Single Body Analysis #6 Friction

$$T_{1,2} - m_1 g = m_1 a$$

$$T_{2,3} - F_{surface,m2} - T_{1,2} = m_2 a$$

$$T_{3,4} - F_{surface,m3} - T_{2,3} = m_3 a$$

$$m_4 g - T_{3,4} = m_4 a$$

$$\boxed{N_2 - m_2 g = m_2 a_y}$$

Single Body Analysis #6 Friction (continued)

$$a_y = 0 \frac{m}{s^2}$$

$$\boxed{N_2 = m_2 g}$$

$$F_{surface,m2} = \mu N_2$$

$$\boxed{F_{surface,m2} = \mu m_2 g}$$

$$N_3 - m_3 g = m_3 a_y$$

$$a_y = 0 \frac{m}{s^2}$$

$$\boxed{N_3 = m_3 g}$$

Single Body Analysis #6 Friction (continued)

$$F_{\text{surface,m3}} = \mu N_3$$

$$\boxed{F_{\text{surface,m3}} = \mu m_3 g}$$

$$T_{1,2} - m_1 g = m_1 a$$

$$T_{2,3} - \mu m_2 g - T_{1,2} = m_2 a$$

$$T_{3,4} - \mu m_3 g - T_{2,3} = m_3 a$$

Single Body Analysis #6 Friction (continued)

$$m_4 g - T_{3,4} = m_4 a$$

$$m_4 g - \mu m_2 g - \mu m_3 g - m_1 g = m_1 a + m_2 a + m_3 a + m_4 a$$

$$m_4 g - \mu m_2 g - \mu m_3 g - m_1 g = (m_1 + m_2 + m_3 + m_4) a$$

$$a = \frac{m_4 g - \mu m_2 g - \mu m_3 g - m_1 g}{m_1 + m_2 + m_3 + m_4}$$

Single Body Analysis #6 Friction (continued)

Var	Given value	Units	Description
g	10	$\frac{m}{s^2}$	Acceleration due to gravity
m_1	30	kg	Mass 1
m_2	20	kg	Mass 2
m_3	35	kg	Masss 3
m_4	55	kg	Mass 4
a		$\frac{m}{s^2}$	Acceleration
$T_{1,2}$		N	Tension 1
$T_{2,3}$		N	Tension 2
$T_{3,4}$		N	Tension 3
$F_{surface,m\ 2}$		N	Friction Force for Mass 2
$F_{surface,m\ 3}$		N	Friction Force for Mass 3
μ	0.20		Coeffiecient of Friction
N_3		N	Normal Force of Mass 3

Single Body Analysis #6 Friction (continued)

N_2		N	Normal Force of Mass 2
a_y	0	$\frac{m}{s^2}$	Acceleration in Y direction for boxes on the table top

$$T_{1,2} - m_1 g = m_1 a$$

$$T_{1,2} = m_1 a + m_1 g$$

$$T_{2,3} - \mu m_2 g - T_{1,2} = m_2 a$$

$$T_{2,3} = m_2 a + \mu m_2 g + T_{1,2}$$

Single Body Analysis #6 Friction (continued)

$$T_{3,4} - \mu m_3 g - T_{2,3} = m_3 a$$

$$T_{3,4} = m_3 a + \mu m_3 g + T_{2,3}$$

$$a = \frac{m_4 g - \mu m_2 g - \mu m_3 g - m_1 g}{m_1 + m_2 + m_3 + m_4}$$

$$= \frac{(55\text{kg})\left(10 \frac{\text{m}}{\text{s}^2}\right) - (0.20)(20\text{kg})\left(10 \frac{\text{m}}{\text{s}^2}\right) - (0.20)(35\text{kg})\left(10 \frac{\text{m}}{\text{s}^2}\right) - (30\text{kg})\left(10 \frac{\text{m}}{\text{s}^2}\right)}{(30\text{kg}) + (20\text{kg}) + (35\text{kg}) + (55\text{kg})}$$

$$= \boxed{1.00 \frac{\text{m}}{\text{s}^2}}$$ ✓

Single Body Analysis #6 Friction (continued)

$$T_{1,2} = m_1 a + m_1 g$$

$$= (30\,\text{kg})\left(1.00\,\frac{\text{m}}{\text{s}^2}\right) + (30\,\text{kg})\left(10\,\frac{\text{m}}{\text{s}^2}\right)$$

$$= \boxed{330.0\,\text{N}}$$ ✓

$$T_{2,3} = m_2 a + \mu m_2 g + T_{1,2}$$

$$= (20\,\text{kg})\left(1.00\,\frac{\text{m}}{\text{s}^2}\right) + (0.20)(20\,\text{kg})\left(10\,\frac{\text{m}}{\text{s}^2}\right) + (330.0\,\text{N})$$

$$= \boxed{390.\,\text{N}}$$ ✓

Single Body Analysis #6 Friction (continued)

$$T_{3,4} = m_3 a + \mu m_3 g + T_{2,3}$$

$$= (35\,\text{kg})\left(1.00\,\frac{\text{m}}{\text{s}^2}\right) + (0.20)(35\,\text{kg})\left(10\,\frac{\text{m}}{\text{s}^2}\right) + (390.\,\text{N})$$

$$= \boxed{495.\,\text{N}}$$ ✓