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Compute $\vec{a} \cdot \vec{b}$.

5. $\vec{a} = \langle 3,1 \rangle,\ \vec{b} = \langle 2,4 \rangle$

7. $\vec{a} = \langle 0,-2 \rangle,\ \vec{b} = \langle -2,4 \rangle$

11. $\vec{a} = \langle 2,-1,3 \rangle,\ \vec{b} = \langle 0,2,4 \rangle$

13. $\vec{a} = 2\vec{i} - \vec{k},\ \vec{b} = 4\vec{j} - \vec{k}$

Compute the angle between the vectors.

15. $\vec{a} = 3\vec{i} - 2\vec{j},\ \vec{b} = \vec{i} + \vec{j}$

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

Determine if the vectors are orthogonal.

21. $\vec{a} = \langle 2,-1 \rangle,\ \vec{b} = \langle 2,4 \rangle$

23. $\vec{a} = \langle 4,-1,1 \rangle,\ \vec{b} = \langle 2,4,4 \rangle$

Find a vector perpendicular to the given vector.

29. $\langle 4,-1,1 \rangle$

31. $6\vec{i} + 2\vec{j} - \vec{k}$

Find $\text{comp}_{\vec{b}}\vec{a}$ **and** $\text{proj}_{\vec{b}}\vec{a}$.

37. $\vec{a} = \langle 2,-1,3 \rangle,\ \vec{b} = \langle 1,2,2 \rangle$

39. $\vec{a} = \langle 2,0,-2 \rangle,\ \vec{b} = \langle 0,-3,4 \rangle$

41. You exert a constant force of 40 pounds in the direction of the handle of a wagon. If the handle makes an angle of $\frac{\pi}{3}$ with the horizontal and you pull the wagon along a flat surface for 1 mile (5280 feet), find the work done.

45. A constant force of $\langle 30, 20 \rangle$ pounds moves an object in a straight line from the point (0, 0) to the point (24, 10). Compute the work done.

46. A constant force of $\langle 60, -30 \rangle$ pounds moves an object in a straight line from the point (0, 0) to the point (10, -10). Compute the work done.

47. Label each statement as true or false. If it is true, briefly explain why; if it is false, give a counterexample.

(a) If $\vec{a} \cdot \vec{b} = \vec{a} \cdot \vec{c}$, then $\vec{b} = \vec{c}$.

(b) If $\vec{b} = \vec{c}$, then $\vec{a} \cdot \vec{b} = \vec{a} \cdot \vec{c}$.

(c) $\vec{a} \cdot \vec{a} = \|\vec{a}\|^2$.

(d) If $\|\vec{a}\| > \|\vec{b}\|$ then $\vec{a} \cdot \vec{c} > \vec{b} \cdot \vec{c}$.

(e) If $\|\vec{a}\| = \|\vec{b}\|$ then $\vec{a} = \vec{b}$.

49. By the Cauchy-Schwartz inequality, $|\vec{a} \cdot \vec{b}| \leq \|\vec{a}\| \|\vec{b}\|$. What relationship must exist between $\vec{a}$ and $\vec{b}$ to have $|\vec{a} \cdot \vec{b}| = \|\vec{a}\| \|\vec{b}\|$?

50. By the triangle inequality, $\|\vec{a} + \vec{b}\| \leq \|\vec{a}\| + \|\vec{b}\|$. What relationship must exist between $\vec{a}$ and $\vec{b}$ to have $\|\vec{a} + \vec{b}\| = \|\vec{a}\| + \|\vec{b}\|$?

53. In a methane molecule (CH_4), a carbon atom is surrounded by four hydrogen atoms. Assume that the hydrogen atoms are at (0, 0, 0), (1, 1, 0), (1, 0, 1) and (0, 1, 1) and the carbon atom is at (0.5, 0.5, 0.5). Compute the **bond angle,** the angle from hydrogen atom to carbon atom to hydrogen atom.

57. Suppose that a beam of an oil rig is installed in a direction parallel to $\langle 10,1,5 \rangle$. If a wave exerts a force of $\langle 0,-200,0 \rangle$ Newtons, find the component of this force along the beam.