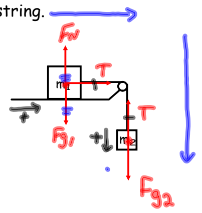
Section 2.3 Strings and Pulleys

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

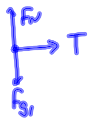


$m_1 = 120.0$ kg
$m_2 = 60.0$ kg
$m_T = 180$ kg

$$F_{Net\,sys} = F_{g2}$$
$$m_T a = m_2 g$$
$$(180\,kg)a = (60\,kg)(9.8\,m/s^2)$$
$$a_{sys} = 3.27\,m/s^2$$

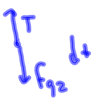
Tension: Use 1 block only.

Let's use m_1.



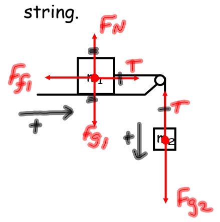
$$F_{Net1} = T$$
$$m_1 a = T$$
$$(120\,kg)(3.27\,m/s^2) = T$$
$$392\,N = T$$

If we used block 2.



$$F_{Net2} = T + F_{g2}$$
$$m_2 a = T + m_2 g$$
$$(60\,kg)(3.27\,m/s^2) = T + (60\,kg)(9.8\,m/s^2)$$
$$-392\,N = T$$

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.



$m_1 = 120.0$ kg
$m_2 = 60.0$ kg
$\mu = 0.700$
$a = ?$
$T = ?$

$$F_{Net\,sys} = F_{g2} - F_{f1}$$
$$m_T a = m_2 g - \mu m_1 g \qquad b/c\ F_N = F_g$$
$$(180\,kg)a = (60\,kg)(9.8\,m/s^2) - (0.700)(120\,kg)(9.8\,m/s^2)$$
$$a = -1.3\,m/s^2$$

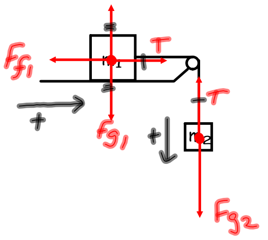
Acceleration of this system cannot be negative. The system is in fact at rest.

$$F_{g2} = m_2 g = (60\,kg)(9.8\,m/s^2) = 588\,N$$
$$F_{f1} = \mu m_1 g = (0.700)(120\,kg)(9.8\,m/s^2) = 823\,N$$

$F_f > F_g$, 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 588N.

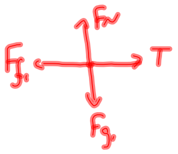
3. Assume that the coefficient of friction between the desktop and the 120.0 kg block is a realistic 0.400. Compute the acceleration of the system and the tension in the string.



$m_1 = 120.0$ kg
$m_2 = 60.0$ kg
$\mu = 0.400$
$a = ?$
$T = ?$

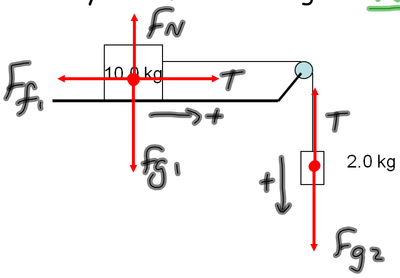
$$F_{Net\,sys} = F_{g2} - F_{f1}$$
$$m_T a = m_2 a - \mu m_1 g \qquad F_N = F_g$$
$$(180\text{kg})a = (60\text{kg})(9.8\text{m/s}^2) - (0.400)(120\text{kg})(9.8\text{m/s}^2)$$
$$a = 0.653\text{m/s}^2$$

use m_1



$$F_{Net1} = T - F_{f1}$$
$$m_1 a = T - \mu m_1 g$$
$$(120\text{ kg})(0.653\text{m/s}^2) = T - (0.4)(120\text{kg})(9.8\tfrac{\text{m}}{\text{s}^2})$$
$$\underline{549N = T}$$

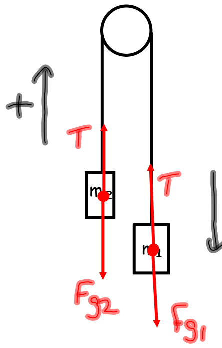
4. What coefficient of friction would prevent the system from moving? MC



$$F_{Net} = F_{g2} - F_{f1}$$
$$0 = m_2 g - \mu m_1 g$$
$$\frac{\mu \cancel{m_1} \cancel{g}}{\cancel{m_1} g} = \frac{m_2 \cancel{g}}{m_1 \cancel{g}}$$
$$\mu = \frac{m_2}{m_1} = \frac{2.0\text{kg}}{10.0\text{kg}} = 0.20$$

always true

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



$m_1 = 110.0$ kg
$m_2 = 85.0$ kg

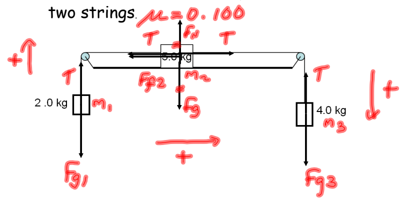
$$F_{net_{sys}} = F_{g1} - F_{g2}$$
$$m_T a = m_1 g - m_2 g$$
$$(195\,kg)a = (110\,kg)(9.8\tfrac{m}{s^2}) - (85\,kg)(9.8\tfrac{m}{s^2})$$
$$a = 1.26\ m/s^2$$

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. $\mu = 0.100$



$$F_{net\,sys} = F_{g3} - F_{g1} - F_{f2}$$
$$m_T a = m_3 g - m_1 g - \mu m g \quad (F_N = F_g)$$
$$(11\,kg)a = (4\,kg)(9.8\tfrac{m}{s^2}) - (2\,kg)(9.8\tfrac{m}{s^2}) - (0.10)(5\,kg)(9.8\tfrac{m}{s^2})$$
$$a = 1.3\ m/s^2$$

Block 1

T, +, $m_1 = 2\,kg$, F_{g1}

$$F_{net1} = T - F_{g1}$$
$$m_1 a = T - m_1 g$$
$$(2\,kg)(1.3\,m/s^2) = T - (2\,kg)(9.8\,m/s^2)$$
$$22.2\,N = T$$
$$22\,N = T$$

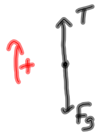
Block 3

T, +, $m_3 = 4\,kg$, F_{g3}

$$F_{net3} = T + F_g$$
$$m_3 a = T + m_3 g$$
$$(4\,kg)(1.3\,m/s^2) = T + (4\,kg)(9.8\,m/s^2)$$
$$\underline{-34\,N = T}$$

Homework: Page 202 1 (a)
Page 225 11 (a) and (b) for pictures (a) and (b), 12 - 14

$* \; g = 9.8\,m/s^2$
$0.1g = 0.98\,m/s^2$



$\uparrow a = 0.98\,m/s^2 = 0.1g$

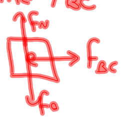
$T > F_g$

$F_{net} = T - F_g$
$ma = T - mg$
$M(0.1g) = T - mg$

$0.1mg + mg = T$
$1.1mg = T$

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

Find F_{BC}



$F_{net} = F_{BC}$
$m_c a = F_{BC}$
$(10kg)(2) = F_{BC}$
$20N = F_{BC}$