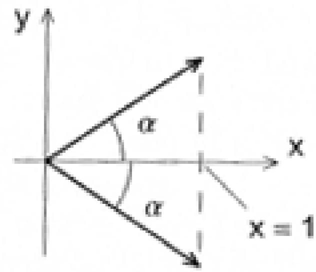
1.6 ⋆ $\mathbf{b}\cdot\mathbf{c} = 1 - s^2$, which is zero if and only if $s = \pm 1$. The vectors **b** and **c** make equal angles, α, above and below (or below and above) the x axis. The angle between them can be 90° only if $\alpha = 45°$.



1.10 ⋆ The particle's polar angle is $\phi = \omega t$, so $x = R\cos(\omega t)$ and $y = R\sin(\omega t)$ or

$$\mathbf{r} = \hat{\mathbf{x}}\, R\cos(\omega t) + \hat{\mathbf{y}}\, R\sin(\omega t).$$

Differentiating, we find that $\dot{\mathbf{r}} = -\hat{\mathbf{x}}\,\omega R\sin(\omega t) + \hat{\mathbf{y}}\,\omega R\cos(\omega t)$ and then

$$\ddot{\mathbf{r}} = -\hat{\mathbf{x}}\omega^2 R\cos(\omega t) - \hat{\mathbf{y}}\,\omega^2 R\sin(\omega t) = -\omega^2\mathbf{r} = -\omega^2 R\hat{\mathbf{r}}.$$

That is, the acceleration is antiparallel to the radius vector and has magnitude $a = \omega^2 R = v^2/R$, the well known centripetal acceleration.

1.18 ⋆⋆ **(a)** $|\mathbf{a}\times\mathbf{b}| = ab\sin\gamma = bh$, where $h = a\sin\gamma$ is the height of the triangle ABC. Therefore $|\mathbf{a}\times\mathbf{b}| = 2$(area of triangle), which is the required first result. The other two follow in the same way.

(b) By part (a), $|\mathbf{c}\times\mathbf{a}| = |\mathbf{b}\times\mathbf{c}|$ or $ca\sin\beta = bc\sin\alpha$, whence $a/\sin\alpha = b/\sin\beta$, as required. The third expression follows in the same way.

1.30 ⋆ Since mass 2 is at rest, the initial total momentum is just $\mathbf{P}_{in} = m_1\mathbf{v}$. The final total momentum is $\mathbf{P}_{fin} = (m_1 + m_2)\mathbf{v}'$. Equating these two and solving for $\mathbf{v}'$, we find that $\mathbf{v}' = \mathbf{v}m_1/(m_1 + m_2)$.

1.35 ⋆ In the absence of air resistance, the net force on the ball is $\mathbf{F} = m\mathbf{g}$, and with the given choice of axes, $\mathbf{g} = (0, 0, -g)$. Thus Newton's second law, $\mathbf{F} = m\ddot{\mathbf{r}}$, implies that $\ddot{\mathbf{r}} = \mathbf{g}$, or

$$\ddot{x} = 0, \qquad \ddot{y} = 0, \qquad \text{and} \qquad \ddot{z} = -g.$$

The initial velocity has components $v_{ox} = v_o\cos\theta$, $v_{oy} = 0$, and $v_{oz} = v_o\sin\theta$, and we can choose the initial position to be the origin. The first of the above equations can be integrated once to give $\dot{x} = v_{ox}$, and again to give $x(t) = v_{ox}t$. In the same way, the y equation gives $y(t) = 0$, and the z equation gives $z(t) = v_{oz}t - \frac{1}{2}gt^2$. The ball returns to the ground when $z(t) = 0$ which gives $t = 2v_{oz}/g$. Substituting this time into the expression for $x(t)$ gives the range, range $= 2v_{oz}v_{ox}/g$.

1.36 ⋆ **(a)** During the flight the only force on the bundle is its weight, and Newton's second law reads $m\ddot{\mathbf{r}} = \mathbf{F} = m\mathbf{g}$, or $\ddot{\mathbf{r}} = \mathbf{g}$. If we choose the origin at sea level directly below the plane at the moment of launch and measure x in the direction of flight and y vertically up, then the solution is $x = v_o t$, $y = h - \frac{1}{2}gt^2$, and $z = 0$.

(b) The time for the bundle to drop to sea level ($y = 0$) is $t = \sqrt{2h/g}$ and the horizontal distance traveled in this time is $x = v_o t = v_o\sqrt{2h/g}$. With the given numbers this is about 220 m.

(c) If the drop is delayed by a time Δt, the bundle will overshoot by a distance $\Delta x = v_o\Delta t$, so $\Delta t = \Delta x/v_o = 0.2$ sec.