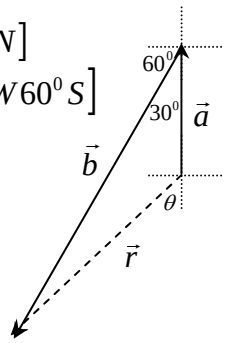
3) Find the displacement of a cruise ship that travels $20km[N]$ and then $60km[W60^0S]$ Draw a detail diagram.

Given

$\vec{a} = 20km[N]$

$\vec{b} = 60km[W60^0S]$



RTF

$\vec{d}$

Formulae

$r^2 = a^2 + b^2 - 2ab\cos(R)$

$\frac{\sin R}{r} = \frac{\sin B}{b}$

Solution

~~Find $|\vec{r}|$~~

$r^2 = a^2 + b^2 - 2ab\cos(R)$

$r = \sqrt{a^2 + b^2 - 2ab\cos(R)}$

$r = \sqrt{(20)^2 + (60)^2 - 2(20)(60)\cos(30)}$

$r = 44.8km$

~~Find θ~~

$\frac{\sin B}{b} = \frac{\sin R}{r}$

$\sin B = \frac{b\sin R}{r}$

$\sin B = \frac{(60)\sin(30)}{44.8}$

$\sin B = 0.669642857$

$\angle B = 42^0$ (*accute*)

$\angle B = 138^0$ (*obtuse*)

$\theta + B = 180^0$

$\theta = 180^0 - 138^0$

$\theta = 42^0$

$\therefore \vec{r} = 45km[S42^0W]$

Find the displacement of a boat that sails $1.0km\left[N30^0W\right], 2.0km\left[W20^0S\right]$ and $2.0km\left[S10^0E\right]$
Draw a detail diagram.

Given

$\vec{a} = 1.0km\left[N30^0W\right]$
$\vec{b} = 2.0km\left[W20^0S\right]$
$\vec{c} = 2.0km\left[S10^0E\right]$

RTF

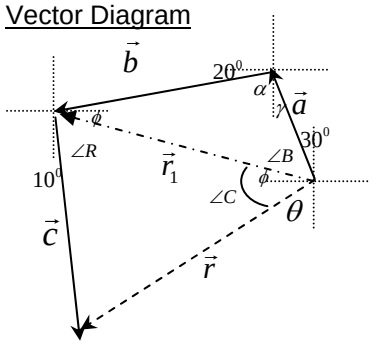
$\vec{d}$

Formulae

$r^2 = a^2 + b^2 - 2ab\cos(R)$
$\frac{\sin R}{r} = \frac{\sin B}{b}$
$\frac{\sin C}{c} = \frac{\sin R}{r}$

Solution

Vector Equation
$\vec{r} = \vec{a} + \vec{b} + \vec{c}$
Vector Diagram



First find $\vec{a} + \vec{b}$
Let $\vec{r}_1 = \vec{a} + \vec{b}$

$\gamma = 30^0$ (Z pattern)
$\alpha = 70^0$ (Complementary Angles)
$R_1 = \gamma + \alpha$
$R_1 = 30^0 + 70$
$R_1 = 100^0$

Find $|\vec{r}_1|$
$r_1^2 = a^2 + b^2 - 2ab\cos(R_1)$
$r_1 = \sqrt{a^2 + b^2 - 2ab\cos(R_1)}$
$r_1 = \sqrt{(1.0)^2 + (2.0)^2 - 2(1.0)(2.0)\cos(100)}$
$r_1 = 2.4km$

Find ϕ
$\frac{\sin B}{b} = \frac{\sin R_1}{r_1}$
$\sin B = \frac{b\sin R_1}{r_1}$
$\sin B = \frac{(2.0)\sin(100)}{2.4}$
$\sin B = 0.820673127$
$\angle B = 55.1^0$

$\phi + \angle B + 30^0 = 90^0$
$\phi = 90^0 - \angle B - 30^0$
$\phi = 90^0 - 55.1^0 - 30^0$
$\phi = 4.9^0$

Find $\angle R$
$\phi + \angle R + 10^0 = 90^0$
$\angle R = 90^0 - 10^0 - \phi$
$\angle R = 90^0 - 10^0 - 4.9^0$
$\angle R = 75.1^0$

Find $|\vec{r}|$
$r^2 = c^2 + r_1^2 - 2cr_1\cos(R)$
$r = \sqrt{c^2 + r_1^2 - 2cr_1\cos(R)}$
$r = \sqrt{(2.0)^2 + (2.4)^2 - 2(2.0)(2.4)\cos(75.1^0)}$
$r = 2.70km$

Find θ
$\frac{\sin C}{c} = \frac{\sin R}{r}$
$\sin C = \frac{c\sin R}{r}$
$\sin C = \frac{(2.0)\sin(75.1)}{2.70}$
$\angle C = 45.7^0$

$\theta + \angle C + \angle B + 30^0 = 180^0$
$\theta = 180^0 - \angle C - \angle B - 30^0$
$\theta = 180^0 - 45.7^0 - 55.1 - 30^0$
$\theta = 49^0$

$\vec{r} = 2.70km\left[S49^0W\right]$
$\therefore \vec{d} = 2.70km\left[S49^0W\right]$