Answer on Question #42186 – Physics – Mechanics | Kinematics | Dynamics

Police investigators, examining the scene of an accident involving two cars, measure the 72m long skid marks of one of the cars with a mass of 2500kg. The coefficient of kinetic friction between rubber and pavement is about 0.80. Estimate the initial speed in mph of that car assuming a level road.

Solution:

$S = 72\text{m} - \text{traveled distance};$
$m = 2500\text{kg} - \text{mass of the car};$
$k = 0.80 - \text{coefficient of kinetic friction berween rubber and pavement};$
$V_0 - \text{initial speed of the car.}$
$N - \text{ reaction force of the car};$

Work-Energy theorem: work done by friction force if equal to change in kinetic energy of the car:

$$W_{friction} = KE_{final} - KE_{initial}$$
$$KE_{final} = 0 \text{ (because final speed of the car is zero)}$$
$$W_{friction} = -KE_{initial} \quad (1)$$
$$KE_{initial} = \frac{mV_0^2}{2} \quad (2)$$
$$W_{friction} = -F_{friction} \cdot S = -Nk \cdot S$$

Work done by friction force has a minus sign, it shows that direction of the force is opposite to direction of motion (cars slows).

Second Newton's law along the Y-axis:

$$N - mg = 0$$
$$N = mg \Longrightarrow$$
$$W_{friction} = -mgk \cdot S \quad (3)$$
$$(3)\text{and}(2)\text{in}(1):$$
$$-mgk \cdot S = -\frac{mV_0^2}{2}$$
$$2gkS = V_0^2$$
$$V_0 = \sqrt{2gkS} = \sqrt{2 \cdot 9.8\frac{m}{s^2} \cdot 0.80 \cdot 72\text{m}} = 33.6\frac{m}{s} = 75.16 \text{ mph}$$

Answer: initial speed is 75.16 mph.