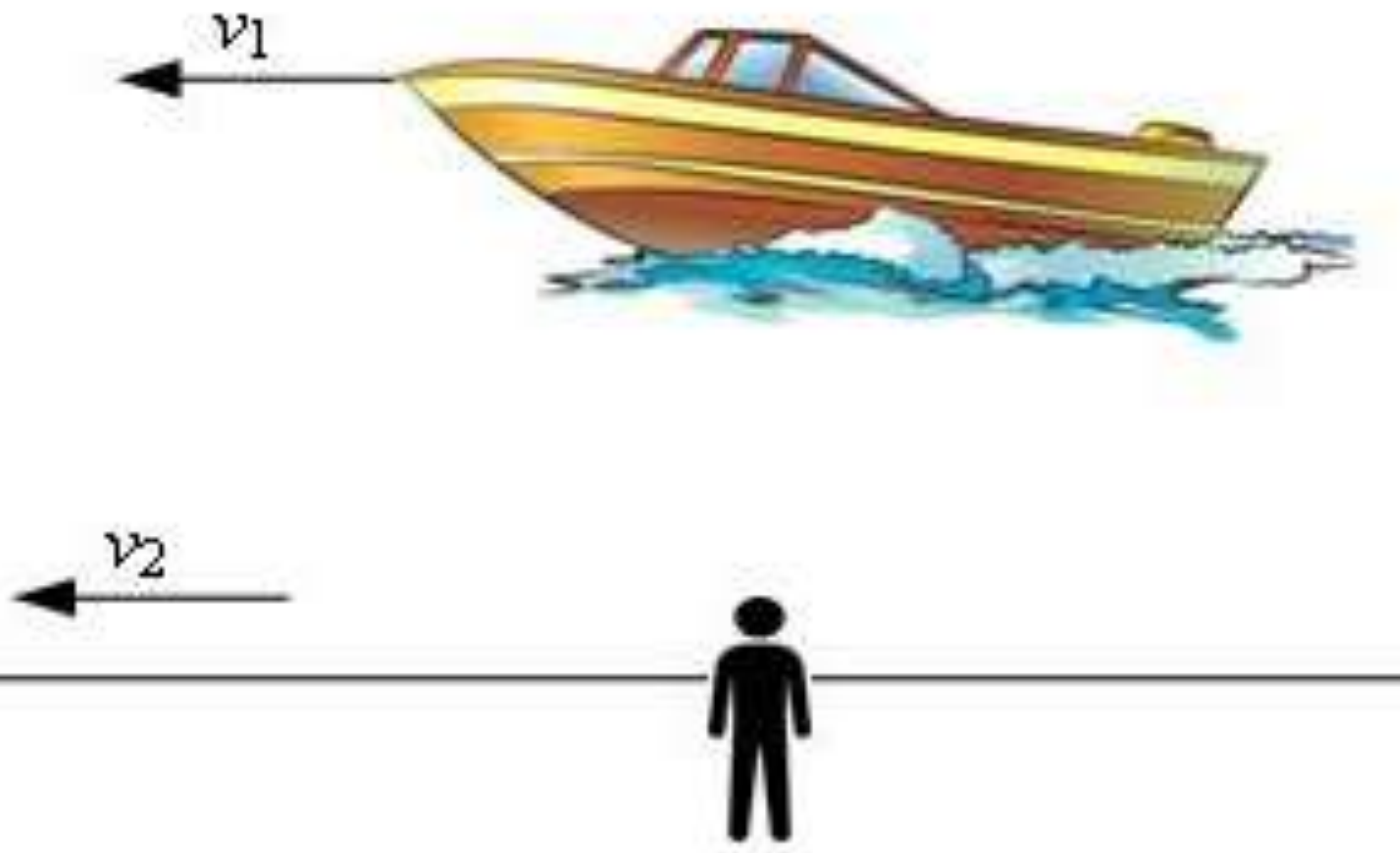
MOTION FROM DIFFERENT POINTS OF VIEW



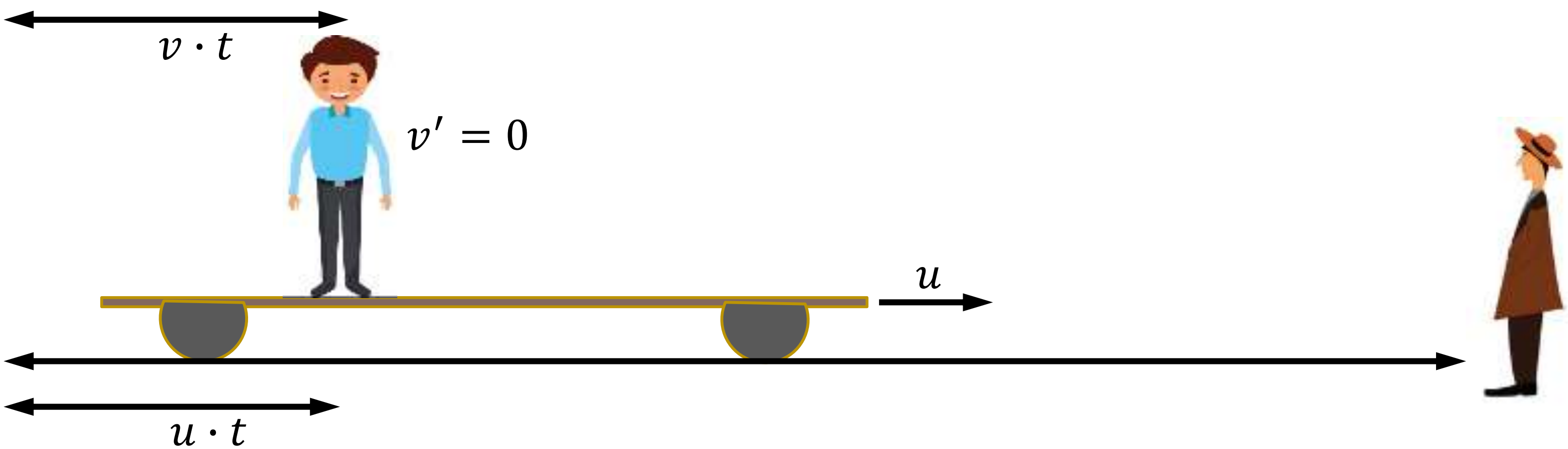
RELATIVE VELOCITY

MOTION FROM DIFFERENT POINTS OF VIEW

Let us consider the motion of the same body (man) in two different reference system which move relative to each other. We assume that one of these systems is fixed (ground) while the other moves uniformly in a straight line relative to this system (train).

We can illustrate this by a simple example of a train travelling in a straight line along a track It is travelling slowly with constant velocity. When a man is on the train then we have three cases:

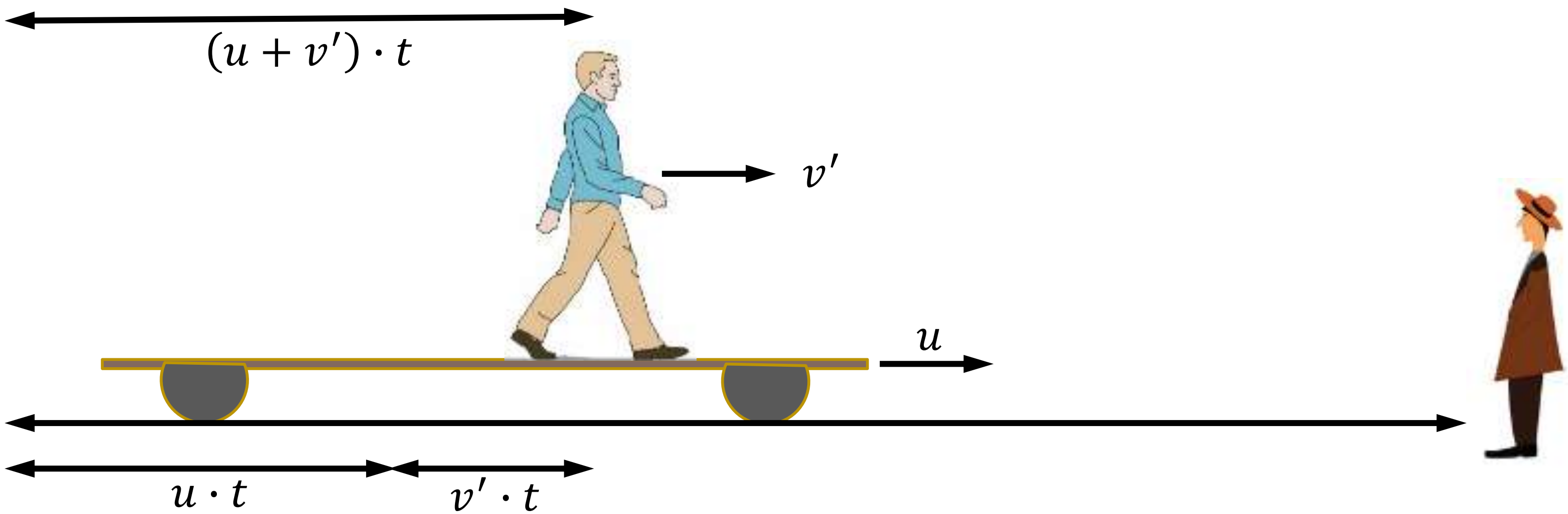
► **Case (I)**



Picture 1: A man is standing on the train

where u is velocity of the train relative to the ground and v' is velocity of the man relative to the train (the velocity of the man in the reference system related to the train). If man stands on the train then it is clear that his velocity relative to the train is zero ($v' = 0$, he is at rest relative to train),. The observer on the ground (he is not moving) finds that the velocity v of the man relative to the ground is $v = u$.

► **Case (II)**



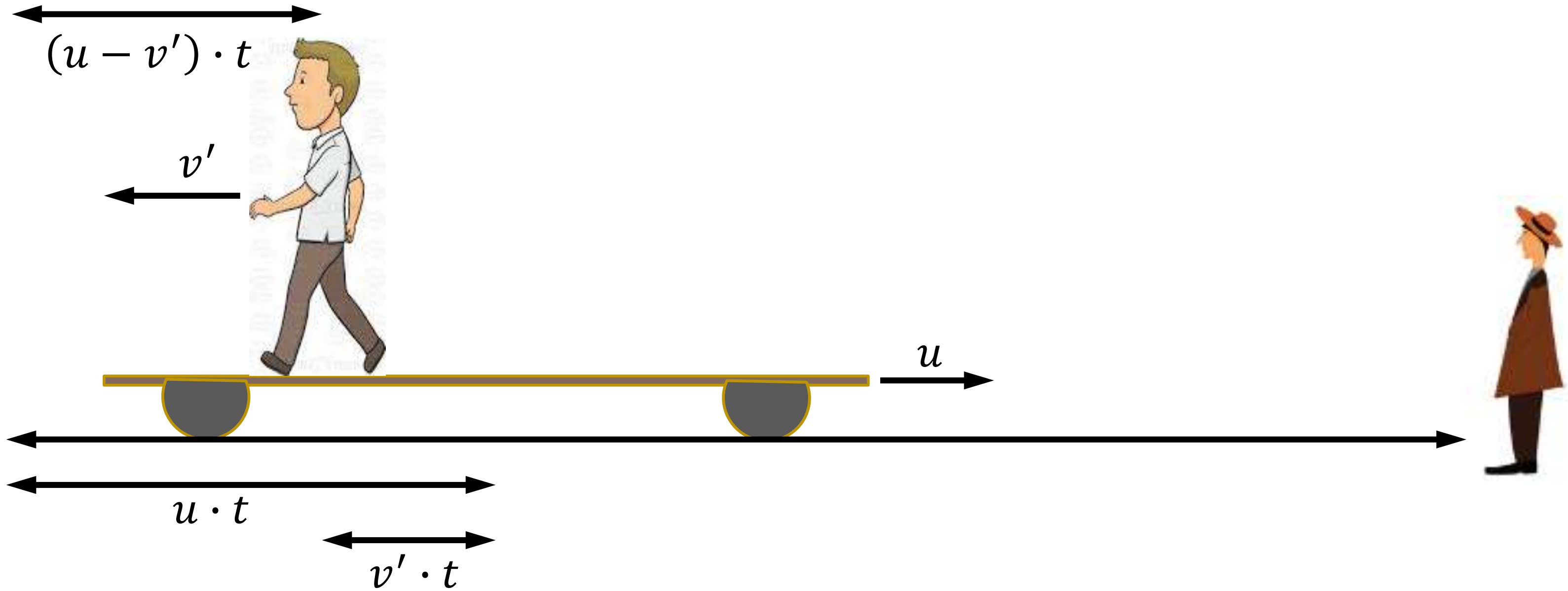
Picture 2: A man is walking on the train in the same direction in which the train moves

The observer on the ground (he is not moving) finds that the velocity v of the man relative to the ground is equal to the sum its velocity relative to the train (v') and the velocity of the train relative to the ground (u): $\boldsymbol{v} = \boldsymbol{u} + \boldsymbol{v}'$

Example 1 : The engine of an aeroplane (picture 3) imparts to it a velocity of 900 km/h relative to air. What is its relative velocity to the Earth for wind whose velocity is 50 km/h?

Picture 3

►Case (III)



Picture 4: A man is walking on the train in the opposite direction in which the train moves

The observer on the ground (he is not moving) finds that the velocity v of the man relative to the ground is equal to the difference of the velocity of the train relative to the ground (u) and velocity of the man relative to the train (v') : $\boldsymbol{v = u - v'}$

This formula represent the velocity summation rules:

$$\vec{\boldsymbol{v}} = \vec{\boldsymbol{v}}' + \vec{\boldsymbol{u}}$$

The velocity of a body relative to a fixed reference system $(\vec{\boldsymbol{v}})$ is equal to the vector sum of the velocity of the moving system relative to the fixed one $\vec{\boldsymbol{u}}$ and velocity of a body relative to the moving reference system $(\vec{\boldsymbol{v}}')$.

RELATIVE VELOCITY

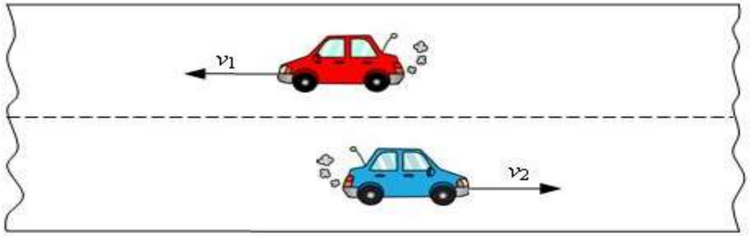
Velocity of the moving bodies with respect to other moving or stationary bodies (looked from the same reference system) is called "relative velocity". :

For example, cars moving in the same direction are often moving at high velocity relative to Earth, but relative to each other they hardly move at all. To an observer at rest at the side of the road, a car might be traveling at 60 km/h, but to an observer in a truck traveling in the same direction at 50 km/h, the car would appear to be traveling only 10 km/h.

Example 2: The two cars are moving with the velocities $\vec{v}_1$ and $\vec{v}_2$ relative to each other (looked from the same reference system). Then we have two cases:

1) If the two cars are moving in opossite directions, then relative velocity of one car relative to the other is: (picture 5):

$$v_r = v_1 + v_2$$

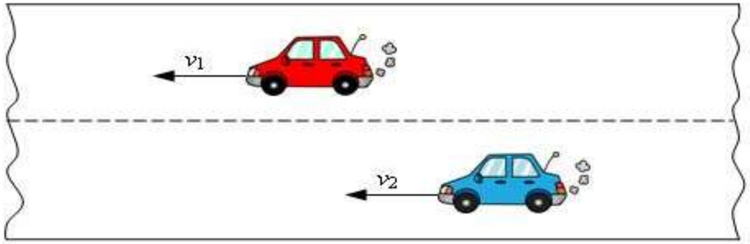


Picture 5

2) If the two cars are moving in the same directions, then relative velocity of one car relative to the other car is:(picture 6):

$$v_r = v_1 - v_2 \quad \text{if } v_1 > v_2$$

$$v_r = v_2 - v_1 \quad \text{if } v_2 > v_1$$

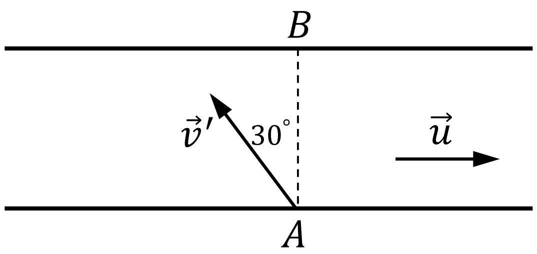


Picture 6

PROBLEMS

1. An airplane flies from *A* to *B* at a distance of 1080 km from west to east. Find the duration of the flight if:
   (a) the wind blows from east to west,
   (b) the wind blows from west to east.
   (c) the wind blows from north to south,
   The velocity of the wind is u =150 *kmlh* and velocity of the airplane with respect to the air is v'=390 km/h.

2. A boat travels across the river from point A to point B on the opposite bank along the straight line AB forming an angle 30º with the bank. If the velocity of the boat relative to the water is 90km/h find:
   (a) the velocity of the river
   (b) the velocity of the boat relative to the bank.



3. A motor ship covers a distance of 30 km between two localities on a river in 1 h downstream and in 1,5 h upstream. Find the flow velocity of the river and the velocity of the motor ship relative to the water assuming that these velocities are constant.

4. A passenger sits by the window of a train moving with a velocity of 90 km/h. A 700-m long train moves from the opposite direction with a velocity of 36 km/h. How long does the second train pass the passenger?