Relative Velocity Part 1

Content

Relative motion allows us to compare the motion of one object with another. First we consider one object to be at rest. Then determine the observed velocity, the relative velocity, of the other. This is calculated by adding the negative velocity of the first object to both velocities, then using vector analysis to calculate the final relative velocity.

Object 1 velocity

Object 2 velocity

Object 2 relative velocity

Negative velocity of Object 1

Object 2 velocity

In the diagram, we add the negative velocity of object 1 to both velocities. Now object 1 is considered at rest, and we can calculate the velocity of object 2 relative to object 1.

Example

Two cars are driving towards each other head on. The first car is driving with a velocity of 10m/s East, the second a velocity of 15m/s West. A crash of where the relative velocity is over 100km/h is fatal for both drivers. If these cars crash, will it be fatal? Describe qualitatively the motion of the second car relative to the first.

* First we will draw a diagram:

10m/s

15m/s

* Now we will add the negative velocity of the first car to both so that car 1 is seen at rest.

10m/s

15m/s

10m/s

10m/s

* Adding the velocities:
* So the relative velocity of the second car is 25m/s West. Qualitatively, the second car appears to be approaching the first car at a speed of 25m/s head on.
* Now we need to convert m/s to km/h to see if it exceeds 100km/h.

So the cars are travelling towards each other with a relative speed of 90km/h which is below the fatality speed.

Example

A car is approaching a T intersection with a velocity of 12m/s South. A second car is approaching the intersection but with a velocity of 35m/s West. What is the velocity of the first car relative to the second?

* Again, first we will draw a diagram of the problem.

12m/s

35m/s

* Next, we add the negative velocity of the second car to both velocities:

12m/s

35m/s

35m/s

35m/s

* Using Pythagoras’ Theorem we calculate the relative velocity of the first car.
* So the first car is moving with a relative speed of 37m/s now we need to calculate the direction.
* So the relative velocity of the first car is 37m/s 109 South East. Qualitatively, to the second car, it appears the first car is approaching with a speed of 37m/s from an angle of 19 to their right.