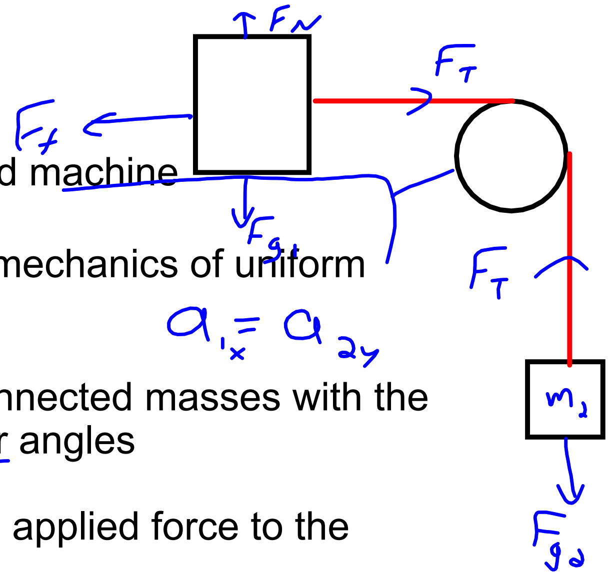
Fletcher Apparatus



- Very similar in design to the Atwood machine
- It was also designed to study the mechanics of uniform acceleration.

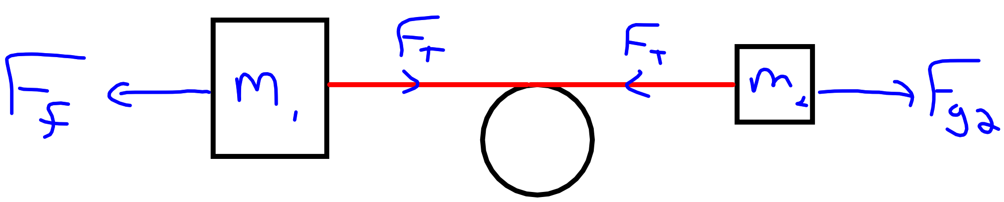
$a_{1x} = a_{2y}$

- The simple design involves two connected masses with the same acceleration at perpendicular angles
- This design was able to control the applied force to the horizontal mass

- Important points to remember:

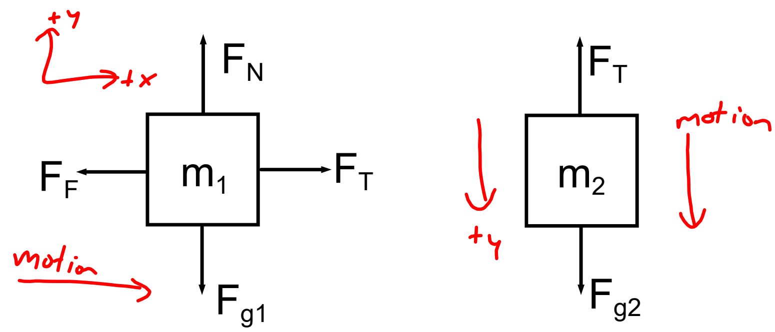
1. Rope and Pulley massless/frictionless so no Forces used to make them move
2. Pulley only acts to change direction/orientation of Tension in rope
3. Objects are still connected so they have the same magnitude of acceleration - perpendicular direction though

- Can re-imagine or model the setup as if it acts in a straight line
  > From this it is more obvious that the internal forces (tension) cancel out and don't contribute to system motion



$$F_{Net,sys} = F_{g2} - F_f = m_{sys} a_{sys}$$

Basic FBD of Fletcher Apparatus (No other applied Forces)



$$F_{Net,2} = F_{g2} - F_T = m_2 a_{2y} \rightarrow F_T = F_{g2} - m_2 a_2$$

$$F_{Net,1,y} = F_N - F_{g1} = m a_{y1} = 0\ N$$

$$F_N = F_{g1}$$

$$F_{Net,1,x} = F_T - F_f = m_1 a_{1x}$$

$$F_{g2} - m_2 a_2 - \mu F_{g1} = m_1 a_1$$

$$m_2 g - \mu m_1 g = m_1 a_1 + m_2 a_2$$

$$g(m_2 - \mu m_1) = (m_1 + m_2) a_{sys}$$

$$\boxed{a_{sys} = \frac{(m_2 - \mu m_1)}{(m_1 + m_2)} g}$$

if μ is large enough (more friction)

$\mu m_1 > m_2$, therefore a_{sys} is "−"

but a_{sys} cannot be "−" only "+" or zero

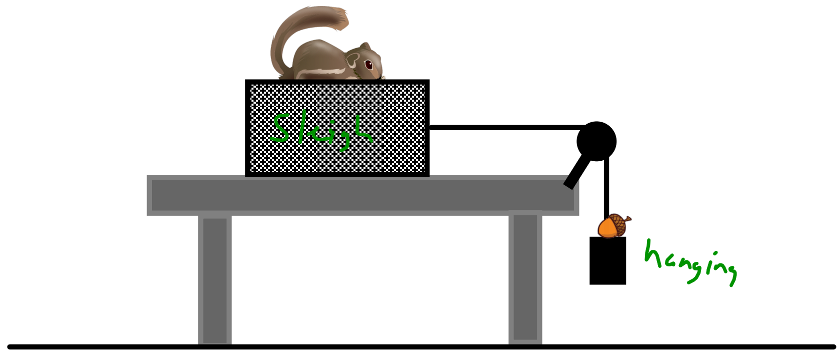
When $\mu m_1 > m_2$, too much friction to move

as long as $m_2 > \mu m_1$ it will move

Modified Fletcher Apparatus

Ex. 3

Sleigh and its load has a mass of 1.10 kg. The sleigh is resting on a horizontal wood table. Suppose the coefficient of kinetic friction between the block and wood is 0.185. The sleigh is attached to a 300. g mass by a string. The string is supported on a pulley allowing the 300. g mass to suspended in the air. What is the acceleration of the system when it is released from rest?



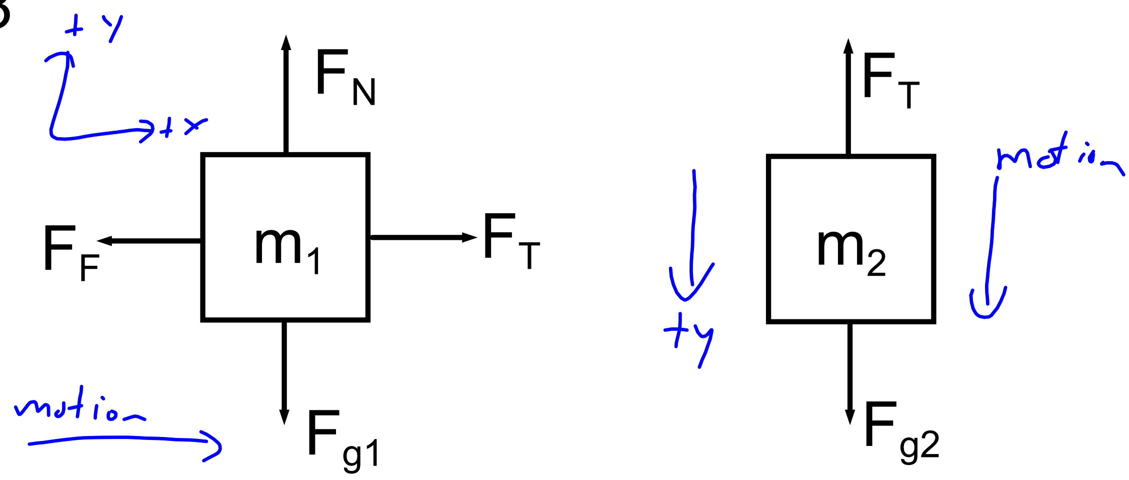
Ex. 4

A wood sleigh of total mass 300. g is resting on a desk. The coefficient of kinetic friction for the wood on the desk is 0.365. The sleigh is connected by a string over a pulley. Being held at rest is a suspended mass. When the mass is released, the sleigh accelerates 0.115 m/s^2 [E]. $\vec{a}$,

a) What is the mass of the suspended object?
b) What is the tension in the string?

Do Practice Problems 24-26 on Page 488

Ex 3



$m_1 = 1.10\ kg$

$m_2 = 300.\ g$

$\mu_k = 0.185$

$\vec{g} = 9.81\ m/s^2$ [down]

$\vec{a}_{1y} = 0\ m/s^2$

$a_{sys} = ?$

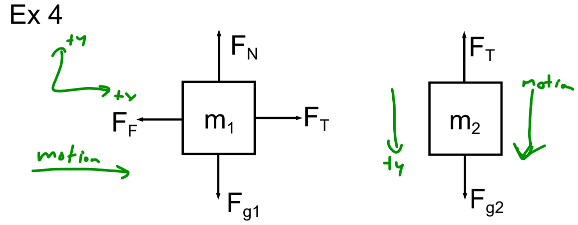
Same setup as previous page

$$a_{sys} = \left(\frac{m_2 - \mu_k m_1}{m_1 + m_2}\right) g$$

$$= \frac{\left(\overset{0.0965}{0.300\ kg - (0.185)(1.10\ kg)}\right)}{0.300\ kg + 1.10\ kg}\left(9.81\ m/s^2\right)$$

$$= 0.6762\ m/s^2 = \boxed{0.68\ m/s^2}$$

Ex 4



$m_1 = 300\,g$

$\mu_k = 0.365$

$\vec{g} = 9.81\,m/s^2\,(down)$

$a_{sys} = 0.115\,m/s^2$

$\vec{a}_{1y} = 0\,m/s^2$

$\vec{a}_{1x} = 0.115\,m/s^2\,(E)$

$m_2 = ?$

$F_T = ?$

Same setup as previous page

$$a_{sys} = \left(\frac{m_2 - \mu m_1}{m_1 + m_2}\right) g$$

$$(m_1 + m_2) a_{sys} = (m_2 - \mu m_1) g$$

$$m_1 a_{sys} + m_2 a_{sys} = m_2 g - \mu m_1 g$$

$$m_1 a_{sys} + \mu m_1 g = m_2 g - m_2 a_{sys}$$

$$\frac{m_1 (a_{sys} + \mu g)}{g - a_{sys}} = \frac{m_2 \cancel{(g - a_{sys})}}{\cancel{(g - a_{sys})}}$$

$$m_2 = m_1 \frac{(a_{sys} + \mu g)}{(g - a_{sys})}$$

$$= (0.300\,kg) \frac{(0.115\,m/s^2 + (0.365)(9.81\,m/s^2))}{(9.81\,m/s^2 - 0.115\,m/s^2)}$$

$$= 0.11439\,kg$$

$$= 0.114\,kg$$

b) $F_{Net,2} = F_{g2} - F_T = m_2 a_2$

$$F_T = F_{g2} - m_2 a_2$$

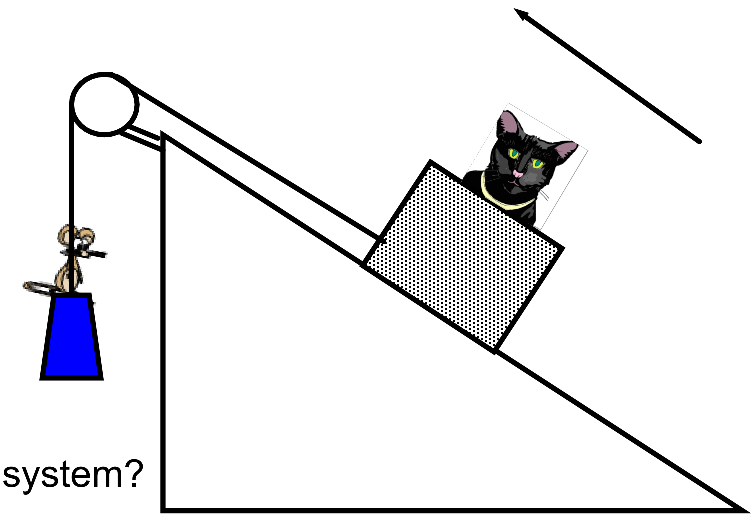
$$= m_2 (g - a_{sys})$$

$$= (0.1143)(9.81\,m/s^2 - 0.115\,m/s^2)$$

$$= 1.10816\,N$$

$$= \boxed{1.11\,N}$$

Connected Systems on Inclined Planes



suspended mass = 4.25 kg
box mass = 6.35 kg

$\theta = 30.$ degrees

$\mu = 0.152$

What is the acceleration of the system?

Ans: $a_{sys} = 0.22\ m/s^2$

Do Practice Problems 27-28 on Page 488

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