

Flight Planning

Direction and Speed



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Direction and Speed

When we plan a flight we need to know what direction we need to fly and how long it will take us to get there.

These are very important considerations so we don't get lost and don't run out of fuel.

Flight Planning

Direction and Speed

In this lesson we will learn about the different ways to define our direction of, and time in flight, and what factors will affect those.

We will also learn how to perform the calculations necessary to quantify these factors using both the manual and electronic E6B.

Flight Planning

Direction and Speed

Terms that we will learn about in this lesson include **True Course**, **True Heading**, **Wind Correction Angle**, **True Airspeed**, and **Ground Speed**.

Direction of flight

Let's say we want to travel from Point A to Point B, and Point B is due west of Point A.



Direction of Flight

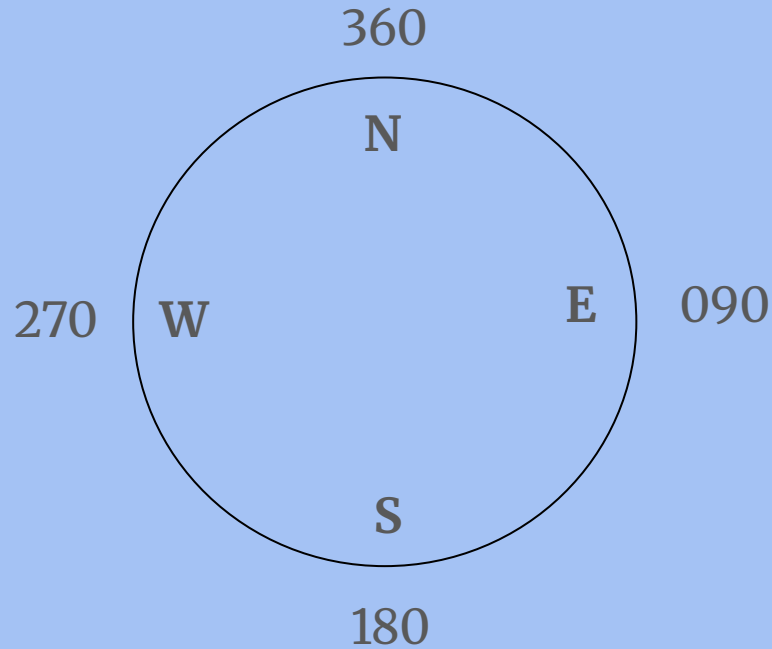
In order to measure our direction of flight we need a frame of reference. For this we use a 360 degree compass rose, where 360 degrees is due north, 090 is due east, 180 degrees is due south, and 270 degrees is due west.

It is important to note that north refers to the geographic north point of the earth.

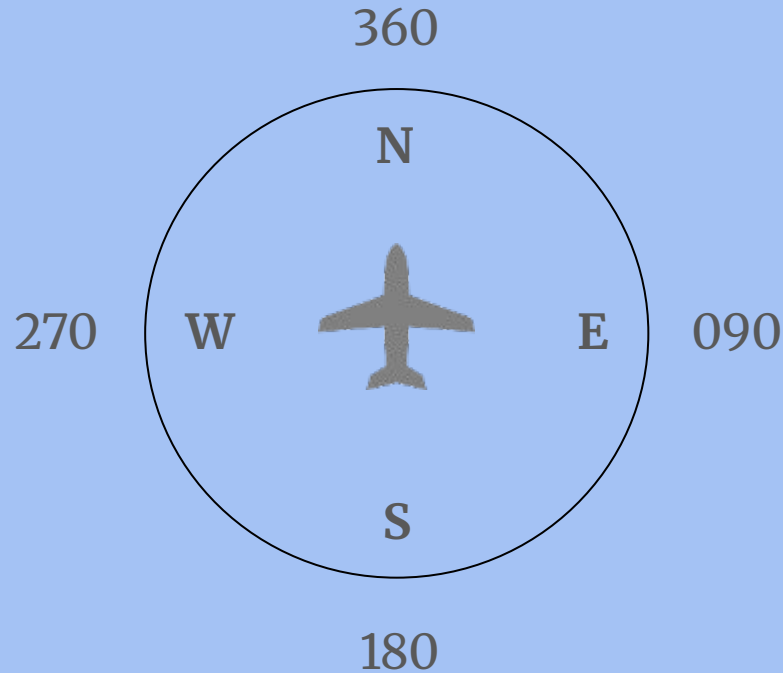
Geographic North



Compass Rose

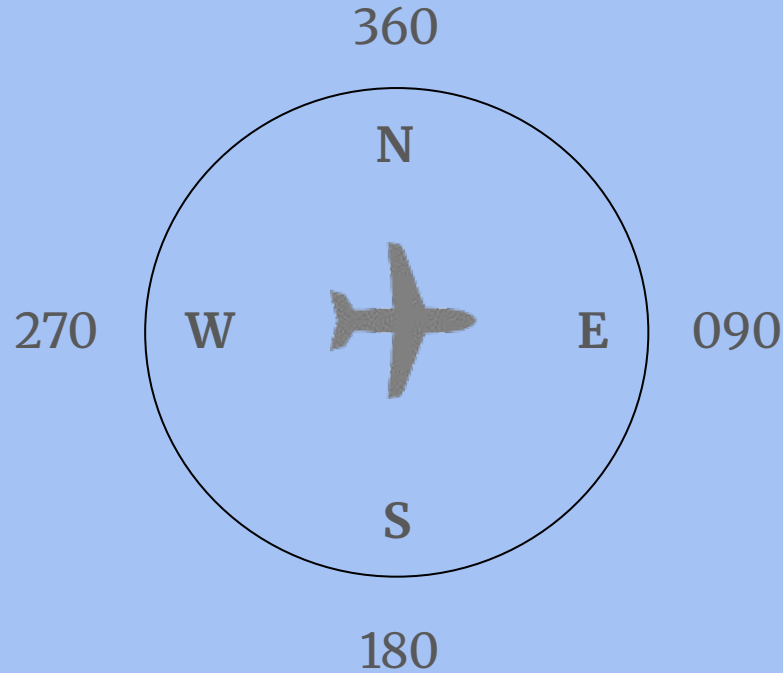


Course and Headings



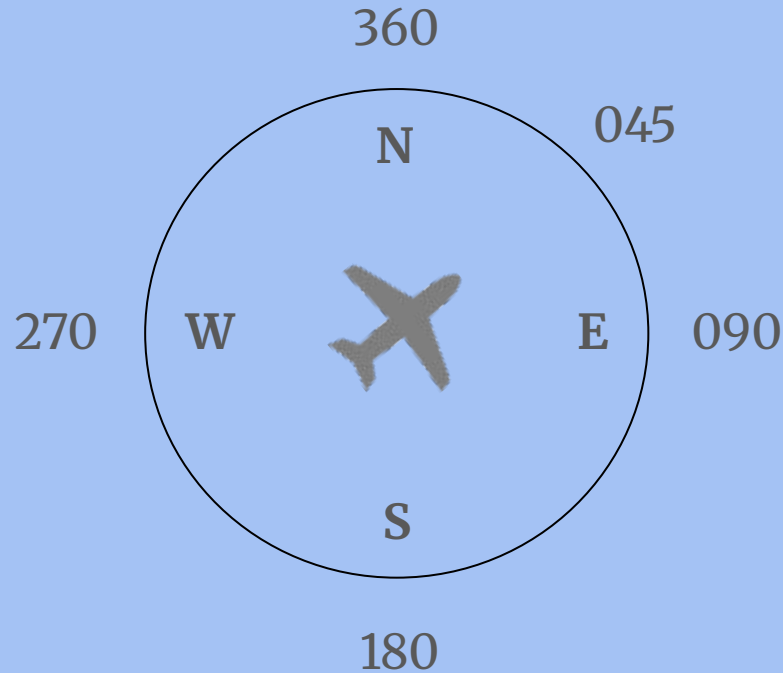
If our destination is due north, our True Course is three-six-zero degrees.

Course and Headings



If our destination is due east, our True Course is zero-niner-zero degrees.

Course and Headings



Halfway in between would be zero-four-five degrees.

Course and Headings

Life would be simple if the earth was flat, still, and dark and cold.

However, the earth is in fact round, it spins, is lit, and more importantly, heated by the sun.

All of these factors make the direction we actually need to fly to get from Point A to Point B a little more complicated.

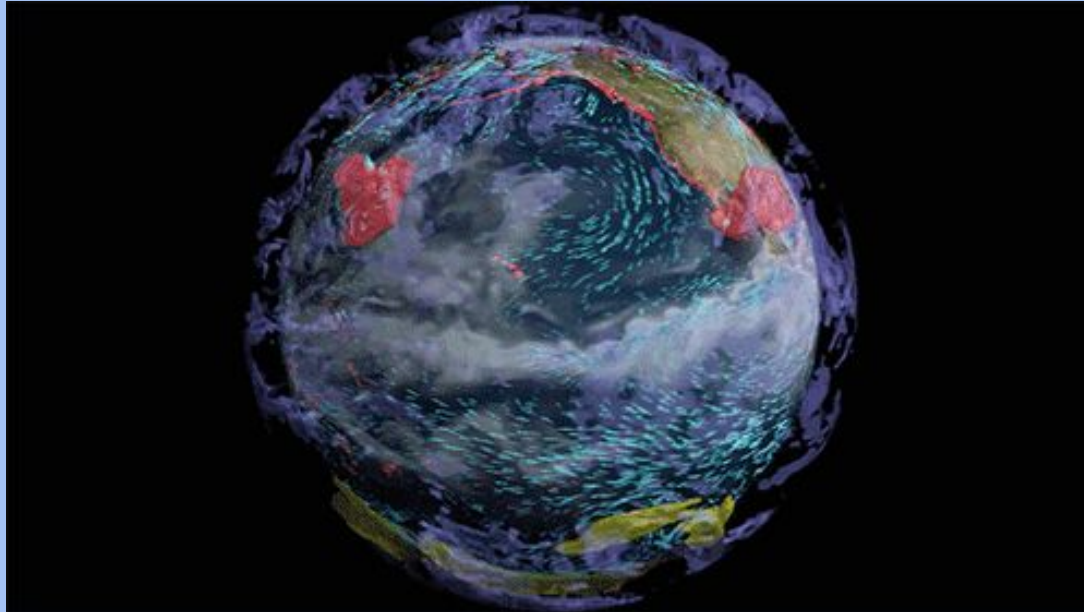
Course and Headings

Let's begin with that pesky sun.

The sun heats the earth. Due to the fact the earth is composed of different materials, e.g. rock, soil, sand, water, all at varying altitudes, the surface of the earth gets heated unevenly.

Course and Headings

The earth in turn heats the air above it...also unevenly.

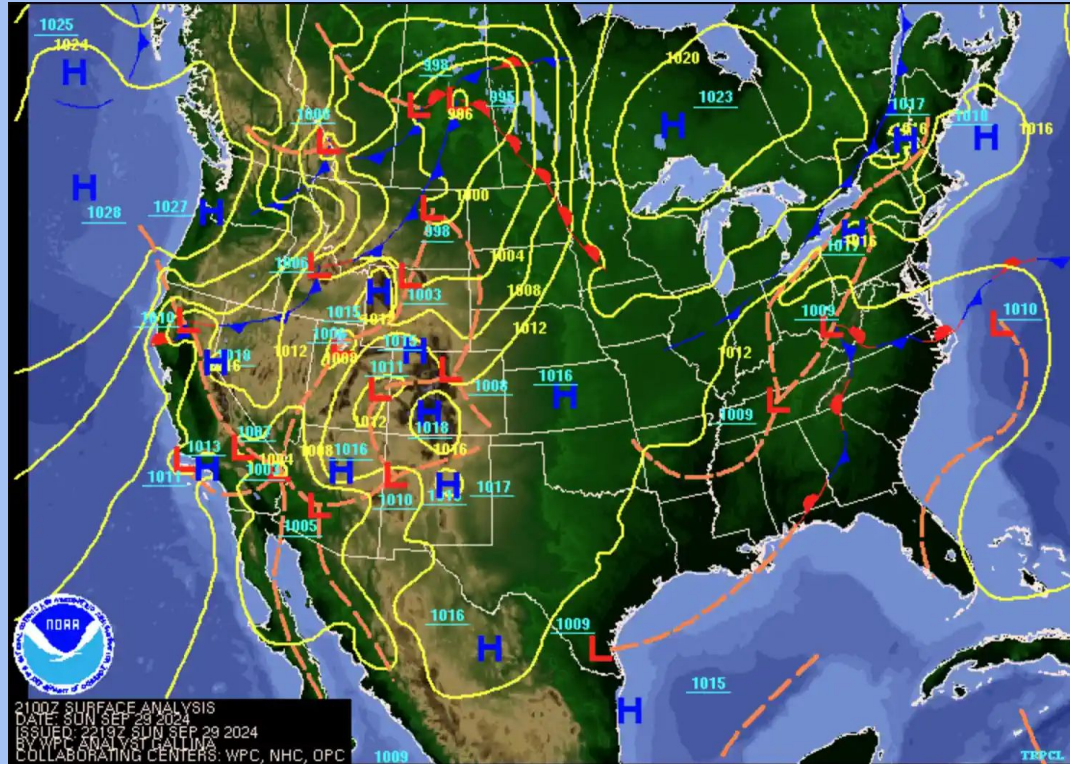


Course and Headings

Warmer air rises, creating low-pressure areas, while cooler air descends, creating high-pressure areas. Air moves from the high-pressure zones to the low-pressure zones.

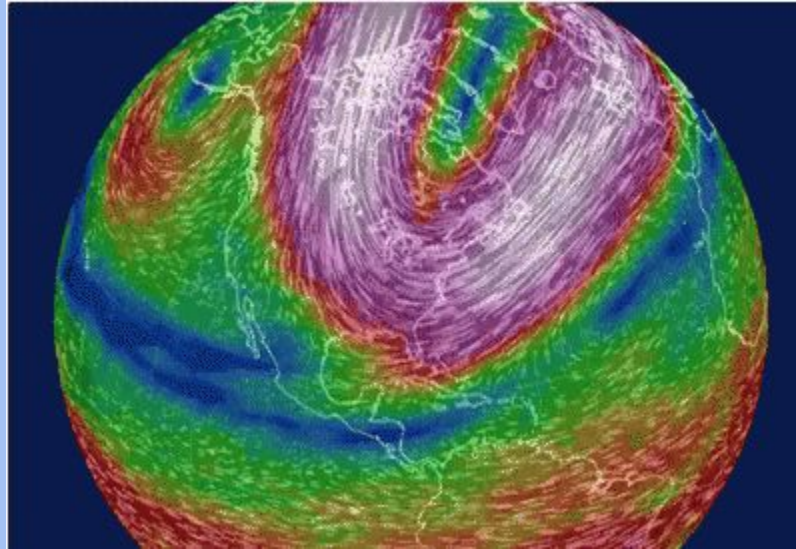
This movement is what we feel as wind. The greater the difference in pressure areas, the stronger the wind.

Course and Headings



Course and Headings

Wind is also affected in the upper atmosphere by the rotation of the earth, which deflects wind patterns.



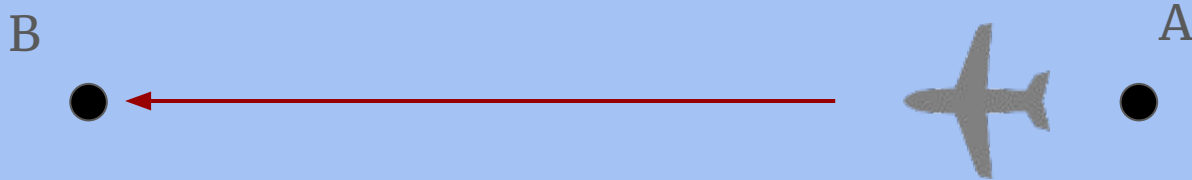
Course and Headings

Winds close to the ground can be slowed due to the friction caused by the earth's surface.

As pilots we need to understand and account for this wind when planning our flight.

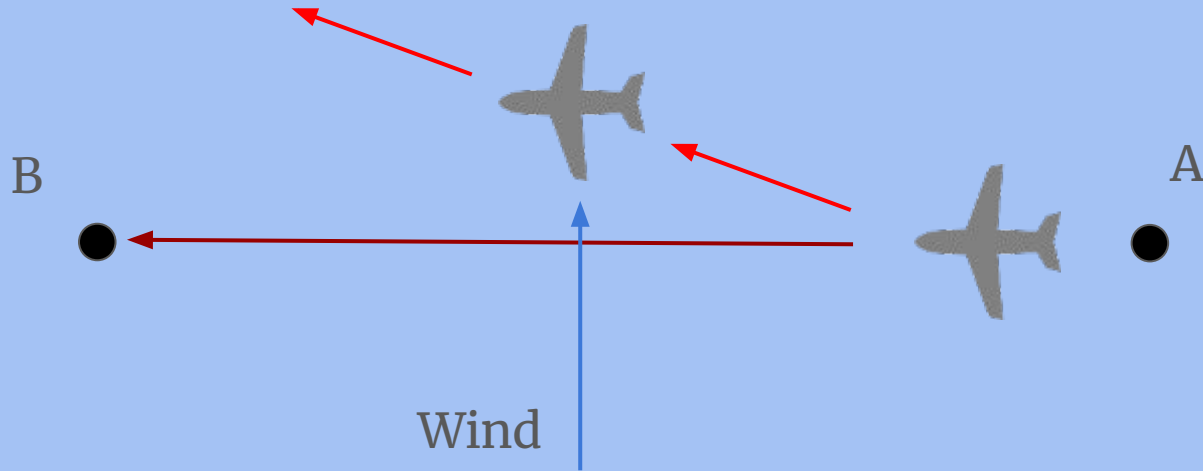
Course and Headings

Looking back at our example, our True Course is 270 degrees.



Crosswind

However, if there was a wind out of the south, it would push us off course. We call this a crosswind.



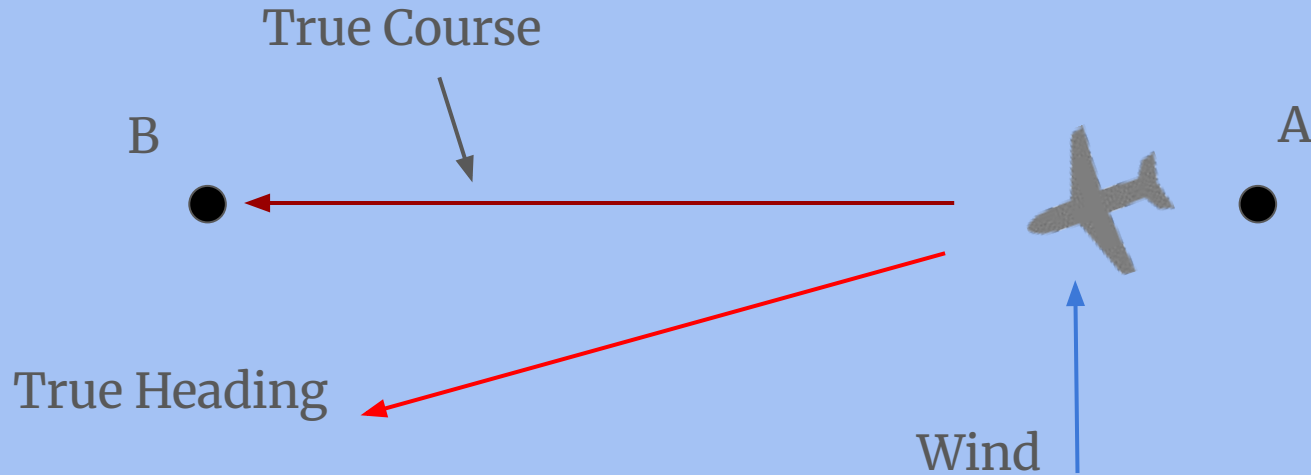
Course and Headings

In order to prevent this from happening, we would need to point the nose of our aircraft somewhat into the wind..



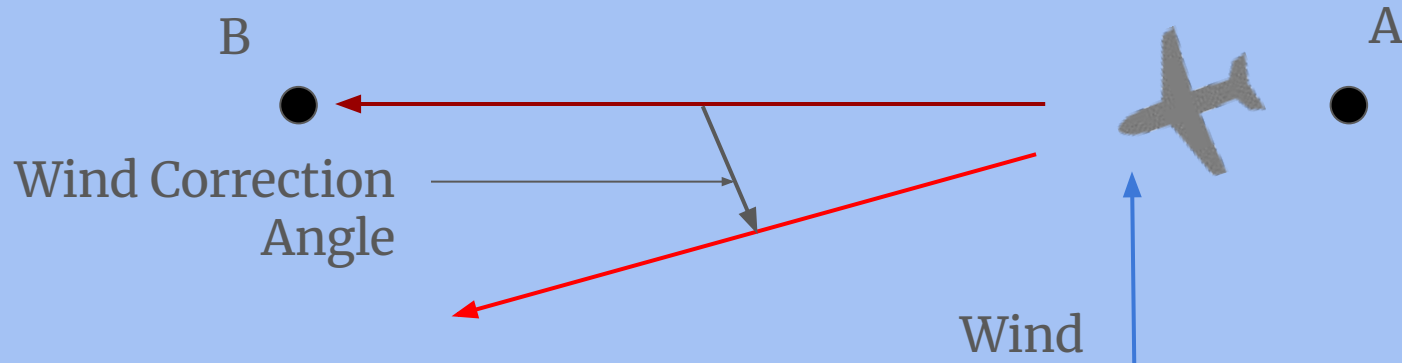
True Heading

The direction the nose of our aircraft is pointing relative to true, or geographic north, is our True Heading.



Wind Correction Angle

The difference between our true course and our true heading is our Wind Correction Angle (WCA).



Winds and Aircraft Speed

In order to calculate the amount of time it will take to get to our destination we will need to know our speed across the ground. In order to calculate this we will need to know our True Airspeed (TA) and the effect the wind will have on our aircraft.

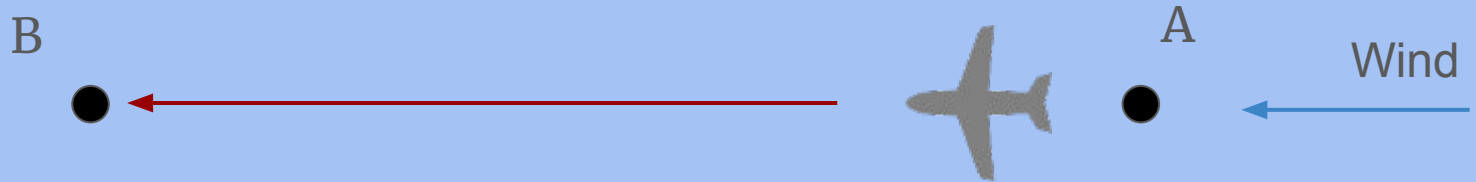
Headwind

If the wind was coming from the exact opposite direction of our course, it would not push us off course, but instead would slow our forward momentum, or speed. We call this a Headwind.



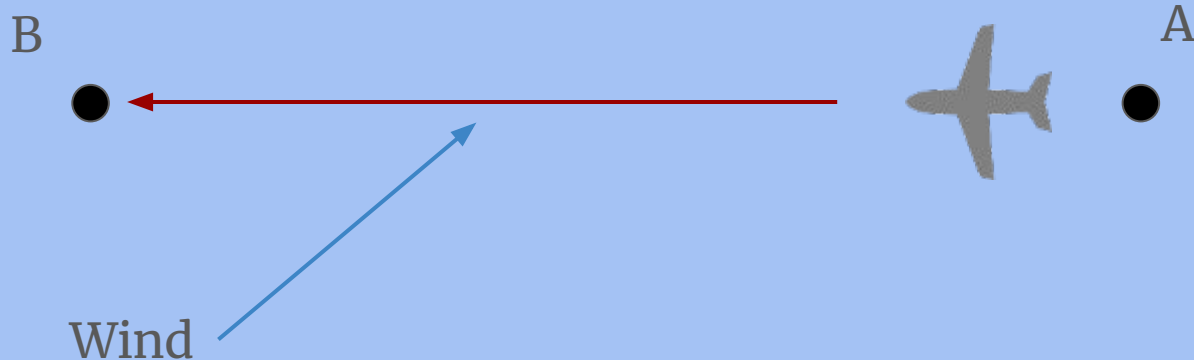
Tailwind

If the wind was coming from directly behind us it would increase our speed. We call this a tailwind.



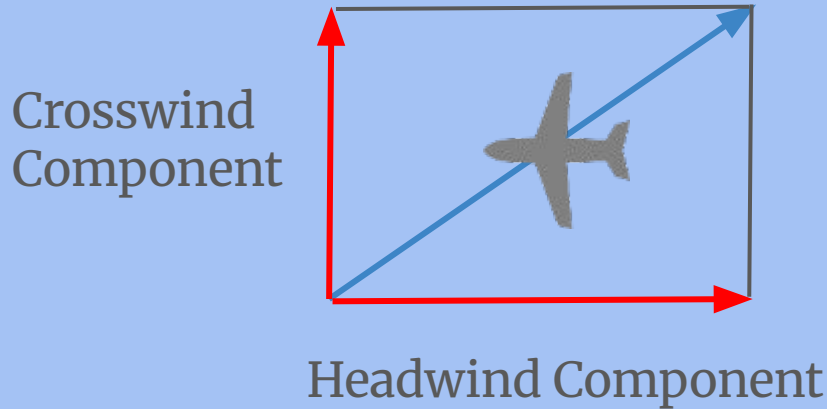
Wind and Speed

In reality wind rarely comes from directly in front or behind us, or directly from the side, but rather at some an angle.



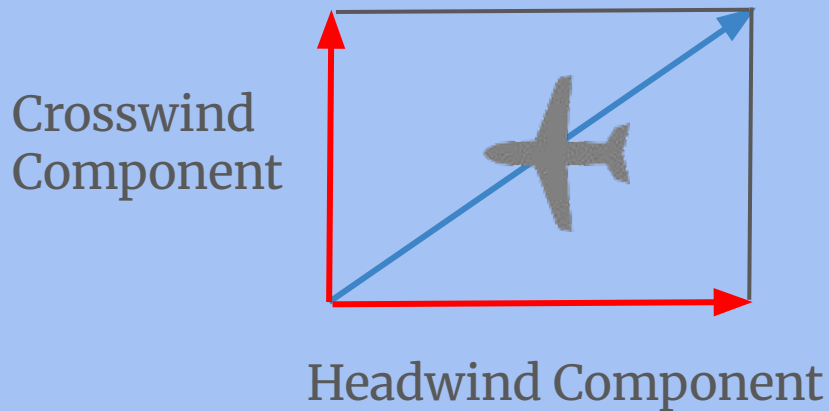
Wind and Speed

A crosswind can be broken down into two portions, a crosswind component, and a headwind (or tailwind) component.



Wind and Speed

This information helps us determine, among other things, what wind correction angle we need to stay on course, how much the wind will affect the time it takes us to get to our destination, and which runways we can safely land on.



Wind and Direction of Flight

In a moment we will learn about the calculations necessary to determine how the wind will affect out direction of, and time in flight.



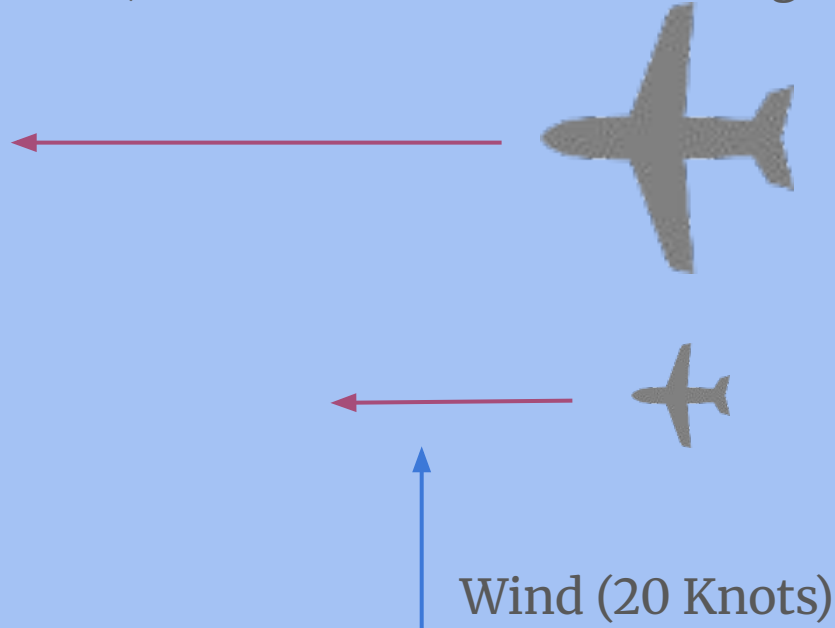
But first...

Answer me this...



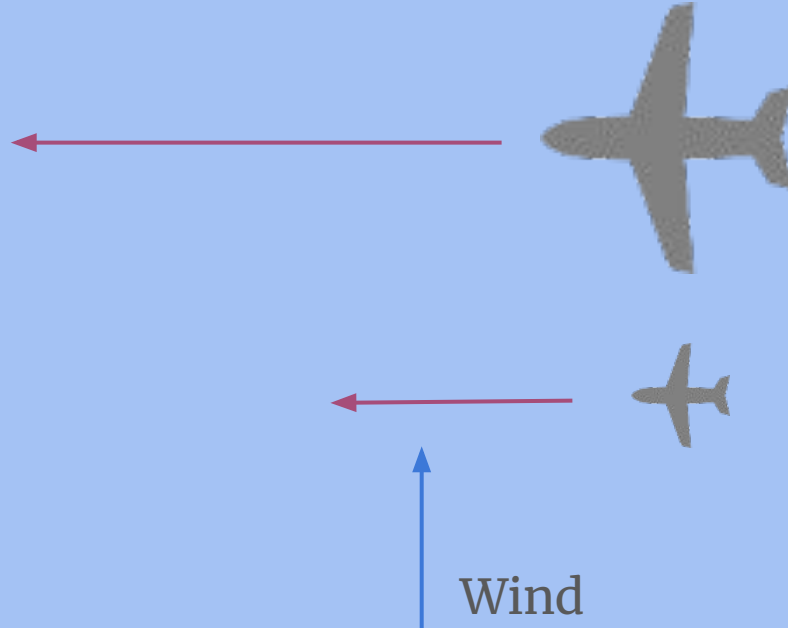
Answer me this...

Let's pretend we have a C172 (gross weight 2,300 lbs, True Airspeed 100 knots), and a B747-800 (gross weight 900,000 lbs, True Airspeed 500 knots) each heading due west, with a 20 knot wind coming from the south.



Answer me this...

After 10 minutes of flying, how much further would the C172 be blown off course than the B747?

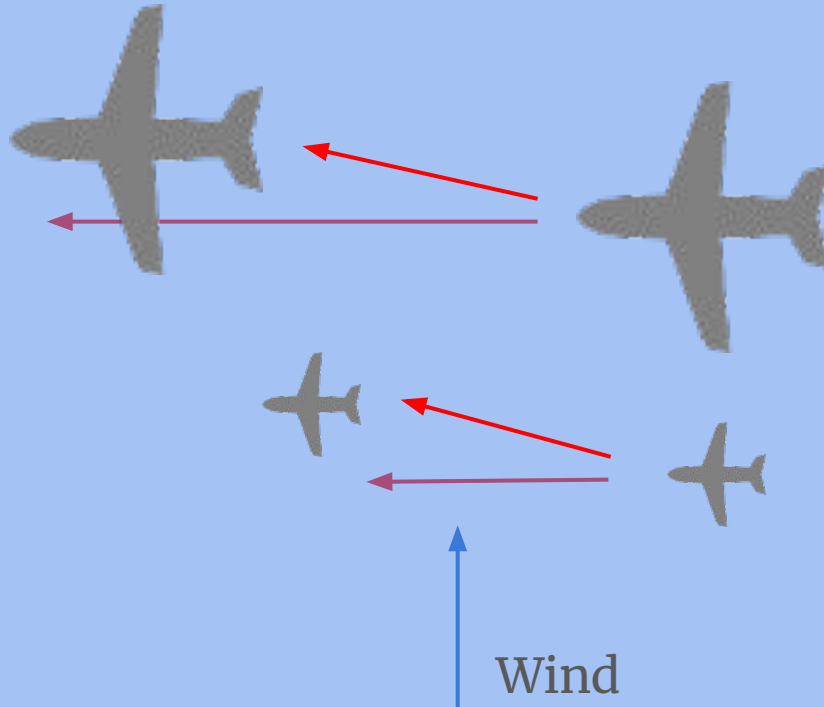


The Answer...

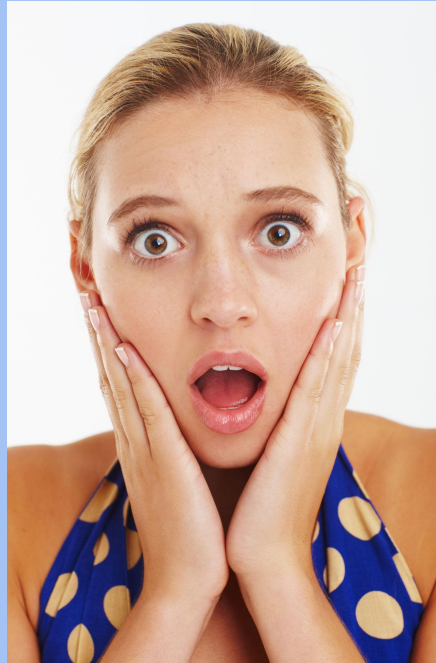
Neither!

Fun Fact

After 10 minutes they will have been pushed the same distance off course.



How is this possible!?!



Why?

Even though the C172 weighs considerably less than the B747, it will not be blown off course any more than the larger, heavier plane during the same period of time.

Because...

Why?

A body in flight becomes a part of the air mass it's in. All aircraft will be pushed the same distance off course in the same amount of time due to wind as all other aircraft, regardless of size or weight, whether it's a balloon or a B747.

Fun Fact...

However, the B747 flies considerably faster than the C172, so over the same distance the C172 would have been in the air mass much longer, and therefor, blown further off course

Fun Fact



100 miles
.2 hours

100 miles
1.0 hours



Questions?



Now to those Calculations

In performing our calculations we will be using both the manual and electronic E6B flight computers.

If you are not familiar with these, please start by reviewing the section entitled, “E6B Flight Computers – Introduction”.

Wind Direction and Speed

Let's take a moment to discuss Wind Direction and Speed.

If we are heading **TO** the east, our heading is 090 (read, **“Zero-niner-zero”**).

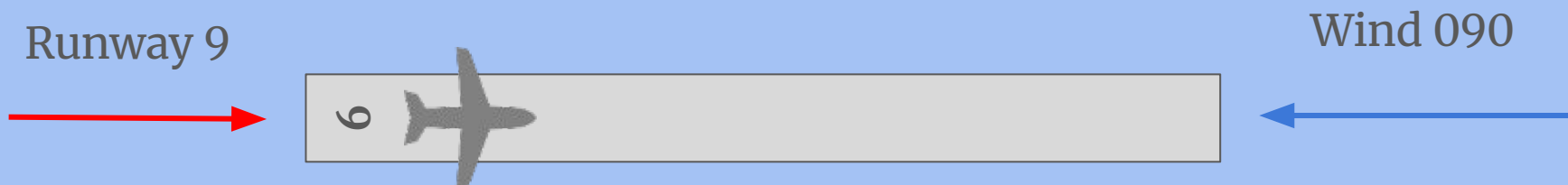
Wind, however, is stated in regards to the direction it is coming **FROM**.

Wind direction and speed is listed with two sets of numbers, such as 090/10 read, **“Zero-niner-zero at ten”** (knots). Meaning, in this case, that the wind is coming from the exact opposite direction of our heading.

Wind Direction and Speed

Since we always want to take off or land into the wind, this makes it easier to determine the most favorable runway.

For example, if the winds are listed as 090, we know that Runway 9, which faces heading zero-niner-zero, is the most appropriate to use.



Wind Direction and Speed

Let's assume our True Course is 270 degrees, and our True Airspeed is 100 kts. The wind is 180/20. Meaning the wind is coming from due south at 20 kts.

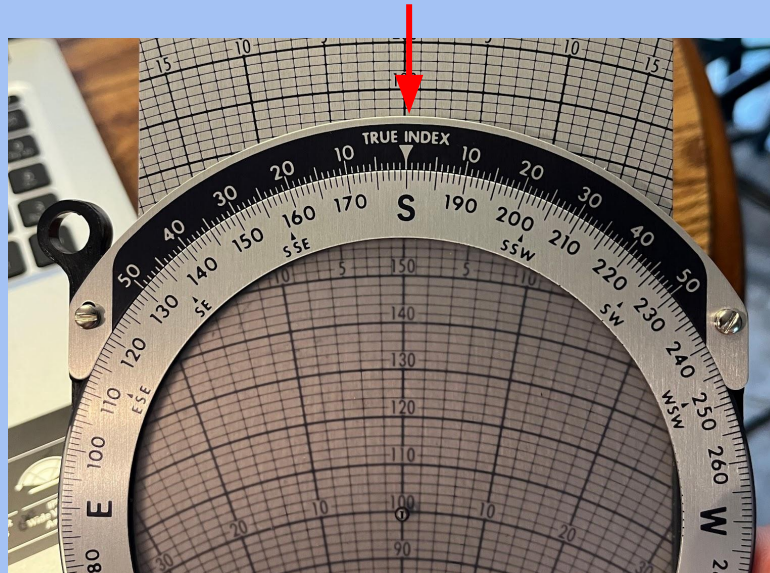
It also helps to draw a diagram to help visualize the situation and check to make sure our results make sense...



Wind Direction and Speed

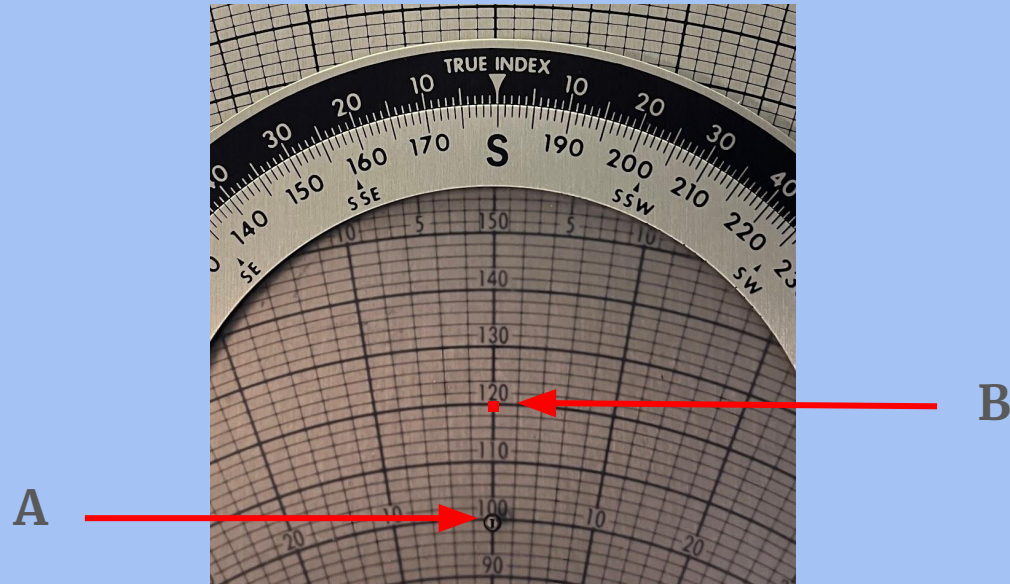
We will begin by using the wind side of our manual E6B with the slow side of the wind card showing.

Step 1: Rotate the inner ring so that the wind direction, 180 degrees, is under the True Index arrow at the top of the disc.



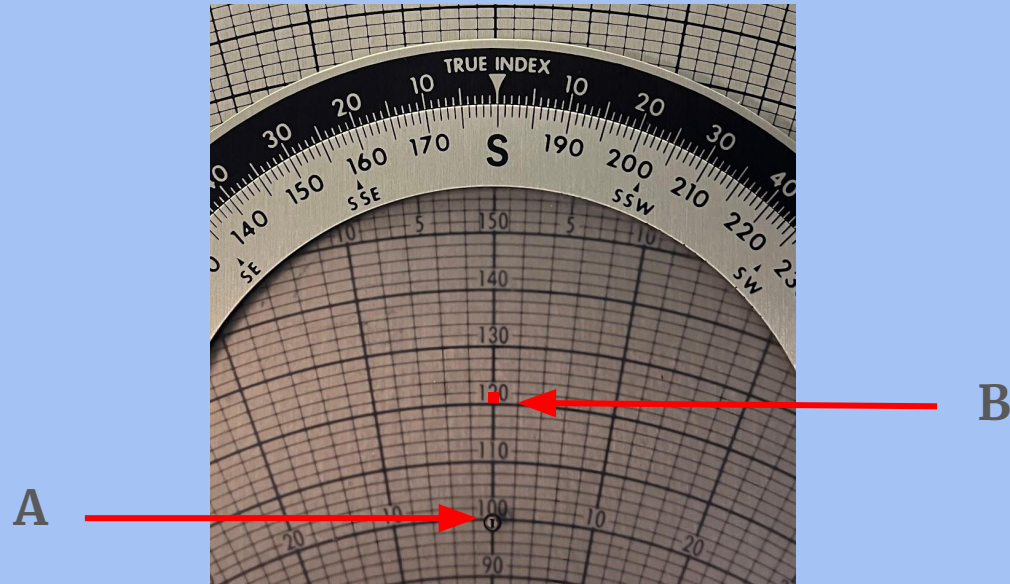
Wind Direction and Speed

Step 2: Slide the wind card so the grommet is directly over the 100 knot arc (A), and place a dot 20 knots (the wind velocity) directly above the grommet (B), which will be at the 120 mark.



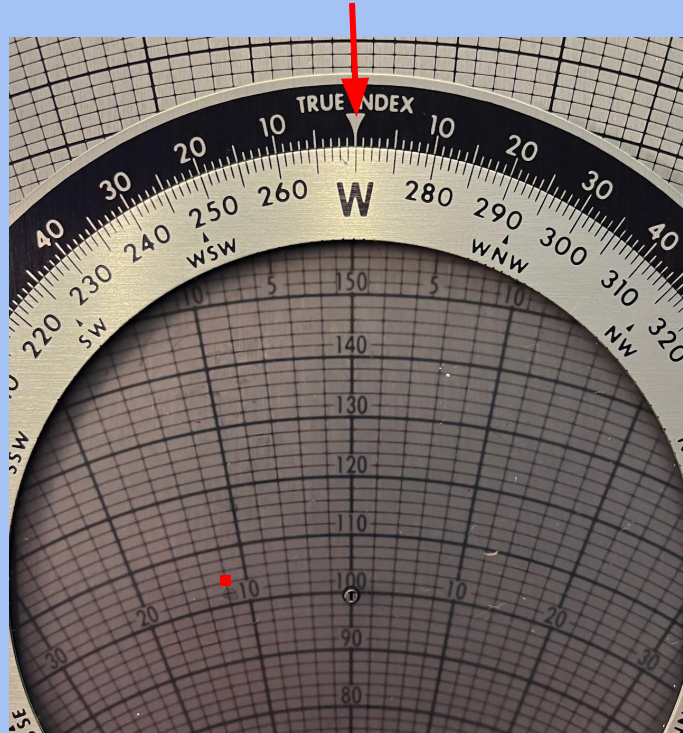
Wind Direction and Speed

Note that it does not matter where we actually place the grommet. What is important is that the mark we make is 20 knots above the grommet. It is just easier to count 20 knots from the 100 knot location.



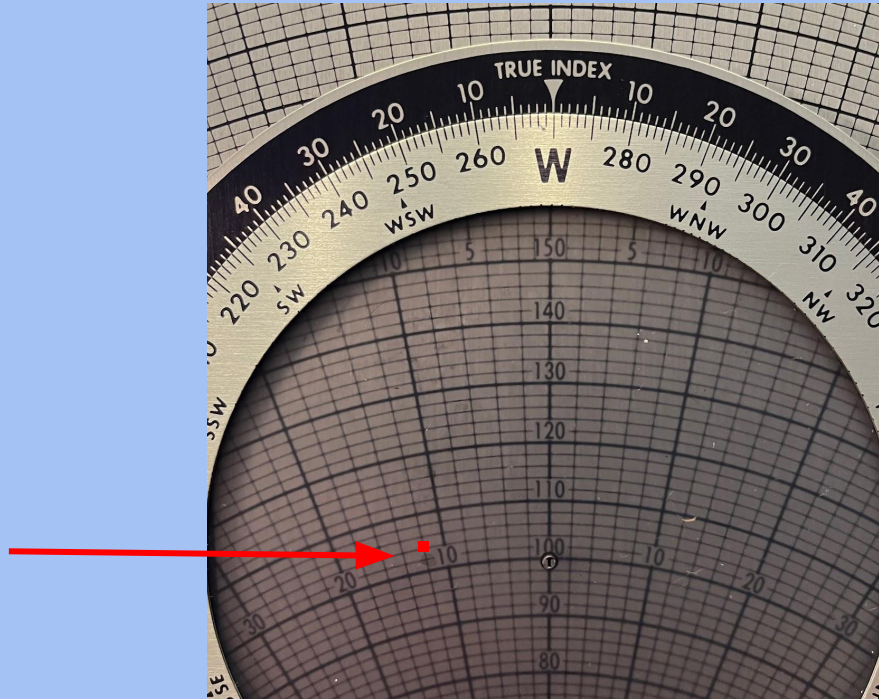
Wind Direction and Speed

Step 3: Rotate the inner ring to the left so our True Course of 270 degrees is directly under the True Index arrow.



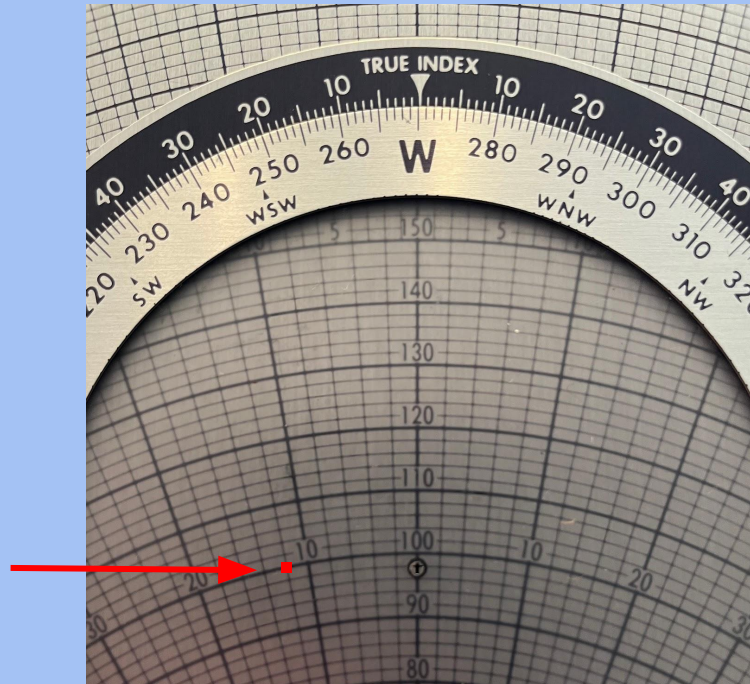
Wind Direction and Speed

Note that when you rotated the ring to the left, the dot we made also rotated left.



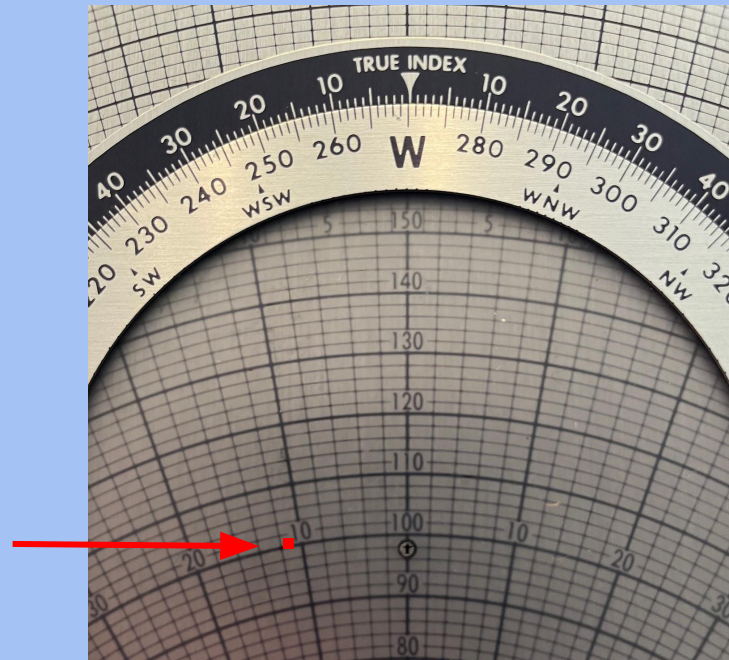
Wind Direction and Speed

Step 4: Slide the card so our red dot is on the line representing our True Airspeed of 100 knots.



Wind Correction Angle

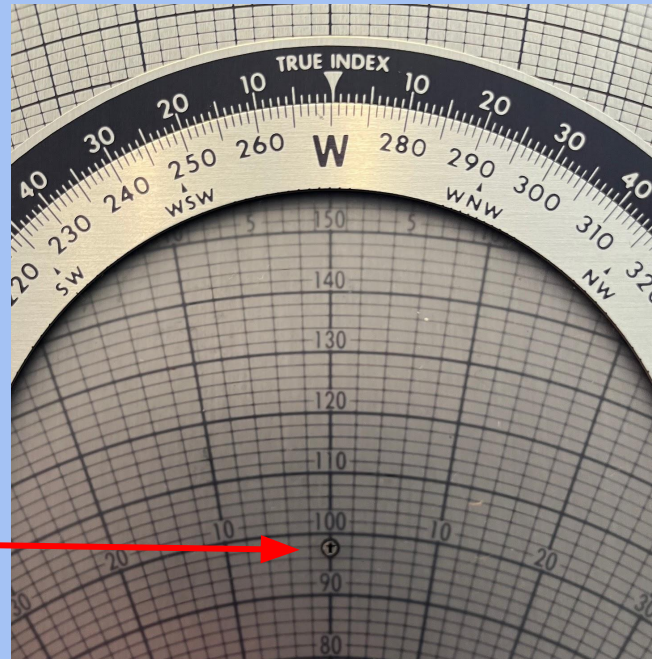
Step 5: The dot landed 12 degrees to the left of center, which means our Wind Correction Angle is 12 degrees left. 12 degrees left of our True Course is 258 degrees, making our True Heading 258 degrees.



Ground Speed

Step 6: The grommet has now magically landed on our Ground Speed, which in this case is 98 knots.

Ground Speed



Wind Direction and Speed

Let's review the steps used with the manual E6B to determine True Heading and Ground Speed given True Course, True Winds, and True Airspeed:

Step 1: Rotate the inner ring so that the wind direction is under the True Index arrow at the top of the disc.

Step 2: Slide the wind card so the grommet is directly over the 100 knot line and place a dot directly above the grommet the number of knots representing the wind speed.

Wind Direction and Speed

Step 3: Rotate the inner ring to the left, or right, whichever direction is closer to the True Course, and put the True Course is directly under the Index arrow.

Step 4: Slide the card so the dot is on the line representing the True Airspeed.

Step 5: Read the number of degrees left or right of the center line to the dot. This is the Wind Correction Angle, left or right, respectively, from the True Course.

Step 6: Read the number under the grommet. This is the Ground Speed.

How about now?



Electronic E6B

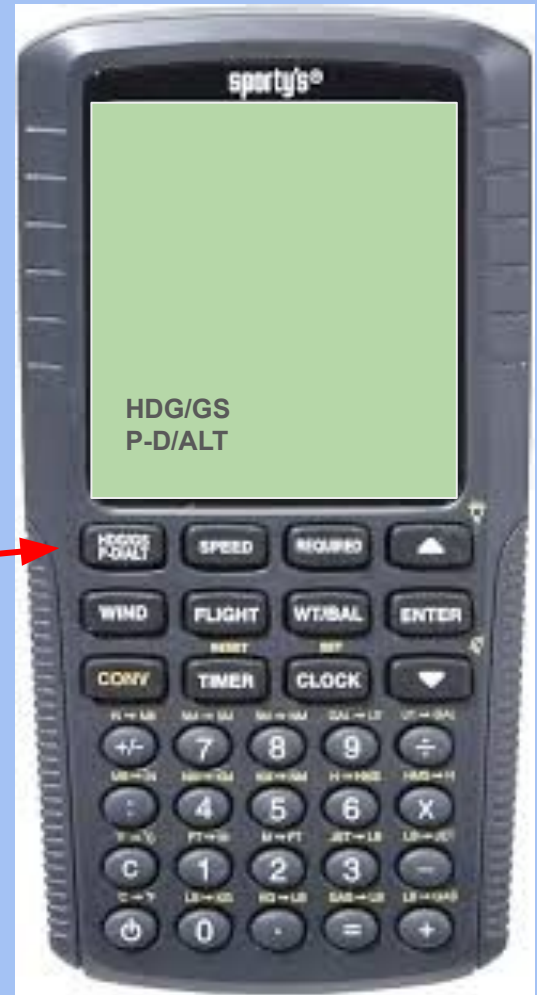
Now let's use the electronic E6B to perform the same calculation...

Start by pressing the ON button



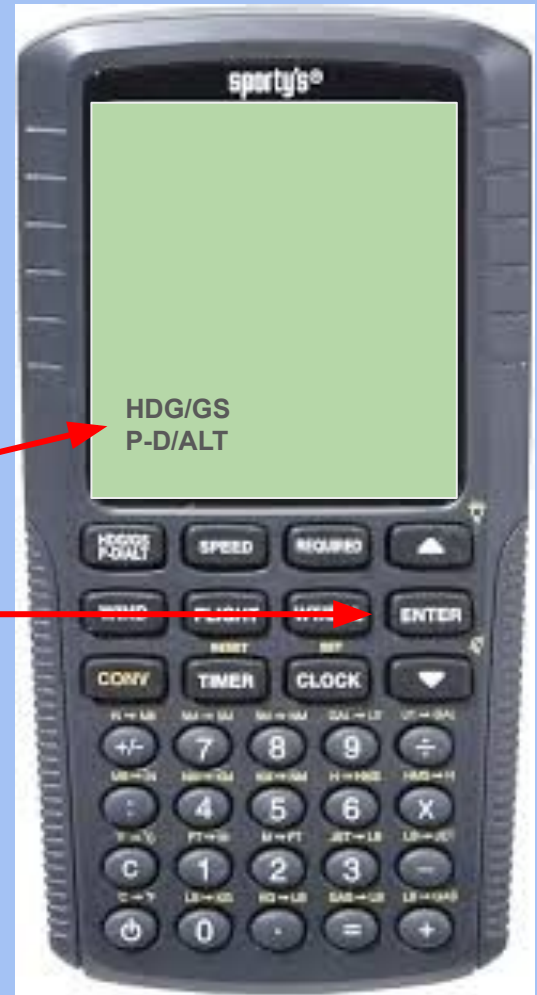
Electronic E6B

Then hit the Headings/Ground Speed
Pressure/Density Altitude Button



Electronic E6B

The Heading/Ground Speed option will be blinking. You can select this by pressing the ENTER button.



Electronic E6B

The Wind Direction Prompt will appear.

Type in the True Wind direction of “180” and hit ENTER.



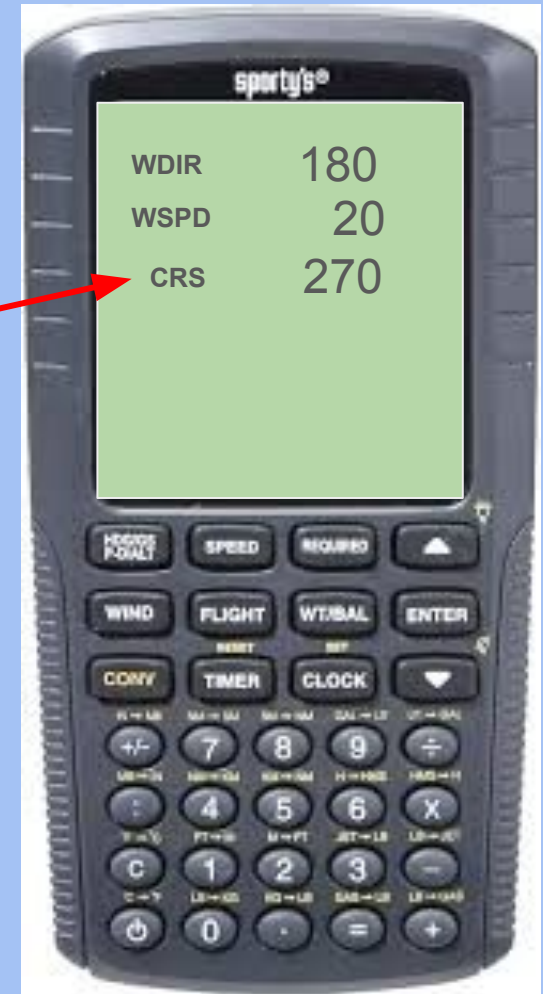
Electronic E6B

The Wind Speed prompt will appear. Type in “20” and hit ENTER.



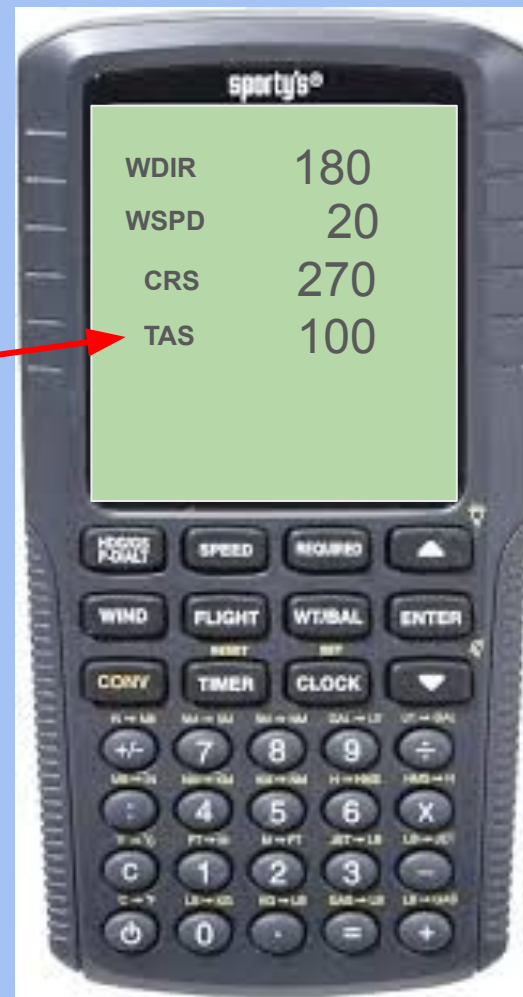
Electronic E6B

The Course prompt will appear.
Type in “270” and hit ENTER.



Electronic E6B

The True Airspeed prompt will appear.
Type in “100” and hit ENTER.

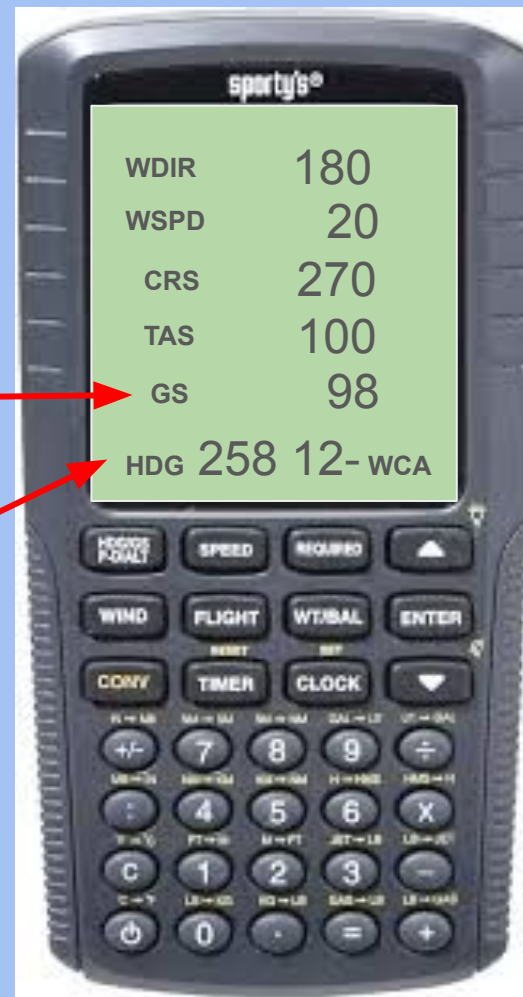


Electronic E6B

The resulting Ground Speed of 98 knots will appear.

As well as the resulting True Heading of 258 degrees as well as the Wind Correction Angle of 12 degrees.

The minus sign after the 12 indicates the WCA needs to be subtracted from the True Course to obtain the True Heading.

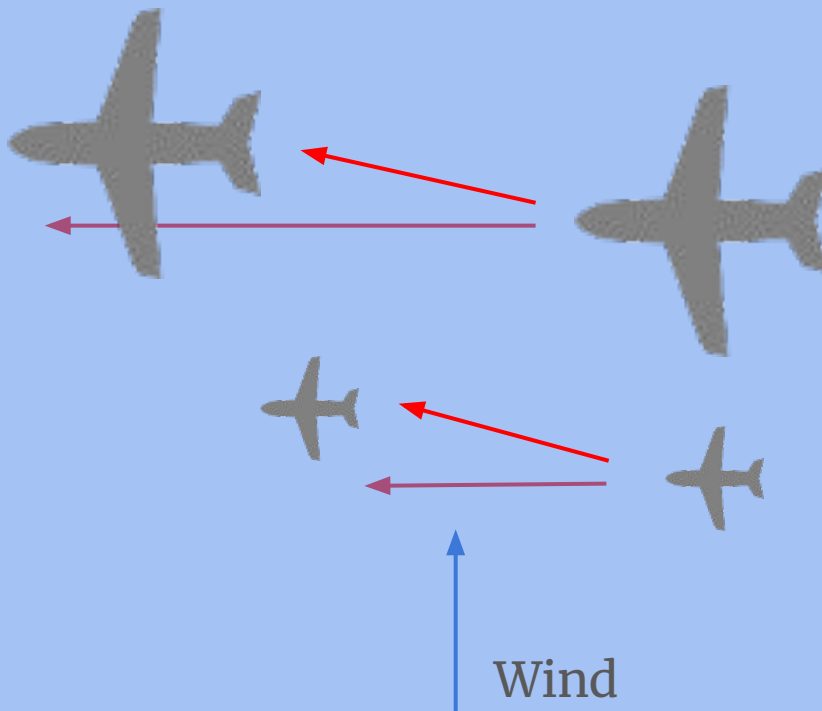


And now?



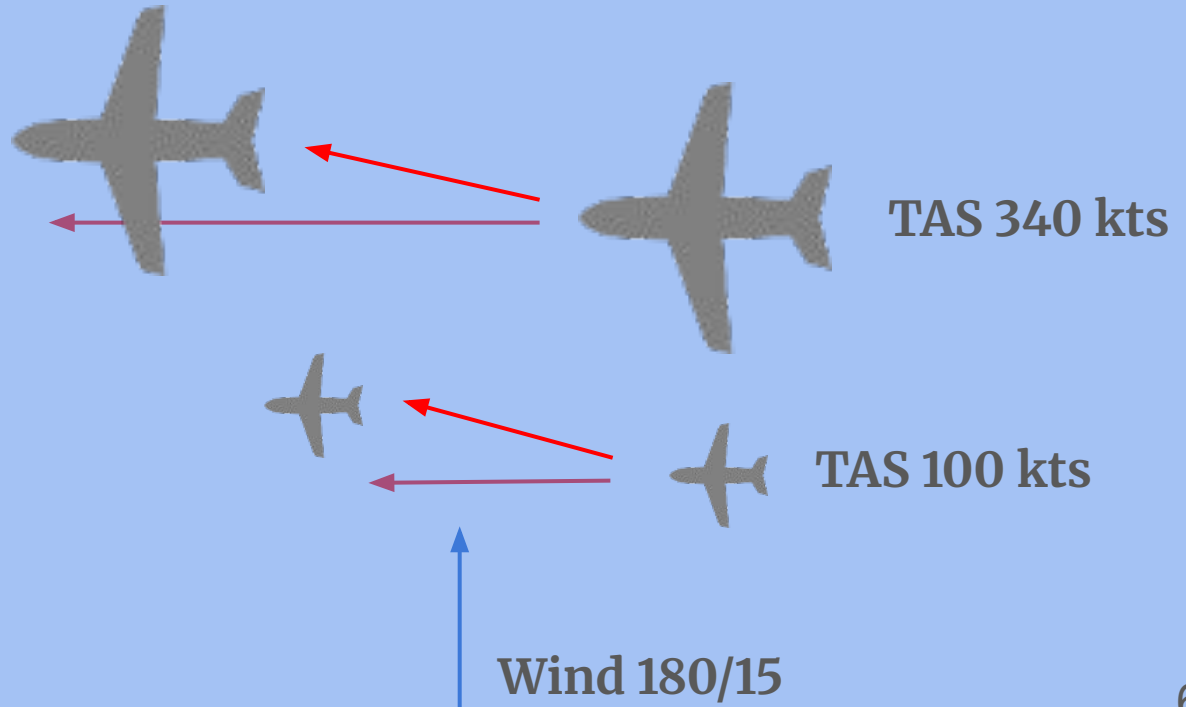
Fun Fact Calculations

Now let's use the E6B to calculate the Wind Correction Angle and Ground Speed of our C172 and B747...



Fun Fact Calculations

The True Course of each aircraft will be 270 degrees. The TAS of the C172 is 100 kts, and 340 kts for the B747. The wind is 180/15.



Wind Direction and Speed

Let's start with the C172...

Step 1: Use the back of the manual E6B and the slow side of the wind card.

Rotate the inner ring so that the wind direction (180) is under the True Index arrow at the top of the disc.

Wind Direction and Speed

Step 2: Slide the wind card so the grommet is directly over the 100 knot line and place a dot 15 knots (wind speed) directly above the grommet.

Step 3: Rotate the inner ring to the left so our True Course of 270 degrees is directly under the True Index arrow.

Step 4: Slide the card so the dot is on the line representing our True Airspeed of 100 kts.

Wind Direction and Speed

Results:

Our dot landed 9 degrees to the left of center, meaning our Wind Correction Angle is left 9 degrees.

The grommet landed on 98 kts, which is our Ground Speed.

If we put the same values in the electronic E6B we also get a 9 degree left Wind Correction Angle (True Heading of 261 degrees), and a Ground Speed of 98.9 kts.

Wind Direction and Speed

Now let's try the B747...

Step 1: Again use the back of the manual E6B. However this time we will need the fast side of the wind card.

Rotate the inner ring so that the wind direction (180) is under the True Index arrow at the top of the disc.

Wind Direction and Speed

Results:

Our dot landed 3 degrees to the left of center, meaning our Wind Correction Angle is left 3 degrees and our True Heading is 267..

The grommet landed right on the 340 kts line, which is our Ground Speed.

If we put the same values in the electronic E6B we also get a 3 degree left Wind Correction Angle (True Heading of 267 degrees), and a Ground Speed of 339.7 kts.

Wind Direction and Speed

Notice at no point during these calculations were we required to input aircraft weight.

Again, the aircraft becomes a part of the air mass it is flying in, and will travel as a part of that air mass. Size and weight has no effect on this.

The faster B747 is traveling much faster so it is in the air mass for considerably less time than the C172, resulting in a smaller wind correction angle to keep it on course.

Last Chance!

