Velocity Vector Addition.

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Heading into 2 dimensional motion, we're going to find that it's imperative that you're comfortable working with vector addition. In this tutorial, we'll prepare ourselves for this.

First, a quick review:

Recall that Vectors have both Magnitude and Direction.

Also, recall that we can use an arrow to represent any vector.

The arrow points in the direction of the vector, while the length of the arrow represents the magnitude of the vector.

We've also done some displacement problems where we've added one displacement to another displacement (remember head-to-tail) to determine the resulting displacement. We've determined that walking 50 m North then 10 m South has the same outcome as just going 40 m North. Or going 100m East then 50 m South has the same outcome as just going 112 m @ 26.6 degrees S of E. Displacement vector addition is pretty easy to visualize, as we can picture each displacement as happening one-after-the-other – we go 50 m N then 10 m S, or 100m then 50 m south. The resultant is just a way of accomplishing the same goal.

What if the vector actions are both happening simultaneously?.........In fact, the vector values add in the exact SAME way.

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Let's consider a velocity example:

A swimmer is swimming across a river. The swimmer aims straight across and the river pulls them downstream. We can call the swimmers velocity Vs (some textbooks put a line over to remind us that velocity is a vector). And.......We can call the water velocity Vw (again, a vector).

If we wanted to know the swimmer's resulting velocity (or velocity relative to the river edge), we would add the vectors. We would write the vector addition in equation form as Vs + Vw......this looks like a regular addition, but WE know that these are vectors so this is a "vector addition"...you're NOT just adding numbers, you're adding VECTORS (ie....you're adding both magnitudes AND directions).

So, to solve this vector addition, we arrange the vectors......... adding.......tail to head.......tail to head, just like the displacement problems.

And...At this point we can use Pythagorean theorem and a little trig and we can determine the resulting speed and angle of the swimmer. The swimmer's "resultant" velocity.

In this case, the swimmer is busy swimming across the river at the SAME time as the river is pulling them downstream. Thus, the "resultant" represents the velocity being experienced by the swimmer at the same time in which they are swimming and the river is flowing.

We can clearly determine what a person standing on the shore would see during this swim.

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So, we can put vectors together to determine a resultant (or total) velocity....but, we can also break a vector up into parts (we call these parts components).

A player throw a football at a velocity of 20 m/s at an angle of 30 degrees above the horizontal.

In this case, we can look at the 20 m/s @ 30 degrees as the resultant velocity. It's the actual velocity that the ball is travelling.

We often find it useful to break a velocity into vertical and horizontal components. We often call the vertical Vy and the horizontal Vx.

This time, we would write this in equation form as Vresultant = Vy + Vx. Again, this represents a "vector addition." As before, we can sketch this vector addition where the components add to be the resultant......tail to head......tail to head.

Again, it's a nice right triangle, so we can use trig again.....but in this case, we're using the resultant to determine the components.

For example, if we were interested in how fast the ball was travelling upwards, we'd want to determine the "vertical component" of the ball's velocity, Vy.

We can do that by rearranging for Vy = VRsin30

This is the component of the 20 m/s that is in the upwards direction.

If the throwing angle was increased to 40 degrees, the vertical component would increase (more time in the air) and the horizontal component would decrease (taking more time to travel a horizontal distance).

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One more example.

We have a plane flying in a wind.

The plane can travel at 300 km/hr in still air. There is a wind blowing NE at 60 km/hr.

If the pilot wants to fly straight North, where do they aim and what resulting speed can they expect?

This is, indeed, another vector addition.

We could represent it as........the velocity of the plane in still air (we'll call it Vp) + the velocity of the wind (VW) = our resultant velocity VR. A vector addition.

Now to draw this. Normally, we'd start by drawing the plane vector (Vp).........but we don't know what that is.

So.....let's start with what we know.

We know that the resultant is straight north, so let's sketch that in......VR straight North.

We also know that VW (wind velocity) is blowing NE........now we refer back to our equation and remember that our VP is going to be added to VW to get the VR, so let's put our Vw finishing at the tip of the resultant velocity......making sure we do it roughly to scale, we'll make the Vw vector a lot smaller than the resultant.

Now, we have to finish the diagram by putting the VP in the missing spot. From the start to the tail of Vw.

We look back at our equation to confirm that our diagram matches the situation. VP + Vw (tip to tail) equals our resultant velocity VR. Yup, confirmed.

So, we're set to answer some questions about this situation.

One thing you notice about this third example is that we don't have a right triangle. It's nice when vector diagrams happen to be right triangles, but they're not always this way.

At this point we can solve this using COSINE LAW and/or SINE LAW.............OR...........break it down into components. We'll get into those details later. For now, we just want to make sure that we can draw an accurate vector diagram.

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In this tutorial, we focused on vector addition. for velocity

First We reviewed what vectors were, ~~along~~ and review with some displacement examples......then, we looked at three different velocity vector examples:

A swimmer in a river, a thrown football, and a plane in a wind. For each of these, we found that we could represent the vector addition as both a vector equation AND as a vector diagram.

When doing a vector diagram, ensure that you're doing tip to tail. Sometimes your diagram will end up being a right triangle (so you can use Pythagorean theorem and basic trig), but this isn't always the case. Sometimes, your diagram will require a little more math to solve.