A truck is traveling at 14.9 m/s down a hill when the brakes on all four wheels lock. The hill makes an angle of 11 ° with respect to the horizontal. The coefficient of kinetic friction between the tires and the road is 0.838. How far does the truck skid before coming to a stop?

Solution:

$F_{fr} -$ friction force;
$\alpha = 11° -$ angle of the inclined plane;
$V_0 = 14.9\frac{m}{s} -$ initial velocity;
$a -$ deceleration of the truck;
$\mu = 0.838 -$ coefficien of kinetic friction;
$S -$ distance that truck traveled;

Newton's second law for the truck on the X-axis:

$x: F_{fr} - mg_x = ma$

Formula for the friction force:

$F_{fr} = \mu N \Longrightarrow$

$\mu N - mg_x = ma \qquad (1)$

Newton's second law for the truck on the Y-axis:

$y: N - mg_y = 0$

$N = mg_y$

From te right triangle ABC:

$\sin\alpha = \frac{mg_x}{mg} \Longrightarrow mg_x = mg\sin\alpha$

$\cos\alpha = \frac{mg_y}{mg} \Longrightarrow mg_y = mg\cos\alpha$

$N = mg_y = mg\cos\alpha \qquad (2)$

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

$\mu mg\cos\alpha - mg\sin\alpha = ma$

$\mu g\cos\alpha - g\sin\alpha = a$

$a = \mu g\cos\alpha - g\sin\alpha = 0.838 \cdot 9.8\frac{m}{s^2} \cdot \cos 11° - 9.8\frac{m}{s^2} \cdot \sin 11° = 6.2\frac{m}{s^2}$

Rate equation of the truck along X-axis:

$z: 0 = V - at$

$V = at$

$t = \frac{V}{a} \qquad (4)$

Equation of motion for the truck along X-axis:

$S = Vt - \frac{at^2}{2} \qquad (5)$

$(4)\text{in}(5)$:

$S = V \cdot \frac{V}{a} - \frac{a}{2} \cdot \left(\frac{V}{a}\right)^2 = \frac{V^2}{a} - \frac{V^2}{2a} = \frac{V^2}{2a} = \frac{\left(14.9\frac{m}{s}\right)^2}{2 \cdot 6.2\frac{m}{s^2}} = 18m$

Answer: distance that truck traveled, is equal to 18m.