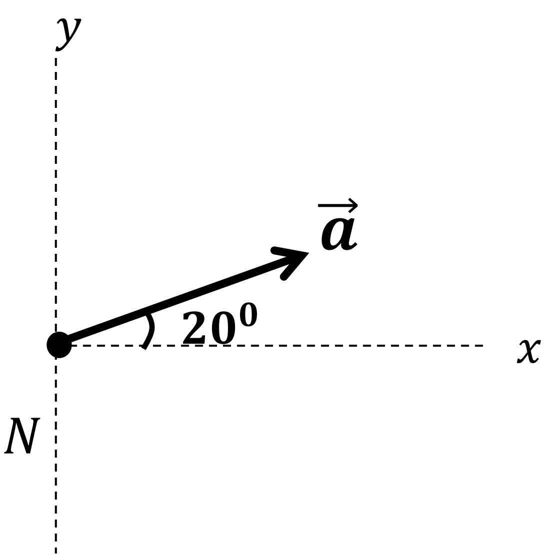
LECTURE 5

BOOK CHAPTER 5
(Force and Motion-I)

Problem 3 (Book chapter 5):

If the 1 kg standard body has an acceleration of 2.00 m/s^2 at 20.0° to the positive direction of an *x* axis, what are (a) the *x* component and (b) the *y* component of the net force acting on the body, and (c) what is the net force in unit-vector notation?



Answer:

(a) The x component acceleration, $a_x = a\cos 20^0$

$$a_x = (2)(0.9397) = 1.879\ m/s^2$$

The x component force, $F_x = ma_x = (1)(1.879) = 1.879\ N$

(b) The y component acceleration, $a_y = a\sin 20^0$

$$a_y = (2)(0.3420) = 0.6840\ m/s^2$$

The y component force, $F_y = ma_y = (1)(0.6840) = 0.6840\ N$

(c) The resultant force (net force) in unit -vector notation,

$$\vec{F} = F_x\hat{\imath} + F_y\hat{\jmath} = 1.879\ \hat{\imath} + 0.684\ \hat{\jmath}$$

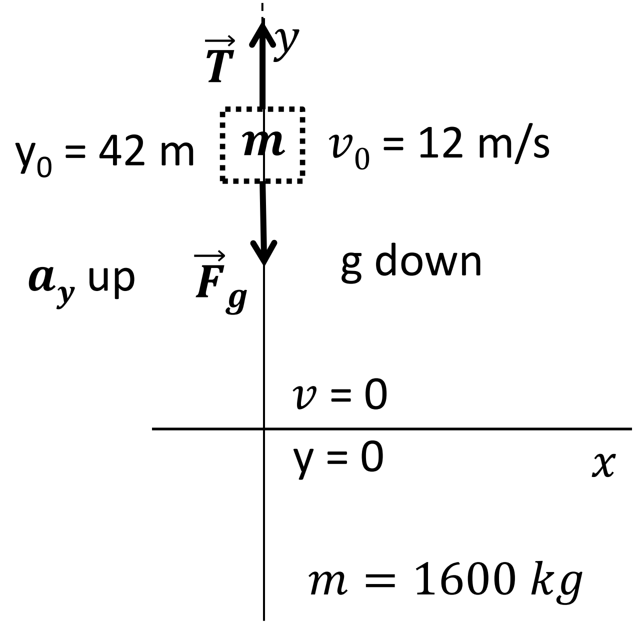
Problem 33 (Book chapter 5): Kabir

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,

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

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

$$0 = 144 - 84a_y$$

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

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

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

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

$$T = 18,422\ N$$

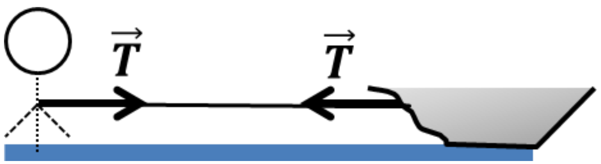
$F_g = mg$

$= 1600(9.8)$

=15680 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) For girl

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) For sled

From Newton's second law,

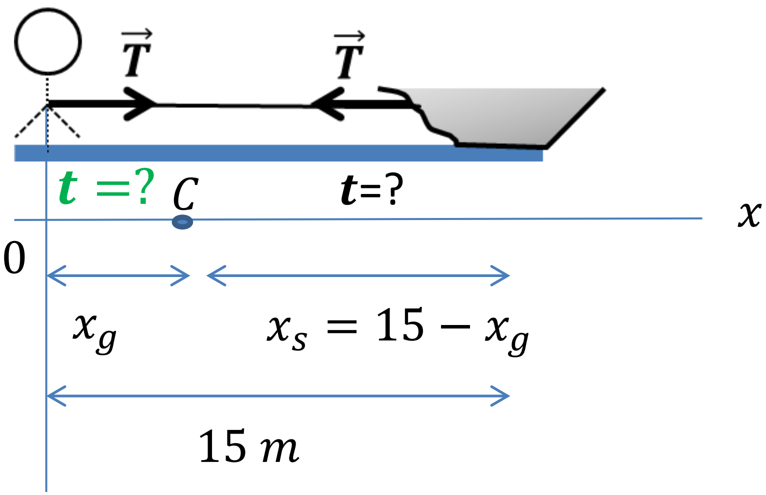
$$\boldsymbol{T = m_s(-a_s)}$$

[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,

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