Assignment 2

AI1110: Probability and Random Variables

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Question 7) A 13 m long ladder is leaning against a wall, touching the wall at a certain height from the ground level.The bottom of the ladder is pulled away from the wall,along the ground at the rate of 2 m/s. How fast is the height of the ladder decreasing when the foot of the ladder is 5 m away from the wall?
Solution. The various parameters involved in this question are listed in Table

TABLE I
VARIABLES USED

Parameter	Variable	value
length of the rod	s	13 m
height from ground level to tip of rod	h	???
distance from the wall to foot of rod	x	???

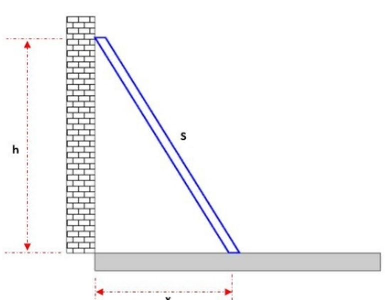

Fig. 1. Figure-1

Baudhāyana Sulba Sūtra: States that, if given a rectangle of side lengths a,b and diagonal length c the sum of the area of squares made by the side lengths of rectangle equals the area of square made by the length of the diagonal of the rectangle.

$$\implies a^2 + b^2 = c^2 \tag{1}$$

In Figure-1, we can draw lines parallel to the ground and wall passing through the tip and foot of ladder respectively to get an imaginary rectangle with side lengths h,x and diagonal length s
From Baudhāyana Sulba Sūtra,we get :

$$h^2 + x^2 = s^2 \tag{2}$$

in this equation s is always constant, $\because$ length of rod never changes
Now differentiating the equation on both sides with respect to time gives us

$$\frac{d(h^2 + x^2)}{dt} = \frac{d(s^2)}{dt} \tag{3}$$

$$\implies 2h\frac{dh}{dt} + 2x\frac{dx}{dt} = 0 \tag{4}$$

$$\implies h\frac{dh}{dt} = -x\frac{dx}{dt} \tag{5}$$

Given, at some time t=t_0, $\frac{dx}{dt}$=2 m/s and $x = 5m$
From Baudhāyana Sulba Sūtra , at time t_0

$$5^2 + h^2 = 13^2 \tag{6}$$

$\therefore h = 12m$
Now from equation (4) substituting $h, x, \frac{dx}{dt}$,we get

$$\frac{dh}{dt}=-\frac{5}{6}m/s$$

The negative sign indicates that h is decreasing, $\therefore$ the height of the ladder is decreasing at a rate of $\frac{5}{6}m/s$