

Mon 19 Apr (Rel. Vel)

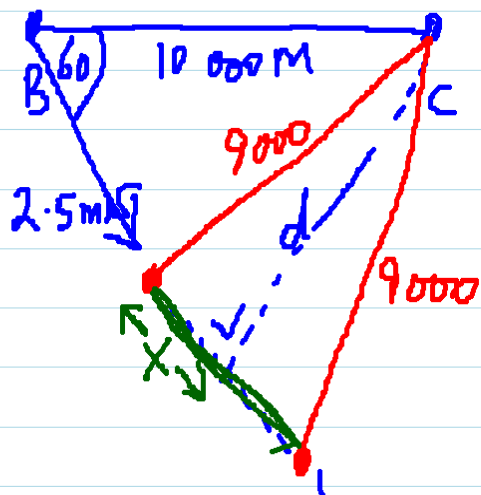
Title

2002 Q2(a)



<http://www.appliedmaths.net/documents/p2002.pdf> - Windows Internet Explorer

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**



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

$$d = 10000 \sin 60 = 10000 \frac{\sqrt{3}}{2}$$

$$= 8660 \text{ m}$$

$$\text{Pythagoras: } x^2 + d^2 = 9000^2$$

$$x^2 + 8660^2 = 9000^2$$

$$x^2 + 74995600 = 81000000$$

$$x^2 = 6004400$$

$$x = 2450 \text{ m}$$

$$\text{In Range: } 2x =$$

$$2(2450) =$$

$$4900 \text{ m}$$

$$\text{Speed} = \frac{\text{DIST}}{\text{TIME}}$$

$$t = \frac{d}{s} = \frac{4900}{2.5}$$

$$= 1960 \text{ sec}$$

(b)

- b) The velocity of ship P relative to a steady wind is 20 km/hr in the direction 80° north of east.
The velocity of ship Q relative to the same steady wind is 10 km/hr in the direction 20° south of west.

Calculate the magnitude and direction of the velocity of ship P relative to ship Q.

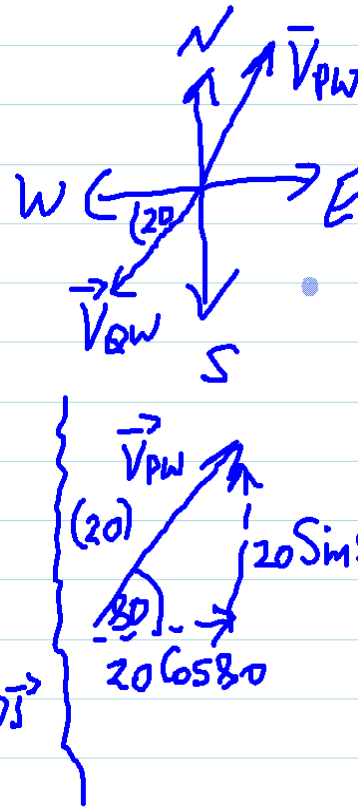
Give your answers to the nearest km and the nearest degree, respectively.

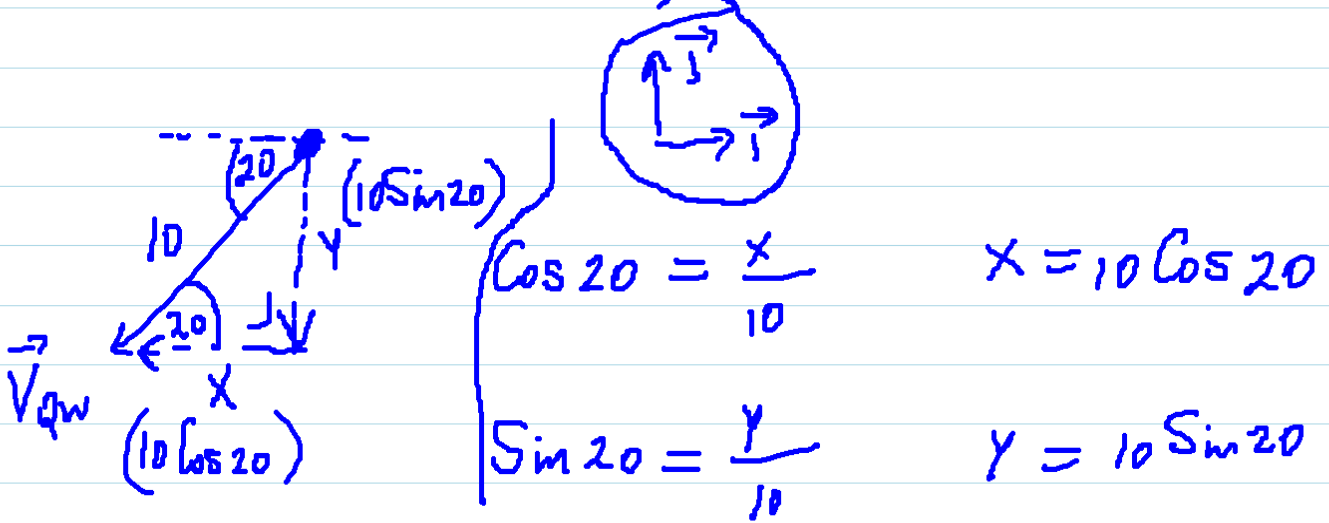
Vel of Ship: \vec{V}_P

Vel of Wind: \vec{V}_W

Vel of P Rel to wind: $\vec{V}_{PW} = \vec{V}_P - \vec{V}_W$

$$\vec{V}_{PW} = 20\cos 80^\circ \vec{i} + 20\sin 80^\circ \vec{j}$$





$$x = 10 \cos 20$$

$$y = 10 \sin 20$$

$$\vec{V}_{QW} = (-10 \cos 20) \vec{i} + (10 \sin 20) \vec{j} = \vec{V}_R - \vec{V}_W$$

$$\vec{V}_{PQ} = \vec{V}_P - \vec{V}_Q = -4\vec{i} - 3\vec{j}$$

SUMMARY	
$\vec{V}_{PW} = \vec{V}_P - \vec{V}_W$	$\vec{V}_P - \vec{V}_W$
$\vec{V}_{QW} = \vec{V}_Q - \vec{V}_W$	$\vec{V}_Q - \vec{V}_W$
$\vec{V}_{PW} - \vec{V}_{QW} = \vec{V}_P - \vec{V}_Q$	$\vec{V}_P - \vec{V}_Q$
	$= \vec{V}_{PQ}$

$$\vec{V}_{PQ} = \vec{V}_{PW} - \vec{V}_{QW}$$

$$= \underbrace{(20 \cos 80^\circ \vec{i} + 20 \sin 80^\circ \vec{j})}_{\vec{V}_{PW}} - \underbrace{(-10 \cos 20^\circ \vec{i} - 10 \sin 20^\circ \vec{j})}_{\vec{V}_{QW}}$$

$$= (20 \cos 80^\circ + 10 \cos 20^\circ) \vec{i} + (20 \sin 80^\circ + 10 \sin 20^\circ) \vec{j}$$