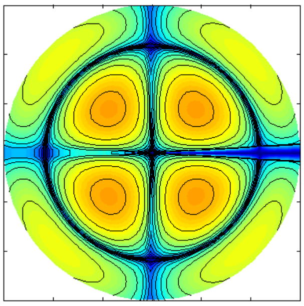


HSC PHYSICS ONLINE

KINEMATICS
PROBLEMS and ANSWERS

P1681

The water in a river flows w.r.t. the ground at a constant velocity $\vec{v}_{WG}$. A canoeist moves at a constant velocity w.r.t the water $\vec{v}_{CW}$.

In what direction θ relative to the ground should the canoeist paddle to travel the minimum distance in crossing the river from one river bank to the other.

In canoeist language, the angle θ when measured relative to the current is called the **attack angle**.

How does the angle of attack change as the current increases?

What is the implications of $\left|\vec{v}_{WG}\right| > \left|\vec{v}_{CW}\right|$?

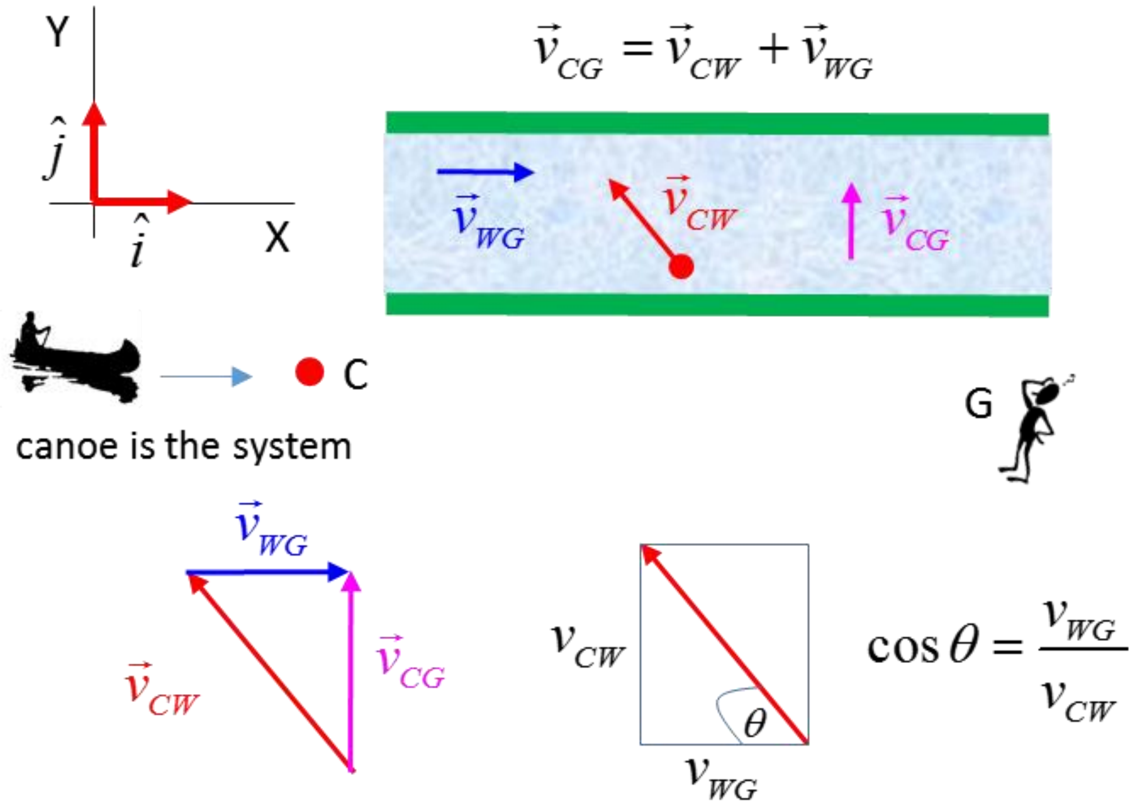
ANSWER

Problem category: relative velocity

Visualise the physical situation

The shortest distance across the river is along the straight line which is perpendicular to the river bank. Hence, the resultant velocity of the canoe must be perpendicular to the river current. Using the principle of vector addition, we simply add the vectors $\vec{v}_{CW}$ for the canoe relative to the water and the water relative to the ground $\vec{v}_{WG}$ to give the resultant vector of the canoe relative to the ground $\vec{v}_{CG}$. This vector addition gives a right angled triangle. The direction of the vector $\vec{v}_{CG}$ is given by the angle attack θ as defined in the diagram.

N.B. The use of subscripts – especially in the vector addition



$$\vec{v}_{CG} = \vec{v}_{CW} + \vec{v}_{WG}$$

$$\cos\theta = \frac{v_{WG}}{v_{CW}}$$

The angle of attack in terms of the speeds is

$$\cos\theta = \frac{v_{WG}}{v_{CW}}$$

We can see from this equation, the faster the current v_{WG}, the larger the value of $\cos\theta$, hence, the smaller the value for the angle θ of attack.

What is the implication of $\left|\vec{v}_{WG}\right| > \left|\vec{v}_{CW}\right|$?

$$\left|\vec{v}_{WG}\right| > \left|\vec{v}_{CW}\right| \Rightarrow \cos\theta > 1$$

but $-1 \le \cos\theta \le 1$

hence θ is undefined.

The canoeist cannot paddle fast enough for the canoe to go straight across the river, the canoe will be swept downstream with the current.