61. (Second problem in **Cluster 1**)

(a) The dot (scalar) product of $3\vec{A}$ and $\vec{B}$ is found using Eq. 3-23:

$$3\vec{A}\cdot\vec{B} = 3\,(4.00\cos 130^\circ)\,(-3.86) + 3\,(4.00\sin 130^\circ)\,(-4.60) = -12.5\ .$$

(b) We call the result $\vec{D}$ and combine the scalars ($(3)(4) = 12$). Thus, $\vec{D} = (4\vec{A})\times(3\vec{B})$ becomes, using Eq. 3-30,

$$12\vec{A}\times\vec{B} = 12\,((4.00\cos 130^\circ)\,(-4.60) - (4.00\sin 130^\circ)\,(-3.86))\,\hat{\mathrm{k}}$$

which yields $\vec{D} = 284\,\hat{\mathrm{k}}$.

(c) Since $\vec{D}$ has magnitude 284 and points in the $+z$ direction, it has radial coordinate 284 and angle-measured-from-z-axis equal to 0°. The angle measured in the xy plane does not have a well-defined value (since this vector does not have a component in that plane)

(d) Since $\vec{A}$ is in the xy plane, then it is clear that $\vec{A}\perp\vec{D}$. The angle between them is 90°.

(e) Calling this new result $\vec{G}$ we have

$$\vec{G} = (4.00\cos 130^\circ)\,\hat{\mathrm{i}} + (4.00\sin 130^\circ)\,\hat{\mathrm{j}} + (3.00)\hat{\mathrm{k}}$$

which yields $\vec{G} = -2.57\,\hat{\mathrm{i}} + 3.06\hat{\mathrm{j}} + 3.00\,\hat{\mathrm{k}}$.

(f) It is straightforward using a vector-capable calculator to convert the above into spherical coordinates. We, however, proceed "the hard way", using the notation in Fig. 3-44 (where θ is in the xy plane and ϕ is measured from the z axis):

$$\begin{aligned} |\vec{G}| = r &= \sqrt{(-2.57)^2 + 3.06^2 + 3.00^2} = 5.00 \\ \phi &= \tan^{-1}(4.00/3.00) = 53.1^\circ \\ \theta &= 130^\circ \quad \text{given in problem 60}\ . \end{aligned}$$