PHYSICS

RELATIVE VELOCITY:1-D

Frames of Reference

A frame of reference is described as a point of observation. Motion can be different depending on which frame of reference you are observing from.

Ex: *Justin Verlander can throw a 100 mph fast ball.*

However ...

If Justin Verlander is on a truck moving towards you at 60 mph and throws his fast ball at 100 mph, then the ball will be observed to travel 160 mph (relative to the stationary observer in the stands)

Velocity Notation

In order to describe a velocity relative to something else we are going to use the following notation:

$_{A}V_{B}$ - Means the velocity of "A" relative to "B"

Ex: A man walks down the aisle of a train at 5 km/h [N]

M -

T -

Therefore:

PHYSICS

RELATIVE VELOCITY:1-D

The Chain Rule

The chain rule is used to add up all the relative quantities in any observed series of motions.

$$ {}_{X}V_{Z} = {}_{X}V_{Y} + {}_{Y}V_{Z} $$

Ex: A train is travelling 80 km/h [E]. A man on the train is walking 5 km/h [E] towards the front of the train. What is the man's relative velocity relative to the ground?

b) *A woman on the train is walking 7 km/h [W].*

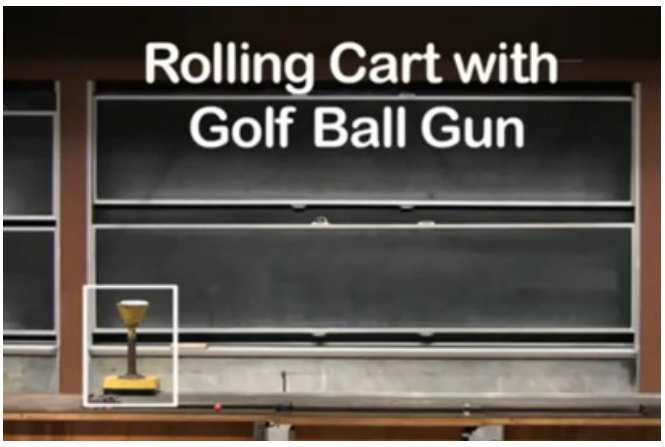
- What is the woman's velocity relative to the ground?

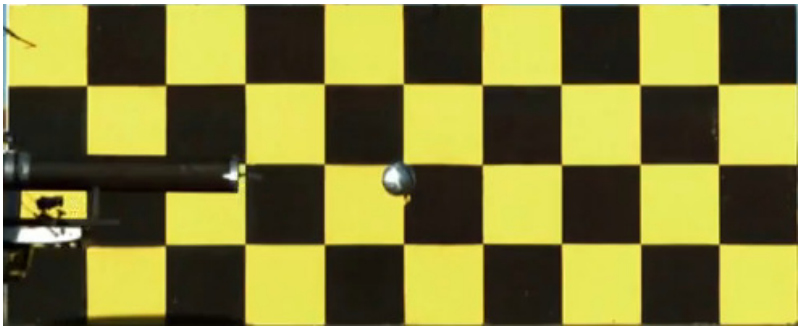
- What is the woman's velocity relative to the man?

PHYSICS

RELATIVE VELOCITY:1-D

Examples of Relative Velocity





PHYSICS

HOMEWORK

RELATIVE QUANTITIES IN 1-DIMENTION

1. A train is traveling at 100 km/h [W]. Joe is walking from the back of the train to towards the front at 2 km/h. Mabel is walking from the front of the train towards the rear at 3 km/h.

a. What is Joe's velocity relative to the ground?

b. What is Mabel's velocity relative to the ground?

c. What is Joe's velocity relative to Mabel?

d. What is Mabel's velocity relative to Joe?

e. A motorcycle passes the train from the opposite direction and is traveling 80 km/h [E]. What is the motorcycle's velocity relative to the train?

f. What is Joe's velocity relative to the motorcycle?

g. What is Mabel's velocity relative to the motorcycle?

2. If a person's displacement relative to the earth is 8 m [W] and a car's displacement relative to that person is 3 m [E], then what is the car's displacement relative to the earth?

3. You are in a car traveling at 13.0 m/s toward the North. A snowmobile located in front of you is also going North but at 7.2 m/s. What is your velocity relative to a passenger on the snowmobile?

4. While travelling on a train, two boys play catch in the aisle. The train is moving north at 30.0 m/s. The ball is tossed front to back at 5.0 m/s relative to the boys. A bystander on the highway observes the ball being tossed toward the back. To the bystander, what is the relative speed of the ball?

5. A helicopter is traveling northwest at 210 km/h relative to a car. The car is traveling at 30 km/h southward relative to the earth. Find the velocity of the earth relative to the helicopter. Be careful.

PHYSICS

HOMEWORK

5. A police car is chasing a stolen car ahead of it. If the police car is traveling at 150 km/h [N] and the stolen car is traveling at 120 km/h [N], then determine:

(A) the velocity of the police car relative to the ground.
(B) the velocity to the police car relative to the stolen car.
(C) the velocity of the stolen car relative to the police car.

6. What is the velocity of John relative the bus in each of the following situations:

(A) John is sitting on the street and the bus is moving at 30 m/s [S] toward him?
(B) John is sitting in his car traveling North at 25 m/s toward a stationary bus?
(C) John is sitting in his car traveling North at 35 m/s and the bus is moving 15 m/s [S] toward him?

7. The current in a river moves at 4.8 m/s [E]. How fast and in what direction must a swimmer move through the water in order to have a resultant velocity relative to the river bank of:

(A) 3.4 m/s [W]
(B) 8.6 m/s [E]

8. The current in a river moves at 3.0 m/s [N]. How fast and in what direction must a swimmer move through the water in order to have a resultant velocity relative to the river bank of

(A) 5.8 m/s [S]
(B) 5.8 m/s [N]

9. Kermit the crab is crawling along the bottom of a river. He checks his speedometer and finds he is moving upstream at 2 m/s relative to the bottom. Floyd the flounder is swimming downstream. Floyd can swim at 4 m/s in still water, but the river is moving at 1 m/s. How fast is Floyd moving relative to Kermit?

10. A bus is moving East at 45.0 m/s, while a car moves toward it at 65.0 m/s. If a man walks fromthe back to the front of the bus at 5.5 m/s, what is the velocity of the man relative to the car?