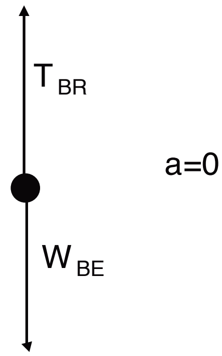
4.24 part a

A 20.0 kg bucket is being raised by a rope at constant velocity. What is the tension in the rope?



Var	Given value	Units	Description
F_{NET}		N	net force
T_{BR}		N	tension on bucket by rope
W_{BE}		N	weight on bucket by earth
m	20.0	kg	mass of bucket
a	0	$\frac{m}{s^2}$	acceleration of bucket
g	9.80	$\frac{m}{s^2}$	acc. due to gravity on earth

$$F_{NET} = T_{BR} + -W_{BE}$$

$$F_{NET} = m\,a$$

$$= (20.0\,\text{kg})\left(0\,\frac{\text{m}}{\text{s}^2}\right)$$

4.24 part a (continued)

$$= 0\,\text{N}$$ ✓

$$W_{\text{BE}} = m\,g$$

$$= (20.0\,\text{kg})\left(9.80\,\frac{\text{m}}{\text{s}^2}\right)$$

$$= 196.\,\text{N}$$ ✓

$$F_{\text{NET}} = T_{\text{BR}} + -W_{\text{BE}}$$

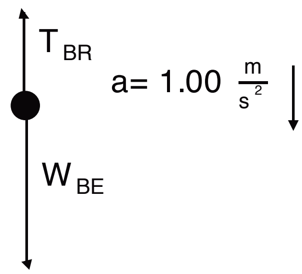
$$T_{\text{BR}} = W_{\text{BE}} + F_{\text{NET}}$$

$$= (196.\,\text{N}) + (0\,\text{N})$$

$$= 196.\,\text{N}$$ ✓

4.24 part b

A 20.0 kg bucket is being lowered by a rope with a constant downward acceleration of 1.00 $\frac{m}{s^2}$. What is the tension in the rope?



Var	Given value	Units	Description
F_{NET}		N	net force
T_{BR}		N	tension on bucket by rope
W_{BE}		N	weight on bucket by earth
m	20.0	kg	mass of bucket
a	–1.00	$\frac{m}{s^2}$	acceleration of bucket
g	9.80	$\frac{m}{s^2}$	acc. due to gravity on earth

$$F_{NET} = T_{BR} + -W_{BE}$$

$$F_{NET} = m\,a$$

4.24 part b (continued)

$$= (20.0\,\text{kg})\left(-1.00\,\frac{\text{m}}{\text{s}^2}\right)$$

$$= -20.0\,\text{N}$$ ✓

$$W_{\text{BE}} = m\,g$$

$$= (20.0\,\text{kg})\left(9.80\,\frac{\text{m}}{\text{s}^2}\right)$$

$$= 196.\,\text{N}$$ ✓

$$F_{\text{NET}} = T_{\text{BR}} + -W_{\text{BE}}$$

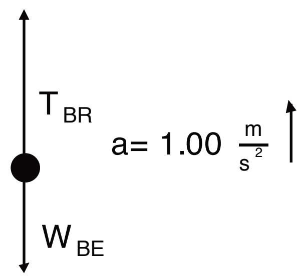
$$T_{\text{BR}} = W_{\text{BE}} + F_{\text{NET}}$$

$$= (196.\,\text{N}) + (-20.0\,\text{N})$$

$$= 176.\,\text{N}$$ ✓

4.24 part c

A 15.0 kg bucket is being raised by a rope with a constant upward acceleration of 1.00 $\frac{m}{s^2}$. What is the tension in the rope?



Var	Given value	Units	Description
F_{NET}		N	net force
T_{BR}		N	tension on bucket by rope
W_{BE}		N	weight on bucket by earth
m	15.0	kg	mass of bucket
a	1.00	$\frac{m}{s^2}$	acceleration of bucket
g	9.80	$\frac{m}{s^2}$	acc. due to gravity on earth

$$F_{NET} = T_{BR} + -W_{BE}$$

$$F_{NET} = m\,a$$

4.24 part c (continued)

$$W_{BE} = mg$$

$$F_{NET} = ma$$

$$= (15.0\,\text{kg})\left(1.00\,\frac{\text{m}}{\text{s}^2}\right)$$

$$= 15.0\,\text{N}$$ ✓

$$W_{BE} = mg$$

$$= (15.0\,\text{kg})\left(9.80\,\frac{\text{m}}{\text{s}^2}\right)$$

$$= 147.\,\text{N}$$ ✓

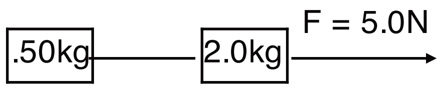
$$F_{NET} = T_{BR} + -W_{BE}$$

$$T_{BR} = W_{BE} + F_{NET}$$

$$= 147.\,\text{N} + 15.0\,\text{N}$$

$$= 162\,\text{N}$$ ✓

4.26



two air track gliders (negligible friction) are connected with a string and pulled to the right with a constant force

To find the acceleration of the whole system, treat the two gliders as one object.

Var	Given value	Units	Description
m_{TOT}		kg	total mass of system
m_1	0.50	kg	mass of 1
m_2	2.0	kg	mass of 2
F_{NET}	5.0	N	net force on whole system
a		$\frac{m}{s^2}$	acc. of system

$$m_{TOT} = m_1 + m_2$$

$$= (0.50\,kg) + (2.0\,kg)$$

$$= 2.5\,kg$$ ✓

4.26 (continued)

$$F_{NET} = m_{TOT}\, a$$

$$a = \frac{F_{NET}}{m_{TOT}}$$

$$= \frac{5.0\,\text{N}}{2.5\,\text{kg}}$$

$$= 2.0\,\frac{\text{m}}{\text{s}^2}$$ ✓

To find the tension in the string connecting the two objects, only consider the forces on m_1, the object on the left. The net force on this object is the tension in the string since there is no friction.

Var	Given value	Units	Description
$F_{NET,1}$		N	net force on object 1
T_{1S}		N	tension on object 1 by string

$$F_{NET,1} = T_{1S}$$

$$F_{NET,1} = m_1\, a$$

$$= (0.50\,\text{kg})\left(2.0\,\frac{\text{m}}{\text{s}^2}\right)$$

$$= 1.0\,\text{N}$$ ✓

4.26 (continued)

$$T_{1S} = F_{NET,1}$$

$$= 1.0\,N$$

4.28

Var	Given value	Units	Description
v_f	0	$\frac{m}{s}$	final velocity
v_i	400	$\frac{m}{s}$	initial velcity
a		$\frac{m}{s^2}$	acceleration
Δx		m	displacement of bullet
F_{NET}	45000	N	net force
m	0.0048	kg	mass

$$F_{NET} = m a$$

$$a = \frac{F_{NET}}{m}$$

$$= \frac{45000\,N}{0.0048\,kg}$$

$$= 9.4 \times 10^6 \frac{m}{s^2}$$ ✓

$$v_f^2 = v_i^2 + 2 a \Delta x$$

$$v_f^2 - v_i^2 = 2 a \Delta x$$

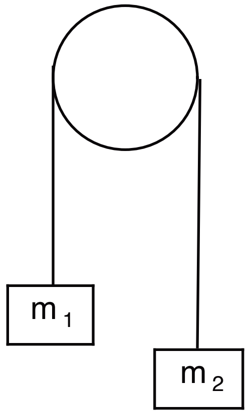
$$\Delta x = \frac{v_f^2 - v_i^2}{2 a}$$

4.28 (continued)

$$= \frac{\left(0\,\frac{\text{m}}{\text{s}}\right)^2 - \left(400\,\frac{\text{m}}{\text{s}}\right)^2}{2\left(9.4\times10^{6}\,\frac{\text{m}}{\text{s}^2}\right)}$$

$$= -8.5\times10^{-3}\text{ m}$$

4.30



First figure out the expected acceleration for an Atwood machine at rest.

Var	Given value	Units	Description
m_{TOT}		kg	total mass
m_1	44.7	kg	mass of 1
m_2	45.3	kg	mass of 2
F_{NET}		N	net force
g	9.80	$\frac{m}{s^2}$	acc. due to gravity on earth
a		$\frac{m}{s^2}$	acceleration

$$m_{TOT} = m_1 + m_2$$

$$= (44.7\,kg) + (45.3\,kg)$$

$$= 90.0\,kg$$

4.30 (continued)

$$F_{NET} = (m_2 - m_1)\,g$$

$$= \big((45.3\,\text{kg}) - (44.7\,\text{kg})\big)\left(9.80\,\frac{\text{m}}{\text{s}^2}\right)$$

$$= 5.88\,\text{N}$$ ✓

$$a = \frac{F_{NET}}{m_{TOT}}$$

$$= \frac{5.88\,\text{N}}{90.0\,\text{kg}}$$

$$= 0.0653\,\frac{\text{m}}{\text{s}^2}$$ ✓

Now calculate the observed acceleration.

Var	Given value	Units	Description
Δx	1.00	m	displacement
v_i	0.00	$\frac{\text{m}}{\text{s}}$	initial velocity
t	5.00	s	time
a_{obs}		$\frac{\text{m}}{\text{s}^2}$	observed acceleration

$$\Delta x = v_i\,t + \frac{1}{2}\,a_{obs}\,t^2$$

4.30 (continued)

$$\Delta x - v_i\, t = \frac{1}{2} a_{obs}\, t^2$$

$$a_{obs} = \frac{\Delta x - v_i\, t}{\frac{1}{2} t^2}$$

$$= \frac{(1.00\,\text{m}) - \left(0.00\,\frac{\text{m}}{\text{s}}\right)(5.00\,\text{s})}{\frac{1}{2}(5.00\,\text{s})^2}$$

$$= 0.0800\,\frac{\text{m}}{\text{s}^2}$$

Since the observed acceleration is greater than expected, the elevator must be accelerating up.