Title

Relative Velocity

30 m/s → (A) 10 m/s → (B)

$\uparrow \vec{j}$, $\rightarrow \vec{i}$

$\vec{V}_A = 30\vec{i}$

$\vec{V}_B = 10\vec{i}$

$\vec{V}_{AB} = \vec{V}_A - \vec{V}_B$

$= 30\vec{i} - 10\vec{i} = 20\vec{i}$ m/s

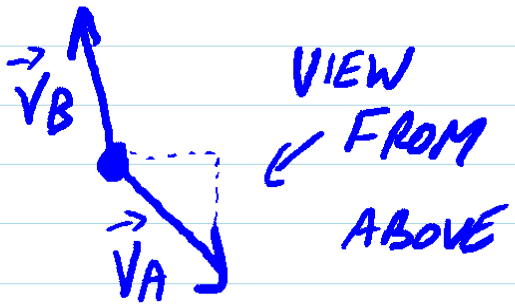
30 m/s → (A) ← 10 m/s (B)

$\vec{V}_A = 30\vec{i}$

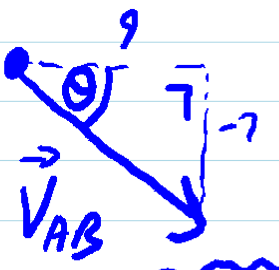
$\vec{V}_B = -10\vec{i}$

$\vec{V}_{AB} = 30\vec{i} - (-10\vec{i})$

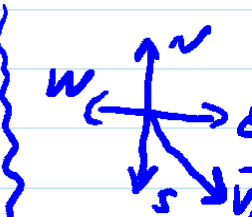
$= 40\vec{i}$ m/s



VIEW FROM ABOVE



VIEW FROM DECK OF SHIP B



$\vec{V}_A = 3\vec{i} - 2\vec{j}$

$\vec{V}_B = -6\vec{i} + 5\vec{j}$

$\vec{V}_{AB} = \vec{V}_A - \vec{V}_B$

$= (3\vec{i} - 2\vec{j}) - (-6\vec{i} + 5\vec{j})$

$= 3\vec{i} - 2\vec{j} + 6\vec{i} - 5\vec{j}$

$= 9\vec{i} - 7\vec{j}$

$\vec{V}_{AB} = 9\vec{i} - 7\vec{j}$

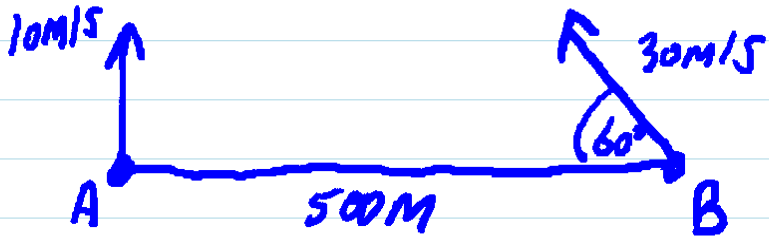
Speed $= |\vec{V}_{AB}| = \sqrt{9^2 + (-7)^2} = \sqrt{130}$ m/s

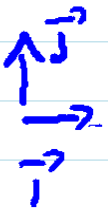
Dir $\tan\theta = \frac{7}{9}$ $\theta = \tan^{-1}\frac{7}{9} = 37.9°$

E 37.9° N

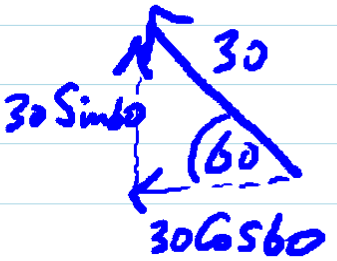
SHORTEST DIST

Q How close do they get?





$$\vec{V}_A = 0\vec{i} + 10\vec{j}$$



$$\vec{V}_B = -30\cos 60\,\vec{i} + 30\sin 60\,\vec{j}$$

$$= -30\left(\tfrac{1}{2}\right)\vec{i} + 30\left(\tfrac{\sqrt{3}}{2}\right)\vec{j}$$

$$= -15\vec{i} + 15\sqrt{3}\,\vec{j}$$

$$\vec{V}_{AB} = \vec{V}_A - \vec{V}_B$$

$$= 10\vec{j} - (-15\vec{i} + 15\sqrt{3}\,\vec{j})$$

15 March

$\vec{V}_{AB} = 15\vec{i} + 10\vec{j} - 15\sqrt{3}\,\vec{j}$

$\vec{V}_{AB} = 15\vec{i} + (10 - 15\sqrt{3})\vec{j}$

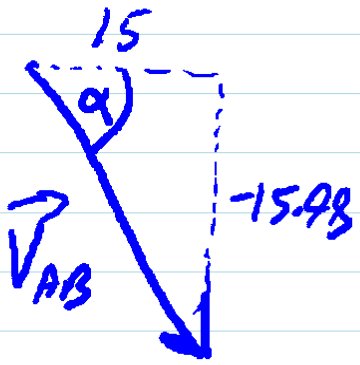
$\vec{V}_{AB} = 15\vec{i} - 15.98\vec{j}$

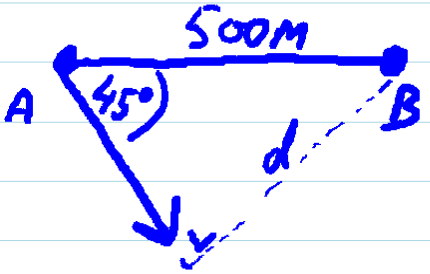
VIEW FROM ABOVE

$\tan\alpha = \frac{15.98}{15}$

≈ 1

$\alpha = 45^\circ$





VIEW FROM B

$\sin 45 = \frac{d}{500}$

$d = 500 \sin 45$

$= 500\left(\frac{1}{\sqrt{2}}\right)$

$= \frac{500}{\sqrt{2}}$ m

2. **(a)** Two boats, B and C, are each moving with constant velocity.
At a certain instant, boat B is 10 km due west of boat C.
The speed and direction of boat B relative to boat C is 2.5 m/s in the direction 60° south of east.

(i) Calculate the shortest distance between the boats, to the nearest metre.

(ii) Calculate the length of time, to the nearest second, for which the boats are less than or equal to 9 km apart. 9000m

(i) 2002 Q2(a)

$\sin 60 = \frac{d}{10000}$

$d = 10000 \sin 60$

$= 10000\,(0.8660) = 8660\,m$