# Chapter 5 Force and Motion I

11. The velocity is the derivative (with respect to time) of given function $x$, and the acceleration is the derivative of the velocity. Thus, $a = 2c - 3(2.0)(2.0)t$, which we use in Newton's second law: $F = (2.0\text{ kg})a = 4.0c - 24t$ (with SI units understood). At $t = 3.0$ s, we are told that $F = -36$ N. Thus, $-36 = 4.0c - 24(3.0)$ can be used to solve for $c$. The result is $c = +9.0\text{ m/s}^2$.

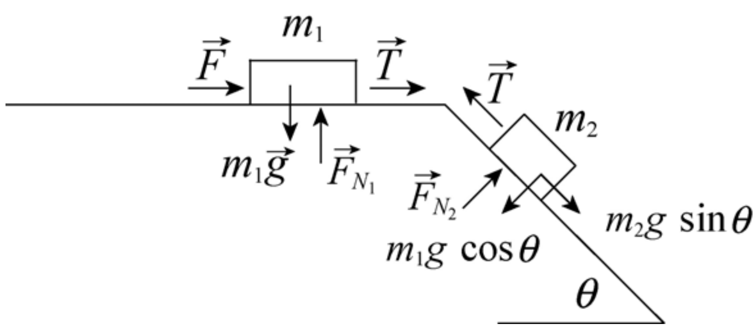
12. From the slope of the graph we find $a_x = 3.0\text{ m/s}^2$. Applying Newton's second law to the $x$ axis (and taking $\theta$ to be the angle between $F_1$ and $F_2$), we have

$$F_1 + F_2\cos\theta = ma_x \quad \Rightarrow \quad \theta = 56°.$$

63. (a) The acceleration (which equals $F/m$ in this problem) is the derivative of the velocity. Thus, the velocity is the integral of $F/m$, so we find the "area" in the graph (15 units) and divide by the mass (3) to obtain $v - v_o = 15/3 = 5$. Since $v_o = 3.0$ m/s, then $v = 8.0\,\text{m/s}$.

(b) Our positive answer in part (a) implies $\vec{v}$ points in the $+x$ direction.

64. The $+x$ direction for $m_2 = 1.0$ kg is "downhill" and the $+x$ direction for $m_1 = 3.0$ kg is rightward; thus, they accelerate with the same sign.




(a) We apply Newton's second law to the $x$ axis of each box:

$$\begin{aligned} m_2 g \sin\theta - T &= m_2 a \\ F + T &= m_1 a \end{aligned}$$

Adding the two equations allows us to solve for the acceleration:

$$a = \frac{m_2 g \sin\theta + F}{m_1 + m_2}$$

With $F = 2.3$ N and $\theta = 30°$, we have $a = 1.8$ m/s$^2$. We plug back in and find $T = 3.1$ N.

(b) We consider the "critical" case where the $F$ has reached the *max* value, causing the tension to vanish. The first of the equations in part (a) shows that $a = g \sin 30°$ in this case; thus, $a = 4.9$ m/s$^2$. This implies (along with $T = 0$ in the second equation in part (a)) that

$$F = (3.0\text{ kg})(4.9\text{ m/s}^2) = 14.7\text{ N} \approx 15\text{ N}$$

in the critical case.