LECTURE 5

BOOK CHAPTER 5
(Force and Motion-I)
And
BOOK CHAPTER 6
(Force and Motion-II)

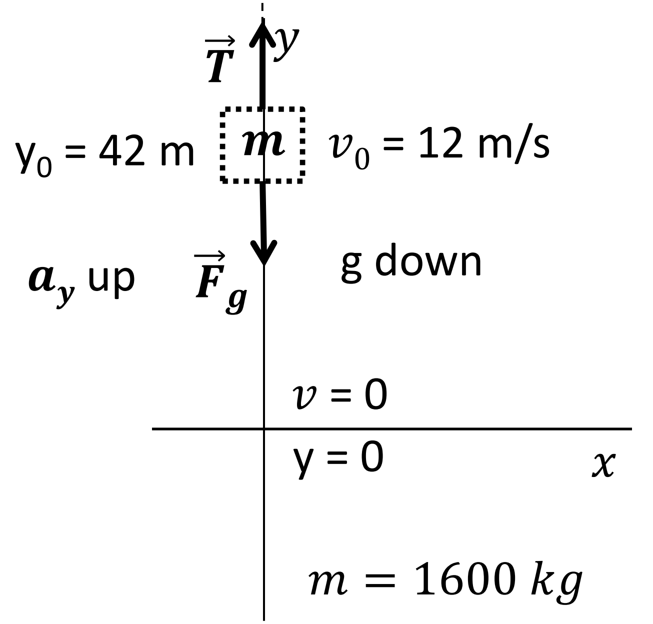
Problem 33 (Book chapter 5): Kabir

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: Newton's second law of motion,

$$+T + m(-g) = m(+a_y)$$

$$T = may + mg = m(a_y + g)$$



To find a_y, we use the equation of motion,

$$v^2 = v_0^2 + 2ay(y - y_0)$$

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

$$0 = 144 - 84a_y$$

$$a_y = +1.714\ m/s^2$$

$$T = m(a_y + g)$$

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

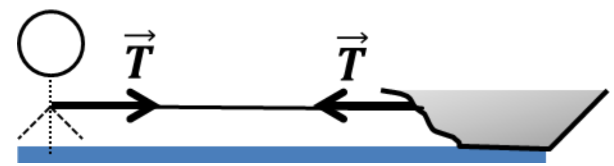
$$T = 1600(1.714 + 9.8)$$

$$T = 18,422\ N$$

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) <u>For girl</u>

From Newton's second law,

$$\boldsymbol{T = m_g(+a_g)}$$

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

$a_g \rightarrow acceleration\ of\ the\ girl$

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

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

(b) <u>For sled</u>

From Newton's second law,

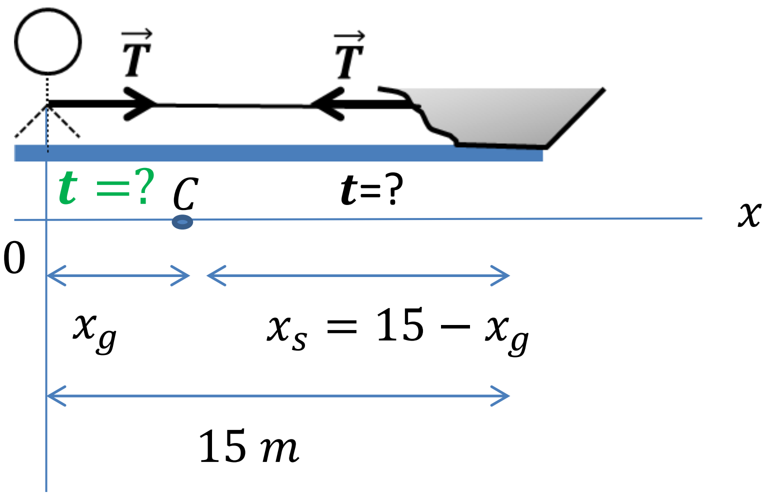
$$\boldsymbol{T = m_s(-a_s)}$$

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

$a_s \rightarrow acceleration\ of\ the$ sled]

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

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



For girl,

$$x_g = 0 + \frac{1}{2}a_g t^2$$

[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]

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

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

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

$$0.3745t^2 = 15$$

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

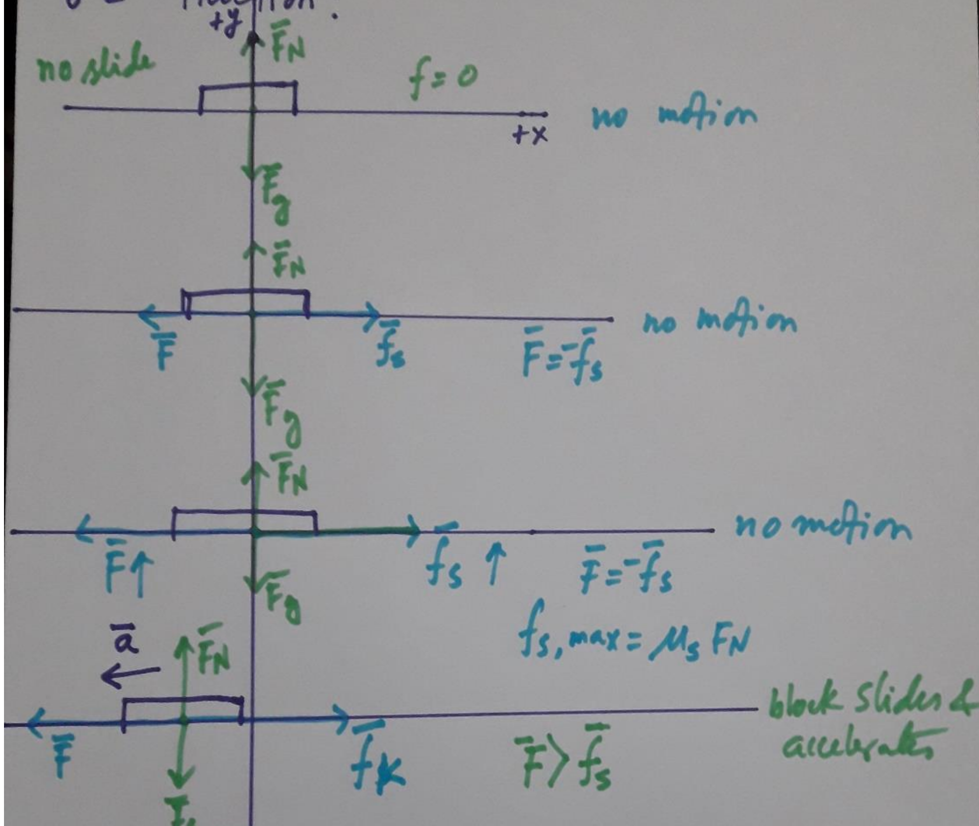
Therefore,

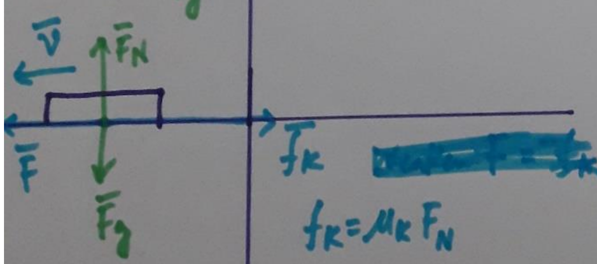
$$\boldsymbol{x_g = \frac{0.13}{2}(6.329)^2 = 2.604\ m}$$

BOOK CHAPTER 6

(Force and Motion-II)

6-2 Friction:





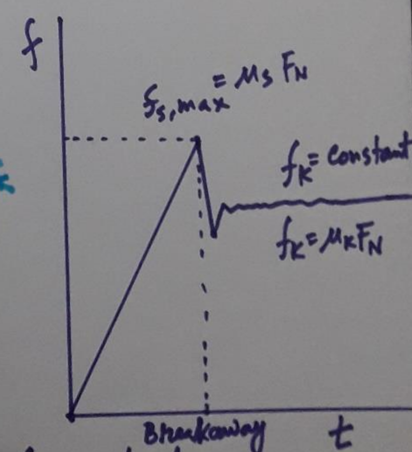


Fig. frictional force

Fig: f as a function of t

6-3 Properties of friction:
Frictional force has three properties.

① $f_s \parallel F$

$\vec{f}_s = -\vec{F}$

② $f_{s,max} = \mu_s F_N$

normal force

coefficient of static friction

maximum static frictional force

③ $f_K = \mu_K F_N$

normal force

coefficient of kinetic friction

Kinetic frictional force

6-1 FRICTION:

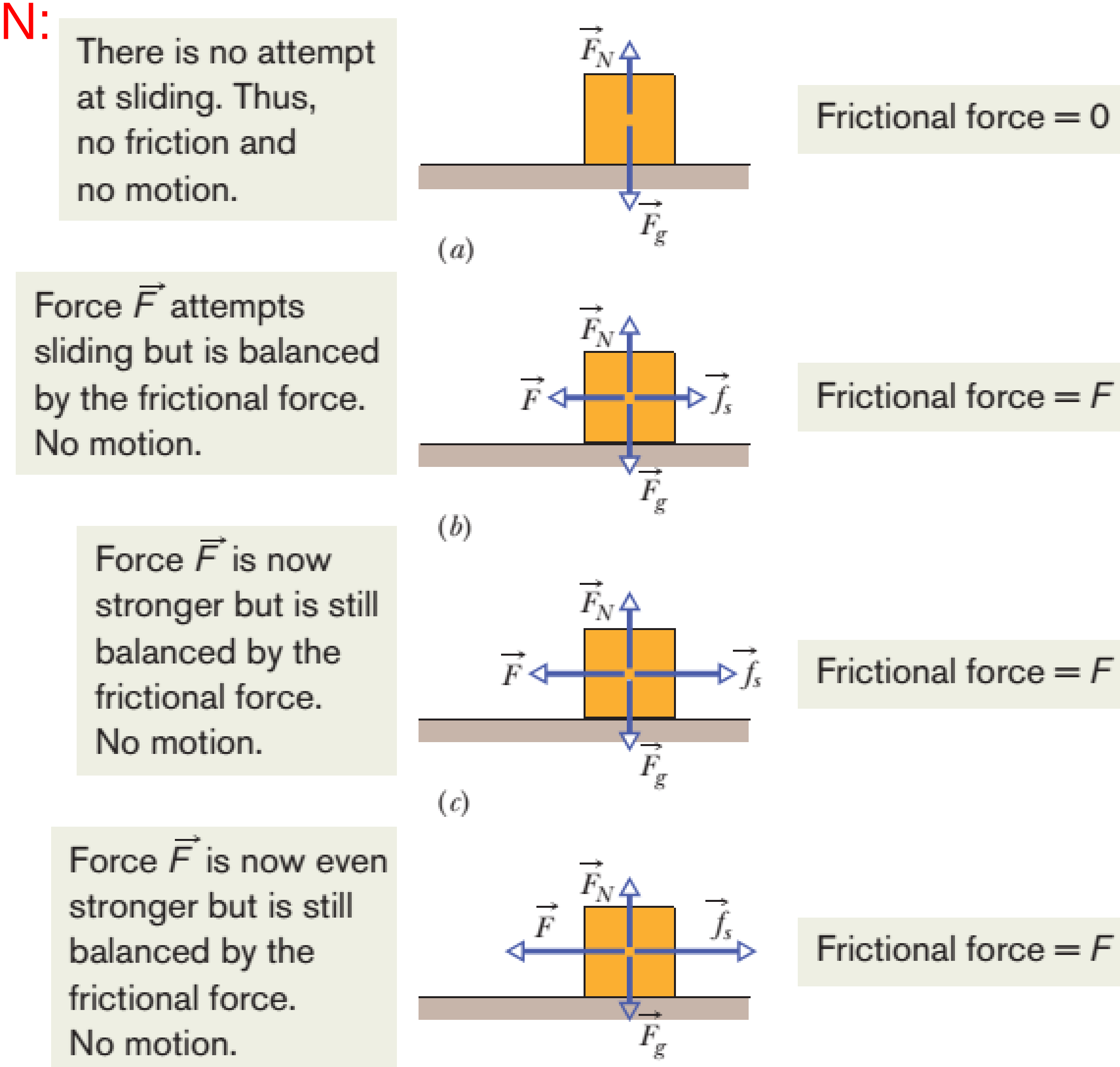


Figure 6-1 (*a*) The forces on a stationary block. (*b–d*) An external force $\vec{F}$, applied to the block, is balanced by a static frictional force $\vec{f}_s$. As F is increased, f_s also increases, until f_s reaches a certain maximum value. (*Figure continues*)

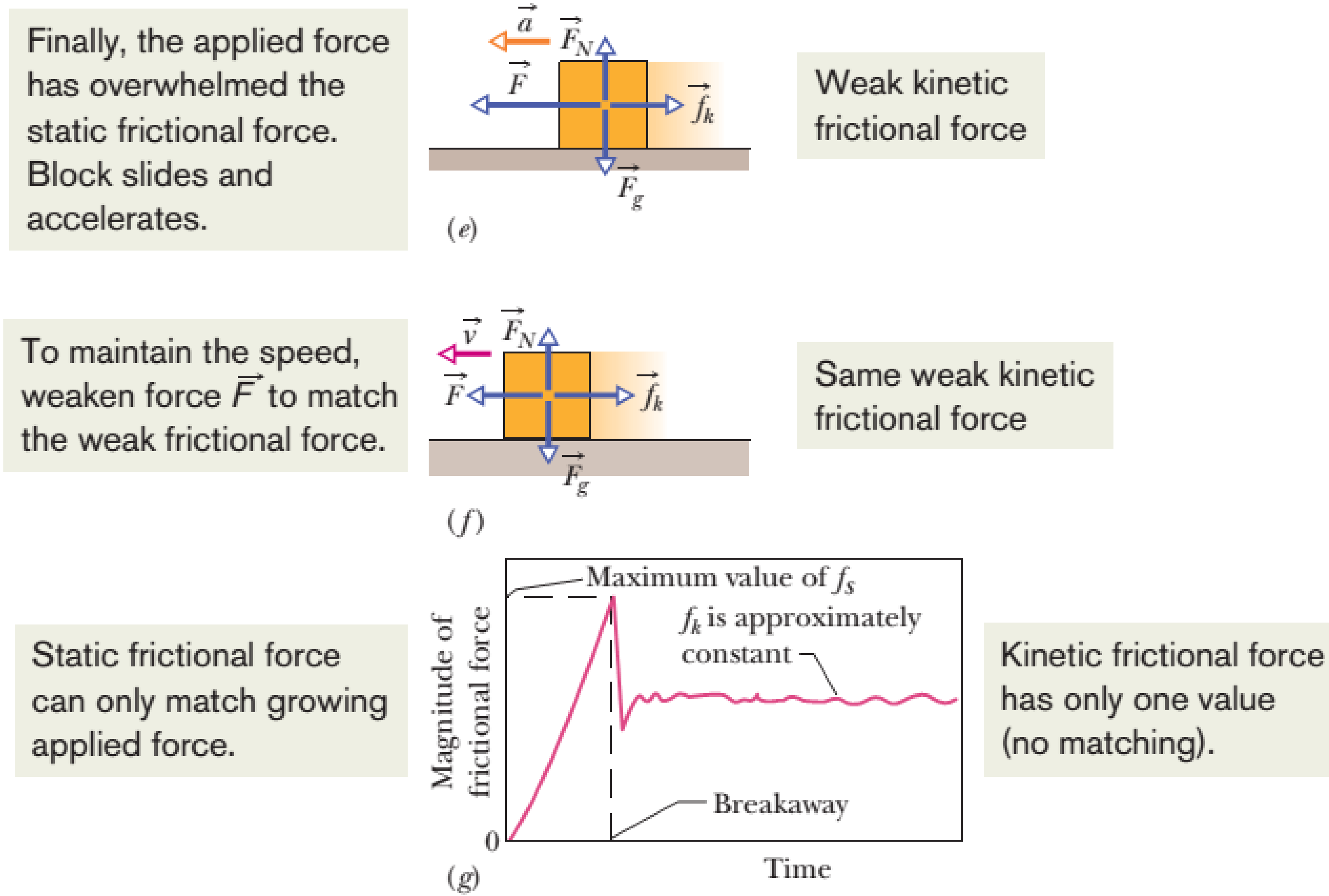


Figure 6-1 (*Continued*) (*e*) Once f_s reaches its maximum value, the block "breaks away," accelerating suddenly in the direction of $\vec{F}$. (*f*) If the block is now to move with constant velocity, F must be reduced from the maximum value it had just before the block broke away. (*g*) Some experimental results for the sequence (*a*) through (*f*). **In *WileyPLUS*, this**

Properties of friction:

Property 1. If the body does not move, then the static frictional force and the component of that is parallel to the surface balance each other. They are equal in magnitude, and is directed opposite that component of F.

Property 2. The magnitude of has a maximum value fs, max that is given by

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

where ms is the coefficient of static friction and FN is the magnitude of the normal force on the body from the surface.
If the magnitude of the component of that is parallel to the surface exceeds fs, max, then the body begins to slide along the surface.

Property 3. If the body begins to slide along the surface, the magnitude of the frictional force rapidly decreases to a value fk given by

$$f_k = \mu_k F_N$$

where mk is the coefficient of kinetic friction.
Thereafter, during the sliding, a kinetic frictional force opposes the motion.

Thank You