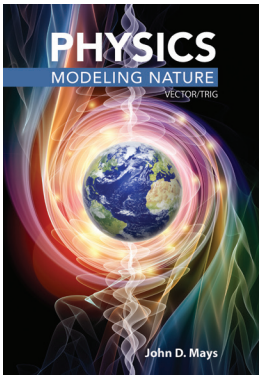
Physics: Modeling Nature



Errata

We always strive to make our textbooks as accurate as possible, but sadly, errors are a reality. We very much appreciate friends who report errata that are not included in this document!
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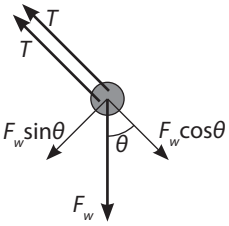
Physics: Modeling Nature (2021)

Chapter 3 Answers

27.b. The calculation of acceleration is fine as is. The corrected calculation of the tensions is as follows:

Finally, we draw the free-body diagram and solve for the tension.



$$2T - F_w \cos\theta = ma$$
$$2T - mg\cos\theta = ma$$
$$T = \frac{m(a + g\cos\theta)}{2} = \frac{100\text{ kg}\cdot\left(54.2\ \frac{\text{m}}{\text{s}^2} + 9.80\ \frac{\text{m}}{\text{s}^2}\cdot\cos 45°\right)}{2} = 3056\text{ N}$$
$$\boxed{T = 3100\text{ N}}$$

(Note that the perpendicular weight component is not cancelled out by anything in the FBD. If the machine pulled only at 45° during the acceleration, there would have to be a normal force from the throwing mechanism cancelling this out, such as a track or chute for the stone to slide in while it is being accelerated. But there is no motion in the perpendicular direction and no mention of friction either, so the other force is not drawn. The motion in an actual trebuchet is more complex, but the problem does not supply the information for a more sophisticated solution.)

Chapter 8 Answers

28. $m_1/m_2 = (5 + 2\sqrt{10})/3$

The corrected version of the last part of the solution follows:

$\frac{1}{2}m_2v_2^2 = 2m_2gr + \frac{1}{2}m_2v_3^2$

$v_2^2 = 4gr + gr = 5gr$

$v_2^2 = 5gr$

$$\left(\frac{2m_1m_2\sqrt{2gr}}{m_2^2 + m_1m_2}\right)^2 = 5gr$$

$8m_1^2m_2^2gr = 5gr\left(m_2^2 + m_1m_2\right)^2$

$8m_1^2m_2^2 = 5\left(m_2^4 + 2m_1m_2^3 + m_1^2m_2^2\right) = 5m_2^4 + 10m_1m_2^3 + 5m_1^2m_2^2$

$3m_1^2m_2^2 = 5m_2^4 + 10m_1m_2^3$

$3m_1^2 = 5m_2^2 + 10m_1m_2$

$3m_1^2 - 10m_1m_2 - 5m_2^2 = 0$

Divide by m_2^2 to make this a quadratic in m_1/m_2:

$$3\left(\frac{m_1}{m_2}\right)^2 - 10\frac{m_1}{m_2} - 5 = 0$$

$$\frac{m_1}{m_2} = \frac{10 \pm \sqrt{100+60}}{6} = \frac{10 \pm \sqrt{160}}{6} = \frac{5 \pm 2\sqrt{10}}{3}$$

Since $m_1 > m_2$,

$$\frac{m_1}{m_2} = \frac{5 + 2\sqrt{10}}{3}$$