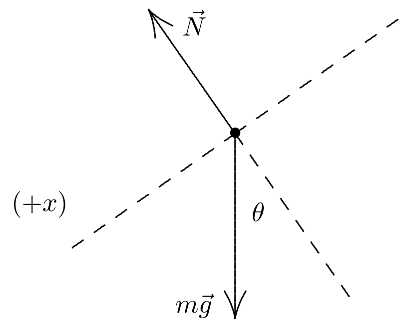
45. The free-body diagram is shown below. $\vec{N}$ is the normal force of the plane on the block and $m\vec{g}$ is the force of gravity on the block. We take the $+x$ direction to be down the incline, in the direction of the acceleration, and the $+y$ direction to be in the direction of the normal force exerted by the incline on the block. The x component of Newton's second law is then $mg\sin\theta = ma$; thus, the acceleration is $a = g\sin\theta$.



(a) Placing the origin at the bottom of the plane, the kinematic equations (Table 2-1) for motion along the x axis which we will use are $v^2 = v_0^2 + 2ax$ and $v = v_0 + at$. The block momentarily stops at its highest point, where $v = 0$; according to the second equation, this occurs at time $t = -v_0/a$. The position where it stops is

$$\begin{aligned} x &= -\frac{1}{2}\frac{v_0^2}{a} \\ &= -\frac{1}{2}\left(\frac{(-3.50\,\mathrm{m/s})^2}{(9.8\,\mathrm{m/s^2})\sin 32.0^\circ}\right) \\ &= -1.18\ \mathrm{m}\ . \end{aligned}$$

(b) The time is

$$t = -\frac{v_0}{a} = -\frac{v_0}{g\sin\theta} = -\frac{-3.50\,\mathrm{m/s}}{(9.8\,\mathrm{m/s^2})\sin 32.0^\circ} = 0.674\ \mathrm{s}\ .$$

(c) That the return-speed is identical to the initial speed is to be expected since there are no dissipative forces in this problem. In order to prove this, one approach is to set $x = 0$ and solve $x = v_0 t + \frac{1}{2}at^2$ for the total time (up and back down) t. The result is

$$t = -\frac{2v_0}{a} = -\frac{2v_0}{g\sin\theta} = -\frac{2(-3.50\,\mathrm{m/s})}{(9.8\,\mathrm{m/s^2})\sin 32.0^\circ} = 1.35\,\mathrm{s}\ .$$

The velocity when it returns is therefore

$$v = v_0 + at = v_0 + gt\sin\theta = -3.50 + (9.8)(1.35)\sin 32^\circ = 3.50\ \mathrm{m/s}\ .$$