CH 5

34. First, we consider all the penguins (1 through 4, counting left to right) as one system, to which we apply Newton's second law:

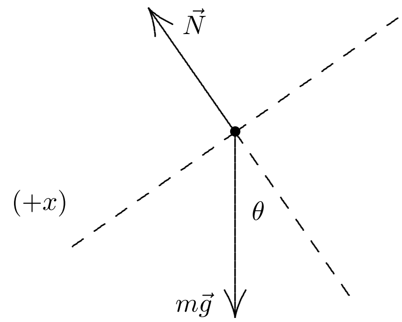
$$\begin{aligned} F_{\text{net}} &= (m_1 + m_2 + m_3 + m_4)a \\ 222\,\text{N} &= (20\,\text{kg} + 15\,\text{kg} + m_3 + 12\,\text{kg})a\ . \end{aligned}$$

Second, we consider penguins 3 and 4 as one system, for which we have

$$\begin{aligned} F'_{\text{net}} &= (m_3 + m_4)a \\ 111\,\text{N} &= (m_3 + 12\,\text{kg})a\ . \end{aligned}$$

We solve these two equations for m_3 to obtain $m_3 = 23\,\text{kg}$. The solution step can be made a little easier, though, by noting that the net force on penguins 1 and 2 is also 111 N and applying Newton's law to them as a single system to solve first for a.

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

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

(b) The time is

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

(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

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

The velocity when it returns is therefore

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

CH # 6

16. We choose $+x$ horizontally rightwards and $+y$ upwards and observe that the 15 N force has components $F_x = F\cos\theta$ and $F_y = -F\sin\theta$.

    (a) We apply Newton's second law to the y axis:

    $$N - F\sin\theta - mg = 0 \quad \Longrightarrow \quad N = (15)\sin 40^\circ + (3.5)(9.8) = 44$$

    in SI units. With $\mu_k = 0.25$, Eq. 6-2 leads to $f_k = 11$ N.

    (b) We apply Newton's second law to the x axis:

    $$F\cos\theta - f_k = ma \quad \Longrightarrow \quad a = \frac{(15)\cos 40^\circ - 11}{3.5} = 0.14$$

    in SI units (m/s^2). Since the result is positive-valued, then the block is accelerating in the $+x$ (rightward) direction.