

Learning Intentions

- To learn how to account for friction in 2 dimensional physics problems.

Questions

- A Prius has a mass of 1360 kg. It is travelling to the right with the flow of traffic at 63 km/h. The driver sees a raccoon on the road, and slams on the brakes. The coefficient of friction between the wheels and the dry road is 1.0.
 - Draw a free body diagram of the car.
 - What is the acceleration of the car, in m/s^2 ?
 - What will be the displacement of the car before it stops?
 - If the road in the previous question were wet, with a coefficient of friction of 0.70, what would be the displacement of the car before it stops?
 - If the road in the previous question were icy, with a coefficient of friction of 0.080, what would be the displacement of the car before it stops?
- A 10 kg box is pulled at a constant velocity across a flat, smooth floor with a rope. The rope makes an angle of elevation of 40 degrees with the floor, and there is a tension force of 140 N in the rope.
 - Draw a free body diagram of the box.
 - What is the normal force on the box?
 - What is the coefficient of kinetic friction between the box and the floor?
- A box is sliding up a 30 degree incline at an initial speed of 12 m/s. The coefficient of kinetic friction between the box and the ground is 0.50.
 - Draw a free body diagram of the box.
 - What distance along the incline will the box travel before coming to a rest?
- A block of mass m is at rest on a θ degree incline.
 - Draw a free body diagram of the box.
 - What is the minimum coefficient of static friction to keep the block from sliding?

5. A box of mass m is being pulled across a table at a constant speed by a force of F Newtons. The force is being applied at an angle of θ degrees of elevation above the horizon. There is a kinetic coefficient of friction of μ_k between the box and the table.
- Draw a free body diagram of the box.
 - If μ_k is 0.50 (such as for mild steel on mild steel) and the mass is 1.0 kg, find the force F as a function of the angle θ . Graph it using an online graphing tool.
 - If the force is 150 Newtons and the mass is 1.0 kg, find the kinetic coefficient of friction μ as a function of the angle θ . Graph it using an online graphing tool.

Answers

- $a = 9.8 \text{ m/s}^2$ [left]
 - $d = 16 \text{ m}$ [right]
 - $d = 22 \text{ m}$ [right]
 - $d = 200 \text{ m}$ [right]
- $F_N = 8.1 \text{ N}$ [up]
 - $\mu = 13$
- $d = 17 \text{ m}$
- $\mu_s = \tan\theta$
- $F = \mu_k mg / (\cos\theta - \mu_k \sin\theta) = 4.905\mu_k / (\cos\theta - \mu_k \sin\theta)$
 - $\mu_k = F \cos\theta / (mg + F \sin\theta) = 150 \cos\theta / (9.81 + 150 \sin\theta)$