Fill in the blanks. GRADED BY ME SCORE: _____ / 6 PTS

NOTE: For each part (ie. [a], [b], [c]), you must fill in all blanks correctly to receive any credit.

[a] If line ℓ_1 is parallel to line ℓ_2, then the DIRECTION vector of line ℓ_1 is PARALLEL to the DIRECTION vector of line ℓ_2.

[b] If line ℓ is parallel to plane $\wp$, then the DIRECTION vector of line ℓ is PERPENDICULAR to the NORMAL vector of plane $\wp$.

[c] If plane $\wp_1$ is perpendicular to plane $\wp_2$, then the NORMAL vector of plane $\wp_1$ is PERPENDICULAR to the NORMAL vector of plane $\wp_2$.

Fill in the blanks. **SCORE: _____ / 4 PTS**

[a] If $\vec{u} \times \vec{v} = <3, -2, -5>$, then $\vec{v} \times \vec{u} =$ $\boxed{<-3, 2, 5>}$ 1 $= -(\vec{u} \times \vec{v})$

[b] If $(\vec{u} \times \vec{v}) \cdot \vec{w} = -6$, then $\vec{u} \cdot (\vec{v} \times \vec{w}) =$ $\boxed{-6}$ 1 $= (\vec{u} \times \vec{v}) \cdot \vec{w}$

[c] If $\vec{u}, \vec{v}$ and $\vec{x}$ are adjacent edges of a parallelepiped, and $\vec{u} \times \vec{v} = <-3, 2, -5>$ and $\vec{x} = <1, 3, 3>$,

then the volume of the parallelepiped is $\boxed{12}$ 2 $= |(\vec{u} \times \vec{v}) \cdot \vec{w}| = |-3 + 6 - 15|$

Suppose that $\vec{b}$ is a vector of magnitude 3, and $\vec{d}$ is a vector of magnitude 4, **SCORE: _____ / 3 PTS**

and the angle between $\vec{b}$ and $\vec{d}$ is $\frac{2\pi}{3}$ radians. Fill in the blanks.

[a] $\|\vec{b}\times\vec{d}\| =$ $\boxed{6\sqrt{3}}$ 2 $= \|\vec{b}\|\,\|\vec{d}\| \sin\theta = 3\cdot 4 \sin\frac{2\pi}{3}$

[b] $\vec{d}\times\vec{d} =$ $\boxed{\vec{0}}$ 1 $\leftarrow$ MUST BE A VECTOR, NOT A NUMBER

Let P be the point $(-1, -5, 3)$.
Let Q be the point $(1, -4, 4)$.
Let R be the point such that $\overrightarrow{PR} = 3\vec{i} + 2\vec{k}$.

ALL ITEMS 1 POINT UNLESS OTHERWISE NOTED

SCORE: _____ / 17 PTS

[a] Find a vector of magnitude 3 perpendicular to both $\overrightarrow{PQ}$ and $\overrightarrow{PR}$.

$\overrightarrow{PQ} = \langle 2, 1, 1 \rangle$

$$\overrightarrow{PQ} \times \overrightarrow{PR} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 2 & 1 & 1 \\ 3 & 0 & 2 \end{vmatrix} = \langle 2, -1, -3 \rangle \quad 2$$

CHECK

$$\boxed{\begin{aligned} \langle 2,-1,-3\rangle \cdot \langle 2,1,1\rangle &= 4-1-3=0 \\ \langle 2,-1,-3\rangle \cdot \langle 3,0,2\rangle &= 6-6=0 \end{aligned}}$$

$$\frac{3}{\|\langle 2,-1,-3\rangle\|} \langle 2,-1,-3\rangle = \boxed{\frac{3}{\sqrt{14}}} \langle 2,-1,-3\rangle \quad 2$$

[b] S is a point such that $PQSR$ is a parallelogram. Find the area of parallelogram $PQSR$.

$$\|\overrightarrow{PQ} \times \overrightarrow{PR}\| = \|\langle 2,-1,-3\rangle\| = \sqrt{14}$$

[c] Find the standard (point-normal) equation of the plane which is parallel to both $\overrightarrow{PQ}$ and $\overrightarrow{PR}$, and also contains P.

$$\vec{n} = \overrightarrow{PQ} \times \overrightarrow{PR} = \langle 2,-1,-3\rangle$$

$$2(x+1) - (y+5) - 3(y-3) = 0$$

[d] Find the angle between the plane in part [c] and the plane $x + 3y + 2z = 7$.

$$\cos^{-1} \frac{|\vec{n}_1 \cdot \vec{n}_2|}{\|\vec{n}_1\|\|\vec{n}_2\|} = \cos^{-1} \frac{|\langle 2,-1,-3\rangle \cdot \langle 1,3,2\rangle|}{\|\langle 2,-1,-3\rangle\| \|\langle 1,3,2\rangle\|} = \cos^{-1} \frac{|2-3-6|}{\sqrt{14}\sqrt{14}}$$

$$= \cos^{-1} \frac{7}{14} = \cos^{-1} \frac{1}{2} = \frac{\pi}{3}$$

[e] Find parametric equations for the line which is parallel to $\dfrac{x+4}{2} = y - 3 = \dfrac{5-z}{6}$, and also contains Q.

$$\boxed{\begin{aligned} x &= 1 + 2t \\ y &= -4 + t \\ z &= 4 - 6t \end{aligned}}$$

$$\frac{x+4}{2} = \frac{y-3}{1} = \frac{z-5}{-6} \quad \vec{d} = \langle 2, 1, -6 \rangle$$