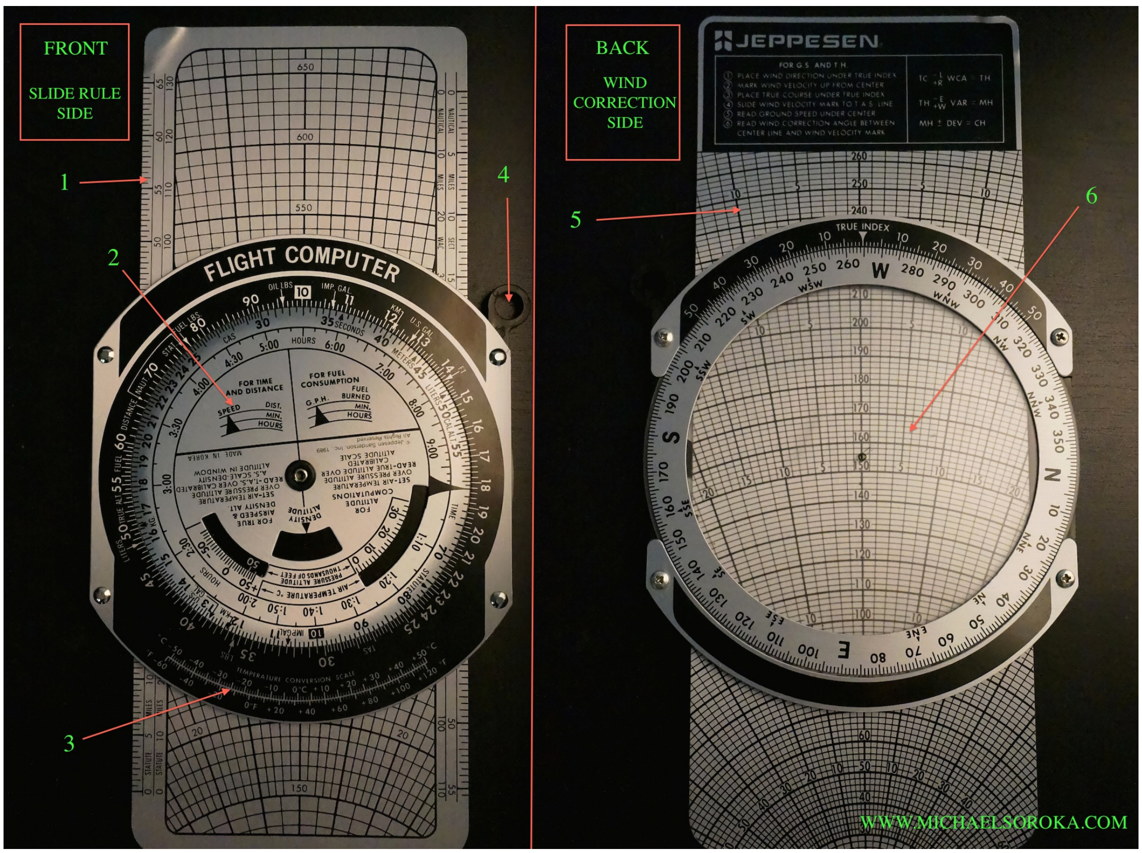
Mastering the Mechanical E6B in 20 minutes

Basic Parts

I am going to use a Jeppesen E6B for this write-up. Don't worry if you don't have a Jeppesen model. Modern E6Bs are essentially copies of the original 1940s design anyway!

The E6B has two sides which are used to perform different tasks. The back side is used for calculating wind correction only (crab angle and groundspeed). The front side is used for everything else. The center metal piece that slides up and down and makes up the majority of the computer (labeled 5) is only used with the back side.



1. Plotter (Has sectional and WAC scales)
2. Rotating scale (What you input data with)
3. Temperature conversion chart
4. ??? If you take the time to read the instruction book, they never mention what this is for. Im assuming its so you can tie a string around your E6B, turning it into a necklace to be used as a fashion accessory on special occasions.
5. Sliding chart for determining wind correction
6. Rotating dial and pencil friendly writing surface for determining wind correction

Getting started

What you will need to use your E6B for:

As a flight student, you will need to use your E6B to perform a couple of different calculations. These can be placed into the three different task groups as follows:

1. Fuel, time, and distance calculations (Multiplication and division)
2. Wind correction - ie. Finding crab angle and ground speed (Trigonometry)
3. Other - Finding TAS, Density Altitude, converting units, ext.

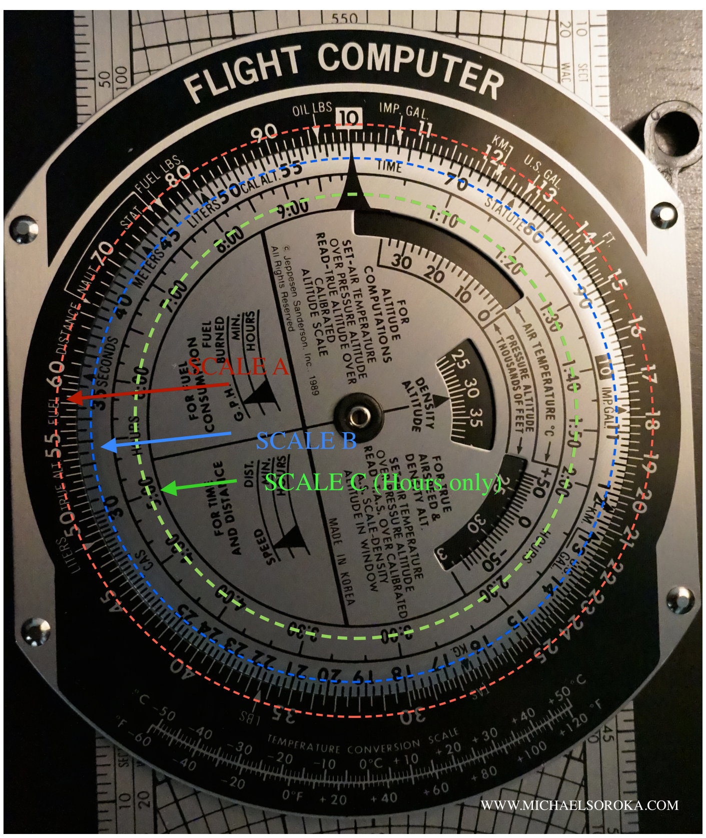
Each one of these three skill groups require a different technique to perform and can be practiced independent of each other.

1 - Fuel, Time, and Distance Calculations

Fuel, time, and distance calculations are performed on the front side of the E6B.

Becoming familiar with scales and pointers

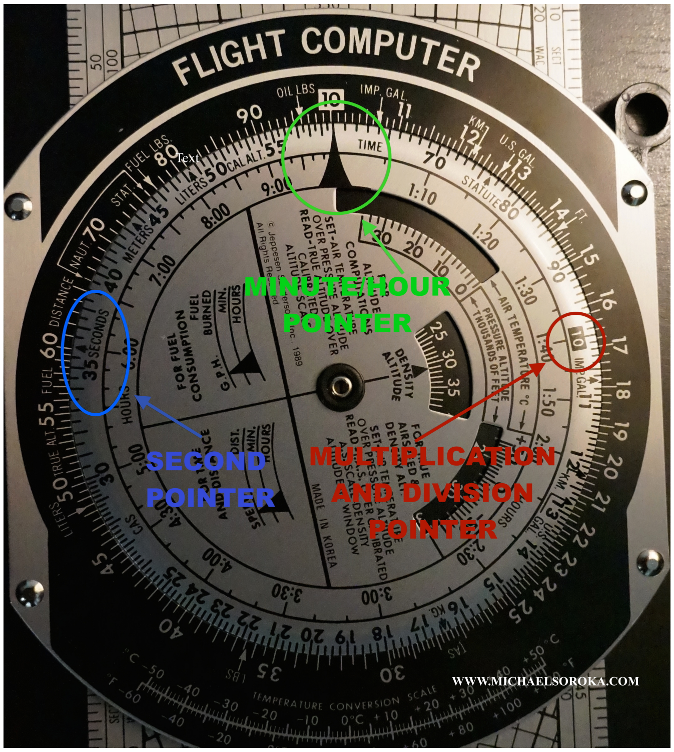
Before actually getting into some problems, you have to learn a little about the parts of the E6B. First I will define the scales and the pointers, and then I will show you how to put them into action.



<u>**Scales**</u>**:**

The front side of the E6B is essentially a circular slide rule with three separate scales. These scales are named and highlighted below:

SCALE A - The outer scale marked in red has a few purposes. It provides a way to input and reference data with pointers (kind of like the buttons on a calculator). It is also where you will read **all variables except time**.
SCALE B - The middle scale is used to **read time in minutes or seconds**. It can also be used for multiplication and division.
SCALE C - The inner scale is **only used to determine time in hours**



Pointers:

Pointers are the input method of the E6B. Different pointers will give you outputs in different units or bases.

MULTIPLICATION AND DIVISION POINTER
This tiny pointer that extends from the center of the "10" in a black box is used to perform multiplication and division problems like 5 × 7 or 22 × 37.5.
SECOND POINTER - This little pointer above the "E" in SECONDS allows you work with seconds. It lies on the "36" because there are 3600 seconds in one hour.
MINUTE/HOUR POINTER - This big triangular pointer is the most commonly used pointer on the E6B. It allows you to work with minutes and hours or do anything in base 60.

Now some problems:

Ok, so now you are familiar with the three different scales on the E6B and the three different pointers. Its time to put them to work!

Multiplying and Dividing (Don't skip)

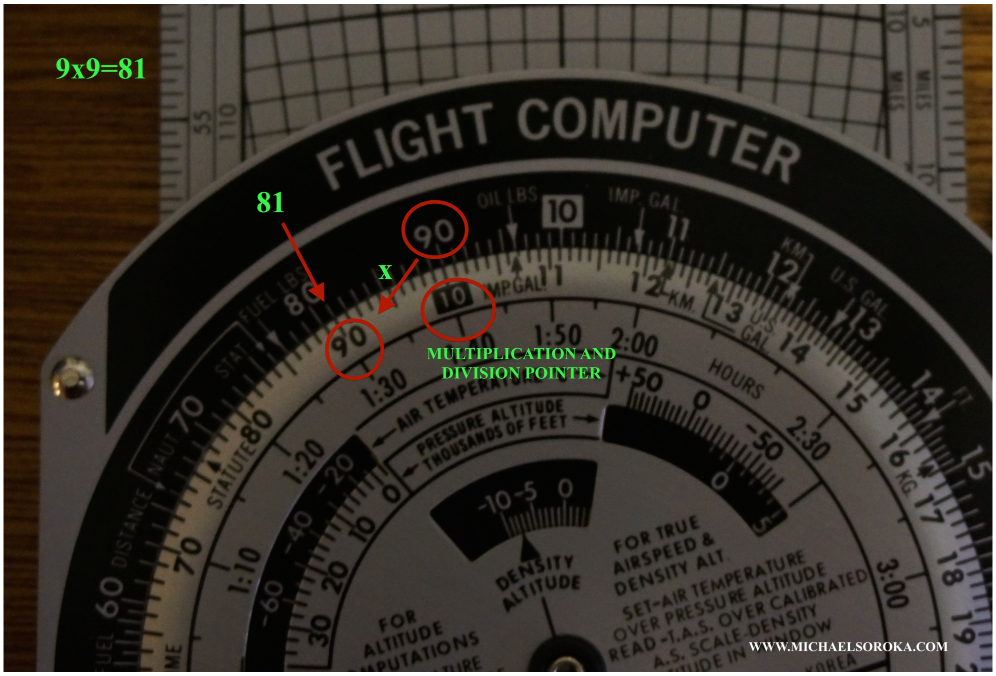
I decided to show how to multiply and divide on the E6B first. Even though these are not the most common operations the E6B is used for, it give you a good idea of how the "brain" on the E6B thinks.

To multiply:

Rotate the **MULTIPLICATION AND DIVISION POINTER** to place the number you want to multiply with under **Scale A**. Then find the number you want to multiply by on **Scale B**. Read your answer directly above this number on **Scale A**.

Here's an example:

What is 9×9?



Ok, I'm sure you have the 9 times tables memorized, but this is a great first problem to help you get used to the E6B.

You will immediately notice that the E6B doesn't actually have a 9 on the **A Scale** or **B Scale**. It instead has the numbers 10-99 on it. One common feature of all slide rules, the E6B included, is that they **do not account for order of magnitude**. This is a good thing and a bad thing.

On the positive side, It means any number on the scale can represent any order of magnitude of that number. So, the 90 in the example above could be a 9, 90, 900, or 900,000,000.

On the negative side, it means that you have to know the expected order of magnitude of your answer. So, if I multiply 9 by 9, I need to know that the 81 output I receive is 81 and not 810, or 810,000,000. Conversely, if I were multiplying 90 by 90, my answer would be 8,100.

This will be a common theme for the rest of the problems.

Now try a problem that's a little harder to do mentally:

22 × 35=?

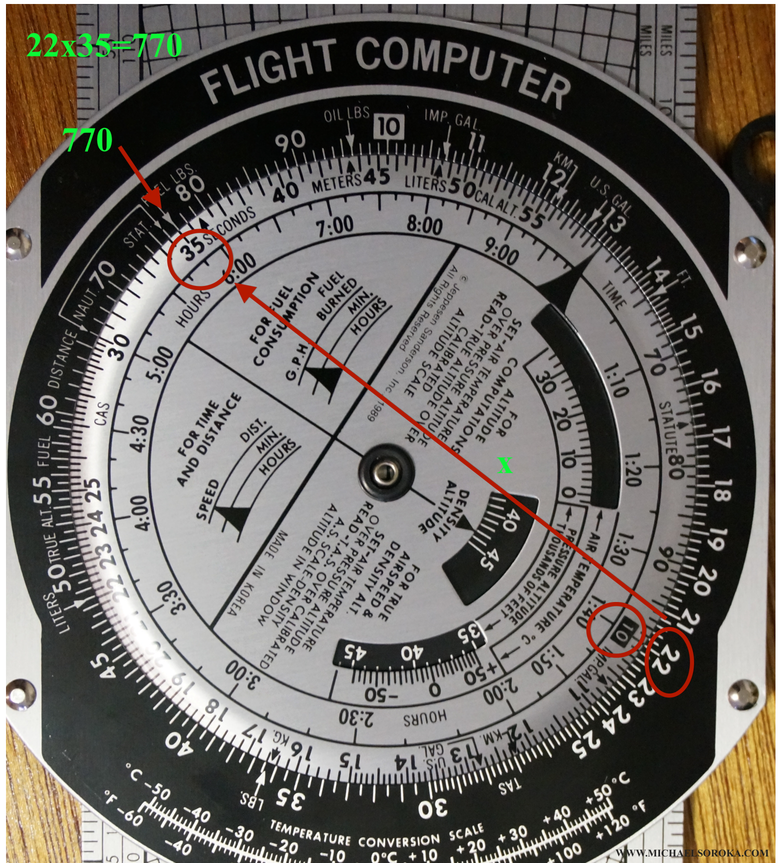
Remember to apply proper order of magnitude. 22 × 35 is 770 not 77 or 7700.

I'm sure your thinking… Wow! what a handy tool. **Now try an aviation related problem:**

On a cross country flight, you climb at **650 feet per minute** for **7 minutes**. How much altitude did you gain?

650fpm × 7min = **4550ft**

Again watch order of magnitude and apply logic as necessary. Your Cessna probably gained more than 45.5 feet but didn't zoom climb to FL450 in 7 minutes. As your E6B skills improve, you will be able to do problems like this much faster than you could with a calculator.

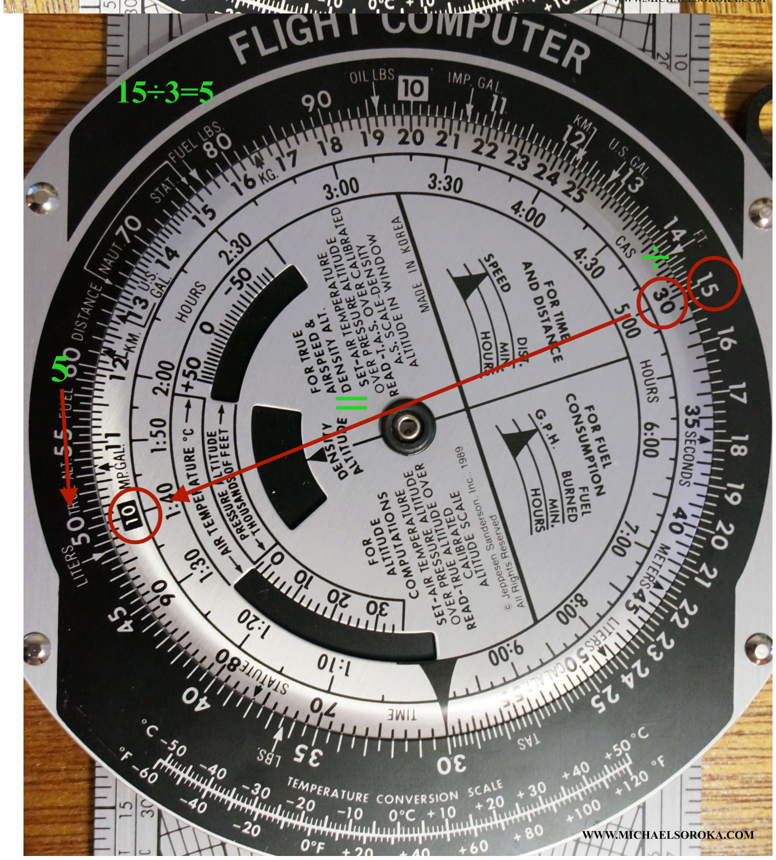


To divide:

To divide with the E6B, use the multiplication technique in reverse:

Rotate the wheel to align your numerator on **Scale A** with your denominator on **Scale B.** Read your answer at the **MULTIPLICATION AND DIVISION POINTER**. (or simply put the numerator over the denominator and read off of the pointer)

Ex: **15 ÷ 3=?**



Now try these division problems:

- 60 ÷ 25 = ?
2.4

- You need to descend **5,000ft** in **7 minutes**. What descent rate will you need?

5000 ft ÷ 7 min = **715fpm** (approximate) - The E6B can only handle two non-zero digits in its answer. The rest are approximated in the scale.

Time between 2 points at a given ground speed (leg time)

This is a common operation that needs to be done to fill out a Nav log or during a diversion in the air.

Typically, time is though of in seconds, minutes, and hours rather than percentage of hours (1:20 rather than 1.33 hours). Because this is a base 60 system, the multiplication pointer wont work for most problems.

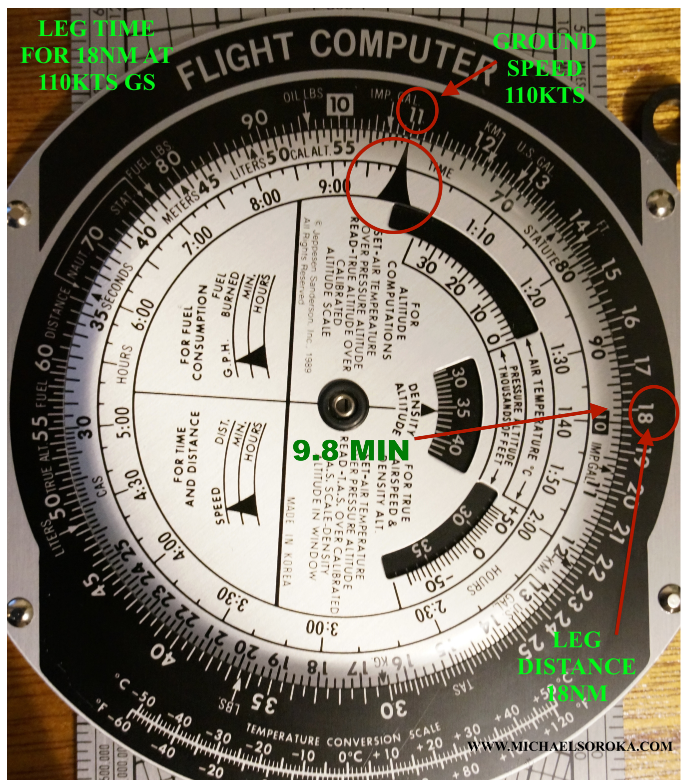
Luckily, the E6B also has a **Minute/hour pointer** and a **Second pointer**.

Before you start a leg time problem, you must first ask yourself: Is going to take hours, minutes, or seconds to get between these two points? This will tell you which scale and which pointer you will need to use.

Let's start with minutes as it is the most commonly used time unit on Nav logs:

Here's the problem: At **110kts** ground speed, how long will it take you to travel between two checkpoints that are **18nm** apart?

Because it will take "minutes" to go between these points, use the **Minute/hour pointer.** Point the **Minute/hour pointer** at the ground speed. Find the distance on **scale A**, and read the answer off of **Scale B** directly across from the distance.
You will get an answer of **9.8 minutes**



The nice thing about the mechanical E6B for these types of problems is that it does not have to be rotated again to calculate different legs if the ground speed is unchanged. This is especially useful for filling out Nav logs and makes the mechanical E6B much faster than its electronic counterpart.

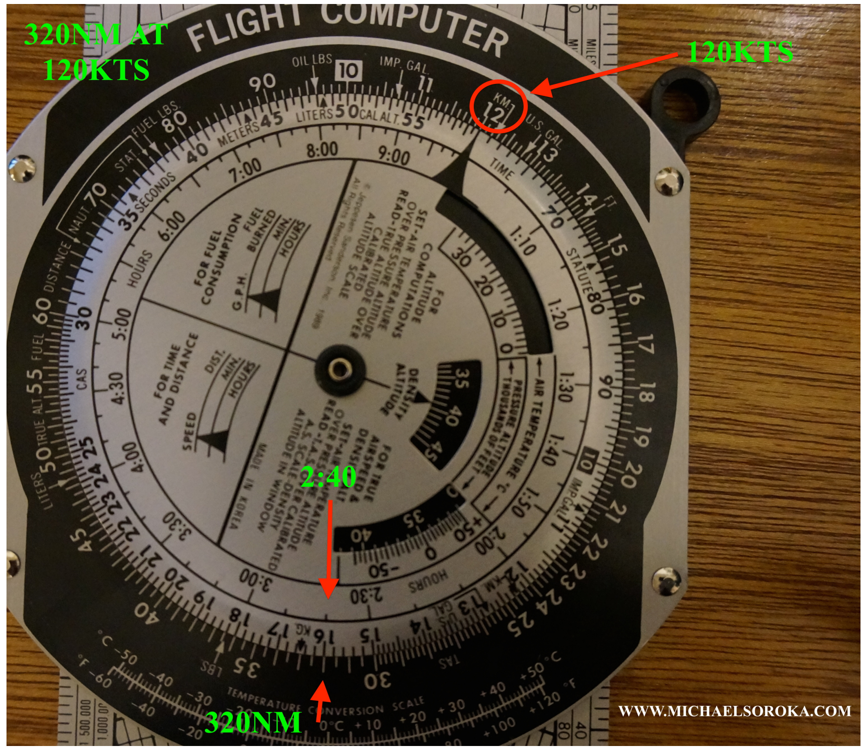
It's up to you to decide what you want to do with a number like this. Unfortunately, the E6B will not return an answer in minutes and seconds. It only works in whole units for minutes. You can either round your answer up or down (9.8 min to 10 min), or **multiply the remainder by 6** to convert to seconds (8×6=48 so 9:48)

Hours between legs

If you suspect it will take hours between legs, the method is the same except: You will still use the **Minute/hour pointer**, but will use **Scale C** instead of scale B.

Ex: How long will it take to fly **320nm** at a groundspeed of **120kts**?

You should get **2:40**

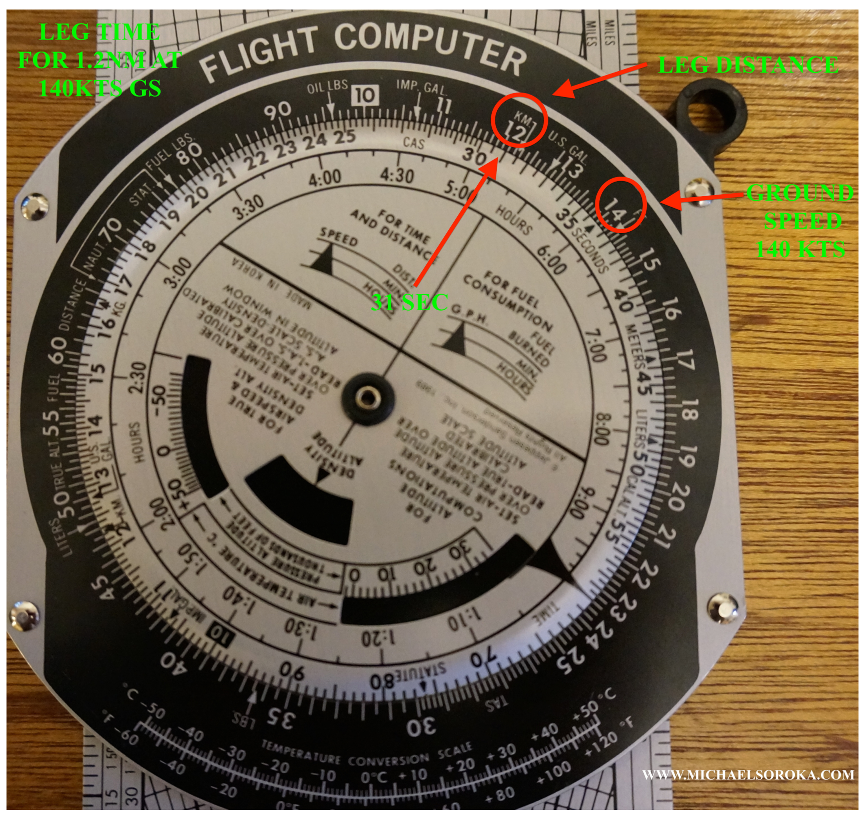


Leg time in seconds

If you suspect it will take seconds between legs, the method is the same except: You will use the **Second pointer** instead of the **Minute/hour pointer** and will use **Scale B**.

Ex: How long will it take to fly **1.2nm** at **140kts**

You should get about **31 seconds**.



Working in reverse to find ground speed and distance

You can work in reverse to find ground speed for a known leg time and distance, and distance for a known leg time and ground speed using the following methods:

Groundspeed: Align the distance you traveled on **Scale A** with the time you traveled on either **Scale B** for minutes or **Scale C** for hours. Read you groundspeed off of the pointer.

Distance: Align the pointer with the groundspeed. Find the time on **Scale B** or **Scale C** for minutes or hours. Follow the time directly across to **Scale A** to get the distance traveled.

Fuel for a given leg

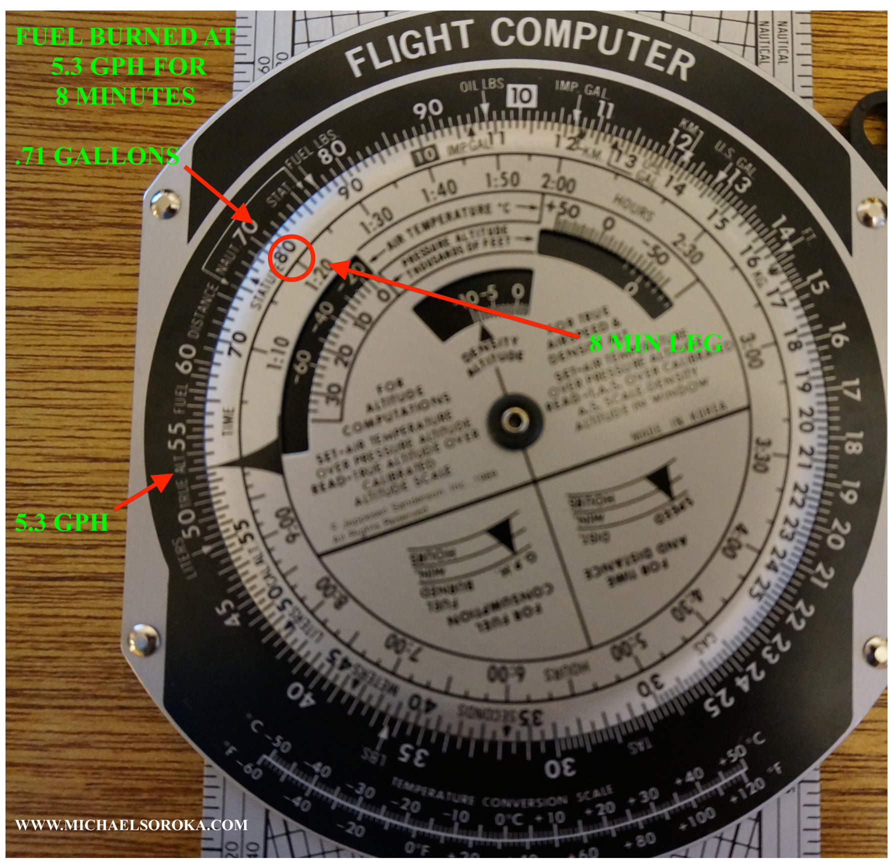
The procedure for determining fuel burn for a given leg is similar to finding leg time. Like leg time, the pointer and scales you use will be different if you are working with seconds, minutes, or hours.

To calculate the fuel burned for **minutes or hours** of flight time, use the **Minute/hour pointer** and point to the the fuel burn in GPH. Find the leg time on either **Scale B** for minutes **Scale C** for hours. Read the fuel burned directly across on **Scale A**.

For **seconds**, use the **Second pointer** and **Scale B**

Ex: How much fuel will a Cessna 152 burn on an **8 minute** leg with a fuel burn of **5.3 GPH**?

You should get around **.71 gallons**.



2 - Crab Angle and Groundspeed Adjusted for Wind

To find crab angle and groundspeed adjusted for wind, you will need to flip the E6B over to the backside.

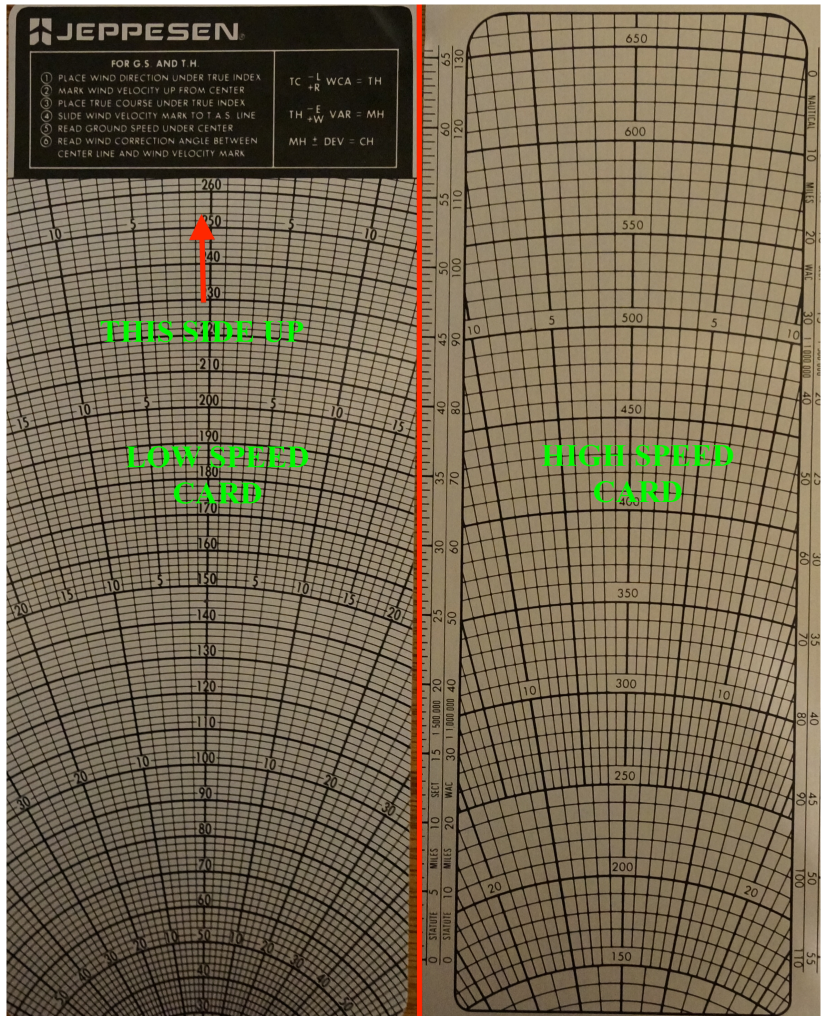
You will also need a pencil

On the backside of the E6B, you will notice a rotating dial and a metal slider. The metal slider is reversible and has one side for low speed aircraft (like light training planes) and one side for high speed aircraft (like jets). Before getting started, make sure you are using the correct side and that your card is facing right-side up.

Now that you are oriented and have your trusty pencil, you can begin the process. Below are the steps:

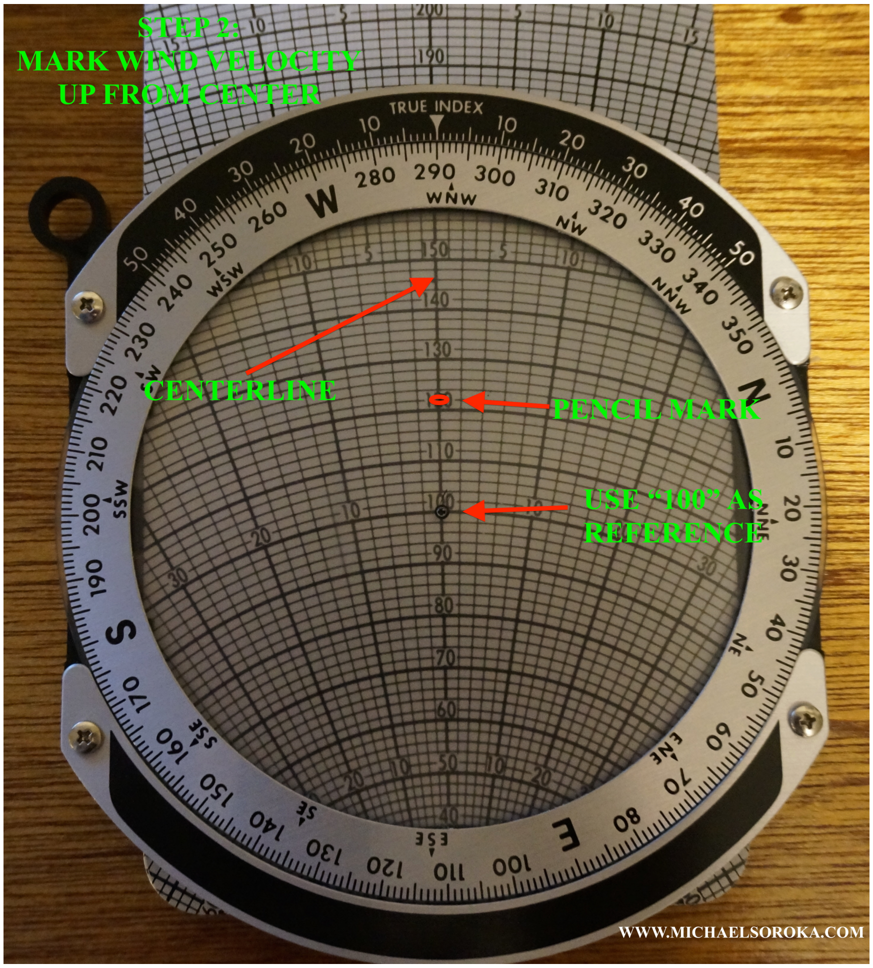
For this example, I will use:

True Airspeed of 125kts
True Course of 070
Winds from 290@22kts



1. Just like the Jeppesen instructions say, rotate the dial the place the wind direction under the true index (the little pointer on top).

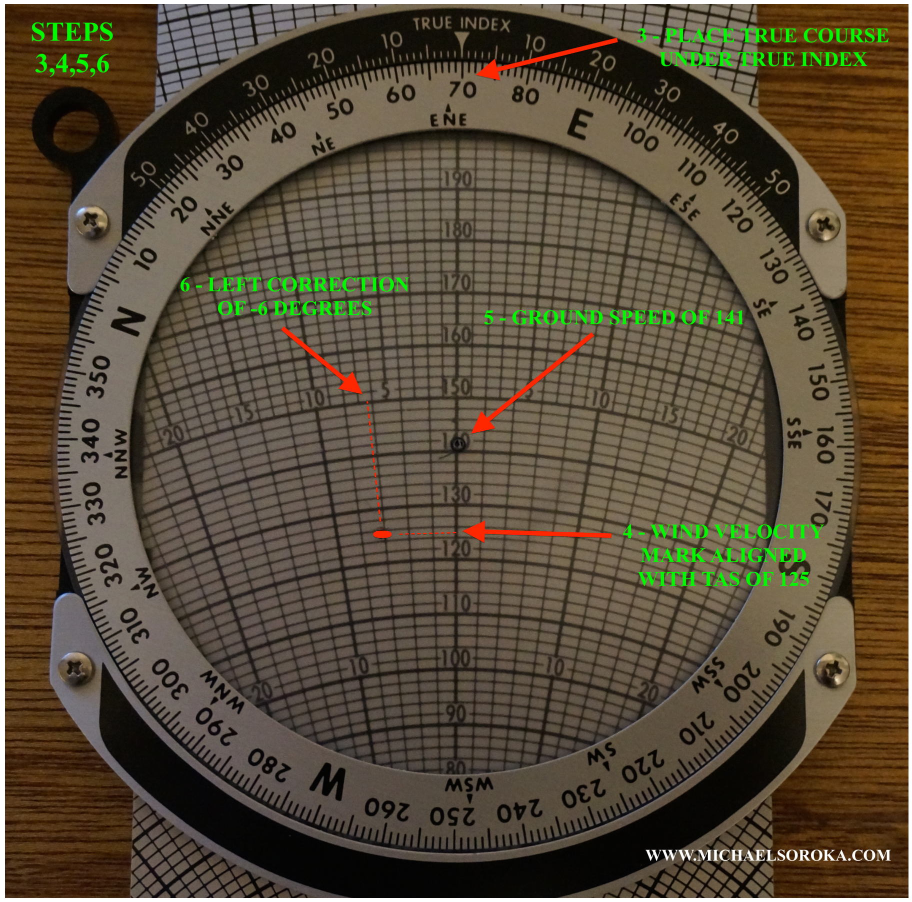
2. The instructions on the E6B are vague for step 2. The objective is to place a small pencil mark on the plastic pencil-friendly surface to identify the wind velocity. If you look down the center of the E6B, you will notice a bold center-line and some numbers from about 30 at the bottom to 260 at the top for the low speed card. You will also notice a grid which marks increments of 2 units between the numbers. These numbers and the grid will be used to reference speed later. For now they will be used as a guide to mark the wind velocity.



- Place the small hole in the center of the plastic directly over the "100" mark. For now, the 100 has no meaning other than to make it easy to count the wind units on the grid.
- Count the units upwards and place a mark on the plastic that corresponds to the wind speed. For example, for 22kts of wind, you would place the mark at "122"

3. Rotate the dial to place the true course under the true index.
4. Now slide the metal slider so that the **pencil mark** you made lines up with your ground speed. In this example, this will mean that the mark will be left of the center-line.
5. Read the groundspeed corrected for wind at the center-line. In this example, the ground speed is **141kts**
6. Find the wind correction angle by counting the units between the pencil mark and the centerline. In this example you will get about **6 degrees**. If you pencil mark falls to the **left of the centerline, subtract** the value from your True Course to get your True Heading. **If your mark falls to the right add the value.**

So after all of that, you should arrive at a **groundspeed of 141kts** and a **True Course of 64 degrees**.



3 - Other stuff (TAS, Density Altitude, and Conversions)

These problems will use the front side of the E6B

TAS and Density Altitude

Because the process for finding TAS and Density Altitude is the same, I have combined these two tasks into one example.

This process will use the Density Altitude window (center window) and Temperature/Pressure Altitude window (right-most window) along with the **A scale** and **B scale**.

To find TAS and Density Altitude, use the Temperature/Pressure Altitude window (right-most window) and align your OAT on top with your Pressure Altitude on the bottom.

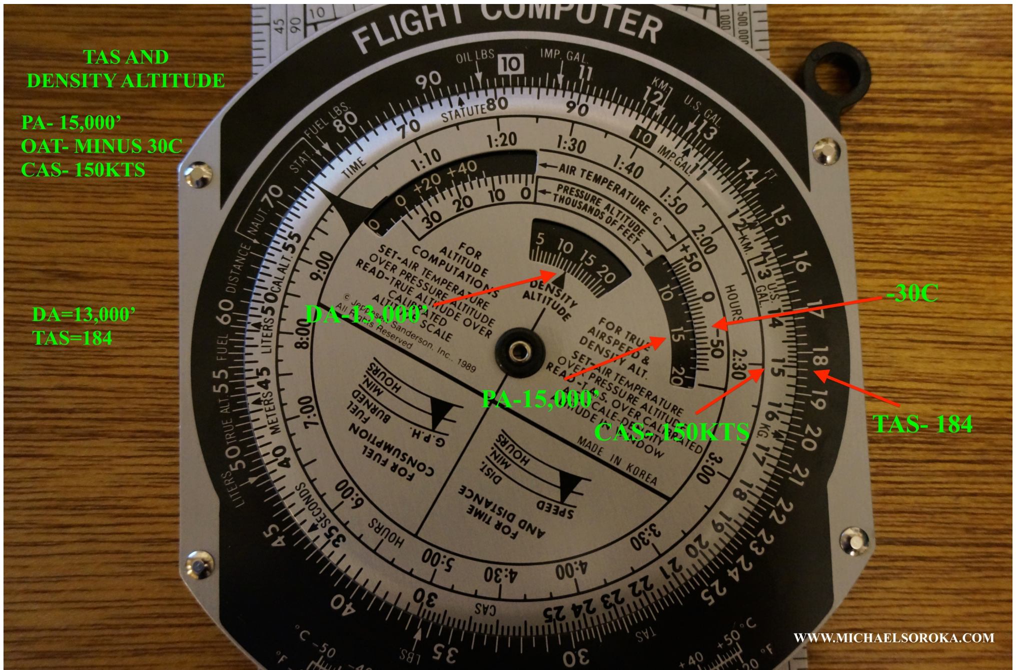
- Read your Density Altitude off of the pointer on the Density Altitude window (center window)
- Find your CAS on the **B scale**. Your TAS is directly across on the **A scale**.

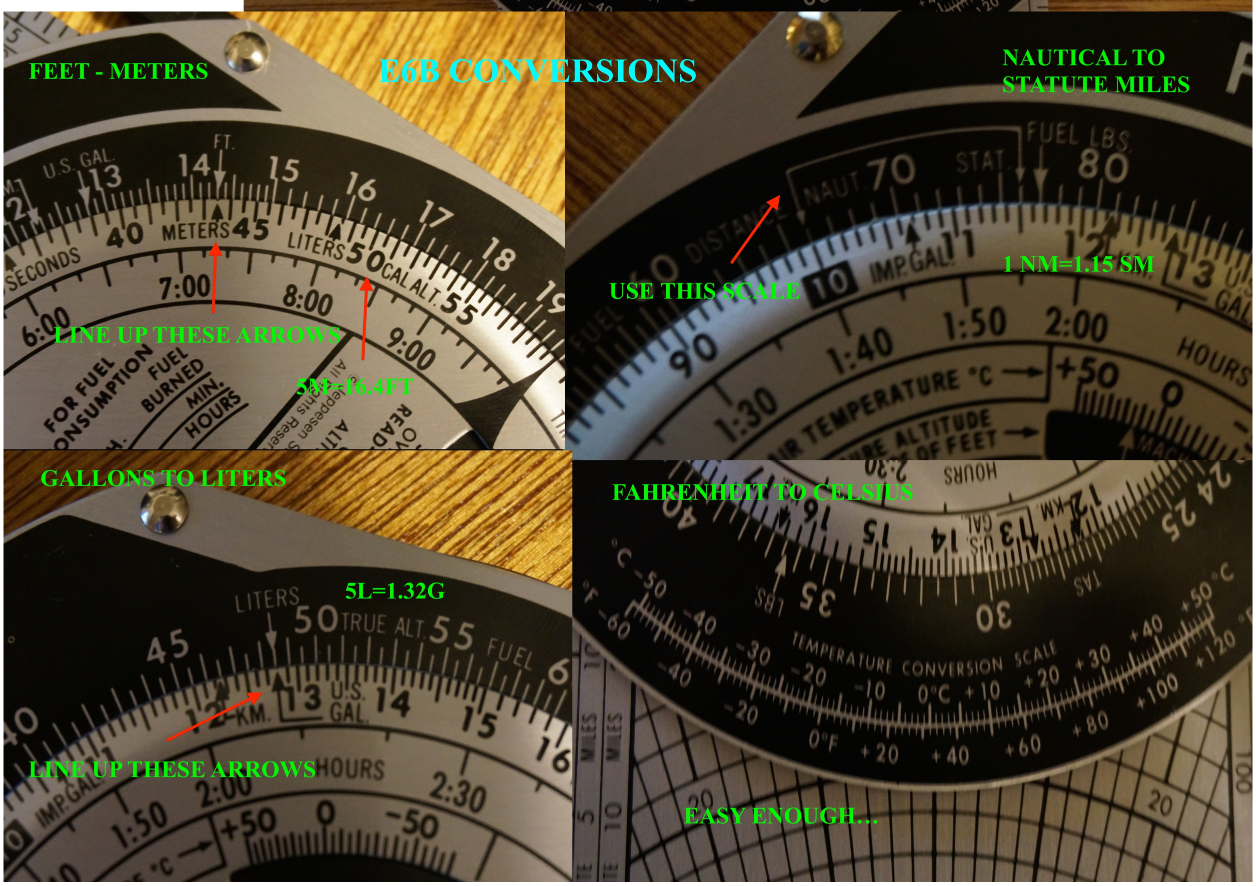
Ex: What is the Density Altitude and TAS under the following conditions:
PA- 15,000'
OAT- minus 30c
CAS- 150kts

You should get **13,000’** and **184kts**

Conversions (below)

The E6B can do a bunch of conversions. Rather than outline each one, I have made a collage of sorts to highlight a couple





Hope this helps!

Remember, practice makes perfect. Im sure over time, you will find the E6B to be faster can a calculator.