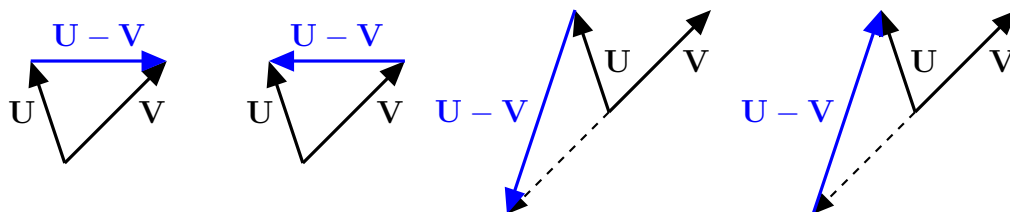


1. Given vectors \mathbf{U} and \mathbf{V} , which of the following graphically describes $\mathbf{U} - \mathbf{V}$? Circle your answer.



2. Circle TRUE or FALSE for each question.

- (a) TRUE FALSE Three distinct planes always meet in exactly one point.
- (b) TRUE FALSE If a vector \mathbf{U} is a scalar multiple of a vector \mathbf{V} , then \mathbf{V} is a scalar multiple of \mathbf{U} .
- (c) TRUE FALSE There are 48 direct symmetries of the cube.
- (d) TRUE FALSE For any two matrices A and B , $AB = BA$.
- (e) TRUE FALSE If two matrices A and B satisfy $AB = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$, then it follows that either $A = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$ or $B = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$.

3. Suppose that two vectors \mathbf{U} and \mathbf{V} satisfy $\mathbf{U} \cdot \mathbf{V} = 42$. Then

- (a) The angle between \mathbf{U} and \mathbf{V} is acute.
- (b) The angle between \mathbf{U} and \mathbf{V} is 90° .
- (c) The angle between \mathbf{U} and \mathbf{V} is obtuse.
- (d) None of the above.

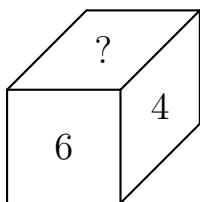
4. Let $\mathbf{U} = \begin{pmatrix} 2 \\ 1 \end{pmatrix}$, let \mathbf{X} be a **nonzero** vector, and put $\mathbf{Y} = P_{\mathbf{U}}(\mathbf{X})$. Circle ALL statements which might be true if an appropriate vector \mathbf{X} is chosen. There may be more than one answer.

- (a) $\mathbf{X} \cdot \mathbf{Y} = 0$.
- (b) $\mathbf{X} \cdot \mathbf{Y} < 0$.
- (c) \mathbf{X} is parallel to \mathbf{Y} .
- (d) $\mathbf{X} = \mathbf{Y}$.
- (e) None of the above.

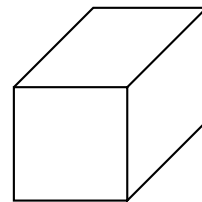
5. Let \mathbf{X} and \mathbf{Y} be a **nonzero** vectors which are not parallel, and put $\mathbf{U} = \mathbf{X} \times \mathbf{Y}$. Circle ALL true statements. There may be more than one answer.

- (a) \mathbf{U} is perpendicular to \mathbf{X} .
- (b) \mathbf{U} is perpendicular to \mathbf{Y} .
- (c) \mathbf{U} is parallel to \mathbf{X} .
- (d) \mathbf{U} is parallel to \mathbf{Y} .
- (e) None of the above.

6. Write the matrix which transforms the die to the following position:



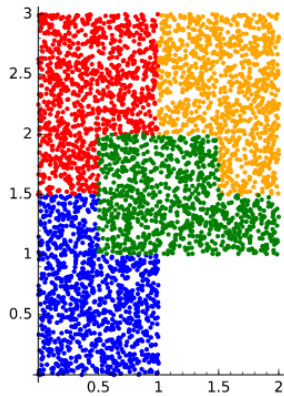
7. Fill in the die after performing the transformation $\begin{bmatrix} 0 & -1 & 0 \\ 0 & 0 & -1 \\ 1 & 0 & 0 \end{bmatrix}$.



8. For which values of m are the vectors $\begin{pmatrix} m \\ 9 \end{pmatrix}$ and $\begin{pmatrix} 4 \\ m \end{pmatrix}$ linearly dependent?

9. Find the following matrix product: $\begin{bmatrix} 3 & -1 \\ 2 & 4 \end{bmatrix} \cdot \begin{bmatrix} -2 & 3 \\ -1 & 4 \end{bmatrix}$.

10. Write the affine transformation, in matrix form, that describes the self-similarity of the green piece of the fractal (center).



11. Find the area of the triangle with vertices $(1, 2, 3)$, $(-1, 1, 1)$, and $(2, 1, -1)$.

12. Find the distance from the vector $(1, 1, 1)$ to the plane $x + 2y + 3z = 6$.

13. Give a parametric representation of the line through $\begin{pmatrix} 4 \\ -1 \end{pmatrix}$ and parallel to $\begin{pmatrix} -2 \\ 3 \end{pmatrix}$.

14. Find symmetric equations of the line through $(3, -1, 4)$ and $(6, 3, -7)$.

15. What is your favorite food?

EXTRA CREDIT: How many vertices, edges, square faces, cubical cells, and four-dimensional hypercubes are there on a five-dimensional hypercube?