Answer on Question#37801 - Physics – Other

A 4.2 x 10^3 kg car accelerates from rest at the top of a driveway that is sloped at an angle of 18.4 degrees with the horizontal. An average frictional force of 4.1 x 10^3 N impedes the car's motion so that the car's speed at the bottom of the driveway is 4.9 m/s.
the acceleration of gravity is 9.81 m/s^2 . What is the length of the driveway?

Solution:

First, we can write the Newton's second law along the slope:

$$F_{net} = ma \qquad (1)$$

$$F_{net} = (mg)_{slope} - F_{friction} = mg \cdot \sin\alpha - F_{friction} \qquad (2)$$

$(2)\text{in}(1)$:

$$mg \cdot \sin\alpha - F_{friction} = ma$$

Acceleration of the car:

$$a = \frac{mg \cdot \sin\alpha - F_{friction}}{m} = g \cdot \sin\alpha - \frac{F_{friction}}{m} =$$

$$= 9.81\frac{m}{s^2} \cdot \sin 18.4° - \frac{4.1 \cdot 10^3 N}{4.2 \cdot 10^3 kg} = 2.12\frac{m}{s^2}$$

Equation of motion for the car:

$$d = \frac{at^2}{2} \qquad (3)$$

Rate equation for the car ($V_1 = 4.9\frac{m}{s}$):

$$V_1 = at \Rightarrow t = \frac{V_1}{a} \qquad (4)$$

$(4)\text{in}(3)$:

$$d = \frac{a\left(\frac{V_1}{a}\right)^2}{2} = \frac{V_1^2}{2a} = \frac{\left(4.9\frac{m}{s}\right)^2}{2 \cdot 2.12\frac{m}{s^2}} = 5.7\ m$$

Answer: length of the driveway is equal to 5.7m.