13. (a) Show that $\mathbf{i} \cdot \mathbf{j} = \mathbf{j} \cdot \mathbf{k} = \mathbf{k} \cdot \mathbf{i} = 0$.
(b) Show that $\mathbf{i} \cdot \mathbf{i} = \mathbf{j} \cdot \mathbf{j} = \mathbf{k} \cdot \mathbf{k} = 1$.

14. A street vendor sells a hamburgers, b hot dogs, and c soft drinks on a given day. He charges $2 for a hamburger, $1.50 for a hot dog, and $1 for a soft drink. If $\mathbf{A} = \langle a, b, c \rangle$ and $\mathbf{P} = \langle 2, 1.5, 1 \rangle$, what is the meaning of the dot product $\mathbf{A} \cdot \mathbf{P}$?

15–20 Find the angle between the vectors. (First find an exact expression and then approximate to the nearest degree.)

16. $\mathbf{a} = \langle \sqrt{3}, 1 \rangle$, $\mathbf{b} = \langle 0, 5 \rangle$

20. $\mathbf{a} = \mathbf{i} + 2\mathbf{j} - 2\mathbf{k}$, $\mathbf{b} = 4\mathbf{i} - 3\mathbf{k}$

29–33 Find the direction cosines and direction angles of the vector. (Give the direction angles correct to the nearest degree.)

30. $\langle 1, -2, -1 \rangle$ **32.** $2\mathbf{i} - \mathbf{j} + 2\mathbf{k}$

#s 30 and 32 are the only questions I think I've ever assigned on direction angles and direction cosines. They just don't come up again, in this course, and I can't remember ever seeing them again, after Calculus III.

23–24 Determine whether the given vectors are orthogonal, parallel, or neither.

24. (a) $\mathbf{u} = \langle -3, 9, 6 \rangle$, $\mathbf{v} = \langle 4, -12, -8 \rangle$
(b) $\mathbf{u} = \mathbf{i} - \mathbf{j} + 2\mathbf{k}$, $\mathbf{v} = 2\mathbf{i} - \mathbf{j} + \mathbf{k}$
(c) $\mathbf{u} = \langle a, b, c \rangle$, $\mathbf{v} = \langle -b, a, 0 \rangle$
(d) $\mathbf{a} = 2\mathbf{i} + 6\mathbf{j} - 4\mathbf{k}$, $\mathbf{b} = -3\mathbf{i} - 9\mathbf{j} + 6\mathbf{k}$

35–40 Find the scalar and vector projections of $\mathbf{b}$ onto $\mathbf{a}$.

36. $\mathbf{a} = \langle 1, 2 \rangle$, $\mathbf{b} = \langle -4, 1 \rangle$

41. Show that the vector $\text{orth}_{\mathbf{a}}\, \mathbf{b} = \mathbf{b} - \text{proj}_{\mathbf{a}}\, \mathbf{b}$ is orthogonal to $\mathbf{a}$. (It is called an **orthogonal projection** of $\mathbf{b}$.)

42. For the vectors in Exercise 36, find $\text{orth}_{\mathbf{a}}\, \mathbf{b}$ and illustrate by drawing the vectors $\mathbf{a}$, $\mathbf{b}$, $\text{proj}_{\mathbf{a}}\, \mathbf{b}$, and $\text{orth}_{\mathbf{a}}\, \mathbf{b}$.