# Appendix B

# Answers to the Exercises

*I believe that every human has a finite number of heart-beats.*
*I don't intend to waste any of mine running around doing exercises.*

— Buzz Aldrin (1930–)

## B.1 Chapter 1

(Page 27.)

1. $\mathbf{a} = (-2.5, 3)$ $\mathbf{b} = (1, 2)$ $\mathbf{c} = (2.5, 2)$
   $\mathbf{d} = (-1, 1)$ $\mathbf{e} = (0, 0)$ $\mathbf{f} = (2, -0.5)$
   $\mathbf{g} = (-0.5, -1.5)$ $\mathbf{h} = (0, -2)$ $\mathbf{i} = (-3, -2)$
2. $\mathbf{a} = (1, 2, 4)$ $\mathbf{b} = (-3, -3, -5)$ $\mathbf{c} = (-3, 6, 2.5)$
   $\mathbf{d} = (3, 0, -1)$ $\mathbf{e} = (0, 0, 0)$ $\mathbf{f} = (0, 0, 3)$
   $\mathbf{g} = (-3.5, 4, 0)$ $\mathbf{h} = (5, -5, -1.5)$ $\mathbf{i} = (4, 1, 5)$
3. See the table below.

| Left-handed | | | | | | Right-handed | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **East** | **Up** | **North** | **East** | **Up** | **North** | **East** | **Up** | **North** | **East** | **Up** | **North** |
| $+x$ | $+y$ | $+z$ | $-x$ | $-y$ | $+z$ | $-x$ | $-y$ | $-z$ | $+x$ | $+y$ | $-z$ |
| $+x$ | $-y$ | $-z$ | $-x$ | $+y$ | $-z$ | $-x$ | $+y$ | $+z$ | $+x$ | $-y$ | $+z$ |
| $+x$ | $+z$ | $-y$ | $-x$ | $-z$ | $-y$ | $-x$ | $-z$ | $+y$ | $+x$ | $+z$ | $+y$ |
| $+x$ | $-z$ | $+y$ | $-x$ | $+z$ | $+y$ | $-x$ | $+z$ | $-y$ | $+x$ | $-z$ | $-y$ |
| $+y$ | $+z$ | $+x$ | $-y$ | $-z$ | $+x$ | $-y$ | $-z$ | $-x$ | $+y$ | $+z$ | $-x$ |
| $+y$ | $-z$ | $-x$ | $-y$ | $+z$ | $-x$ | $-y$ | $+z$ | $+x$ | $+y$ | $-z$ | $+x$ |
| $+y$ | $+x$ | $-z$ | $-y$ | $-x$ | $-z$ | $-y$ | $-x$ | $+z$ | $+y$ | $+x$ | $+z$ |
| $+y$ | $-x$ | $+z$ | $-y$ | $+x$ | $+z$ | $-y$ | $+x$ | $-z$ | $+y$ | $-x$ | $-z$ |
| $+z$ | $+x$ | $+y$ | $-z$ | $-x$ | $+y$ | $-z$ | $-x$ | $-y$ | $+z$ | $+x$ | $-y$ |
| $+z$ | $-x$ | $-y$ | $-z$ | $+x$ | $-y$ | $-z$ | $+x$ | $+y$ | $+z$ | $-x$ | $+y$ |
| $+z$ | $+y$ | $-x$ | $-z$ | $-y$ | $-x$ | $-z$ | $-y$ | $+x$ | $+z$ | $+y$ | $+x$ |
| $+z$ | $-y$ | $+x$ | $-z$ | $+y$ | $+x$ | $-z$ | $+y$ | $-x$ | $+z$ | $-y$ | $-x$ |

4. (a) Right-handed. (b) Swap $y$ and $z$. (c) Swap $y$ and $z$.
5. (a) Right-handed.
   (b) $x_{\text{us}} \leftarrow y_{\text{aero}}, \quad y_{\text{us}} \leftarrow -z_{\text{aero}}, \quad z_{\text{us}} \leftarrow x_{\text{aero}}$
   (c) $x_{\text{aero}} \leftarrow z_{\text{us}}, \quad y_{\text{aero}} \leftarrow x_{\text{us}}, \quad z_{\text{aero}} \leftarrow -y_{\text{us}}$
6. (a) CW (b) CCW (c) CCW (d) CW
7. (a) 15 (b) 30 (c) 3840 (d) 2016840 (e) 5050
8. (a) $\pi/6$ (b) $-\pi/4$ (c) $\pi/3$ (d) $\pi/2$ (e) $-\pi$
   (f) $5\pi/4$ (g) $-3\pi/2$ (h) 2.923 (i) 9.198 (j) $-6\pi$
9. (a) $-30^\circ$ (b) $120^\circ$ (c) $270^\circ$ (d) $-240^\circ$ (e) $360^\circ$
   (f) $1^\circ$ (g) $10^\circ$ (h) $-900^\circ$ (i) $1800^\circ$ (j) $36^\circ$
10. The scarecrow should have said:

    > The sum of the squares of the legs of a right triangle is equal to the square of the remaining side.

    since the Pythagorean theorem is $c^2 = a^2 + b^2$, where $a$ and $b$ are the legs of the right triangle and $c$ is the hypotenuse.
11. (a) $(\sin(\alpha)/\csc(\alpha)) + (\cos(\alpha)/\sec(\alpha)) = \sin^2(\alpha) + \cos^2(\alpha) = 1$
    (b) $(\sec^2(\theta) - 1)/\sec^2(\theta) = 1 - (1/\sec^2(\theta)) = 1 - \cos^2(\theta) = \sin^2(\theta)$
    (c) $1 + \cot^2(t) = 1 + (\cos^2(t)/\sin^2(t)) = (\sin^2(t)/\sin^2(t)) + (\cos^2(t)/\sin^2(t)) = (\sin^2(t) + \cos^2(t))/\sin^2(t) = 1/\sin^2(t) = \csc^2(t)$
    (d) $\cos(\phi)(\tan(\phi) + \cot(\phi)) = \sin(\phi) + (\cos^2(\phi)/\sin(\phi)) = (\sin^2(\phi) + \cos^2(\phi))/\sin(\phi) = 1/\sin(\phi) = \csc(\phi)$