

LESSON 5

BOOK CHAPTER 5
(Force and Motion-I)

And

BOOK CHAPTER 6
(Force and Motion-II)

Problem 33 (Book chapter 5):

An elevator cab and its load have a combined mass of 1600 kg. Find the tension in the supporting cable when the cab, originally moving downward at 12 m/s, is brought to rest with constant acceleration in a distance of 42 m.

Answer:

We have from Newton's second law,

$$T - mg = ma$$

$$T = ma + mg = m(a + g) = 1600(a + 9.8)$$

To find a , we use the following formula,

$$v^2 = v_0^2 + 2ay$$

$$0 = (-12)^2 + 2a(-42)$$

$$0 = 144 - 84a$$

$$84a = 144$$

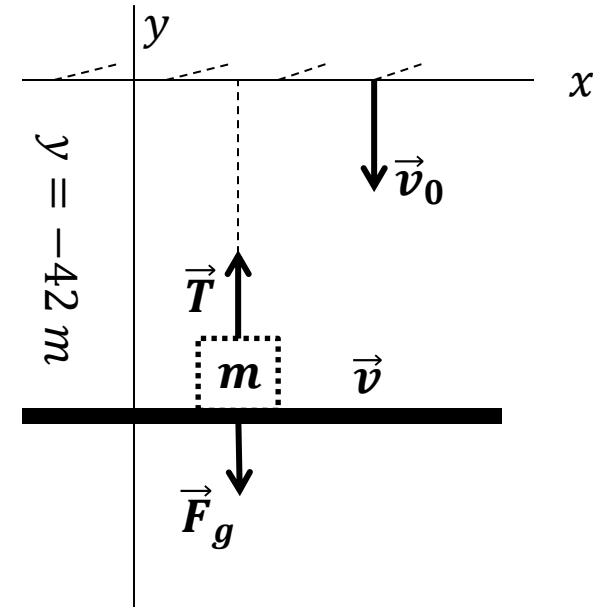
$$a = 1.714 \text{ m/s}^2$$

Therefore,

$$T = 1600(1.714 + 9.8)$$

$$T = 1600(1.714 + 9.8)$$

$$\mathbf{T = 18,422 \text{ N}}$$



Here, $v_0 = -12 \text{ m/s}$

$v = 0 \text{ m/s}$

$m = 1600 \text{ kg}$

$y = -42 \text{ m}$

$T = ?$

Problem 37 (Book chapter 5):

A 40 kg girl and an 8.4 kg sled are on the frictionless ice of a frozen lake, 15 m apart but connected by a rope of negligible mass. The girl exerts a horizontal 5.2 N force on the rope. What are the acceleration magnitudes of (a) the sled and (b) the girl? (c) How far from the girl's initial position do they meet?

Answer:

Since the rope is of negligible mass, the pulls at both ends of the rope have the same magnitude T .

(a) For girl

From Newton's second law,

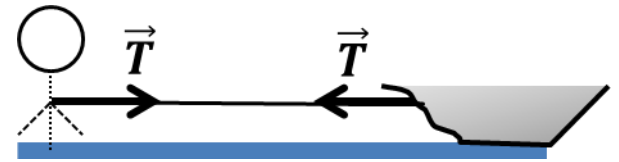
$$T = m_g a_g$$

[where, $m_g \rightarrow$ mass of the girl

$a_g \rightarrow$ acceleration of the girl

and $T \rightarrow$ magnitude of the tension force
along the rope]

$$a_g = \frac{T}{m_g} = \frac{5.2}{40} = 0.13 \text{ m/s}^2$$



(b) For sled

From Newton's second law,

$$T = m_s a_s$$

[where, $m_s \rightarrow$ mass of the sled

$a_s \rightarrow$ acceleration of the sled]

$$a_s = \frac{T}{m_s} = \frac{5.2}{8.4} = 0.619 \text{ m/s}^2$$

(c) We assume that they will meet at point C after a time t .

For girl,

$$x_g = 0 + \frac{1}{2} a_g t^2 \quad \text{[since initial velocity of girl is zero]}$$

$$x_g = \frac{1}{2} a_g t^2$$

For sled,

$$-(15 - x_g) = -\frac{1}{2} a_s t^2$$

[since the displacement and acceleration are negative to x axis]

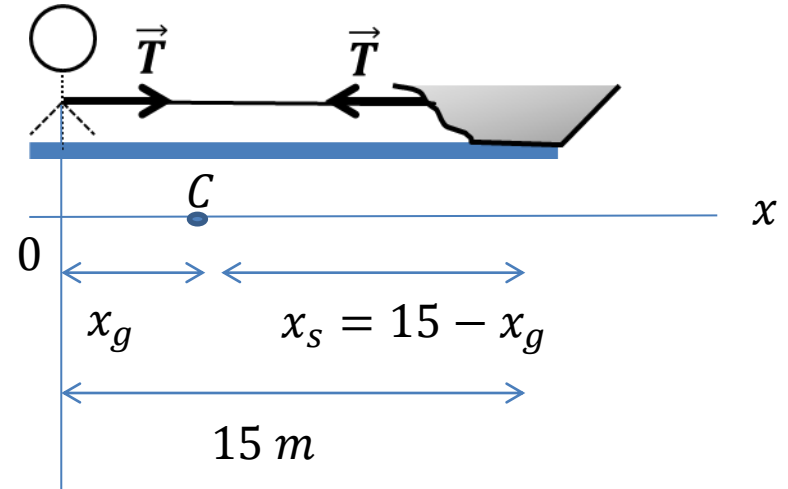
$$15 - \frac{1}{2} a_g t^2 = \frac{1}{2} a_s t^2$$

$$15 - \frac{0.13}{2} t^2 = \frac{0.619}{2} t^2$$

$$15 - 0.065 t^2 = 0.3095 t^2$$

$$0.3745 t^2 = 15$$

$$t = 6.329 \text{ s}$$



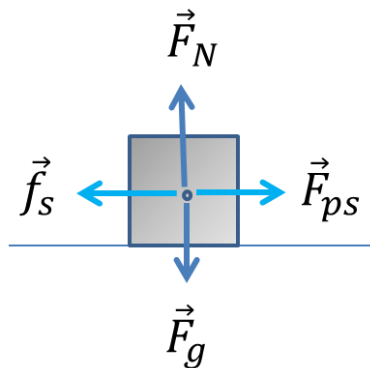
Therefore,

$$x_g = \frac{0.13}{2} (6.329)^2 = 2.604 \text{ m}$$

BOOK CHAPTER 6

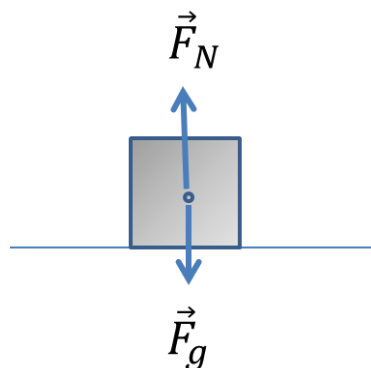
(Force and Motion-II)

Properties of friction:



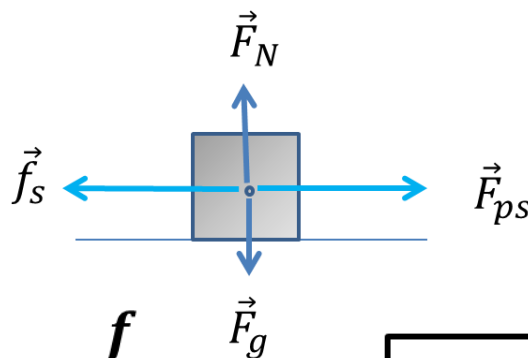
Weak applied force, box remains at rest.

$$F_{ps} = f_s$$



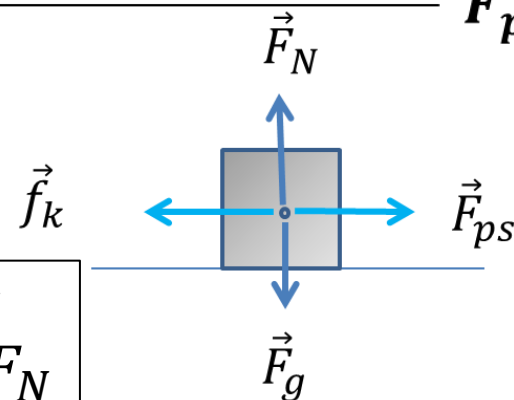
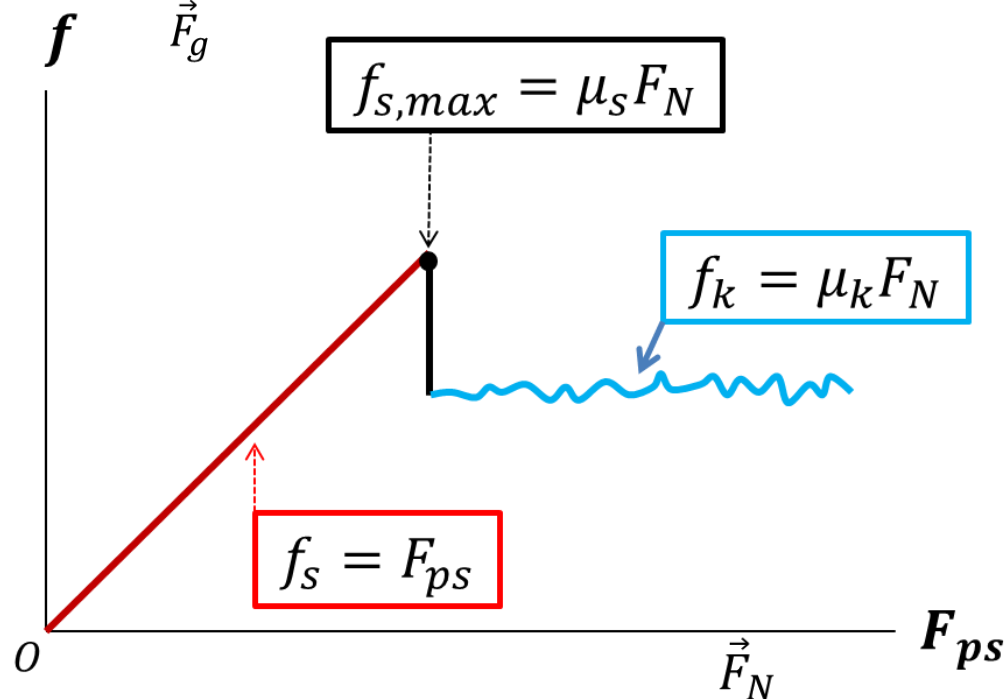
No applied force, box at rest.

No friction, $f_s = 0$



Stronger applied force,
box just about to slide.

$$f_{s,max} = \mu_s F_N$$



Box sliding at approximately
constant speed: $f_k = \mu_k F_N$

Friction: When a force tends to slide a body along a surface, a **frictional force** from the surface acts on the body. The frictional force is parallel to the surface (\vec{F}_{ps}) and directed so as to oppose the sliding. It is due to bonding between the body and the surface.

If the body does not slide, the frictional force is a **static frictional force** (\vec{f}_s).

If there is sliding, the frictional force is a **kinetic frictional force** (\vec{f}_k).

Properties of Friction:

□ If a body does not move, the static frictional force (\vec{f}_s) and the applied force parallel to the surface (\vec{F}_{ps}) are equal in magnitude, and \vec{f}_s is directed opposite to that \vec{F}_{ps} . If the F_{ps} increases, f_s also increases.

□ The magnitude of \vec{f}_s has a maximum value $f_{s,max}$ that is given by

$$f_{s,max} = \mu_s F_N$$

where μ_s is the **coefficient of static friction** and F_N is the magnitude of the normal force on the body from the surface. If the magnitude of the \vec{F}_{ps} exceeds $f_{s,max}$, then the body begins to slide along the surface.

- If the body begins to slide along the surface, the magnitude of the frictional force rapidly decreases to a value f_k given by

$$f_k = \mu_k F_N$$

where μ_k is the **coefficient of kinetic friction**. Thereafter, during the sliding, a kinetic frictional force with magnitude f_k opposes the motion.

Thank You