### 7.2 Velocity

#### A Velocity
Velocity is a vector and the measurement unit is \( \text{m/s} \) or \( \text{km/h} \).

Ex 1. Convert 5\( \text{m/s} \) into \( \text{km/h} \).

#### B Relative Velocity
The relative velocity of the object \( B \) traveling at \( \vec{v}_B \) relative to the object \( A \) traveling at \( \vec{v}_A \) is given by:

\[
\vec{v}_{BA} = \vec{v}_B - \vec{v}_A
\]

Note. If \( A \) is at rest (\( \vec{v}_A = \vec{0} \)) then:

\[\vec{v}_{BA} = \vec{v}_B\]

Ex 2. A car is traveling at \( \vec{v}_c = 100 \text{km/h}[E] \), a motorcycle is traveling at \( \vec{v}_m = 80 \text{km/h}[W] \), a truck is traveling at \( \vec{v}_t = 120 \text{km/h}[N] \) and an SUV is traveling at \( \vec{v}_s = 100 \text{km/h}[SW] \). Find the relative velocity of the car relative to:

- a) motorcycle
- b) truck
- c) SUV

#### C Boat Velocity
The boat velocity relative to ground is vector sum between the boat velocity relative to water \( \vec{v}_{bw} \) and the water velocity relative to ground \( \vec{v}_{wg} \):

\[
\vec{v}_{bg} = \vec{v}_{bw} + \vec{v}_{wg}
\]

Ex 3. A river flows eastward with 4\( \text{m/s} \). A motorboat heads downstream the river between two towns which are 50 km apart along the south bank of the river. If the motorboat speed in still water is 12\( \text{m/s} \), find:

- a) the speed of the motorboat relative to the ground when traveling downstream

#### D Plane Velocity
The plane velocity relative to ground is vector sum between the plane velocity relative to air \( \vec{v}_{pa} \) and the air velocity relative to ground \( \vec{v}_{ag} \):

\[
\vec{v}_{pa} = \vec{v}_{pa} + \vec{v}_{ag}
\]

Ex 4. A plane is scheduled to travel from the airport \( A \) to an airport \( B \) where \( \overline{AB} = 600 \text{km}[060^\circ] \). The speed of the plane relative to air is 300\( \text{km/h} \) and a strong wind of 100\( \text{km/h} \) is blowing eastward.

- a) Draw a diagram to illustrate the situation.
b) the time required to cover the distance between the towns downstream

c) the speed of the motorboat relative to the ground when traveling upstream

d) the time required to cover the distance between the towns upstream

<table>
<thead>
<tr>
<th>b) In what direction should the pilot head the plane?</th>
</tr>
</thead>
<tbody>
<tr>
<td>c) What is the speed of the plane relative to ground?</td>
</tr>
<tr>
<td>d) How long will the trip last?</td>
</tr>
</tbody>
</table>

Ex 5. A river is 800m wide and flows eastward at 10m/s. Peter is driving a motorboat heading always perpendicular to the current. The speed of the motorboat in still water is 20m/s.

<table>
<thead>
<tr>
<th>a) Draw a diagram to illustrate the situation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>b) What is the speed of the boat relative to ground?</td>
</tr>
<tr>
<td>c) How long does it take to cross the river?</td>
</tr>
<tr>
<td>d) How much downstream does Peter reach the opposite bank?</td>
</tr>
</tbody>
</table>

Ex 6. Jane can swim at 5m/s in still water. She wishes to swim across a river 200m wide to a point directly opposite from where she is standing. The river flows westward at 4m/s and she is standing on the South bank of the river.

<table>
<thead>
<tr>
<th>a) Draw a diagram to illustrate the situation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>b) What is the speed of Jane relative to ground?</td>
</tr>
<tr>
<td>c) In what direction must Jane head?</td>
</tr>
<tr>
<td>d) How long does it take to cross the river?</td>
</tr>
</tbody>
</table>

**Reading:** Nelson Textbook, Pages 365-368

**Homework:** Nelson Textbook: Page 369 #1, 3, 4, 6, 9, 11, 13, 14