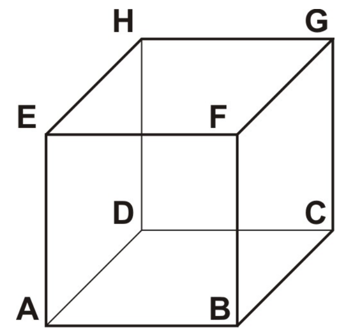
1. Consider the cube $ABCDEFGH$ with the side length equal to $10cm$. Find the magnitude of the following vectors:

a) $\overrightarrow{AB}$ b) $\overrightarrow{BD}$ c) $\overrightarrow{BH}$



2. Prove or disprove each statement.

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

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

3. Two vectors are defined by $\vec{a}=4N[E]$ and $\vec{b}=5N[090°]$. Find the sum vector $\vec{s}=\vec{a}+\vec{b}$ the difference vector $\vec{d}=\vec{a}-\vec{b}$.

4. Two vectors are defined by $\vec{a}=2km[W]$ and $\vec{b}=4km[S]$. Find the sum vector $\vec{s}=\vec{a}+\vec{b}$ the difference vector $\vec{d}=\vec{a}-\vec{b}$.

5. Two vectors are defined by $\vec{a}=20m[E]$ and $\vec{b}=30m[150°]$. Find the sum vector $\vec{s}=\vec{a}+\vec{b}$ the difference vector $\vec{d}=\vec{a}-\vec{b}$.

6. Given $\vec{a}=2\vec{i}-3\vec{j}+\vec{k}$, $\vec{b}=-\vec{i}+\vec{j}+2\vec{k}$, simplify the following expressions:

a) $\vec{a}+\vec{b}$ b) $\vec{a}-2\vec{b}$ c) $2\vec{a}-3\vec{b}$

7. Find a unit vector parallel to the sum between $\vec{a}=2m[E]$ and $\vec{b}=3m[N]$.

8. Given $\vec{u}=8m[W]$ and $\vec{v}=10m[S30°W]$, determine the magnitude and the direction of the vector $2\vec{u}-3\vec{v}$.

9. Adam can swim at the rate of $2km/h$ in still water. At what angle to the bank of a river must he head if he wants to swim directly across the river and the current in the river moves at the rate of $1km/h$?

10. A plane is heading due north with an air speed of $400km/h$ when it is blown off course by a wind of $100km/h$ from the northeast. Determine the resultant ground velocity of the airplane (magnitude and direction).

11. A car is travelling at $\overrightarrow{v_{car}}=100km/h[E]$, a motorcycle is travelling at $\overrightarrow{v_{moto}}=80km/h[W]$, a truck is travelling at $\overrightarrow{v_{truck}}=120km/h[N]$ and an SUV is travelling at $\overrightarrow{v_{SUV}}=100km/h[SW]$. Find the relative velocity of the car relative to:

a) motorcycle
b) truck
c) SUV

	1. Find the algebraic vector $\overrightarrow{AB}$ in ordered triplet notation and unit vector notation where $A(2,-3,4)$ and $B(0,-2,3)$. **2.** Find the magnitude of the vector $\vec{v}=-2\vec{i}+\vec{j}-3\vec{k}$. **3.** Given $\vec{a}=(-1,2,-3)$, $\vec{b}=2\vec{i}-\vec{j}+\vec{k}$, and $\vec{c}=\vec{i}+\vec{j}$ do the required operations: a) $2\vec{a}-\vec{b}+3\vec{c}$ b) $3(\vec{a}+2\vec{b})-2(\vec{a}-\vec{c})$ **4.** Given $A(1,-2,3)$, $B(-2,3,-4)$, and $C(0,1,-1)$, find the coordinates of a point $D(x,y,z)$ such that $ABCD$ is a parallelogram.
	5. The magnitudes of two vectors $\vec{a}$ and $\vec{b}$ are $\lvert\vec{a}\rvert=2$ and $\lvert\vec{b}\rvert=3$ respectively, and the angle between them is $\alpha=60°$. Find the value of the dot product of these vectors.
	6. Find the dot product of the vectors $\vec{a}$ and $\vec{b}$ where $\vec{a}=(1,-2,0)$ and $\vec{b}=\vec{i}-2\vec{j}-\vec{k}$. **7.** For what values of *k* are the vectors $\vec{a}=(6,3,-4)$ and $\vec{b}=(3,k,-2)$ a) perpendicular (orthogonal)? b) parallel (collinear)?
	8. Find the angle between the vectors $\vec{a}$ and $\vec{b}$ where $\vec{a}=(1,-2,-1)$ and $\vec{b}=-2\vec{j}+\vec{k}$. **9.** A triangle is defined by three points $A(0,1,2)$, $B(1,0,2)$, and $C(-1,2,0)$. Find the angles $\angle A$, $\angle B$, and $\angle C$ of this triangle.
	10. Given the vector $\vec{a}=(2,-3,4)$, find the scalar projection: a) of $\vec{a}$ onto the unit vector $\vec{i}$ b) of $\vec{a}$ onto the vector $\vec{i}-\vec{j}$ c) of $\vec{a}$ onto the vector $\vec{b}=-\vec{i}+2\vec{j}+\vec{k}$ d) of the unit vector $\vec{i}$ onto the vector $\vec{a}$
	11. Given two vectors $\vec{a}=(0,1,-2)$ and $\vec{b}=(-1,0,3)$, find: a) the vector projection of the vector $\vec{a}$ onto the vector $\vec{b}$ b) the vector projection of the vector $\vec{b}$ onto the vector $\vec{a}$ c) the vector projection of the vector $\vec{a}$ onto the unit vector $\vec{k}$ d) the vector projection of the vector $\vec{i}$ onto the vector $\vec{a}$
	12. The magnitudes of two vectors $\vec{a}$ and $\vec{b}$ are $\lvert\vec{a}\rvert=2$ and $\lvert\vec{b}\rvert=3$ respectively, and the angle between them is $\alpha=60°$. Find the magnitude of the cross product of these vectors.

13. For each case, find the cross product of the vectors $\vec{a}$ and $\vec{b}$.

a) $\vec{a} = (1,-2,0)$, $\vec{b} = (0,-1,2)$

b) $\vec{a} = -\vec{i} + 2\vec{j}$, $\vec{b} = \vec{i} - 2\vec{j} - \vec{k}$

14. Use the cross product properties to prove the following relations:

a) $(\vec{a} - \vec{b}) \times (\vec{a} + \vec{b}) = 2(\vec{a} \times \vec{b})$

b) $(\vec{a} \times \vec{b}) \cdot (\vec{a} \times \vec{b}) + (\vec{a} \cdot \vec{b})(\vec{a} \cdot \vec{b}) = (\vec{a} \cdot \vec{a})(\vec{b} \cdot \vec{b})$

15. Find an unit vector perpendicular to both $\vec{a} = (0,1,1)$ and $\vec{b} = (1,1,0)$.

16. Find the area of the parallelogram defined by the vectors $\vec{a} = (1,-1,0)$ and $\vec{b} = (0,1,2)$.

17. Find the area of the triangle defined by the vectors $\vec{a} = (1,2,3)$ and $\vec{b} = (3,2,1)$.

18. Find the volume of the parallelepiped defined by the vectors $\vec{a} = (0,1,1)$, $\vec{b} = (0,1,0)$ and $\vec{c} = (1,0,1)$.

19. Consider the following vectors: $\vec{a} = \vec{i} + \vec{j} - \vec{k}$, $\vec{b} = 3\vec{i} - 2\vec{j}$, and $\vec{c} = 3\vec{i} - 2\vec{k}$. Compute the required operations in terms of the unit vectors $\vec{i}$, $\vec{j}$, and $\vec{k}$.

a) $\vec{a} + \vec{b}$ b) $\vec{a} - 2\vec{b}$ c) $\vec{a} \cdot \vec{b}$

d) $\vec{b} \times \vec{c}$ e) $(\vec{a} \times \vec{b}) \cdot \vec{c}$ f) $(\vec{a} \times \vec{b}) \times \vec{c}$

g) $Proj(\vec{a} \ onto \ \vec{b})$

1. Find the equation of a 2D line which

a) passes through the points $A(0,-2)$ and $B(-3,1)$

b) passes through the point $A(1,-3)$ and is parallel to the vector $\vec{v} = (-2,-3)$

c) passes through the point $A(-2,3)$ and is perpendicular to the vector $\vec{v} = (3,-4)$

d) passes through the point $A(1,1)$ and is parallel to the line $y = -2 + 3x$

e) passes through the point $A(-2,-1)$ and is perpendicular to the line $2x - 3y + 4 = 0$

2. Find the point(s) of intersection between the two given lines.

a) $\vec{r} = (1,2) + t(3,1)$ and $\begin{cases} x = 2 - 3s \\ y = 1 - 2s \end{cases}$

b) $\frac{x-1}{-2} = \frac{y+2}{4}$ and $y = -2x$

c) $y = -3x + 1$ and $6x + 2y - 3 = 0$

	3. Find the equation of the perpendicular line to the given line through the given point. a) $\vec{r}=(0,1)+t(2,1)$, $B(2,-4)$ b) $\frac{x+1}{3}=\frac{y-2}{-2}$, $B(0,2)$ C) $2x-3y+4=0$, $B(3,1)$
	4. Find the distance from the given point to the given line. a) $\vec{r}=(-1,-2)+t(-1,2)$, $B(0,2)$ b) $\frac{x-3}{-2}=\frac{y+2}{3}$, $B(1,3)$ c) $x+2y-3=0$, $B(0,0)$
	5. Find the vector equation of a line that: a) passes through the points $A(0,1,2)$ and $B(-2,3,1)$ b) passes through the point $A(2,-1,4)$ and is perpendicular on the xy plane c) passes trough the point $A(3,-2,1)$ and is parallel to the y -axis d) passes through the point $A(2,-2,3)$ and is parallel to the vector $\vec{u}=(3,-2,1)$ e) passes through the origin O and is parallel to the vector $\vec{i}-2\vec{j}$
	6. Convert the equation(s) of the line from the vector form to the parametric form or conversely: a) $\vec{r}=(0,1,2)+t(3,4,5)$ b) $\begin{cases} x=-1-2t \\ y=1+3t \\ z=2 \end{cases}$
	7. Convert each form of the equation(s) of the line to the other two equivalent forms. a) $\vec{r}=(0,1,2)+t(1,0,3)$ b) $\begin{cases} x=-1-t \\ y=2-3t \\ z=-4 \end{cases}$ c) $\frac{x-1}{2}=\frac{y+2}{-1}=\frac{z+3}{-2}$
	8. Find the x-int, y-int, and z-int for the line $\vec{r}=(1,-2,3)+t(1,-2,4)$ if they exist. **9.** Find the xy-int, yz-int, and zx-int for the line $\vec{r}=(-2,3,4)+t(-1,1,-2)$ if they exist.
	10. Find if the lines are parallel or not. a) $\vec{r}=(1,2,3)+t(1,-2,3)$, $\vec{r}=(3,2,1)+s(-2,4,-6)$ b) $\vec{r}=(1,2,3)+t(2,1,3)$, $\vec{r}=(3,2,1)+s(4,2,-6)$ c) $\vec{r}=(5,0,5)+t(-3,3,-6)$, $\vec{r}=(3,2,1)+s(1,-1,2)$
	11. In the case the lines are parallel and distinct, find the distance between the lines. a) $\vec{r}=(1,2,3)+t(1,-2,3)$, $\vec{r}=(3,2,1)+s(-2,4,-6)$ b) $\vec{r}=(1,2,3)+t(2,1,3)$, $\vec{r}=(3,2,1)+s(4,2,-6)$ c) $\vec{r}=(5,0,5)+t(-3,3,-6)$, $\vec{r}=(3,2,1)+s(1,-1,2)$

	12. For each case, find the distance between the given line and the given point. a) $\vec{r}=(1,2,-3)+t(2,-1,-2),\quad M(3,-2,1)$ b) $\begin{cases} x=-2+2t \\ y=3+t \\ z=1-2t \end{cases}$, $E(0,2,-3)$ c) $\frac{x-2}{3}=\frac{y-1}{2}=\frac{z}{-1}$, $B(-2,1,-3)$
	13. Find the point of intersection if it exists. a) $\vec{r}=(1,2,3)+t(1,-2,3)$, $\vec{r}=(1,1,1)+s(2,-1,0)$ b) $\vec{r}=(1,3,5)+t(0,1,2)$, $\vec{r}=(0,2,4)+s(-1,0,1)$

	1. Find the vector equation of a plane a) passing through the point $A(-1,2,-3)$ and parallel to the vectors $\vec{u}=(-2,1,0)$ and $\vec{v}=(2,-3,-1)$ b) passing through the points $A(2,3,2)$ and $B(2,1,5)$ and $C(3,-1,0)$ c) passing through the origin and containing the line $\vec{r}=(1,-3,2)+t(1,1,1)$ d) passing through the point $A(2,-1,3)$ and is parallel to the yz-plane.
	2. Convert the vector equation for a plane to the parametric equations or conversely. a) $\vec{r}=(0,-1,2)+t(1,-2,3)+s(2,-3,4)$ b) $\begin{cases} x=1-2t+3s \\ y=t-2s \\ z=-2+4t \end{cases}$
	3. Find the scalar equation of a plane that: a) passes through the point $(1,2,3)$ and is perpendicular to the y-axis b) passes through the point $(1,0,-1)$ and is parallel to the yz-plane c) passes through the origin and is perpendicular to the vector $(1,-2,4)$
	4. Find the intersection with the coordinate axes for the plane $\pi:-2x+3y-6z+12=0$.
	5. For each case, find the distance between the given plane and the given point. a) $\vec{r}=(1,0,2)+t(0,1,2)+s(2,0,1)$, $B(2,3,0)$ b) $2x-3y+z-6=0$, $R(-2,0,3)$

	6. Find the intersection between the given line and the given plane. a) $\pi : 9x + 13y - 2z = 29$, $L : \begin{cases} x = 5 + 2t \\ y = -5 - 5t \\ z = 2 + 3t \end{cases}$ b) $\pi : 4x - y + 11z + 1 = 0$, $L : \vec{r} = (-2,4,1) + t(3,1,-1)$
	7. Find the equation of the line of intersection for each pair of planes (if it exists). a) $\pi_1 : 2x - 3y + z - 1 = 0$, $\pi_2 : 4x - 6y + 2z - 2 = 0$ b) $\pi_1 : 3x + 6y - 9z - 3 = 0$, $\pi_2 : 2x + 4y - 6z - 4 = 0$ c) $\pi_1 : x + 2y + 3z + 1 = 0$, $\pi_2 : x + 2y + z + 2 = 0$
	8. Find the angle between each pair of planes. a) $\pi_1 : x + 2y + 3z + 1 = 0$, $\pi_2 : 3x + 2y + z + 2 = 0$ b) $\pi_1 : x + y + z + 1 = 0$, $\pi_2 : x - y - 1 = 0$
	9. Solve the following system of equations. Give a geometric interpretation of the result. 1) $\begin{cases} x - 3y - 2z = -9 \\ 2x - 5y + z = 3 \\ -3x + 6y + 2z = 8 \end{cases}$ 2) $\begin{cases} x + y + 2z = -2 \\ 3x - y + 14z = 6 \\ x + 2y = -5 \end{cases}$ 3) $\begin{cases} x - y + z + 1 = 0 \\ -2x + 2y - 2z - 2 = 0 \\ 3x - 3y + 3z + 3 = 0 \end{cases}$ 4) $\begin{cases} x + y + z - 2 = 0 \\ x - y + z - 1 = 0 \\ 2x + 2y + 2z - 3 = 0 \end{cases}$