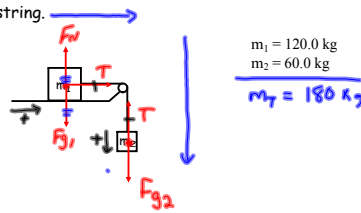


Section 2.3 Strings and Pulleys

1. Assume the desktop is frictionless. Compute the acceleration of the system and the tension in the string.



$$m_1 = 120.0 \text{ kg}$$

$$m_2 = 60.0 \text{ kg}$$

$$m_T = 180 \text{ kg}$$

$$F_{\text{net,sys}} = F_{g2}$$

$$m_T a = m_2 g$$

$$(180 \text{ kg}) a = (60 \text{ kg})(9.8 \text{ m/s}^2)$$

$$a = 3.27 \text{ m/s}^2$$

Tension: Use 1 block only.

Let's use  $m_1$ .

$$F_{\text{net}1} = T$$

$$m_1 a = T$$

$$(120 \text{ kg})(3.27 \text{ m/s}^2) = T$$

$$392 \text{ N} = T$$

If we used block 2.

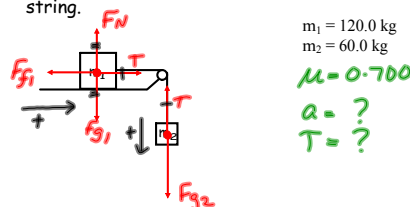
$$F_{\text{net}2} = T + F_{g2}$$

$$m_2 a = T + m_2 g$$

$$(60 \text{ kg})(3.27 \text{ m/s}^2) = T + (60 \text{ kg})(9.8 \text{ m/s}^2)$$

$$-200.1 = T$$

2. Assume that the coefficient of friction between the desktop and the 120.0 kg block is 0.700. Compute the acceleration of the system and the tension in the string.



$$m_1 = 120.0 \text{ kg}$$

$$m_2 = 60.0 \text{ kg}$$

$$\mu = 0.700$$

$$a = ?$$

$$T = ?$$

$$F_{\text{net,sys}} = F_{g2} - F_{f1}$$

$$m_T a = m_2 g - \mu m_1 g \quad \text{b/c } F_N = F_g$$

$$(180 \text{ kg}) a = (60 \text{ kg})(9.8 \text{ m/s}^2) - (0.700)(120 \text{ kg})(9.8 \text{ m/s}^2)$$

$$a = -1.3 \text{ m/s}^2$$

Acceleration of this system cannot be negative. The system is in fact at rest.

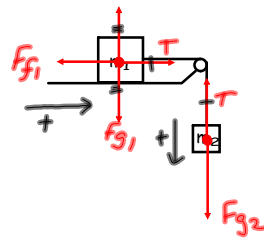
$$F_{g2} = m_2 g = (60 \text{ kg})(9.8 \text{ m/s}^2) = 588 \text{ N}$$

$$F_{f1} = \mu m_1 g = (0.700)(120 \text{ kg})(9.8 \text{ m/s}^2) = 823 \text{ N}$$

$F_f > F_g$ , so the blocks will not move.

The tension in the string is due to the force of gravity acting on  $m_2$ . So, the Tension is 588 N.

3. Assume that the coefficient of friction between the desktop and the 120.0 kg block is a realistic 0.400. Compute the acceleration of the system and the tension in the string.



$$m_1 = 120.0 \text{ kg}$$

$$m_2 = 60.0 \text{ kg}$$

$$\mu = 0.400$$

$$a = ?$$

$$T = ?$$

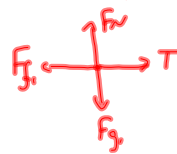
$$F_{\text{net sys}} = F_{g2} - f_{f1}$$

$$m_1 a = m_2 a - \mu m_1 g \quad F_N = F_g$$

$$(120 \text{ kg}) a = (60 \text{ kg})(9.8 \text{ m/s}^2) - (0.400)(120 \text{ kg})(9.8 \text{ m/s}^2)$$

$$a = 0.653 \text{ m/s}^2$$

use  $m_1$



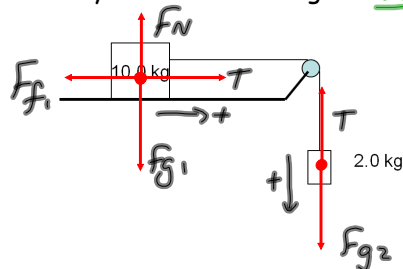
$$F_{\text{net } 1} = T - F_{f1}$$

$$m_1 a = T - \mu m_1 g$$

$$(120 \text{ kg})(0.653 \text{ m/s}^2) = T - (0.4)(120 \text{ kg})(9.8 \text{ m/s}^2)$$

$$\underline{549 \text{ N} = T}$$

4. What coefficient of friction would prevent the system from moving? MC



$$F_{\text{net}} = F_{g2} - F_{f1}$$

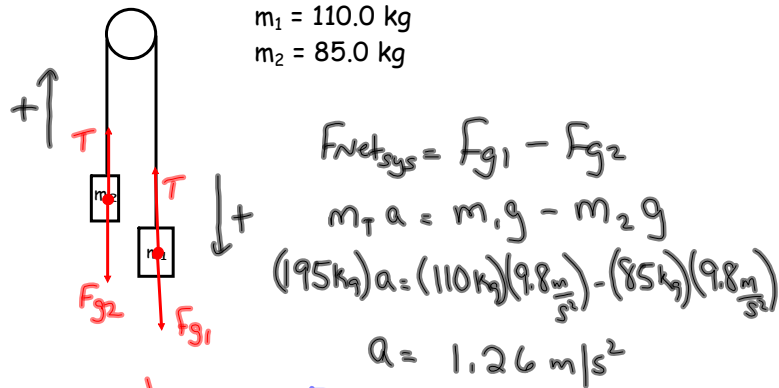
$$0 = m_2 g - \mu m_1 g$$

$$\frac{\mu m_1 g}{m_1 g} = \frac{m_2 g}{m_1 g}$$

$$\mu = \frac{m_2}{m_1} = \frac{2.0 \text{ kg}}{10.0 \text{ kg}} = 0.20$$

always true

5. If the pulley wheel provides no friction, determine the acceleration of the system and the tension in the string.



Atwood's Machine

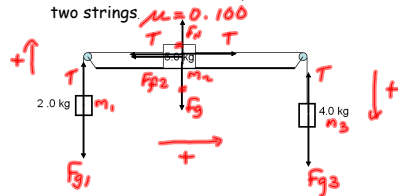
Note

$$m_T a = m_1 g - m_2 g$$

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

$$a = \left( \frac{m_1 - m_2}{m_1 + m_2} \right) g$$

6. Assuming that the tabletop is frictionless determine the acceleration of the system and the tension in the two strings.



$$F_{net,sys} = F_{g3} - F_{g1} - F_{p2}$$

$$m_T a = m_3 g - m_1 g - \mu m_2 g \quad (F_N = F_g)$$

$$(11 \text{ kg}) a = (4 \text{ kg})(9.8 \frac{\text{m}}{\text{s}^2}) - (2 \text{ kg})(9.8 \frac{\text{m}}{\text{s}^2}) - (0.10)(5 \text{ kg})(9.8 \frac{\text{m}}{\text{s}^2})$$

$$a = 1.3 \text{ m/s}^2$$

Block 1

$$F_{net1} = T - F_{g1}$$

$$m_1 a = T - m_1 g$$

$$(2 \text{ kg})(1.3 \text{ m/s}^2) = T - (2 \text{ kg})(9.8 \text{ m/s}^2)$$

$$22.2 \text{ N} = T$$

$$22 \text{ N} = T$$

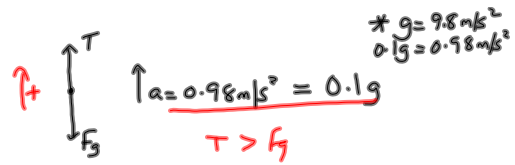
Block 3

$$F_{net3} = T + F_g$$

$$m_3 a = T + m_3 g$$

$$(4 \text{ kg})(1.3 \text{ m/s}^2) = T + (4 \text{ kg})(9.8 \text{ m/s}^2)$$

$$-34 \text{ N} = T$$



$$F_{\text{net}} = T - F_g$$

$$ma = T - mg$$

$$M(0.1g) = T - mg$$

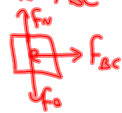
$$0.1mg + mg = T$$

$$1.1mg = T$$



$$a = \frac{F_{\text{net}}}{m_T} = \frac{34 \text{ N}}{17 \text{ kg}} = 2 \text{ m/s}^2$$

Find  $F_{BC}$



$$F_{\text{net}} = F_{BC}$$

$$m_c a = F_{BC}$$

$$(10 \text{ kg})(2) = F_{BC}$$

$$20 \text{ N} = F_{BC}$$