1.68 $R_x = A_x + B_x$

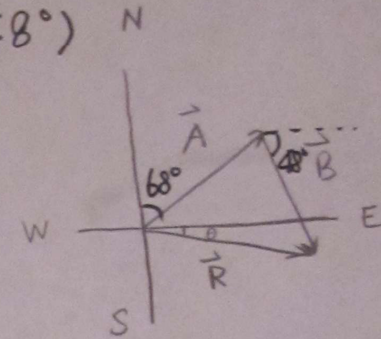
$= (170\,km)\sin 68^\circ + (230\,km)\cos(-48^\circ)$

$= 311.5\,km$

$R_y = A_y + B_y$

$= (170\,km)\cos 68^\circ + (230\,km)\sin(-48^\circ)$

$= -107.2\,km$



$|R| = \sqrt{R_x^2 + R_y^2} = 330\,km$

$\tan\theta = \left|\frac{R_y}{R_x}\right| = 0.344$ $\theta = 19^\circ$ South of east

1.74 $\vec{A} + \vec{B} + \vec{C} + \vec{D} = 0$ $\vec{D} = -(\vec{A} + \vec{B} + \vec{C})$

$D_x = -[(147\,km)\cos 85^\circ + (106\,km)\cos 167^\circ + (166\,km)\sin 235^\circ]$

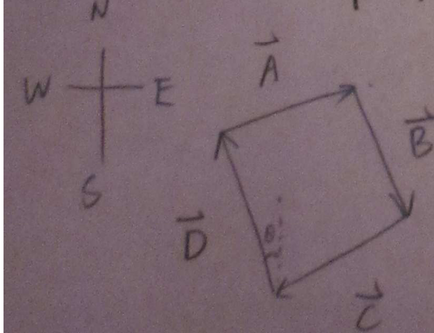
$= -34.3\,km$

$D_y = -[(147\,km)\sin 85^\circ + (106\,km)\sin 167^\circ + (166\,km)\cos 235^\circ]$

$= 185.7\,km$

$|D| = \sqrt{D_x^2 + D_y^2} = 189\,km$

$\tan\theta = \left|\frac{D_y}{D_x}\right| = 0.185$ $\theta = 10.5^\circ$ west of north



1.94 Obtain a unit vector perpendicular to the two vectors given in Ex 1.53.

$A = \begin{pmatrix} -2 \\ 3 \\ 4 \end{pmatrix}$ and $B = \begin{pmatrix} 3 \\ 1 \\ -3 \end{pmatrix}$.

The idea is that: since any two vectors that do not lie along the same line span a two-dimensional plane, there is only one vector, up to a scalar multiple, perpendicular to that plane. We know that $\vec{\boldsymbol{A}} \times \vec{\boldsymbol{B}}$ is such a vector. (**Caution.** $\vec{\boldsymbol{A}} \times \vec{\boldsymbol{B}}$ is a vector, not a number!)

$$\begin{aligned}
\vec{\boldsymbol{A}} \times \vec{\boldsymbol{B}} &= \det \begin{pmatrix} \hat{\boldsymbol{i}} & \hat{\boldsymbol{j}} & \hat{\boldsymbol{k}} \\ -2 & 3 & 4 \\ 3 & 1 & -3 \end{pmatrix} = \hat{\boldsymbol{i}} \det \begin{pmatrix} 3 & 4 \\ 1 & -3 \end{pmatrix} - \hat{\boldsymbol{j}} \det \begin{pmatrix} -2 & 4 \\ 3 & -3 \end{pmatrix} + \hat{\boldsymbol{k}} \det \begin{pmatrix} -2 & 3 \\ 3 & 1 \end{pmatrix} \\
&= \hat{\boldsymbol{i}}[3(-3) - 4 \cdot 1] - \hat{\boldsymbol{j}}[(-2)(-3) - 4 \cdot 3] + \hat{\boldsymbol{k}}[(-2)1 - 3 \cdot 3] \\
&= -13\hat{\boldsymbol{i}} + 6\hat{\boldsymbol{j}} - 11\hat{\boldsymbol{k}}
\end{aligned}$$

(It is always a good idea to check that the resulting cross product is really perpendicular to the original two vectors!) Finally, we have to normalize the vector $\vec{\boldsymbol{A}} \times \vec{\boldsymbol{B}}$ so that its magnitude is one, so we need to know the magnitude of $\vec{\boldsymbol{A}} \times \vec{\boldsymbol{B}}$.

$$|\vec{\boldsymbol{A}} \times \vec{\boldsymbol{B}}| = \sqrt{(-13)^2 + 6^2 + (-11)^2} = \sqrt{326}.$$

Therefore, the unit vector $\hat{\boldsymbol{u}}$ in the direction of $\vec{\boldsymbol{A}} \times \vec{\boldsymbol{B}}$ is $\boxed{-\frac{13}{\sqrt{326}}\hat{\boldsymbol{i}} + \frac{6}{\sqrt{326}}\hat{\boldsymbol{j}} - \frac{11}{\sqrt{326}}\hat{\boldsymbol{k}}}$.

1.96 $|A| = |B| = 3$. $A \times B = \begin{pmatrix} 2 \\ 0 \\ -5 \end{pmatrix}$. What is the angle between A and B?

Recall that $|A \times B| = |A||B| \sin\theta$. $|A \times B| = \sqrt{2^2 + (-5)^2} = \sqrt{29}$ So $\sin\theta = \frac{\sqrt{29}}{9}$. This gives $\theta \approx 0.6414$ rad $= 0.6414 \times \frac{360°}{2\pi} \approx 36.75°$.