1-1. Find the transformation matrix that rotates the axis x_3 of a rectangular coordinate system $45°$ toward x_1 around the x_2-axis.

1-3. Find the transformation matrix that rotates a rectangular coordinate system through an angle of $120°$ about an axis making equal angles with the original three coordinate axes.

1-7. Consider a unit cube with one corner at the origin and three adjacent sides lying along the three axes of a rectangular coordinate system. Find the vectors describing the diagonals of the cube. What is the angle between any pair of diagonals?

1-9. For the two vectors

$$\mathbf{A} = \mathbf{i} + 2\mathbf{j} - \mathbf{k}, \quad \mathbf{B} = -2\mathbf{i} + 3\mathbf{j} + \mathbf{k}$$

find

(a) $\mathbf{A} - \mathbf{B}$ and $|\mathbf{A} - \mathbf{B}|$ **(b)** component of $\mathbf{B}$ along $\mathbf{A}$ **(c)** angle between $\mathbf{A}$ and $\mathbf{B}$
(d) $\mathbf{A} \times \mathbf{B}$ **(e)** $(\mathbf{A} - \mathbf{B}) \times (\mathbf{A} + \mathbf{B})$

1-10. A particle moves in a plane elliptical orbit described by the position vector

$$\mathbf{r} = 2b \sin \omega t\, \mathbf{i} + b \cos \omega t\, \mathbf{j}$$

(a) Find $\mathbf{v}$, $\mathbf{a}$, and the particle speed.
(b) What is the angle between $\mathbf{v}$ and $\mathbf{a}$ at time $t = \pi/2\omega$?

1-20. Show that

(a) $\sum_{i,j} \varepsilon_{ijk}\, \delta_{ij} = 0$ **(b)** $\sum_{j,k} \varepsilon_{ijk}\, \varepsilon_{ljk} = 2\delta_{il}$ **(c)** $\sum_{i,j,k} \varepsilon_{ijk}\, \varepsilon_{ijk} = 6$

1-22. Evaluate the sum $\sum_k \varepsilon_{ijk}\, \varepsilon_{lmk}$ (which contains 3 terms) by considering the result for all possible combinations of i, j, l, m; that is,
(a) $i = j$ **(b)** $i = l$ **(c)** $i = m$ **(d)** $j = l$ **(e)** $j = m$ **(f)** $l = m$
(g) $i \neq l$ or m **(h)** $j \neq l$ or m

Show that

$$\sum_k \varepsilon_{ijk}\, \varepsilon_{lmk} = \delta_{il}\delta_{jm} - \delta_{im}\delta_{jl}$$

and then use this result to prove

$$\mathbf{A} \times (\mathbf{B} \times \mathbf{C}) = (\mathbf{A} \cdot \mathbf{C})\mathbf{B} - (\mathbf{A} \cdot \mathbf{B})\mathbf{C}$$