

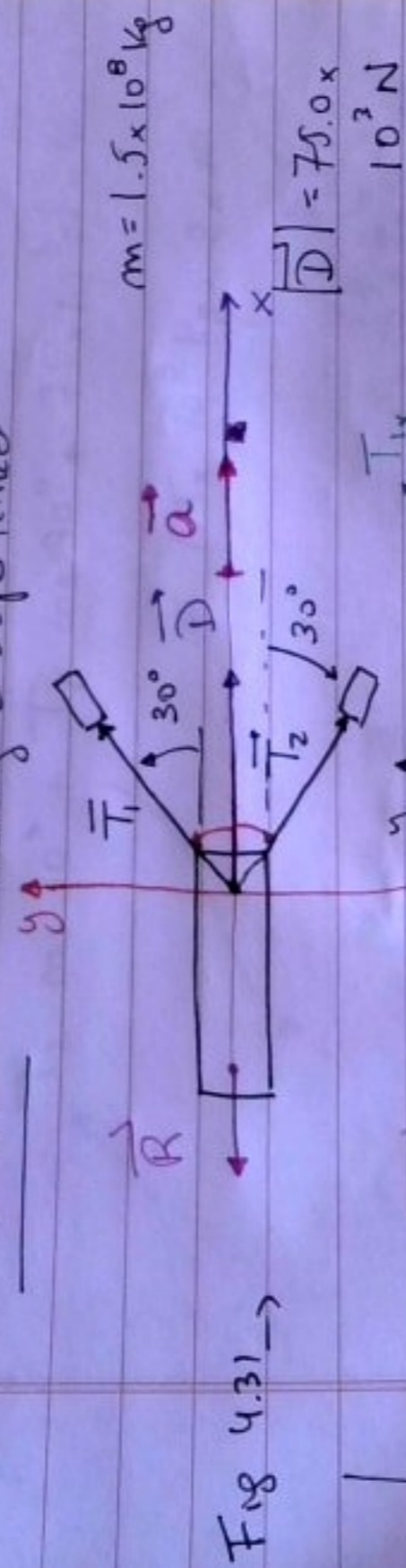
CHAPTER 4

4.12 $\sum \vec{F} = m \vec{a}$

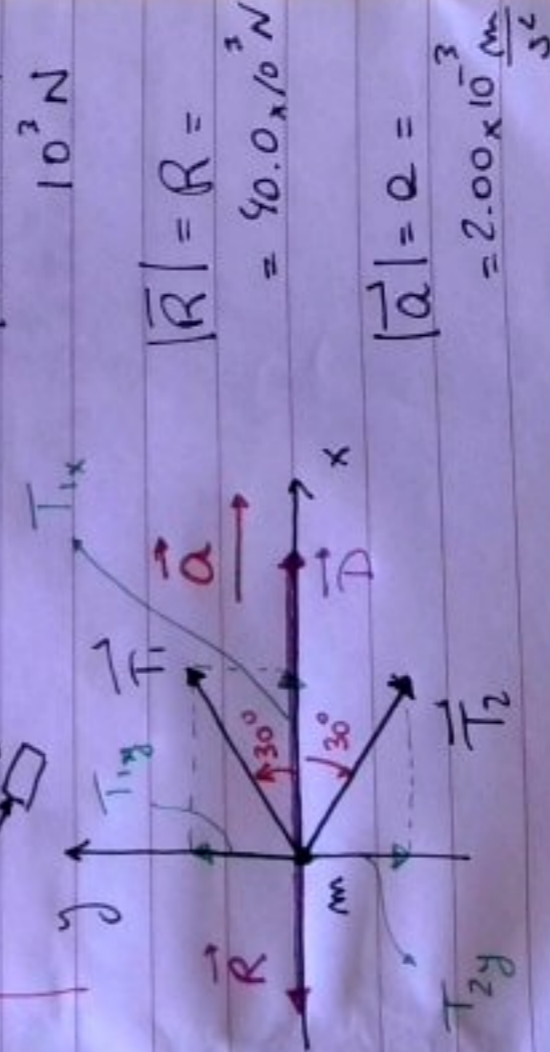
Non-equilibrium

$a \neq 0$

Ex 14 Towing a supertanker



free-body diagram



Find \vec{T}_1, \vec{T}_2

Solve $\begin{cases} |\vec{T}_1| = T_1 \\ |\vec{T}_2| = T_2 \end{cases}$

Force variables $\begin{cases} \vec{T}_1 \\ \vec{T}_2 \end{cases}$ given $\begin{cases} \vec{D} \\ \vec{R} \\ \sum \vec{F} \end{cases}$

$\sum F_x = ma$

$\sum F_y = 0$

x-component	y-component
$+T_1 \cos 30^\circ$	$T_1 \sin 30^\circ$
$+T_2 \cos 30^\circ$	$-T_2 \sin 30^\circ$
$75 \times 10^3 \text{ N}$	0
$-40 \times 10^3 \text{ N}$	0
$\sum F_x = ma$	$\sum F_y = 0$
(2)	(1)

2

$$(1) \quad \Sigma F_y = 0$$

$$T_1 \sin 30^\circ - T_2 \sin 30^\circ = 0$$

$$(T_1 - T_2) = \frac{0}{\sin 30^\circ} = 0 \quad \leftarrow \sin 30^\circ \times (T_1 - T_2) = 0$$

$$(T_1 - T_2) = 0 \quad \Rightarrow \quad T_1 - T_2 = 0 \quad \Rightarrow \quad T_1 = T_2 \quad (1')$$

(2)

$$\begin{aligned} \text{substitute (1')} \\ \text{into (2)} \end{aligned} \quad T_1 \cos 30^\circ + T_2 \cos 30^\circ + 75 \times 10^3 \text{ N} - 40 \times 10^3 \text{ N} =$$

$$= 1.5 \times 10^8 \text{ kg} \times 2 \times 10^{-3} \text{ m/s}^2$$

$$2 T_1 \cos 30^\circ + 35 \times 10^3 \text{ N} = 1.5 \times 10^8 \times 2 \times 10^{-3} \text{ N}$$

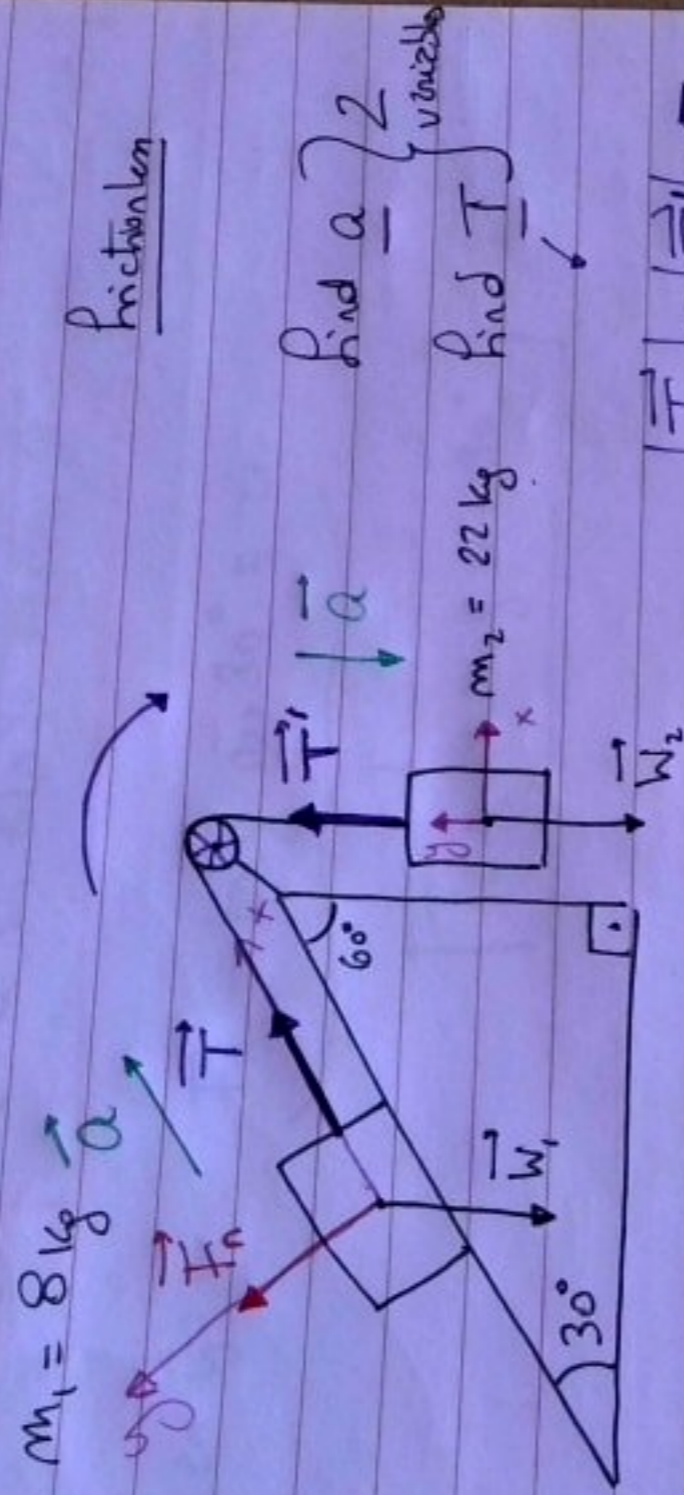
$$T_1 = 1.53 \times 10^5 \text{ N} = T_2$$

$$2 \times T_1 \cos 30^\circ + 35 \times 10^3 \text{ N} = 3 \times 10^5 \text{ N}$$

$$\begin{aligned} 2 T_1 \cos 30^\circ &= 3 \times 10^5 \text{ N} - 35 \times 10^3 \text{ N} \\ T_2 = T_1 &= \frac{3 \times 10^5 \text{ N} - 35 \times 10^3 \text{ N}}{2 \times \cos 30^\circ} = 1.53 \times 10^5 \text{ N} \end{aligned}$$

3

Ex 18. Accelerating blocks.

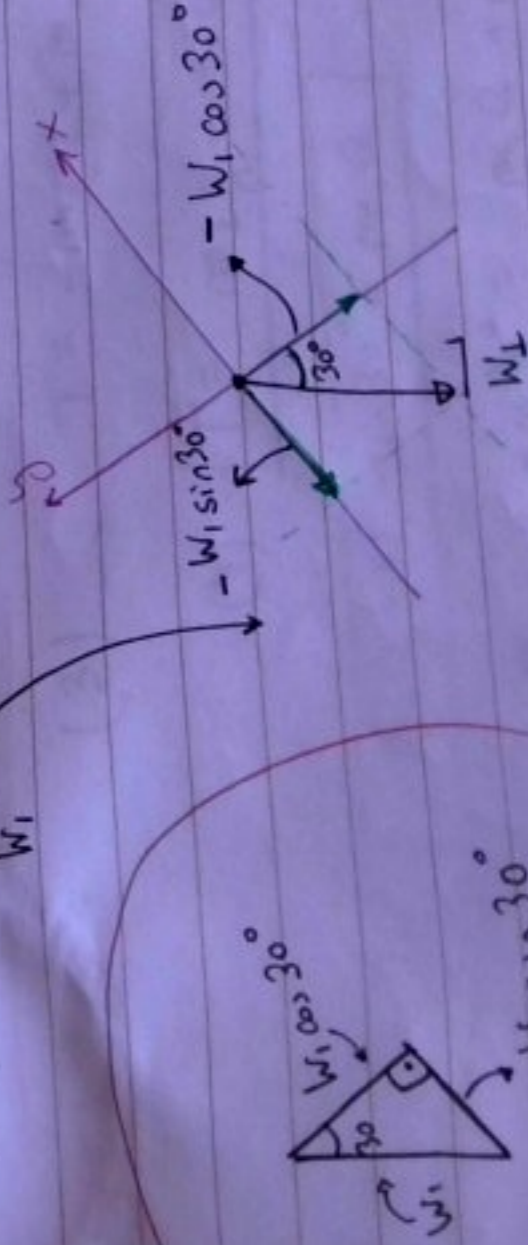
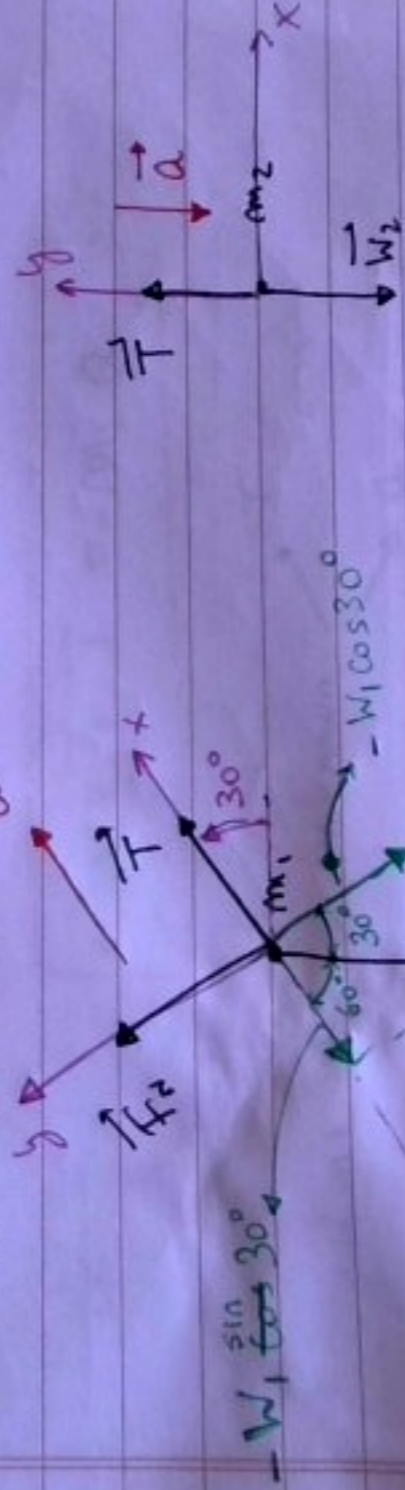


Frictionless

bind a } 2
 variables

$$|\vec{T}| = |\vec{T}'| = T$$

free-body diagram



For m_1 :

[4]

(1) in \hat{x} : $T - W_1 \sin 30^\circ = +m_1 a$

$$W_1 = m_1 g$$

$$W_2 = m_2 g$$

in \hat{y} :

$$F_N - m_1 g \cos 30^\circ = 0$$

(2)

$$F_N = +m_1 g \cos 30^\circ$$

For m_2 :

(3) in \hat{y} :

$$-m_2 g + T = -m_2 a$$

2 equations + 2 unknown $\begin{matrix} \nearrow T \\ \searrow a \end{matrix}$

Eq (1) - Eq (3)

substitution: (3) \rightarrow $T = -m_2 a + m_2 g$

$$(4) \quad T = m_2 g - m_2 a$$

(4) \rightarrow (1)

$$m_2 g - m_2 a - W_1 \sin 30^\circ = m_1 a$$

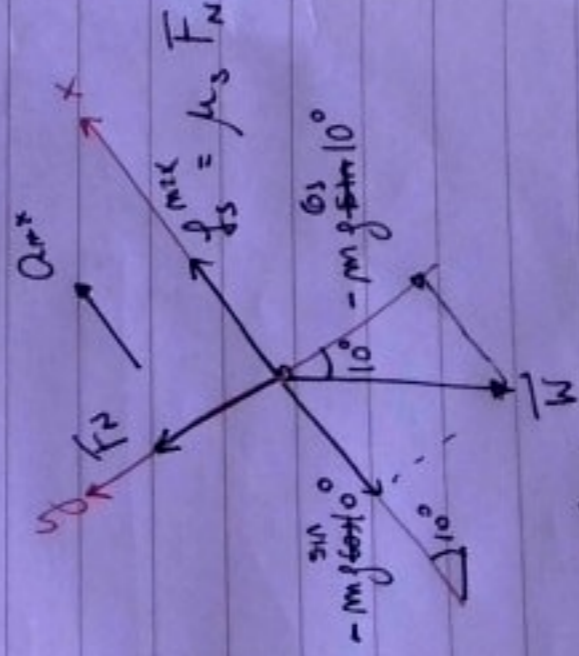
$$m_2 g - m_1 g \sin 30^\circ = m_1 a + m_2 a = (m_1 + m_2) a$$

$$g (m_2 - m_1 \sin 30^\circ) = (m_1 + m_2) \cdot a$$

$$a = g \left(\frac{m_2 - m_1 \sin 30^\circ}{m_1 + m_2} \right) = 5.89 \text{ m/s}^2$$

$$T = m_2 g - m_2 a = m_2 (g - a) = 86.3 \text{ N}$$

Ex 17



$$F_N = mg \cos 10^\circ \Rightarrow f_s^{\max} = \mu_s mg \cos 10^\circ$$

$$-mg \sin 10^\circ + \mu_s mg \cos 10^\circ = m a_{\max}$$

$$a_{\max} = g (\mu_s \cos 10^\circ - \sin 10^\circ) = 1.68 \text{ m/s}^2$$

Chapter 5

6

S.1, S.2, S.3, S.4, S.5, S.7

↓
maybe.