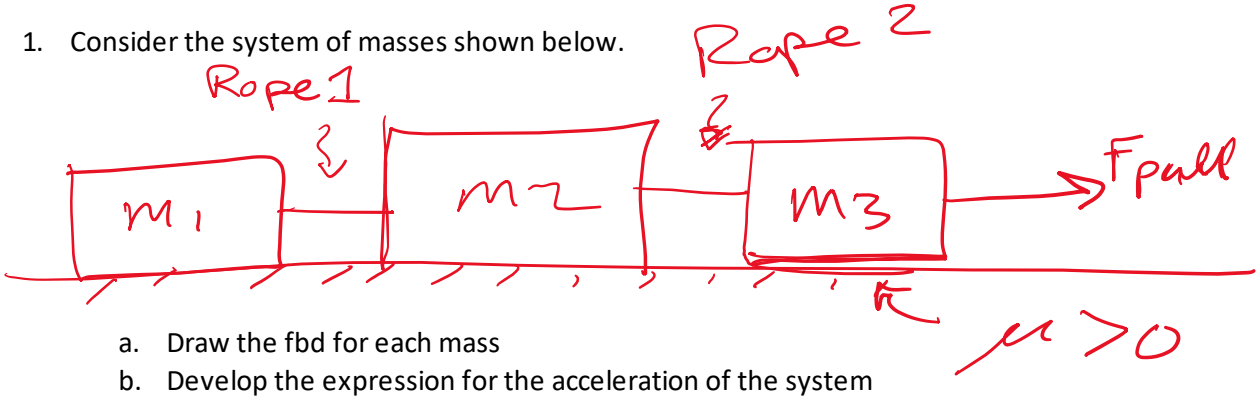
Warm-up practice: Dynamics – Systems of Masses

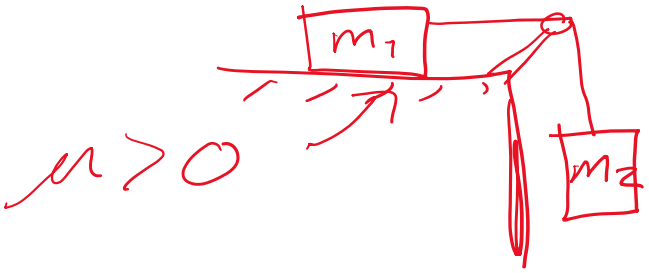
Warm-up practice problems (after the lesson on "example situation # 1 to 8" from the "Analysis of Systems of Masses" lesson/worksheet

1. Consider the system of masses shown below.



   a. Draw the fbd for each mass
   b. Develop the expression for the acceleration of the system
   c. Develop the expression for F_{T1}
   d. Develop the expression for F_{T2}

2. Consider the system of masses shown below.



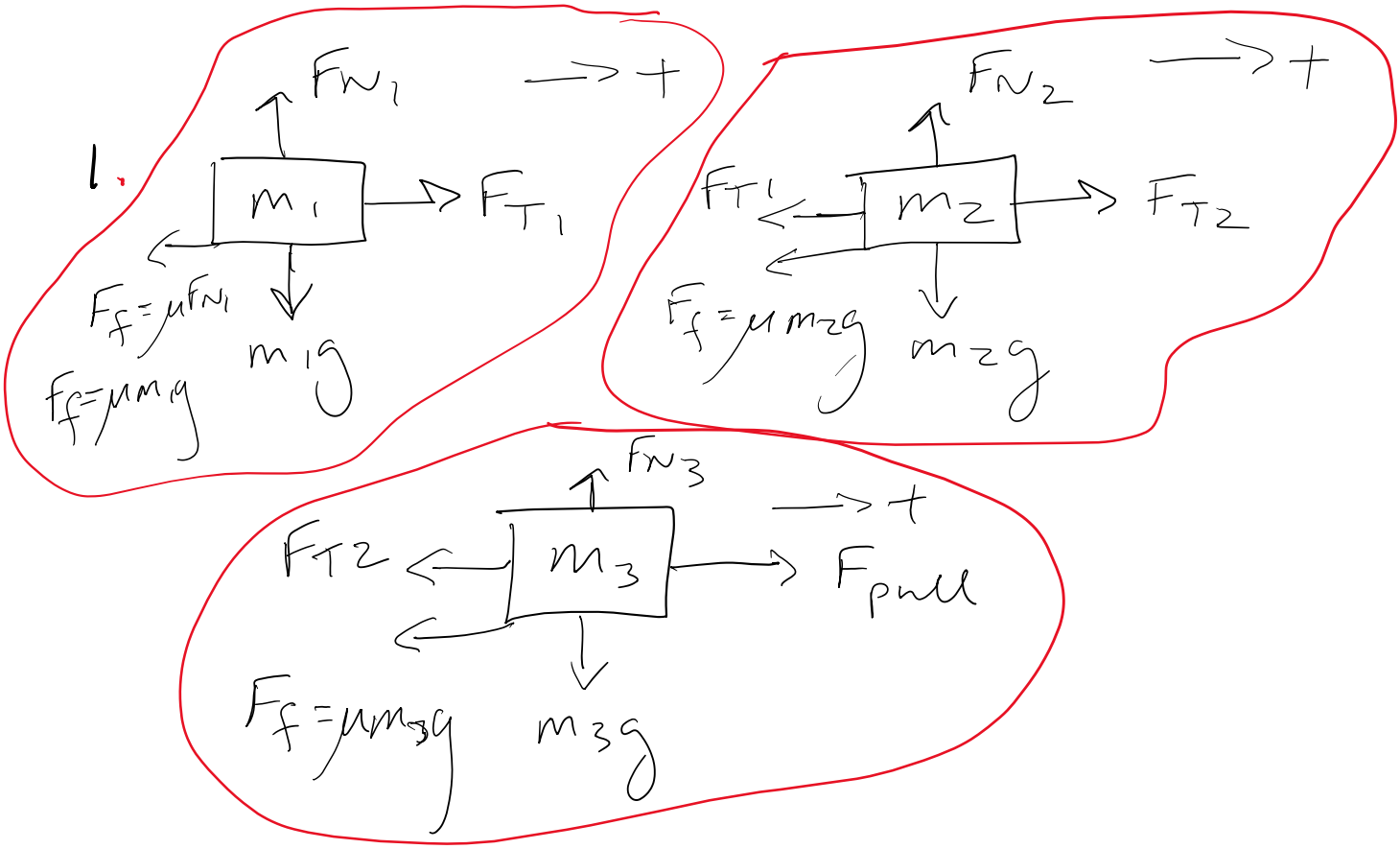
   a. Draw the fbd for each mass
   b. Develop the expression for the acceleration of the system

For (c) to (e) use: $m_1 = 6.0$ kg; $m_2 = 5.0$ kg

   c. Determine the value of μ_s for which the system will just barely remain at rest
   d. Determine the acceleration of the system if $\mu_k = 0.50$
   e. Determine the value of F_T if $\mu_k = 0.50$

Answer Key – for Dynamics Systems of masses warm-up (relevant to "Example situation #1 to 8")

1.



(b) $\sum F_1 = m_1 a = F_{T_1} - \mu m_1 g$

$\sum F_2 = m_2 a = F_{T_2} - F_{T_1} - \mu m_2 g$

$\sum F_3 = m_3 a = F_{pull} - F_{T_2} - \mu m_3 g$

Sum $m_1 a + m_2 a + m_3 a = F_{pull} - \mu m_1 g - \mu m_2 g - \mu m_3 g$

$$\vec{a} = \frac{F_{pull} - \mu g (m_1 + m_2 + m_3)}{m_1 + m_2 + m_3}$$

(c) using eq'n for ΣF_1

$$F_{T1} = m_1 a + \mu m_1 g$$

$$\therefore \boxed{F_{T1} = m_1 (a + \mu g)}$$

(d) using eq'n for F_2

$$F_{T2} = m_2 a + F_{T1} + \mu m_2 g$$

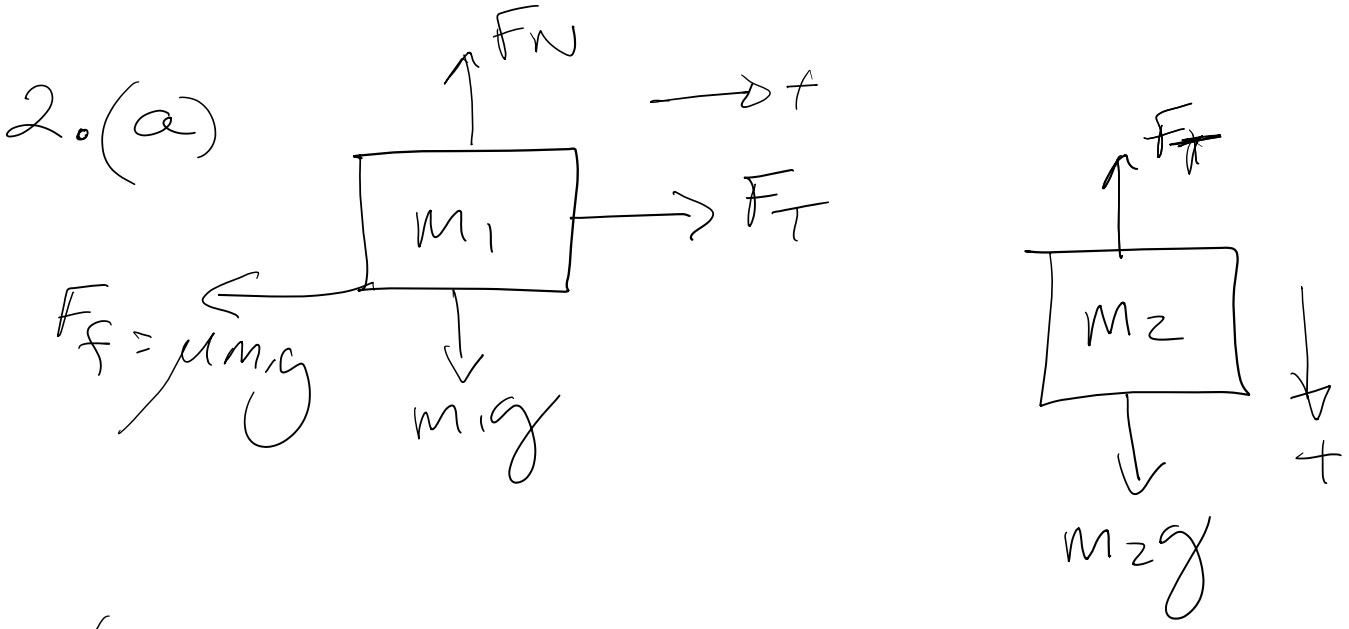
substitution

$$F_{T2} = m_2 a + (m_1 a + \mu m_1 g) + \mu m_2 g$$

$$\boxed{F_{T2} = a(m_1 + m_2) + \mu (m_1 + m_2) g}$$

note this is the total mass that Rope 2 is pulling

2.(a)



(b) $\sum F_1 = m_1 a = F_T - \mu m_1 g$

$\sum F_2 = m_2 a = m_2 g - F_T$

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sum $m_1 a + m_2 a = m_2 g - \mu m_1 g$

$\therefore \vec{a} = \dfrac{g(m_2 - \mu m_1)}{m_1 + m_2}$

(c) if $\vec{a} = 0$

then $m_2 - \mu m_1 = 0$

(numerator of eq'n)

$\therefore m_2 - \mu m_1 = 0$

$\therefore \mu_s = \dfrac{m_2}{m_1} = \dfrac{5.0}{6.0} =$ **0.83**

(d) if $\mu_K = 0.50$

$$\vec{a} = \frac{g(m_2 - \mu m_1)}{m_1 + m_2}$$

$$= \frac{(9.8)(5 - 0.5 \times 6)}{6 + 5} = 1.781818\ldots$$

$$\boxed{\vec{a} = +1.8\,m/s^2}$$ (m_2 $\vec{a}$ down, m_1 $\vec{a}$ to right)

(e) from eq'n for F_2

$$F_T = m_2 g - m_2 a = m_2(g - a)$$

$$= (5.0\,kg)(9.8 - 1.781818\ldots)$$

$$\boxed{F_T = 4.0 \times 10^1\,N}$$