Answer on Question #61866, Physics / Other

19. A body of mass m is pulled along a smooth surface by a force P inclined at angle θ above the horizontal. If the mass starts from rest, which of the following correctly gives the distance moved by the body in time t.

Solution:

The kinetic equation is

$$d = v_o t + \frac{1}{2} a t^2$$

where

d is the distance moved by the body in time t

$v_0 = 0$ is initial speed

a is acceleration

Newton's Second Law

$$F = ma$$
$$F = P\cos\theta$$

Thus,

$$a = \frac{P\cos\theta}{m}$$

Finally,

$$d = \frac{1}{2}\frac{P\cos\theta}{m}t^2$$

Answer: $d = \frac{1}{2}\frac{P\cos\theta}{m}t^2$

20 A car travels along a horizontal road which is an arc of a circle of radius 125 m. The greatest speed at which the car can travel without slipping is 42 km/h. Find the coefficient of friction between the tyres of the car and the surface of the road.

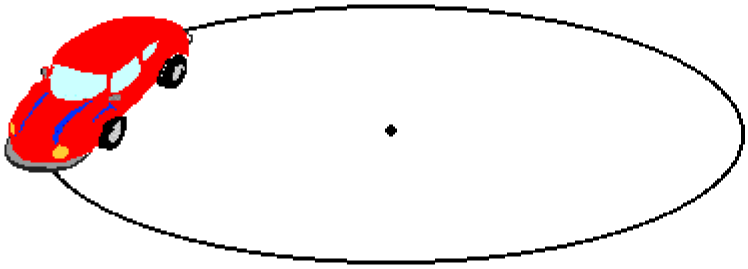
a. 1/6

b. 1/4

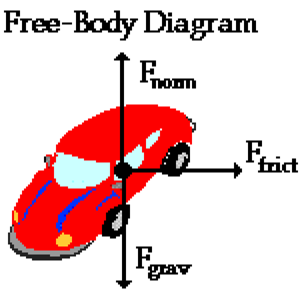
c. 1/7

d. 1/9

Solution:



An analysis of the situation would reveal that there are three forces acting upon the object - the force of gravity (acting downwards), the normal force of the pavement (acting upwards), and the force of friction (acting inwards or rightwards). It is the friction force that supplies the centripetal force requirement for the car to move in a horizontal circle. Without friction, the car would turn its wheels but would not move in a circle (as is the case on an icy surface). This analysis leads to the free-body diagram shown at the right. Observe that each force is represented by a vector arrow that points in the specific direction that the force acts; also notice that each force is labeled according to type (F_{frict}, F_{norm}, and F_{grav}). Such an analysis is the first step of any problem involving Newton's second law and a circular motion.



The mass of the object can be used to determine the force of gravity acting in the downward direction. Use the equation

$$F_{grav} = m\,g$$

where g is 9.8 m/s/s. Knowing that there is no vertical acceleration of the car, it can be concluded that the vertical forces balance each other.

Thus, $F_{grav} = F_{norm}$

Since the force of friction is the only horizontal force, it must be equal to the net force acting upon the object. So if the net force can be determined, then the friction force is known. To determine the net force, the mass and the kinematic information (speed and radius) must be substituted into the following equation:

$$F_{net} = \frac{mv^2}{R}$$

Since the force of friction is the only horizontal force, it must be equal to the net force acting upon the object.

The force of friction can be determined using the following equation:

$$F_{frict} = \mu F_{norm}$$

where the coefficient of friction is μ.

Thus,

$$\frac{mv^2}{R} = \mu mg$$

$$\mu = \frac{v^2}{Rg}$$

$$v = 42\ \frac{km}{h} = \frac{42}{3.6}\ \frac{m}{s} = 11.67\ \frac{m}{s}$$

$$\mu = \frac{v^2}{Rg} = \frac{11.67^2}{125 \cdot 9.8} = 0.11 = \frac{1}{9}$$

Answer: d. 1/9