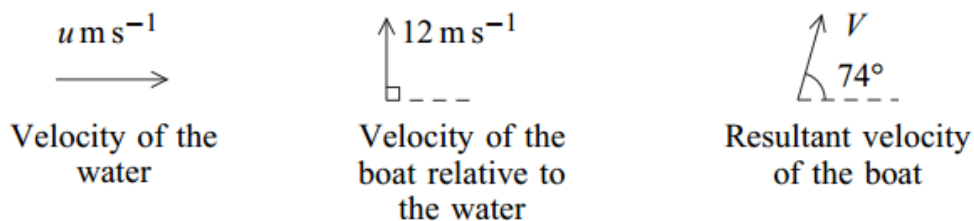

Mechanics 1: Resultant Velocities

Past Paper Questions
2006 - 2013

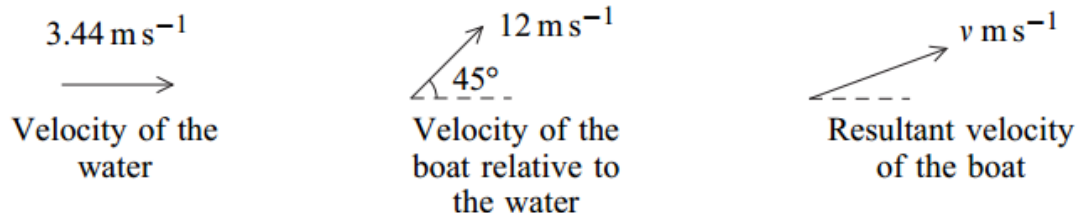
Name:

4 Water flows in a constant direction at a constant speed of $u \text{ m s}^{-1}$. A boat travels in the water at a speed of 12 m s^{-1} relative to the water.

- (a) The direction in which the boat travels relative to the water is perpendicular to the direction of motion of the water. The resultant velocity of the boat is $V \text{ m s}^{-1}$ at an angle of 74° to the direction of motion of the water, as shown in the diagram.



- (i) Find V . (2 marks)
- (ii) Show that $u = 3.44$, correct to three significant figures. (3 marks)
- (b) The boat changes course so that it travels relative to the water at an angle of 45° to the direction of motion of the water. The resultant velocity of the boat is now of magnitude $v \text{ m s}^{-1}$. The velocity of the water is unchanged, as shown in the diagram below.

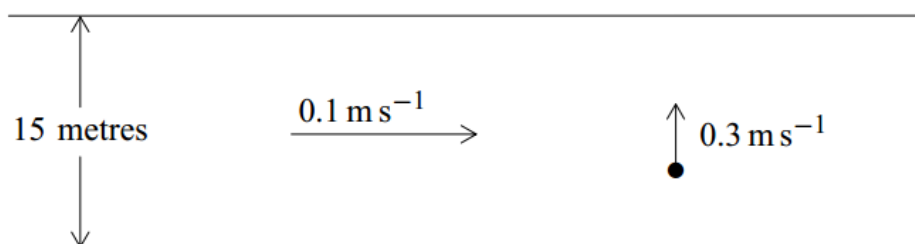


Find the value of v .

(4 marks)

January 2007

- 5 A girl in a boat is rowing across a river, in which the water is flowing at 0.1 m s^{-1} . The velocity of the boat relative to the water is 0.3 m s^{-1} and is perpendicular to the bank, as shown in the diagram.



- (a) Find the magnitude of the resultant velocity of the boat. (2 marks)
- (b) Find the acute angle between the resultant velocity and the bank. (3 marks)
- (c) The width of the river is 15 metres.
- (i) Find the time that it takes the boat to cross the river. (2 marks)
- (ii) Find the total distance travelled by the boat as it crosses the river. (2 marks)

June 2007

- 5 An aeroplane flies in air that is moving due east at a speed of $V \text{ m s}^{-1}$. The velocity of the aeroplane relative to the air is 150 m s^{-1} due north. The aeroplane actually travels on a bearing of 030° .

- (a) Show that $V = 86.6 \text{ m s}^{-1}$, correct to three significant figures. (2 marks)
- (b) Find the magnitude of the resultant velocity of the aeroplane. (3 marks)

January 2008

- 2 The velocity of a ship, relative to the water in which it is moving, is 8 m s^{-1} due north. The water is moving due east with a speed of $U \text{ m s}^{-1}$. The resultant velocity of the ship has magnitude 10 m s^{-1} .

- (a) Find U . (2 marks)
- (b) Find the direction of the resultant velocity of the ship. Give your answer as a bearing to the nearest degree. (2 marks)

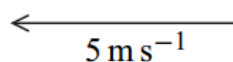
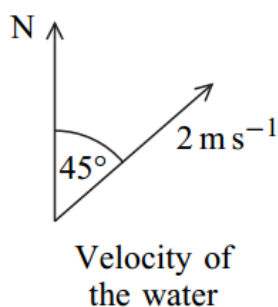
June 2008

4 An aeroplane is travelling due north at 180 m s^{-1} relative to the air. The air is moving north-west at 50 m s^{-1} .

- (a) Find the magnitude of the resultant velocity of the aeroplane. *(4 marks)*
- (b) Find the direction of the resultant velocity, giving your answer as a three-figure bearing to the nearest degree. *(4 marks)*

January 2009

7 A boat is travelling in water that is moving north-east at a speed of 2 m s^{-1} . The velocity of the boat relative to the water is 5 m s^{-1} due west.

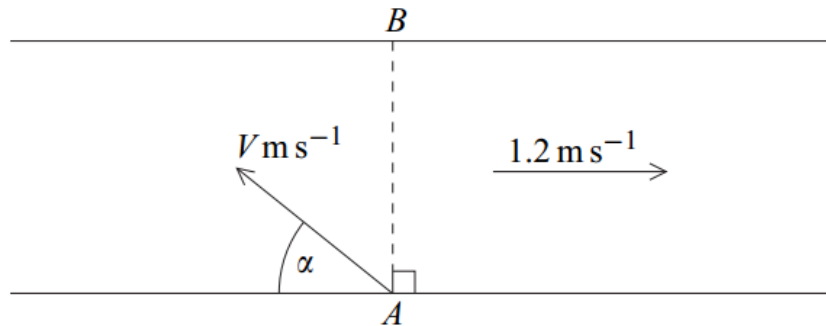


- (a) Show that the magnitude of the resultant velocity of the boat is 3.85 m s^{-1} , correct to three significant figures. *(4 marks)*
- (b) Find the bearing on which the boat is travelling, giving your answer to the nearest degree. *(4 marks)*

June 2009

- 4** A river has parallel banks which are 16 metres apart. The water in the river flows at 1.2 m s^{-1} parallel to the banks. A boat sets off from one bank at the point A and travels perpendicular to the bank so that it reaches the point B , which is directly opposite the point A . It takes the boat 10 seconds to cross the river.

The velocity of the boat relative to the water has magnitude $V \text{ m s}^{-1}$ and is at an angle α to the bank, as shown in the diagram.

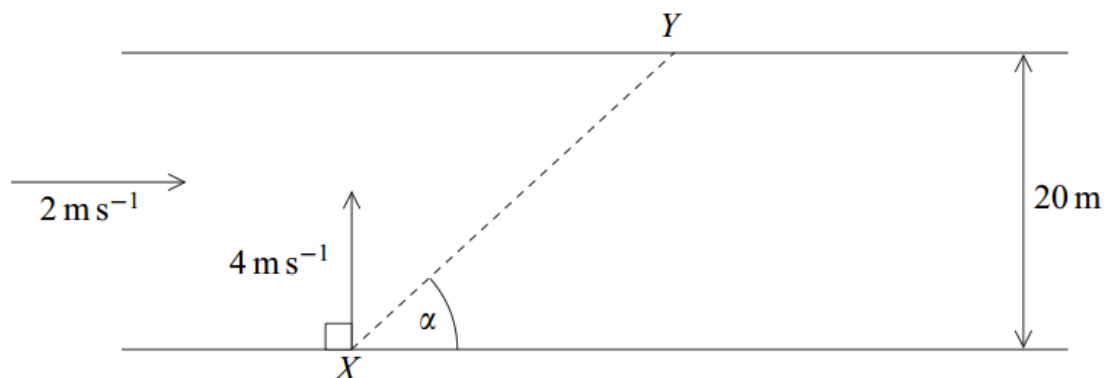


- (a) Show that the magnitude of the resultant velocity of the boat is 1.6 m s^{-1} . (1 mark)
- (b) Find V . (3 marks)
- (c) Find α . (2 marks)
- (d) State one modelling assumption that you needed to make about the boat. (1 mark)

June 2010

- 5** An aeroplane is travelling along a straight line between two points, A and B , which are at the same height. The air is moving due east at a speed of 30 m s^{-1} . Relative to the air, the aeroplane travels due north at a speed of 100 m s^{-1} .
- (a) Find the magnitude of the resultant velocity of the aeroplane. (3 marks)
- (b) Find the bearing on which the aeroplane is travelling, giving your answer to the nearest degree. (2 marks)

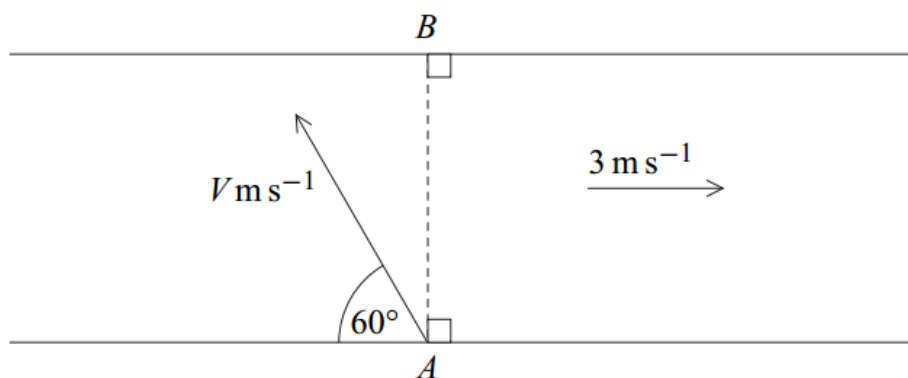
- 4** A canoe is paddled across a river which has a width of 20 metres. The canoe moves from the point X on one bank of the river to the point Y on the other bank, so that its path is a straight line at an angle α to the banks. The velocity of the canoe relative to the water is 4 m s^{-1} perpendicular to the banks. The water flows at 2 m s^{-1} parallel to the banks.



Model the canoe as a particle.

- (a) Find the magnitude of the resultant velocity of the canoe. (2 marks)
- (b) Find the angle α . (2 marks)
- (c) Find the time that it takes for the canoe to travel from X to Y . (2 marks)

- 4** A small ferry is used to cross a river which has straight parallel banks that are 200 metres apart. The water in the river moves at a constant speed of 3 m s^{-1} . The ferry travels from a point A on one bank to a point B directly opposite A on the other bank. The velocity of the ferry relative to the water is $V \text{ m s}^{-1}$ at an angle of 60° to the upstream bank, as shown in the diagram.



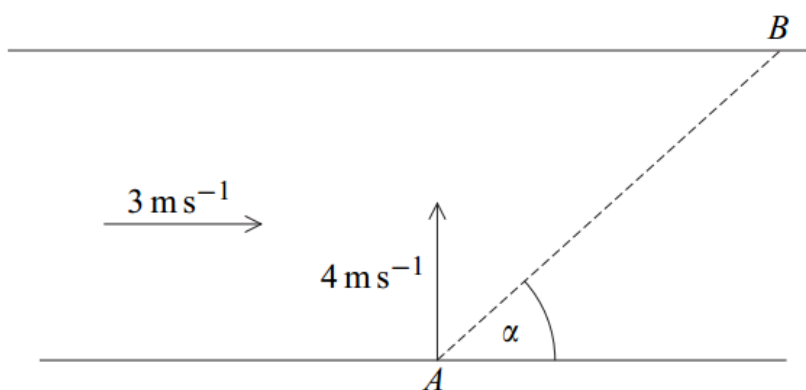
- (a) Find V . (3 marks)
- (b) Find the time that it takes for the ferry to cross the river, giving your answer to the nearest second. (3 marks)

June 2012

- 1** As a boat moves, it travels at 5 m s^{-1} due north, relative to the water. The water is moving due west at 2 m s^{-1} .
- (a)** Find the magnitude of the resultant velocity of the boat. *(2 marks)*
- (b)** Find the bearing of the resultant velocity of the boat. *(3 marks)*

January 2013

- 6** A river has straight parallel banks. The water in the river is flowing at a constant velocity of 3 m s^{-1} parallel to the banks. A boat crosses the river, from the point A to the point B , so that its path is at an angle α to the bank. The velocity of the boat relative to the water is 4 m s^{-1} perpendicular to the bank. The diagram shows these velocities and the path of the boat.



- (a)** Show that $\alpha = 53.1^\circ$, correct to three significant figures. *(2 marks)*
- (b)** The boat returns along the same straight path from B to A . Given that the speed of the boat relative to the water is still 4 m s^{-1} , find the magnitude of the resultant velocity of the boat on the return journey. *(6 marks)*

- 3** A ship travels through water that is moving due east at a speed of 1.4 m s^{-1} . The ship travels due north relative to the water at a speed of 7 m s^{-1} . The resultant velocity of the ship is $V \text{ m s}^{-1}$ on a bearing α .

Velocity of the water

1.4 m s^{-1}
→

N
↑

Velocity of the ship relative to the water

↑
 7 m s^{-1}

- (a) Find V . *(2 marks)*
- (b) Find α , giving your answer as a three-figure bearing, correct to the nearest degree. *(3 marks)*