

# 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	$l$	13 m
height from ground level to tip of rod	$h$	???
distance from the wall to foot of rod	$x$	???

From Pythagoras Theorem, we can say that at any point of time

$$h^2 + x^2 = l^2 \quad (1)$$

in this equation  $l$  is always constant

$\therefore$  length of rod never changes

Now differentiating the equation on both sides with respect to time gives us

$$\frac{d(h^2 + x^2)}{dt} = \frac{d(l^2)}{dt} \quad (2)$$

$$\implies 2h \frac{dh}{dt} + 2x \frac{dx}{dt} = 0 \quad (3)$$

$$\implies h \frac{dh}{dt} = -x \frac{dx}{dt} \quad (4)$$

Given, at some time  $t=t_0$

$$\frac{dx}{dt} = 2 \text{ m/s and } x = 5 \text{ m}$$

From Pythagoras Theorem, at time  $t_0$

$$5^2 + h^2 = 13^2 \quad (5)$$

$$\therefore h = 12 \text{ m}$$

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

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

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