

We will practice going between reference frames to look at relative velocities in one dimension.

Let's say that an observer is standing on the sidewalk and that observer sees a car drive past to the right at a speed of  $v_{\text{car}}$ .

The observer also sees a bike that's riding to the left at a slower speed,  $v_{\text{bike}}$ .

Now, I'm interested in what the car looks like from the perspective of the bike.

The bike sees itself as stationary and sees the world around it moving to the right.

To the bike, the observer on the sidewalk appears to be moving to the right with the speed of  $v_{\text{bike}}$ .

The car was moving to the right relative to the reference frame of the observer standing on the sidewalk.

So to the bike, the car looks like it's going even faster to the right with a total speed of  $v_{\text{car}}$  plus  $v_{\text{bike}}$ .

Let's say, later on the biker throws an apple in the direction of her movement and sees this apple travel to the left with the speed of  $v_{\text{apple}}$ .

Now I want to know what an observer sees in the stationary frame on the sidewalk.

The apple appears to be traveling a speed  $v_{\text{apple}}$  faster than the biker all to the left.

So the observer on the sidewalk will see the apple move to the left with a total speed of  $v_{\text{apple}}$  plus  $v_{\text{bike}}$ .

Now let's say the person throws the apple forward at a speed  $v_{\text{apple}}$ .

What does the car see?

To the car the apple is going to the left at the speed of  $v_{\text{car}}$  minus  $v_{\text{apple}}$ .

How about the bike?

To the bike, the apple is going at a speed of  $v_{\text{apple}}$  plus  $v_{\text{bike}}$  to the right.