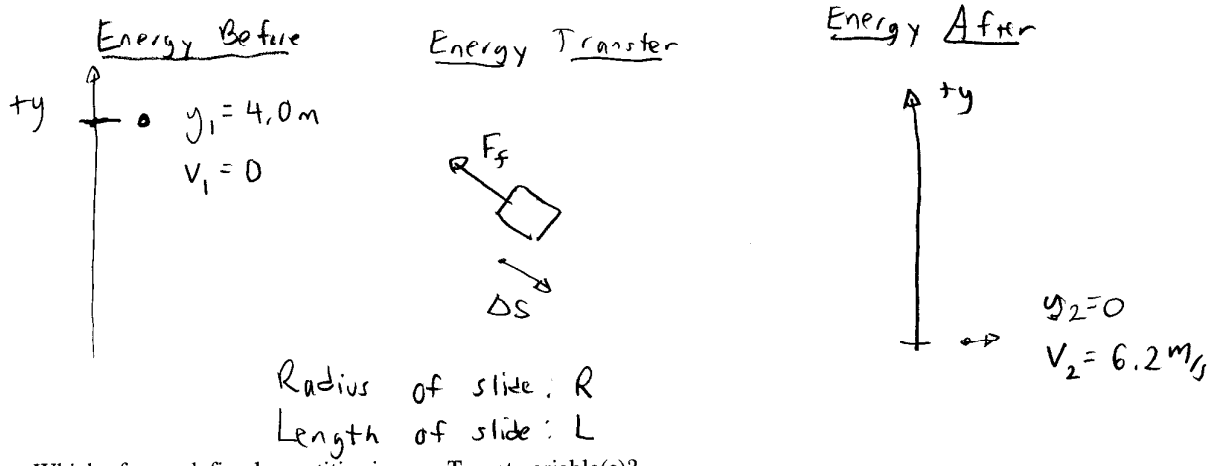
Question(s): What is the problem asking you to find?

what is the average force of friction

Approach: Outline the approach you will use.

Conservation of Energy, with external work caused by friction

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



Radius of slide: R
Length of slide: L

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

F_f

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

$W = \int \vec{F} \cdot d\vec{s}$ $\qquad$ $W_{ext} = \Delta K + \Delta U + \Delta E_{int}$

PLAN the SOLUTION

Construct Specific Equations (Same Number as Unknowns)

Find F_f:

$\Delta s, W_{ext}, F_f$

$W_{ext} = \int \vec{F}_f \cdot d\vec{s}$

① $= \vec{F}_f \cdot \int d\vec{s} = \vec{F}_f \cdot \Delta\vec{s} = F_f \Delta s \cos\phi$

$= -F_f \Delta s$

② $\Delta s = L = R\theta$

θ

③ $\theta = \cos^{-1}\frac{R-h}{R}$

$W_{ext} = \Delta K + \Delta U + \Delta E$ (0)

$= K_2 - K_1 + U_2 - U_1$ (0, 0)

④ $W_{ext} = \frac{1}{2}mv_2^2 - mgy_1$

Plug ③ into ②, ② into ①, and ④ into ①

$\frac{1}{2}mv_2^2 - mgy_1 = -F_f R\left(\cos^{-1}\frac{R-h}{R}\right)$

$F_f = -\frac{\frac{1}{2}mv_2^2 + mgy_1}{R\cos^{-1}\left(\frac{R-h}{R}\right)}$

This must be in Radians

Check Units

$\frac{\frac{[M][L]^2}{[T]^2} - \frac{[M][L]}{[T]^2}[L]}{[L]} = \frac{[M][L]}{[T]^2} = \text{Force}$

EXECUTE the PLAN

Calculate Target Quantity(ies)

$F_f = -\frac{\frac{1}{2}(25\,kg)(6.2\,m/s)^2 + (25\,kg)(9.8\,m/s^2)(4.0\,m)}{(12.0\,m)\cos^{-1}\left(\frac{12-4}{12}\right)}$

$= 50\ N$

EVALUATE the ANSWER

Is Answer Properly Stated?

Yes, in Newtons

Is Answer Unreasonable?

No, it is a relatively small force

Is Answer Complete?

Yes

(extra space if needed)

Date:_____ Group Number:_____

Name: Key

Name:_____

Name:_____

Name:_____