6.3 Equations of Planes Worksheet with solutions

This document was composed and formatted by Annie Bernatchez.

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1) Does each point lie on the plane $3x - 5y - 6z = 12$

a) $A(0,\ 0,\ -2)$	b) $B(1,\ 1,\ -2)$
LS $= 3(0) - 5(0) - 6(-2) = 12$ RS $= 12$ LS = RS, so A is on the plane.	LS $= 3(1) - 5(1) - 6(-2) = 10$ RS $= 12$ LS $\neq$ RS, so B is NOT on the plane.

2) Find the x-, y-, and z-intercepts of each plane.

a) $2x - 3y + 6z = 12$	b) $4x - 8z = 16$
x-int: $2x = 12,\ x = 6$ y-int: $-3y = 12,\ y = -4$ z-int: $6z = 12,\ z = 2$ $(6,\ 0,\ 0)$, $(0,\ -4,\ 0)$, $(0,\ 0,\ 2)$	x-int: $4x = 16,\ x = 4$ No y-intercept. z-int: $-8z = 16,\ z = -2$ $(4,\ 0,\ 0)$, no y-int, $(0,\ 0,\ -2)$

3) Write the parametric equations of each plane given its vector equation.

a) $[x,\ y,\ z] = [3,\ -1,\ 2] + t[4,\ -2,\ 3] + s[5,\ 1,\ 0]$	b) $[x,\ y,\ z] = [0,\ 8,\ 7] + t[1,\ 0,\ -3] + s[1,\ -4,\ 7]$
$\pi : \begin{cases} x = 3 + 4t + 5s \\ y = -1 - 2t + s \\ z = 2 + 3t \end{cases}$	$\pi : \begin{cases} x = t + s \\ y = 8 - 4s \\ z = 7 - 3t + 7s \end{cases}$

4) Write the vector equation of a plane given its parametric equations.

a) $\pi : \begin{cases} x = 1 - 9t + 4s \\ y = 8 - 7t + s \\ z = -1 - 3t + 2s \end{cases}$	b) $\pi : \begin{cases} x = 4 - t - s \\ y = 3 + 4s \\ z = 2t \end{cases}$
$[x,\ y,\ z] = [1,\ 8,\ -1] + t[-9,\ -7,\ -3] + s[4,\ 1,\ 2]$	$[x,\ y,\ z] = [4,\ 3,\ 0] + t[-1,\ 0,\ 2] + s[-1,\ 4,\ 0]$

5) Determine the x-, y-, and z-intercepts of the plane $[x,\ y,\ z] = [1,\ -3,\ 2] + t[4,\ -3,\ 5] + s[-1,\ 7,\ 0]$

$\pi : \begin{cases} x = 1 + 4t - s \\ y = -3 - 3t + 7s \\ z = 2 + 5t \end{cases}$

x-int ($y = z = 0$):	y-int ($x = z = 0$):	z-int ($x = y = 0$):
$0 = 2 + 5t,\ t = -\frac{2}{5}$ $0 = -3 - 3t + 7s,\ s = \frac{9}{35}$ $x = 1 + 4\left(-\frac{2}{5}\right) - \frac{9}{35}$ $x = -\frac{6}{7}$	$0 = 2 + 5t,\ t = -\frac{2}{5}$ $0 = 1 + 4t - s,\ s = -\frac{3}{5}$ $y = -3 - 3\left(-\frac{2}{5}\right) + 7\left(-\frac{3}{5}\right)$ $y = -6$	$0 = 1 + 4t - s,\ s = 1 + 4t$ $0 = -3 - 3t + 7(1 + 4t),\ t = -\frac{4}{25}$ $z = 2 + 5\left(-\frac{4}{25}\right)$ $z = \frac{6}{5}$

x-int: $\left(-\frac{6}{7},\ 0,\ 0\right)$, y-int: $(0,\ -6,\ 0)$, z-int: $\left(0,\ 0,\ \frac{6}{5}\right)$

6) Write a vector equation for each plane:

a) contains the origin; has direction vectors $\vec{a} = [2,\ -1,\ 7]$ and $\vec{b} = [3,\ 5,\ 2]$

$[x,\ y,\ z] = [0,\ 0,\ 0] + t[2,\ -1,\ 7] + s[3,\ 5,\ 2]$

b) contains the points $D(1,\ -2,\ 3)$, $E(5,\ -1,\ 8)$, and $F(3,\ 9,\ 2)$

$\vec{m_1} = \overrightarrow{DE} = [4,\ 1,\ 5]$

$\vec{m_2} = \overrightarrow{DF} = [2,\ 11,\ -1]$

$[x,\ y,\ z] = [1,\ -2,\ 3] + t[4,\ 1,\ 5] + s[2,\ 11,\ -1]$

7) Determine the vector equation of the plane that contains the points $A(2,\ -1,\ 4)$, $B(-3,\ 4,\ 5)$, and $C(8,\ -1,\ 6)$.

$\vec{m_1} = \overrightarrow{AB} = [-5,\ 5,\ 1]$

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$\overrightarrow{m_2} = \overrightarrow{AC} = [6, 0, 2]$

$[x, y, z] = [2, -1, 4] + t[-5, 5, 1] + s[6, 0, 2]$

8) A plane is perpendicular to $[x, y, z] = [1, -10, 8] + s[1, 2, -1]$ and contains the point $P(-1, 4, -2)$. Determine if the point $A(7, 10, 16)$ is also on this plane.

$\overrightarrow{PA} = [8, 6, 18] = 2[4, 3, 9]$

If A is on the plane, $\overrightarrow{PA}$ would be perpendicular to $[1, 2, -1]$. Check the dot product.

$\overrightarrow{PA} \cdot [1, 2, -1] = [8, 6, 18] \cdot [1, 2, -1]$

$\overrightarrow{PA} \cdot [1, 2, -1] = 2$

Since the dot product is not zero, $\overrightarrow{PA}$ is not perpendicular, so A is NOT on the plane.

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