① Vectors parallel to the plane are

$$\vec{v} = \begin{bmatrix} 1 \\ -1 \\ -1 \end{bmatrix} - \begin{bmatrix} -1 \\ -1 \\ -1 \end{bmatrix} = \begin{bmatrix} 2 \\ 0 \\ 0 \end{bmatrix}$$

and $\vec{w} = \begin{bmatrix} -1 \\ -1 \\ 1 \end{bmatrix} - \begin{bmatrix} -1 \\ -1 \\ -1 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 2 \end{bmatrix}$. The cross product of these vectors is:

$$\begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 2 & 0 & 0 \\ 0 & 0 & 2 \end{vmatrix} = \vec{i} \begin{vmatrix} 0 & 0 \\ 0 & 2 \end{vmatrix} - \vec{j} \begin{vmatrix} 2 & 0 \\ 0 & 2 \end{vmatrix} + \vec{k} \begin{vmatrix} 2 & 0 \\ 0 & 0 \end{vmatrix}$$

$$= -4\vec{j} = \begin{bmatrix} 0 \\ -4 \\ 0 \end{bmatrix} = \vec{n}.$$

Choosing $(x_0, y_0, z_0) = (-1, -1, -1)$,

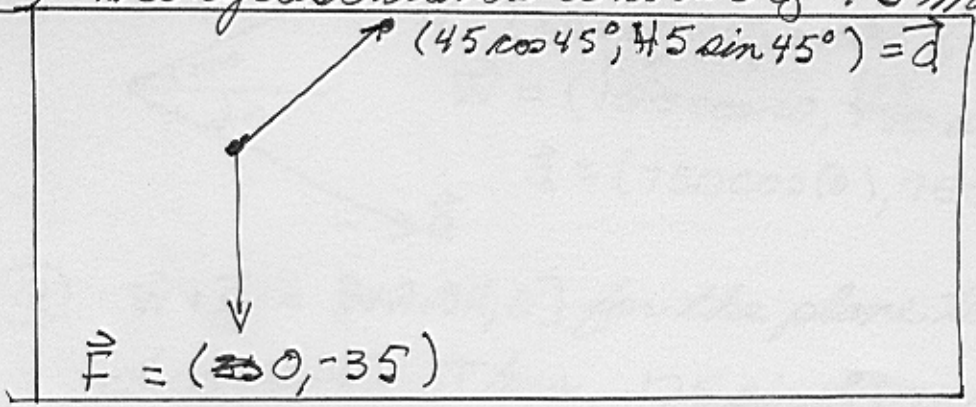
we have an equation for the plane is

$\vec{n} \circ (x - x_0, y - y_0, z - z_0) = 0$, that is,

$(0, -4, 0) \circ (x+1, y+1, z+1) = 0$,

i.e. $-4(y+1) = 0$, or $\boxed{y = -1}$.

(2) The cyclist travels a total of 45 miles. The picture is:



The total work against the wind is thus:

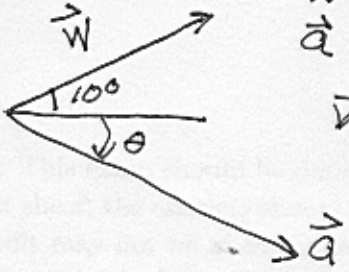
$$(0,-35)\circ\left(45\tfrac{\sqrt{2}}{2}, 45\tfrac{\sqrt{2}}{2}\right) = (-35)(45)\left(\tfrac{\sqrt{2}}{2}\right) \text{ mi-lb}$$

≈ -1113.7 ft.-lb mi $\approx (-1113.7) * 5280$ ft.lb,

that is, approximately 5,880,336 ft.lb.

(Incidentally, this corresponds to about 1,900 dietary calories.)

(3)



Let $\vec{w}$ = [the wind vector] and
$\vec{a}$ = [the velocity vector of the plane].

$\vec{w} = (\frac{125}{7}\cancel{50}\cos 10, \frac{125}{\cancel{750}}\sin 10)$

$\vec{a} = (750\cos(\theta), 750\sin(\theta))$.

(a) $\vec{w}+\vec{a} = [\|\vec{w}+\vec{a}\|, 0]$ for the plane to be travelling due east. Thus, $125\sin 10° + 750\sin\theta = 0$,

that is, $\sin\theta = \frac{-125\sin 10°}{750}$, i.e.

$\theta = \arcsin\left(\frac{-125\sin 10°}{750}\right) \approx -1.66°$

(b) The ground speed is

~~$\|\vec{w}+\vec{a}\| \approx 750\cos(1.66°) + 125\cos(10°)$~~

~~≈ 873 kilometers per hour.~~

ooo

$\approx \sqrt{(750\cos(-1.66°)+125\cos(10°))^2 + (750\sin(-1.66°) + 125\sin 10°)^2}$

≈ 873 kilometers per hour.