P.2–1 Given three vectors **A**, **B**, and **C** as follows,

$$\mathbf{A} = \mathbf{a}_x + \mathbf{a}_y 2 - \mathbf{a}_z 3,$$
$$\mathbf{B} = -\mathbf{a}_y 4 + \mathbf{a}_z,$$
$$\mathbf{C} = \mathbf{a}_x 5 - \mathbf{a}_z 2,$$

find

a) $\mathbf{a}_A$
b) $|\mathbf{A} - \mathbf{B}|$
c) $\mathbf{A} \cdot \mathbf{B}$
d) θ_{AB}
e) the component of **A** in the direction of **C**
f) $\mathbf{A} \times \mathbf{C}$
g) $\mathbf{A} \cdot (\mathbf{B} \times \mathbf{C})$ and $(\mathbf{A} \times \mathbf{B}) \cdot \mathbf{C}$
h) $(\mathbf{A} \times \mathbf{B}) \times \mathbf{C}$ and $\mathbf{A} \times (\mathbf{B} \times \mathbf{C}$

P.2–2 Given

$$\mathbf{A} = \mathbf{a}_x - \mathbf{a}_y 2 + \mathbf{a}_z 3,$$
$$\mathbf{B} = \mathbf{a}_x + \mathbf{a}_y - \mathbf{a}_z 2,$$

find the expression for a unit vector **C** that is perpendicular to both **A** and **B**.

P.2–16 The position of a point in cylindrical coordinates is specified by $(4, 2\pi/3, 3)$. What is the location of the point

a) in Cartesian coordinates?
b) in spherical coordinates?

P.2–21 Given a vector function $\mathbf{E} = \mathbf{a}_x y + \mathbf{a}_y x$, evaluate the scalar line integral $\int \mathbf{E} \cdot d\boldsymbol{\ell}$ from $P_1(2, 1, -1)$ to $P_2(8, 2, -1)$

a) along the parabola $x = 2y^2$,
b) along the straight line joining the two points.

P.2–23 Given a scalar function

$$V = \left(\sin \frac{\pi}{2} x\right)\left(\sin \frac{\pi}{3} y\right)e^{-z},$$

determine

a) the magnitude and the direction of the maximum rate of increase of V at the point $P(1, 2, 3)$,
b) the rate of increase of V at P in the direction of the origin.

P.2–25 The equation in space of a plane containing the point (x_1, y_1, z_1) can be written as

$$\ell(x - x_1) + m(y - y_1) + p(z - z_1) = 0,$$

where ℓ, m, and p are direction cosines of a unit normal to the plane:

$$\mathbf{a}_n = \mathbf{a}_x \ell + \mathbf{a}_y m + \mathbf{a}_z p.$$

Given a vector field $\mathbf{F} = \mathbf{a}_x + \mathbf{a}_y 2 + \mathbf{a}_z 3$, evaluate the integral $\int_S \mathbf{F} \cdot d\mathbf{s}$ over the square plane surface whose corners are at (0, 0, 2), (2, 0, 2), (2, 2, 0), and (0, 2, 0).