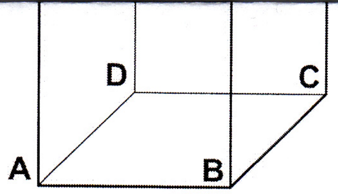
1. a) 10 cm b) $10\sqrt{2}$ cm c) $10\sqrt{3}$ cm 2. a) true b) false	 **2.** Prove or disprove each statement. a) If $\vec{a}=\vec{b}$ then $\lvert\vec{a}\rvert=\lvert\vec{b}\rvert$. b) If $\lvert\vec{a}\rvert=\lvert\vec{b}\rvert$ then $\vec{a}=\vec{b}$.
3. $\vec{a}=(4,0)$; $\vec{b}=(5,0)$ $\vec{s}=(9,0)$; $\vec{d}=(-1,0)$ 4. $\vec{a}=(-2,0)$; $\vec{b}=(0,-4)$ $\vec{s}=(-2,-4)=2\sqrt{5}$[S 26.56° W] $\vec{d}=(-2,4)=2\sqrt{5}$[N 26.56° W] 5. $\vec{a}=(20,0)$; $\vec{b}=(15,-15\sqrt{3})$ $\vec{s}=(35,-15\sqrt{3})=10\sqrt{19}$[S 53.41° E] $\vec{d}=(5,15\sqrt{3})=10\sqrt{7}$[N 10.89° E]	**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. a) $(1,-2,3)$ b) $(4,-5,-3)$ c) $(7,-9,-4)$ 7. $\pm\frac{1}{\sqrt{13}}(2,3)$ 8. $(-1,15\sqrt{3})=26$ [N 2.2° W]	**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. 60° 10. $(-50\sqrt{2}, 400-50\sqrt{2})=$ $=336.8\ \frac{km}{h}$ [N 12.12° W] 11. a) $(180,0)=180\ \frac{km}{h}$ [E] b) $(100,-120)=156\ \frac{km}{h}$ [S 39.8° E] c) $(100+50\sqrt{2}, 50\sqrt{2})=$ $=184.78$ [N 67.5° E]	**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. $\vec{AB} = (-2,1,-1) = -2\vec{i} + \vec{j} - \vec{k}$ 2. $\lvert\vec{v}\rvert = \sqrt{14}$ 3. a) $(-1,8,-7)$ b) $(13,-2,3)$ 4. $D(3,-4,6)$	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. $\vec{a} \cdot \vec{b} = 3$	**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. $\vec{a} \cdot \vec{b} = 5$ 7. a) $-26/3$ b) $3/2$	**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. $\theta = 28.71°$ 9. $\angle A = 125.26°$ $\angle B = 35.26°$ $\angle C = 19.47°$	**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. a) 2 b) $5/\sqrt{2}$ c) $-4/\sqrt{6}$ d) $2/\sqrt{29}$	**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. a) $(3/5, 0, -9/5)$ b) $(0, -6/5, 12/5)$ c) $(0, 0, -2)$ d) $\vec{0}$	**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. $3\sqrt{3}$	**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. a) $(-4, -2, -1)$ b) $(-2, -1, 0)$ 15. $\pm\left(\frac{-1}{\sqrt{3}}, \frac{1}{\sqrt{3}}, \frac{-1}{\sqrt{3}}\right)$	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. 3	**16.** Find the area of the parallelogram defined by the vectors $\vec{a}=(1,-1,0)$ and $\vec{b}=(0,1,2)$.
17. $2\sqrt{6}$	**17.** Find the area of the triangle defined by the vectors $\vec{a}=(1,2,3)$ and $\vec{b}=(3,2,1)$.
18. 1	**18.** Find the volume of the parallelepiped defined by the vectors $\vec{a}=(0,1,1)$, $\vec{b}=(0,1,0)$ and ~~$\vec{c}=(0,0,1)$~~. $\vec{c}=(1,0,1)$
19. a) $(4, -1, -1)$ b) $(-5, 5, -1)$ c) 1 d) $(4, 6, 6)$ e) 4 f) $(6, -19, 9)$ g) $\frac{1}{13}(3, -2, 0)$	**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. a) $(0, -2) + t(-3, 3)$ b) $(1, -3) + t(-2, -3)$ c) $(-2, 3) + t(4, 3)$ d) $(1, 1) + t(1, 3)$ e) $(-2, -1) + t(2, -3)$	**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. a) $(6, 11/3)$ b) coincident lines c) parallel lines	**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. a) $(2,-4)+t(1,-2)$ b) $(0,2)+t(2,3)$ c) $(3,1)+t(2,-3)$	b) $\frac{\ }{3}=\frac{\ }{-2}$, $B(0,2)$ C) $2x-3y+4=0$, $B(3,1)$
4. a) $6/\sqrt{5}$ b) $4/\sqrt{13}$ c) $3/\sqrt{5}$	**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. a) $(0,1,2)+t(-2,2,-1)$ b) $(2,-1,4)+t(0,0,1)$ c) $(3,-2,1)+t(0,1,0)$ d) $(2,-2,3)+t(3,-2,1)$ e) $t(1,-2,0)$	**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. a) $\begin{cases} x=3t \\ y=1+4t \\ z=2+5t \end{cases}$ b) $(-1,1,2)+t(-2,3,0)$	**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. a) $\begin{cases} x=t \\ y=1 \\ z=2+3t \end{cases}$; $\frac{x}{1}=\frac{z-2}{3}$; $y=1$ b) $\frac{x+1}{-1}=\frac{y-2}{-3}$; $z=-4$ $(-1,2,-4)+t(-1,-3,0)$ c) $\begin{cases} x=1+2t \\ y=-2-t \\ z=-3-2t \end{cases}$; $(1,-2,-3)+$ $+t(2,-1,-2)$	**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. $(0,0,-1)$ 9. $(-4,5,0)$ $(0,1,8)$ $(1,0,10)$	**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. a) parallel b) not parallel c) parallel	**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. a) $d=\sqrt{48/7}$ b) Not applicable (not parallel) c) $d=0$ (coincident)	**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. a) 6 b) $2\sqrt{17}/3$ c) $\sqrt{269/14}$	c) $\frac{x-2}{3}=\frac{y-1}{2}=\frac{z}{-1}$, $B(-2,1,-3)$
13. a) Not applicable (skew lines) b) (1,2,3)	**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. a) $(-1,2,-3)+t(-2,1,0)+s(2,-3,-1)$ b) $(2,3,2)+t(0,-2,3)+s(1,-4,-2)$ c) $t(1,1,1)+s(1,-3,2)$ d) $(2,-1,3)+t(0,1,0)+s(0,0,1)$	**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. a) $\begin{cases} x=t+2s \\ y=-1-2t-3s \\ z=2+3t+4s \end{cases}$ b) $\vec{r}=(1,0,-2)+t(-2,1,4)+$ $+s(3,-2,0)$	**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. a) $y=2$ b) $x=1$ c) $x-2y+4z=0$	**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. (6,0,0) (0,-4,0) (0,0,2)	**4.** Find the intersection with the coordinate axes for the plane $\pi:-2x+3y-6z+12=0$.
5. a) $d=17/\sqrt{21}$ b) $d=7/\sqrt{14}$	**5.** For each case, find the distance between the given plane and the given point. a) $\vec{r}=(1,0,2)+t(0,1,2)+s(2,0,1)$, $B(2,3,0)$

6. a) $(3,0,1)$

b) $L \subset \pi$

(line is contained into plane)

7. a) coincident planes

b) no intersection (parallel and distinct planes)

c) $\vec{r} = (-\frac{5}{2}, 0, \frac{1}{2}) + t(-2,1,0)$

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. a) 44.42°

b) 90°

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.

1) $P(2,1,4)$; $\vec{n_1} \cdot (\vec{n_2} \times \vec{n_3}) \neq 0$

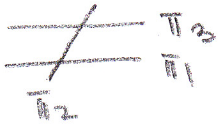
2) $\vec{r} = (1,-3,0) + t(-4,2,1)$

$\vec{n_1} \cdot (\vec{n_2} \times \vec{n_3}) = 0$ (coplanar normals)

3) coincident planes

4) no intersection

"H case"



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) $\begin{cases} x + y + z - 2 = 0 \\ x - y + z - 1 = 0 \\ 2x + 2y + 2z - 3 = 0 \end{cases}$