Flight Computer E6-B
Manual

Index

Introduction

Congratulations with your ASE Circular Flight Computer E6-B. The computer is designed for durability, easy use and precise calculations during training, preparation and flight.

Before using your computer

Please be aware that all calculations have to be considered correct or not before you use it in real flight. The results you get from your calculations are based upon your input and the correct use of the computer. The many different calculations you can make with the computer has a build in risk for using the calculator wrong. Please make sure you are familiar with the correct use and consult the manual or your flight instructor if needed.

Good luck with your calculation and your aviation activities.

The two pages

The computer have two pages with different purposes. The calculation page is used for numerous different types of calculations, the wind page is used for calculations of wind, and wind based calculations.
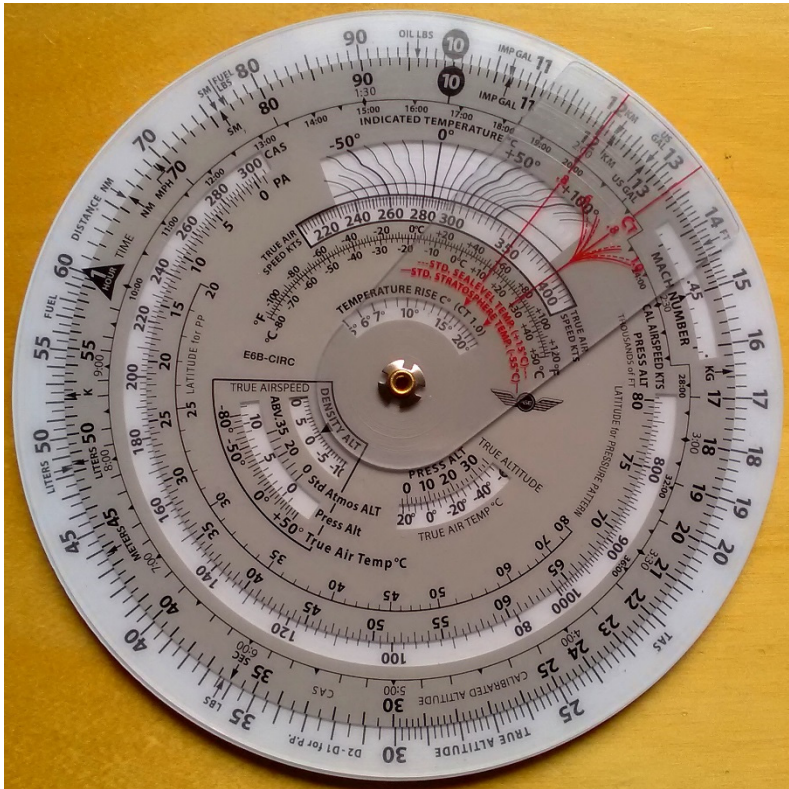
Figure 1: The calculation page.

Fig. 2: The wind calculation page.
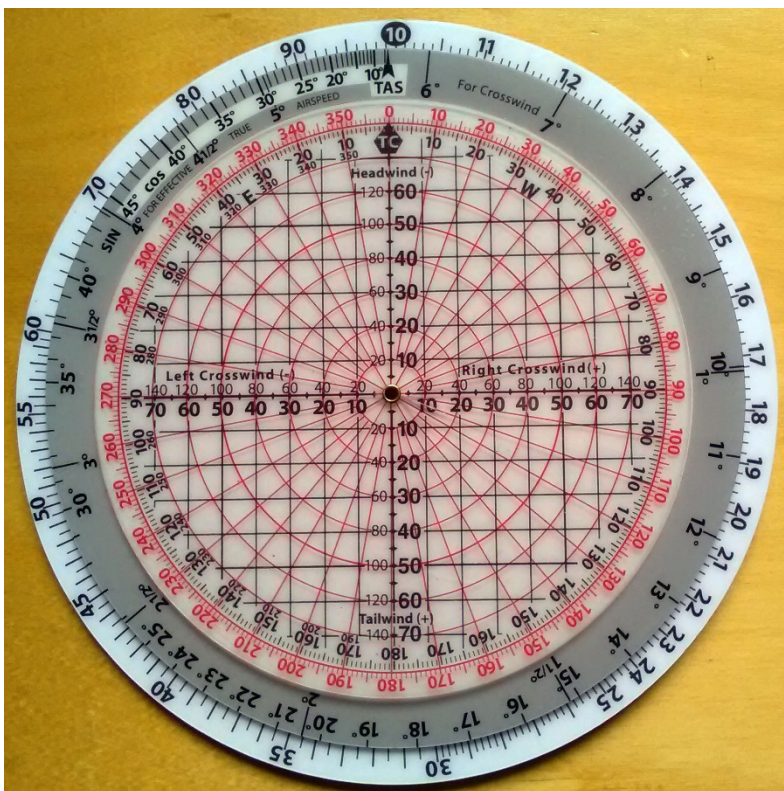
The calculation page

On the calculator page of the flight computer you will find conventional slide rulers. It consists of the rotating disk with numbers on the middle scale. When set against similar numbers on the fixed portion on the outer scale, you will be able to make calculations of time, speed, distance, fuel consumption, and convert statute miles to nautical miles and opposite.

On the inner scale on the rotating disk is graduated in hours and the calculator side has "windows" that make it possible to calculate airspeed and altitude figures.

You will see a tab with red letters. This makes it possible to calculate figures in relations to temperature rising and you will be able to find true air temperature, the speed in Mach numbers and the true airspeed.

You will find the 1 Hour triangle on the rotating disk. It is marked differently than the other numbers, because many of your calculations will be around time calculations – and very often based upon one hour as a reference.

Start with rotating all the number on the middle scale to match up with the numbers on the outer scale. Each figure can mean something different. Like "1" could be mean something different as "10", "0.1", "100" or even "1,000". It is up to you to qualify the right figure.

For this first use the "10" as "10". If you are calculations fuel and the figure 10 means 100 pounds of fuel, the 11 would mean 110 pounds (see Figure 1).

If you look at the outer scale you can see the calibration marks are different after 15. This mean that each is equal to .2 the this would read 15.2 at the first calibration mark. If you make a calculation with speed and see 16.2 this would probably mean 162 knots – but you need to keep track of the right magnitude.

Further to the right on the scale from 30 the calibration becomes even wider, meaning 0.1 by the short lines and 0.2 by the bigger lines.

From 60 the calibration is equal to 1.

It is important that you recognise what each line of calibrations mean.

You should use the calculation side to establish the right ratios.

When the numbers are matched (under each other on inner and outer scale), the ratio is 1 to 1 (see Figure 3).

Please set the number 1 opposite to 12 on the outer disk. The numbers on the outer disk are precisely double the value of the numbers on the inner disk. 140 is opposite of 70, 50 is opposite of 25, 6.0 is opposite of 3.0. Later on you will use these rations when you have to solve time-speed-distance and fuel calculations.

Rotate the disk until the numbers on the middle scale match up with the numbers on the outer scale. 10 are at the top. The "10" could read as ".1", "1", "100" or even "1.000". This is all depending upon the problem. For this calculation you should see it as 10.

By making a calculation around 1,000 pounds of fuel, the number 10 would be meaning 1,000 and each calibration mark would be equal to 10 pounds – and 11 would mean 1,100 pounds (see figure 1).

On the outer scale you see that between 15 and 16 each calibration mark is equal to .2 and the mean that the first calibration mark after 15 mean 15.2. In a calculation of speed this would typically mean 152.

After 30 the calibration marks mean .5 and at 60 they mean 1. The different meaning of the calibration marks mean that you have to understand what each mark mean on all the scales.

The calculator side are used to calculate ratios. The ratio between the figures are 1 to 1 when the numbers are matched (see figure 3). If you set the rate arrow (number 1) by the number 12 on the outer disk you will see that all the numbers on the outer disk are twice the value of the numbers on the inner disk. 160 is exactly twice the value of 80, 50 is opposite 25, 8.0 is opposite 4 etc. This is used to slove time/speed/distance calculations and fuel consumption calculations.

Figure 3. Line up the 1 triangle (the rate arrow) with the number 12 on the outer disk (scale).

If you take a look at the inside scale on the disk you will find calibration lines that look like clock times. 8:00, 5:00, etc. which mean hours. This inner scale is used for hours and the scale in the middle mean minutes. Below 90 you see 1:30 – 90 minutes is one hour and 30 minutes. Below 30 you see 5:00 – meaning that 300 minutes is equal to 5 hours. When converting minutes to seconds you place the rate arrow by the number of

minutes on the outer scale and you will find the resulting number of seconds opposite to the "seconds" arrow.

When converting minutes to seconds you have to place the arrow of the rate opposite the number of minutes on the outer scale. Read the equivalent seconds opposite the "seconds" arrow right of the number 35 on the inner scale.

Basic Arithmetic

Multiplication

If you set index 10 under the multiplicand you read the product over the multiplier. For example 8 (the multiplier) x 11 (the multiplicand) = 88 (the product).

1. Turn the unit index (10) on the blue disk opposite the multiplicand (11) on the white disk.
2. Read the product (88) on the white disk over the multiplier (8).

Do not forget; a given number on the computer like 30 can also represent other values like 3.0, 300 or 3,000.

1. Place the unit index (10) on the blue disk opposite the multiplicand (200) on the white disk.
2. Read the product on the white disk above the multiplier (16). The answer is 3,200.

Division

Place the dividend over the divisor. You read the quotient over the unit index (10). For example:

30 (dividend) / 5 (divisor) = 6 (quotient)

1. Turn the disk so the divisor (5) on the blue disk is opposite the dividend (30) on the white disk.

2. Read the quotient (6) on the white disk opposite the unit index (10) on the white disk.

Do not forget; a given number on the computer like 30 can also represent other values like 3.0, 300 or 3,000. Choose the appropriate value to a given problem.

For example:

820 / 42 = ?

1. Rotate the divisor (42) on the blue disk over to the dividend (820) on the white disk.
2. You read the quotient on the white disk opposite the unit index (10) on the blue disk – the answer is _____

You can play with these arithmetic calculations (answers on the last page)

1.	18 x 5	
2.	16 x 60	
3.	170 / 15	
4.	230 / 3	

Conversions

The values you use have to be compatible. It is not possible to mix nautical miles and statute miles, liters and gallons or Celsius and Fahrenheit. Your computer let you convert values. You need to place the converting arrow for the one scale opposite the corresponding arrow on the other scale and find the value opposite each other on the corresponding scale. Align 10 on the inner scale with 10 on the outer scale. The labelled

arrows can be found on the inner and/or outer scales for 10 different items:

- Nautical Miles, NM (near 66 on both scales)
- Statute Miles, SM (near 76 on both scales)
- Feet, FT (near 14 on the outer scale)
- Meters, M (near 44 on the inner scale)
- Kilometers, KM (near 12 on both scales)
- Imperial Gallons, IMP GAL (near 11 on both scales)
- U.S. Gallons, US GAL (near 13 on both scales)
- Liters, L (near 48 on both scales)
- Pounds, LBS (near 36 on the outer scale)
- Kilograms, KG (near 17 on the inner scale)

Nautical Miles to Statute Miles

Distances on maps are often in statute miles. Some times in nautical miles or kilometres. The Airspeed indicator is normally in knots. The conversation between the two values is possible by using the special markings on the slide rule of you flight computer. Convert knots into miles per hour is possible in two different ways: (1) align the NM and SM arrows or (2) use the NM and SM arrows on the outer disc. Look on the outside scale for the figure "70" and find the markings NM and SM beside the figure "70". Place the value under the appropriate arrow and read the converted value under the other marking.
(see Figure 4).

To convert i. e. 105 knots to statute miles per hour:

1. Set the arrow marked NM on the outer scale opposite of 105 on the middle scale.
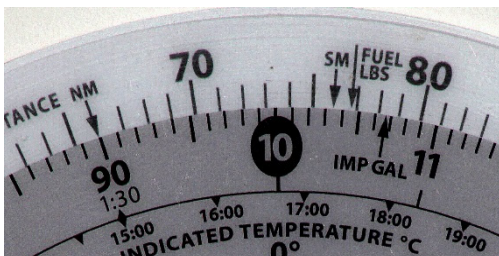
2. Read 121 under the SM arrow.

Figure 4: Place the nautical value (105) under the NM arrow and read the corresponding statute value under the SM arrow.

You can convert either nautical or statute miles to kilometers. Find the KM marking on the outer scale (near the 12). Set the known value beneath the NM or SM arrow as before, and read the kilometers under the KM marking (see Figure 5). To convert 120 statute miles to kilometers:

1. Place 120 opposite of the STATUTE arrow.

2. Read actual value 192 in kilometres under the KM marking.

Figure 5. Set the SM value under the SM arrow and read the corresponding KM value under the KM arrow.

Try these sample problems:
(Answers are on the last pages)

	Nautical miles	Static miles	Kilo-meters
1.	40		
2.		50	
3.			120
4.	30		

U.S. Gallons to Imperial Gallons

The Approved Flight Manual of your aircraft lists the fuel capacity in U.S. gallons, but in some countries fuel is delivered in Imperial gallons. On your flight computer some arrows are marked US GAL and IMP GAL and provided on both middle and outer scales to help you convert between these quantities.
For example, assume your tanks are marked to be able to hold 50 U.S. gallons. How many Imperial gallons will they hold (see Figure 6)?

1. Line up the US GAL arrow on the middle scale (near 13) opposite the IMP GAL (near 11) arrow on the outer scale.

2. Find 50 on the middle scale.

3. Read 41.5 Imperial gallons on the outer scale. Since cause Imperial gallons are larger than U.S. gallons, the number of U.S. gallons will be larger.
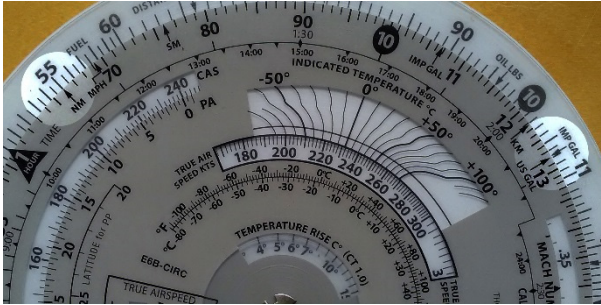
Figure 6. Align the US GAL and IMP GAL arrows to convert between these units.

You have purchased fuel in Canada and the delivery slip says 45 Imperial gallons. How many U.S. gallons have you purchased? Line up the IMP GAL arrow on the middle scale (near 11) with the US GAL arrow on the outer scale (near 13). Find 45 on the middle scale and read 54 U.S. gallons on the outer scale.

Quantity to Weight Conversions

Aviation gasoline (like AVGAS 100LL) weighs 6 pounds per U.S. gallon (see Figure 7).
Weight and balance calculation are important in aviation.
Weight and balance calculations, gasoline wright-per-gallon can be done by aligning the US GAL arrow on the middle scale (near "13") with the FUEL LBS marker on the outer scale (near "80"). Fuel in gallons are seen om the middle scale and fuel weight on the outer scale. To find the weight of 38 US gallons:

1. Align the arrows US GAL and FUEL LBS.

2. Find 38 on the middle scale and read 224 pounds on the outer scale.Figure 7. Place Fuel LBS arrow above US GAL arrow and read the weight of fuel above total gallons.

Fig. 7: Place Fuel LBA arrow above US GAL arrow and read the weight of fuel above total gallons.

In the same way you can calculate weight by lining the US GAL arrow on the middle scale (near "13") with the OIL LBS marker on the outer scane (near "10"). The oil gallons are seen on the middle scale and oul weights you can read on the outer scale (see Figure 8). Fond the weight of 2 gallons (equal to 8 quarts) of oil:

1. Align the arrows US GAL and OIL LBS.

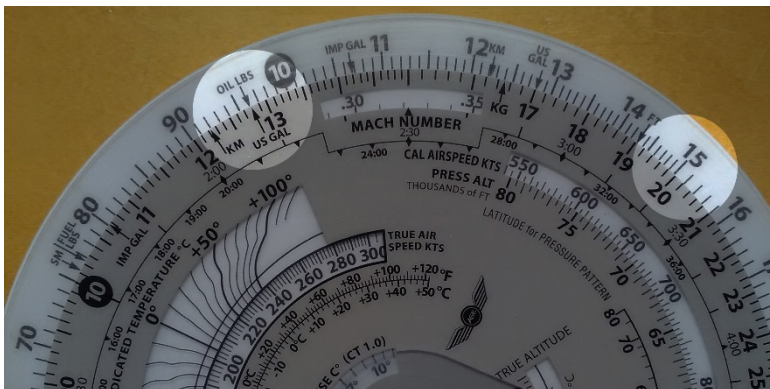2. You see 15 pounds on the outer scale by 2 gallons on the middle scale.

Figure 8. Place Oil LBS arrow above US GAL arrow then read weight of oil above total gallons.

In the same way imperial gallon weight of fuel and oil can be calculated by lining up IMP GAL arrow on the middle scale (near "11") with the FUEL LBS (near "80") or OIL LBS arrow (near "10") on the outer scale.

To convert liters to U.S. gallons, pounds to kilograms, or feet to meters you must align the appropriate arrows on the middle and outer scales. For example, to convert pounds to kilograms:

1. Find the arrows marked LBS (near 35 outer on the scale) and KG (near 17 on the inner scale), and line them up.

2. Any value in pounds on the outer scale will be opposite of its converted value in kilograms on the middle scale: 2,000 lbs is 907 kg, and 160 kg is 352 lbs.

3. The same procedure have to be followed for the other conversions.

Time, Speed, and Distance Problems

The rate arrow (1 HOUR triangle on the blue scale) is normally set to indicate a value per hour on the outer scale. You have three basic time-speed-distance problems. In two of these you know the rate, while in the third, the rate is part of the answer you are looking for.

To find the Time En Route, let's assume you know your ground speed is 120 knots (nautical miles per hour) and the distance to your destination is 210 nautical miles (see Figure 9):

1. Set the rate arrow (1 HOUR triangle) to 120.

2. Speed and distance are always on the outer scale; 210.

3. Look directly opposite to that value on the inner time scale to find the Time En Route of 105 minutes or 1:05.
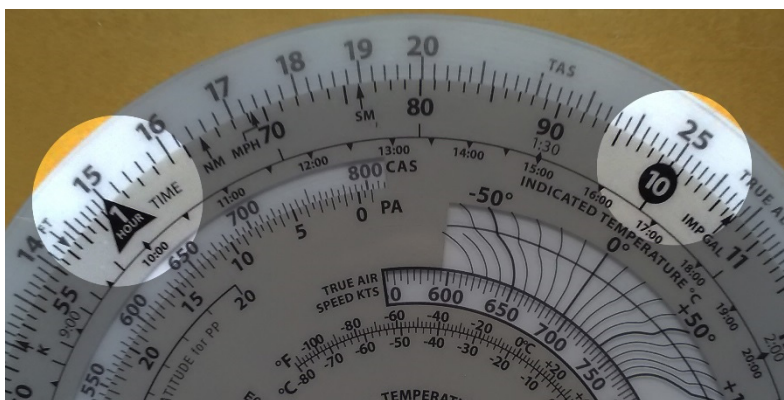

Figure 9. Place time index under ground-speed then read time en-route under distance.

To find calculate how far you can fly if your fuel endurance is 3.5 hours and your ground speed is known to be 130 knots (see Figure 10):

1. Set the rate arrow to 130 on the outer scale.

2. Find 3:30 on the grey scale between 3:00 and 4:00.

3. The value on the outer scale is 45, but you know that 3 hours at 130 knots should cover 400 nautical miles, so the outer scale is read as 450, not 45 or 4,500. This mean that each large calibration mark is worth 10 nautical miles. The answer is 450 nautical miles.
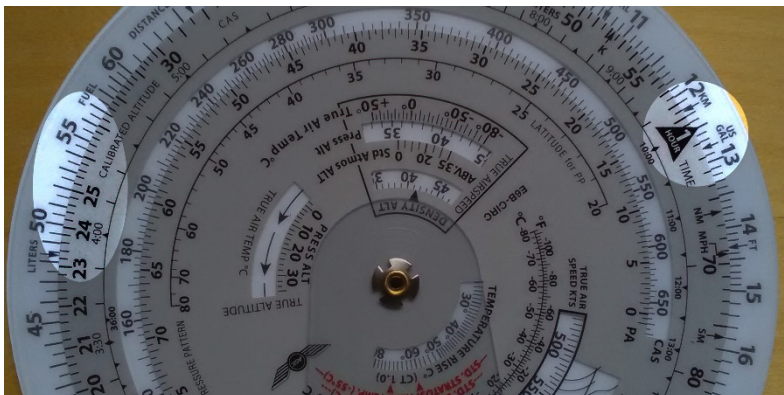
Figure 10. Place the time index under ground speed, find fuel endurance on inner scale, then read distance opposite this number on the outer scale.

The most common type of time-speed-distance problem, the time and distance are known by, and you need to find the unknown speed. The rate arrow give the answer. You have for example flown between two known ground reference points 25 NM apart and checked the time between them to be: 12 (twelve minutes, that is, not twelve hours) (see Figure 11).

1. Set 12 minutes on the middle scale opposite to 25 on the outer scale.

2. The rate arrow points to your ground speed, 125 knots.
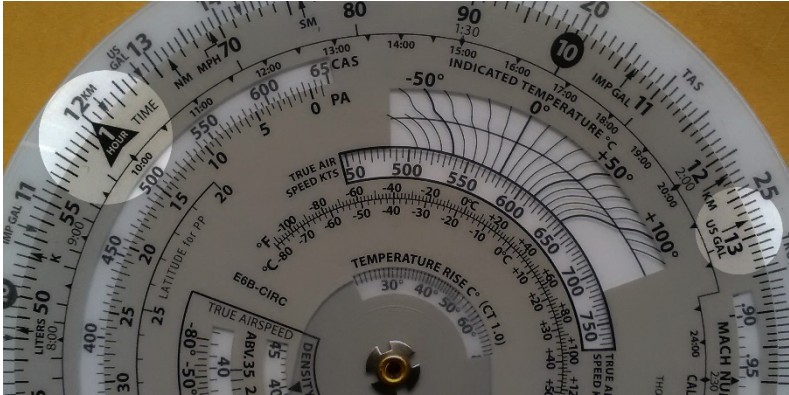
Figure 11. Set elapsed time under distance then read ground speed above the time index.

Try these time-speed-distance problems:
(Answers are on last page)

	Speed	Time	Distance
1.	125 KTS		524 NM
2.		2:30	345
3.	110 KTS	1:40	
4.		0:24	44
5.	95	1:24	

Feet per Mile vs. Feet per Minute

Aircraft performance are very different. The authorities establish the climb and descent requirements in feet per mile,

rather in feed per minute. This mean a climb of 300 feet per mile will result in a 3° climb angle for any aircraft. A light aircraft like a trainer are typically climbing at this angle by 90 knots (ground speed). This mean that the climb rate is 450 feet per minute. A large jet that follow that gradient by 240 knots will show a vertical speed of 1.200 feet per minute.

It is possible to convert feet per mile to feet per minute. Place the rate arrow by the ground speed, you then find the feet per minute on the outer scale by the feet per mile value on the middle scale. For example, to find feet per minute:

1. Set the rate (1 HOUR) arrow to 90 kts.

2. Find 300 feet per mile on the middle scale to read a climb rate of 450 feet per minute on the outer scale.

Another example:

1. Set the rate arrow at 240 knots.

2. Look above 300 on the middle scale.

3. You should find a vertical speed of 1,200 feet per minute.

Try to calculate these rate of climb problems:
(Answers are on the last page)

	Ground speed required	Feet per mile	Feet per minute
1.	120	350	
2.	100	250	
3.	150	300	

Fuel Consumption Problems

Calculations concerning fuel consumption, fuel endurance, and fuel capacity can be solved using the same numbers you used in the time-speed-distance problems. Just with the exception of time values, only the names change.

Given that your airplane's Flight Manual indicates fuel consumption of 6.2 gallons per hour at a given power setting and that the usable fuel capacity is 38 gallons. How many hours endurance do you have in the tanks (see Figure 12)?

1. Line up the rate arrow (1 HOUR) with 6.2 on the outer scale.

2. Now find 38 on the outer scale.

3. Opposite of 38, read fuel endurance in hours: 6:08 on the inner scale.

The outer scale, which was used for speed and distance, is now also used to indicate gallons per hour and fuel capacity.
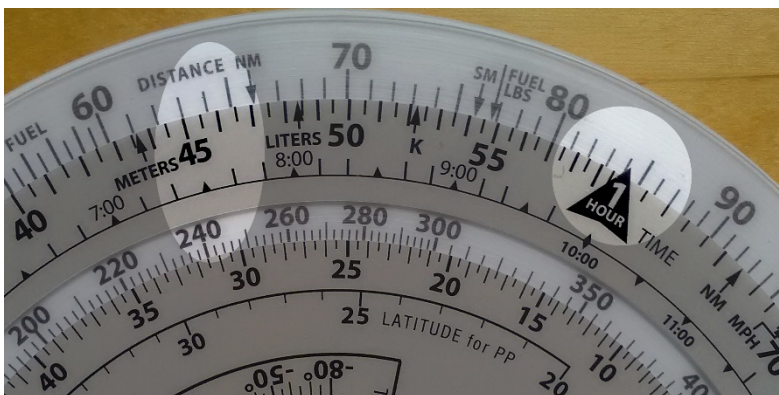
Figure 12. Point rate index to fuel consumption, you find fuel capacity on outer scale and read fuel endurance below.

When you paid for your fuel you noted on the delivery ticket that it took 30 gallons to fill the tanks. You flew four hours and thirty minutes before the stop for fuel. You can calculate the average fuel consumption per hour? This time the rate arrow provides the answer (see Figure 13).

1. Set 4:30 on the inner scale—opposite of 30 on the outer scale.

2. The rate arrow indicates the average fuel burn rate: 6.7 gallons per hour.
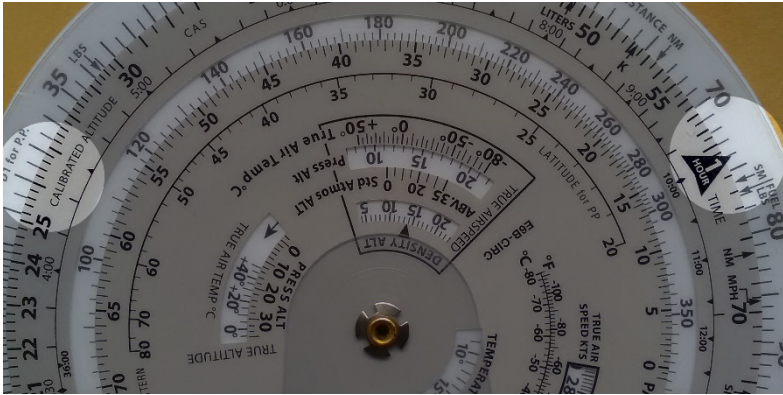
Figure 13. Set time flown opposite gallons and read fuel rate above the rate arrow.

Remember that fuel consumption is greater during the climb to altitude, so this average value does not accurately reflect the precise fuel consumption in cruising flight.

Try these examples:
(Answers are on the last page)

Gallons per Hour

	Time	Total	Used
1.	7.8	3:20	
2.		4:50	62
3.	8.5		38
4.	10	2:30	
5.	12		22

Using the Altitude and Speed Correction Windows

In the aircraft the altimeters and airspeed indicators are made to give correct indications under standard conditions at the standard sea level. The earth's atmosphere does not change linearly as you gain more and more altitude; the density will be affected by variations in temperature and pressure. The flight computer provides windows on the slide rule side so you can allow for these variations when converting calibrated airspeed to true airspeed or indicated altitude to true altitude.

True Airspeed and Density Altitude

The outer scale is marked TAS meaning true airspeed. The middle scale is marked CAS meaning calibrated airspeed.

The Flight Manual for your airplane contains a table that allows you to convert IAS (indicated airspeed) to CAS. The difference is must clear at low speeds and becomes very small by cruise speeds. To find TAS you must know the pressure altitude. Set your altimeter to 29.92 and read the altitude indicated; that is the pressure altitude. Remember or write down the outside air temperature and convert it to Celsius using the conversion scale above the Temperature Rise window.

Try to find the true airspeed and density altitude. The pressure altitude is 15,000, the air temperature is -15°, CAS (calibrated airspeed) is 145 knots (see Figure 14).

1. You must find 45 on the outer blue scale and go inward towards the middle of the disk to find the Pressure Altitude and Density Altitude windows.

2. Set now the pressure altitude (15,000) in the window opposite the outside air temperature (-15° C).

3. Do not move the scale but find CAS (145) on the outer blue scale, and read TAS 182 knots opposite on the outer white scale.

4. Read now the density altitude under the arrow in the "DENSITY ALTITUDE" window.

Figure 14. Align outside air temperature opposite the pressure altitude then read density altitude over the arrow.

By a pressure altitude of 15,000 feet and an air temperature of -15°C, the calibrated airspeed equal to 145 knots converts to a true airspeed of 182 knots and a density altitude of 15,000 feet.

Here are some sample problems:
(Answers are on the last page)

	Pressure altitude	Temp	CAS	TAS	Density altitude
1.	14,000	5°C	160		
2.	20,000	-20°C	200		
3.	8,000	15°C	150		

True Altitude

The true altitude is the precise height of an aircraft above mean sea level (MSL). To find true altitude, use calibrated altitude (or indicated altitude if calibrated is not available) and true air temperature. True altitude can be seen directly above calibrated altitude if the station altitude is unknown or at sea level.

By a pressure altitude of *15,000* feet, a calibrated altitude of *13,500* feet, a true air temperature of *-20°C*, and ground station altitude of *1,200* feet. Find the true altitude above ground and sea level.

1. Find 22 on the outer blue scale and move inward towards the center of the disk to find the True Altitude Window.

2. Align pressure altitude *(15,000)* with true air temperature *(-20°C)*

3. Subtract station altitude from calibrated altitude to find calibrated altitude above ground: *13,500 − 1,200 = 12,300* feet.

4. Find the calibrated altitude above ground *(12,300)* on the outer blue scale and read true altitude above ground *(12,000)* on the outer white scale

5. Add the station altitude to true altitude above ground to get true altitude above sea level: *1,200 + 12,000 = 13,200 feet*.

True Air Temperature

True air temperature (TAT) is indicated air temperature (IAT) corrected for the heat from compression caused by the high-speed flight. True airspeed calculations are thereby effected by a temperature recovery coefficient Ct. The Ct varies with installation and design of the temperature probe on your airplane. Once Ct is determined for a particular airplane, the coefficient will not vary greatly with speed or altitude.

The Ct tab is marked with a straight thin line for .8 and a curved line with the Ct plotted for values between .6 and 1.1. The .8 Ct is the most common coefficient by normal operations. If you take a look at the dashed lines you will see they apply to the standard sea level temperature of +15°C and the solid lines apply to the standard sea level temperature of -55° C. If you fly between the sea level and 35,00 feet it is necessary to interpolate between the two lines. You are then able to calculate the true air temperature by subtracting the temperature rise from the indicated air temperature.

This function will also be able to display the Mach number and true airspeed for you.

Try to calculate using this figures: Calibrated airspeed of *500* knots, pressure altitude of *15,000* feet, indicated air temperature of *30°C* – find the air true air temperature (see Figure 15).

1. Using the Cal Airspeed Kts window (below the 1 hour rate index), align pressure altitude (15,000) below calibrated airspeed (500).

2. Using the Ct tab, place hairline at intersection of indicated air temperature (30) and rising line in the Indicated Temperature window.

3. Read temperature rise indicated by arrow (49) and subtract from indicated air temperature (30 − 49 = -19°C).
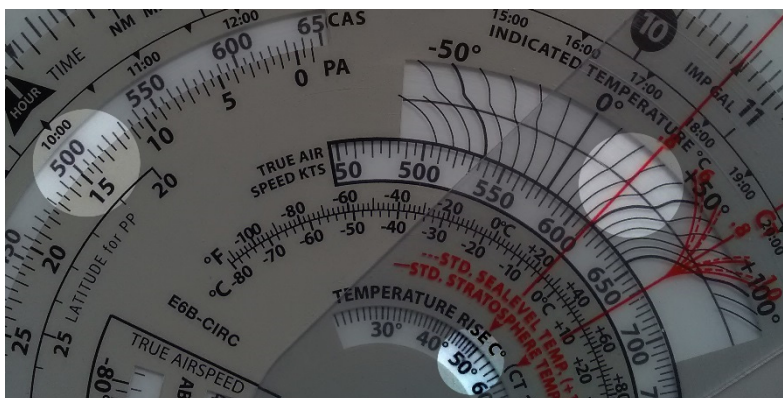

Figure 15. Find temperature rise to determine true air temperature.

With a calibrated airspeed of 400 knots, a pressure altitude of 20,000 feet, a coefficient of 0.6, indicated air temperature of 10°C – try to find the true airspeed and the Mach number.

1. Place calibrated airspeed (400) above pressure altitude (20,000).

2. Rotate Ct tab so .6 intersects the indicated air temperature (10°C).

3. Read true airspeed (535) and Mach number (.85).

Mach Index Arrow

Set the 10 index on the blue disk opposite the 60 on the white disk. This setting will help you find the double-ended Mach index arrow in the small Press Alt window in the lower left portion of the disk. This double-ended Mach Index relates a "standard atmosphere" altitude with the standard temperature for that altitude. The temperature of the "standard atmosphere" can be used to help you estimate outside air temperature.

For example, with a pressure altitude of 28,000 find the estimated free air temperature.

1. Set the Mach Index arrow to the pressure altitude (28,000 feet) on the Standard Atmos. scale.

2. At the bottom of the arrow read the Std. Atmos. temperature below pressure altitude (28,000 feet), which is -40°C.

Converting Mach Number to True Airspeed

You can convert Mach Number to True Airspeed (or vice versa), use the double-ended Mach index arrow in the small Press Alt window in the lower left portion of the disk. Line up the true Air Temp (do not use Indicated Air Temperature) opposite this Mach Number Index. Mach Number on the inner scale reads opposite True Airspeed (in nautical miles per hour) on the outer scale.

In Figure 16, at an outside air temperature of +15°C and Mach 1 (10 on the outer blue scale), read 645 knots on the outer scale.
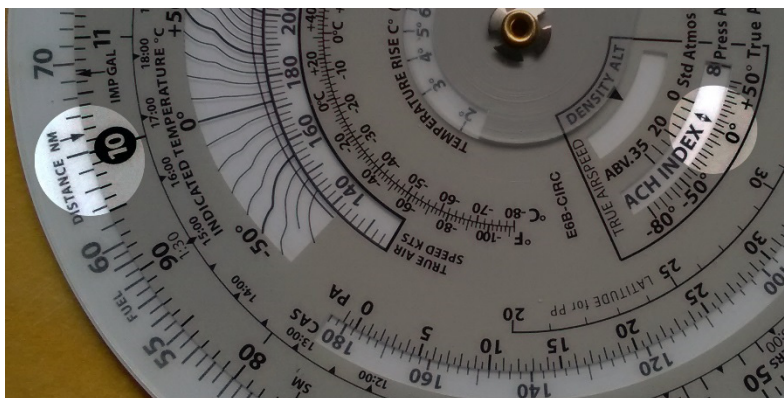

Figure 16. Set double-pointed MACH INDEX at outside air temperature and read true airspeed on the white disk above the Mach Number on the blue disk.

True Airspeed from Mach Number and Indicated Air Temperature

The Mach Number is a measurement of speed based on the ratio of the speed of the aircraft to the speed of sound under the same atmospheric conditions. An airplane flying at Mach 1 is flying at the speed of sound. Mach Number is affected by temperature; for example, Mach 1 is 669.6 MPH at -50°C and 806.9 MPH at +50°C. In aircraft with a Mach indicator, it is possible to find true airspeed from Mach Number and temperature (see Figure 17).

At a Mach number of .5, indicated air temperature of +15°C, and coefficient of .8, what is the true airspeed?

1. Set Mach number arrow (on the outer blue disk) at Mach number (.5).

2. Set Ct tab so .8 cursor hairline intersects rising line at +15°C.
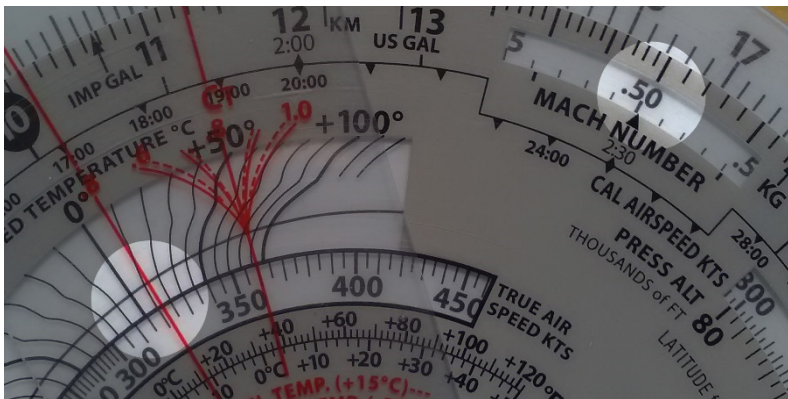
3. Read true airspeed 322 knots.

Figure 17. Find true airspeed with Mach number and indicated air temperature.

True Altitude

When the air is colder than standard your altimeter can mislead you into thinking you are higher than you are. Determine true altitude by the following steps:

1. Determine pressure altitude by setting 29.92 momentarily on the altimeter.

2. Set pressure altitude next to outside air temperature in the altitude correction window.

3. Subtract station altitude from indicated/calibrated altitude to determine calibrated altitude AGL.

4. Find calibrated altitude AGL on the middle scale and read the correction to station altitude on the outer scale.

5. Add the correction to station altitude to get true altitude MSL.

In a situation where the station altitude is unknown, you can read the calibrated altitude MSL on the middle scale and you can read the true altitude MSL on the outer scale.

In Figure 18 the pressure altitude is 10,000 feet, station altitude is 5,000 feet, outside air temperature is -19°C, and your indicated (the calibrated) altitude is 12,000 feet. The difference between 5,000 feet station altitude and 12,000 feet indicated altitude is 7,000 feet. Opposite 7,000 feet on the middle scale read correction to station altitude (6,600 feet) on the outer scale - 5,000 feet plus 6,600 feet equals 11,600 feet true altitude.
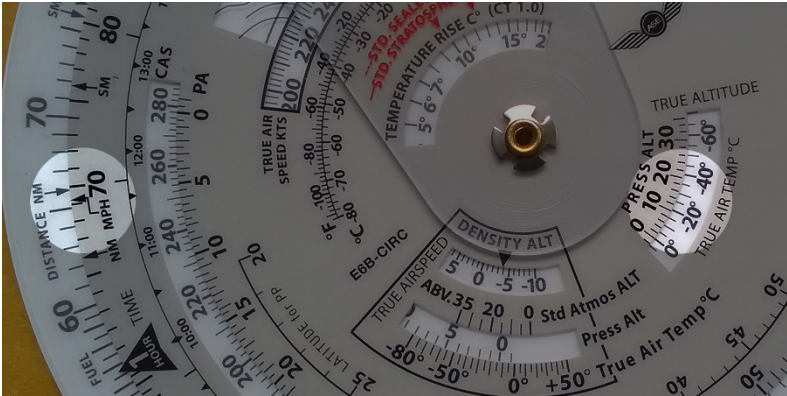
Figure 18.

CAUTION:

If the temperature between the surface and the aircraft does not decrease at the standard rate of 2°C per 1,000 feet or if the pressure at flight level is non-standard, reliance on a computer solution to determine obstruction clearance can be very hazardous.

Find True Altitude:

(Answers are on the last page)

	Pressure altitude	Indicated/ calibrated altitude	Temp.	Station altitude	True altitude
1.	10,500	10,000	-20°C	5,000	
2.	12,000	11,000	-30°C	3,000	
3.	8,000	7,600	-15°C	2,000	

Pressure Pattern

When you cross a weather system, the shortest route may not be a straight line. This principle is most useful for longer trips (i.e. more than 300 NM) and when crossing a high or low system.

Flying south of the straight line gives better winds. To be efficient, you want to fly a constant heading instead of crabbing left then right. Therefore, you need to apply a crosswind component. By knowing your groundspeed and pressure along your route you can plot the offset of the minimum crab path.

To calculate the crosswind component using your flight computer:

• D = radio altimeter reading minus pressure altimeter reading.

• *D1 and D2 designate first and second readings respectively, taken with an intervening time interval.*

• On the northern hemisphere if D2 − D1 is positive, wind is from the right. If D2 − D1 is negative, wind is from the left. On the southern hemisphere this rule is opposite.

Given D1 is *520 feet* and D2 is *200 feet*, the distance travelled between readings is *320 NM* and mid-latitude is *43° N*. Try to find the crosswind component:

1. D2 − D1 = 200 − 520 = -320 feet. Place 320 on the outside disk opposite the distance travelled (340) on the blue scale.

2. Rotate the Ct index tab until hairline passes through 43 degrees on latitude scale. At the end of the hairline read the crosswind on the outside scale (29.5 knots). Since D2 − D1

is negative and flight is in the northern hemisphere, the wind is rom the left.

Off-Course Problems

Navigating on a longer distance you can occasionally find yourself and the airplane off the planned course. This is because of the wind. When you find yourself over a landmark to one side of the course line you can estimate the distance you have drifted off course – you flight log should be able to help you tu determine how far you have flown hand far it is to your destination.

To do the calculations you need two computer setups. The first one will give you the heading correction necessary to offset wind drift, or "course to parallel." *On the middle scale, set the distance flown opposite of the distance off course on the outer scale; the rate arrow points to the degrees of heading change to parallel the course.*

Example: After flying *125 miles*, you note that you are *8 miles* off course (see Figure 19).

1. First, *set 125* on the outer blue scale to line up with *8* on the outer white scale.

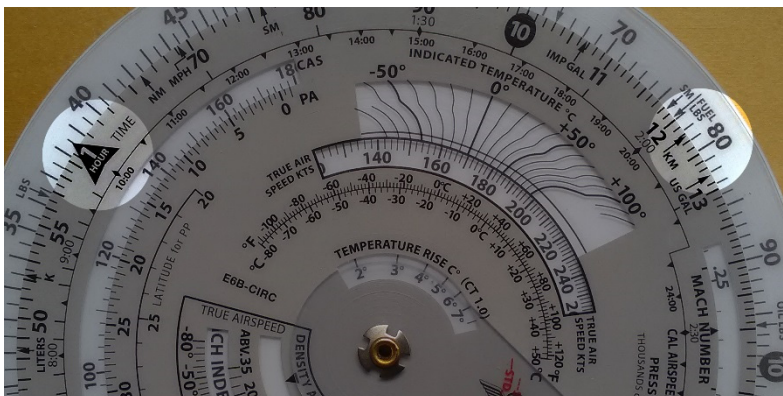2. Read 3.8° at the rate arrow. The figure is approximately.

Figure 19. Set distance flown on middle scale opposite off-course distance and read correction above the rate arrow.

The second setup will give you the additional heading change required to fly back to the original course line. On the middle scale, set distance remaining opposite of the distance off course; read additional degrees of heading change opposite of the rate arrow. Add the two answers and apply the result to your heading.

Example: Your destination is 235 miles ahead (see Figure 20).

1. Set 235 on the middle scale opposite 8 on the outer scale.

2. Read approximately 2° at the rate arrow.

3. Change course ≈ 6° (3.8 + 2) toward the course line and, if the wind doesn't change, you will rejoin the original course line as you approach the destination.
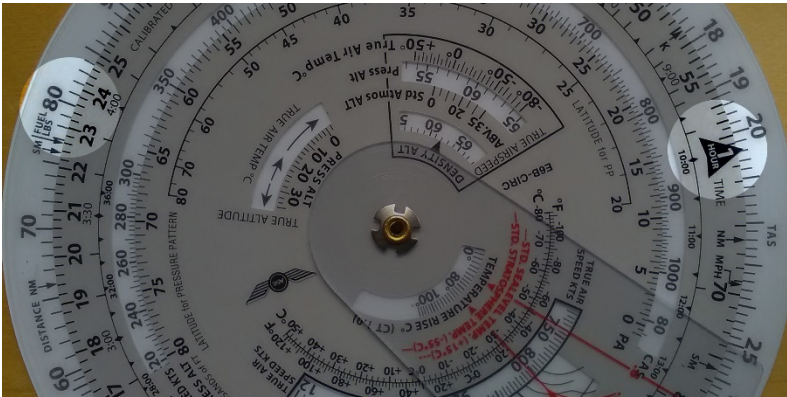
Figure 20.

The Wind Side of the computer

The wind side of the computer gives you a graphic method of calculating problems by use of trigonometry and will be displaying the answers in a useful form as well as can be used for basic arithmetic.

The surface of the top disk is suitable for marking with a No. 2 pencil, which can be easily removed with eraser or by lightly scrubbing with water.
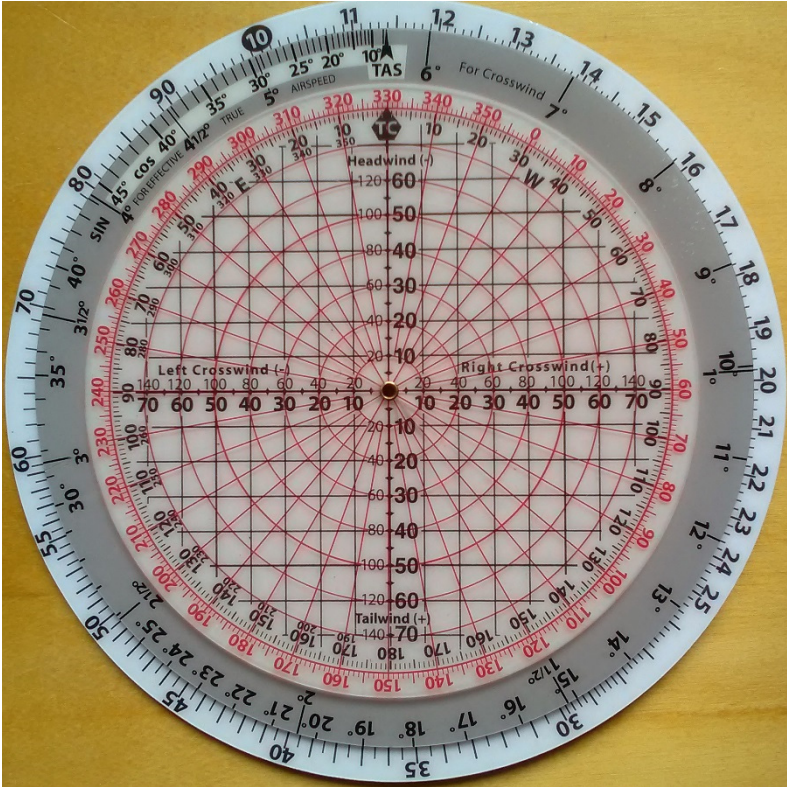
Figure 21.

Addition and Subtraction

You can do addition and subtraction if you use the wind side of your calculator – this for numbers up to 360. Use the outside scale of the top disc together with the curving scale on either side of the TC index on the middle scale. The curving scale you can read as high as 180 left and 360 to the right.

For example, add 27 and 48:

1. Align 27 (on the blue scale on the transparent inner disk) with TC index.

2. Since you are adding, move right of the TC index along the black scale to 48 and find the answer above (75).

Another example, subtract 27 from 48.

1. Align 48 (on the blue scale on the transparent inner disk) with TC index.

2. Since you are subtracting, move left of the TC index along the black scale to 27 and find the answer above (21).

Magnetic versus True Winds

Winds are normally given in True, while airport towers report winds in Magnetic. It's important not to mix units when calculating wind problems. To convert between these units, set the magnetic course on the blue scale opposite the applicable variation and your true course can be read opposite the true course outline.

For example, if magnetic course is 275 and variation is 14° E, what is the true course?

1. Place MC (275) on blue scale over 14 on black scale to left of TC indicator.

2. Read TC on blue scale above TC arrow (289).

Wind Triangle

The computers wind side uses a variation of the conventional wind triangle to compute wind correction angle (WCA) and groundspeed (GS). The E6-B Circular applies headwind or tailwind to the true airspeed line to compute ground speed. As

the WCA increases to 10° or more, the effective true airspeed scale (located left of the TAS index) must be used rather than true airspeed to find accurate ground speed.

Two wind scales on the horizontal and vertical lines radiate from the center of the computer for low speed (0-80) or high speed (0-160) computations. Use only one scale at a time; they may not be used interchangeably for a single computation. Use the large scale (0-80) if the wind is less than 80 knots or MPH. Use the small scale (0-160) if the wind is more than 80.

On the middle blue disc there are 2 crosswind scales with units of 1, 1-1/2, 2, 2-1/2, etc. and larger units of 10, 11, 12, etc. Use the scale applicable to your airspeed. If the crosswind component is less than 10% of the true airspeed, the WCA should be read on the lower scale.

Preflight Planning

Remember: Two wind scales on the horizontal and vertical lines radiate from the center of the computer for low speed (0-80) or high speed (0-160) computations. Use only one scale at a time; they may not be used interchangeably for a single computation. Use the large scale (0-80) if the wind is less than 80 knots or MPH. Use the small scale (0-160) the wind is more than 80.

To determine ground speed and wind correction angle you must know four things: true course (or magnetic course and variation), true airspeed, true wind direction, and wind velocity. The winds aloft forecast provides the latter two; true course is measured directly on your sectional or WAC chart, and TAS is either converted from indicated airspeed in flight or taken from the airplane's performance charts during preflight planning.

For example: You have laid out a course on a sectional chart and measured it to be 130° true using your plotter (140 magnetic, 10° W variation). The winds aloft forecast calls for the wind at your chosen altitude to be 100° at 40 knots, and the performance data for the airplane says that you can expect a true airspeed of 180 knots at that altitude (see Figure 22).

1. Rotate the blue disc to set the TAS INDEX to 18 (180 knots).

2. Rotate the top disk to set true course (130) at the TC INDEX.

3. Place wind dot at intersection of wind direction (100) and wind velocity circle (40 knots).

4. Read crosswind component on scale below dot (20 knots left crosswind).

5. Find crosswind component (20 knots) on outer scale and note WCA below (6+).

6. The wind dot shows a left crosswind therefore a left crab so we subtract crab angle from magnetic course to get magnetic heading: 140 – 6 = 134 degrees magnetic heading.

7. Return to the wind dot and read directly to the right of it to find a headwind of 35 knots. Subtract headwind from TAS to find ground speed: 180 – 35 = 145 knots ground speed.
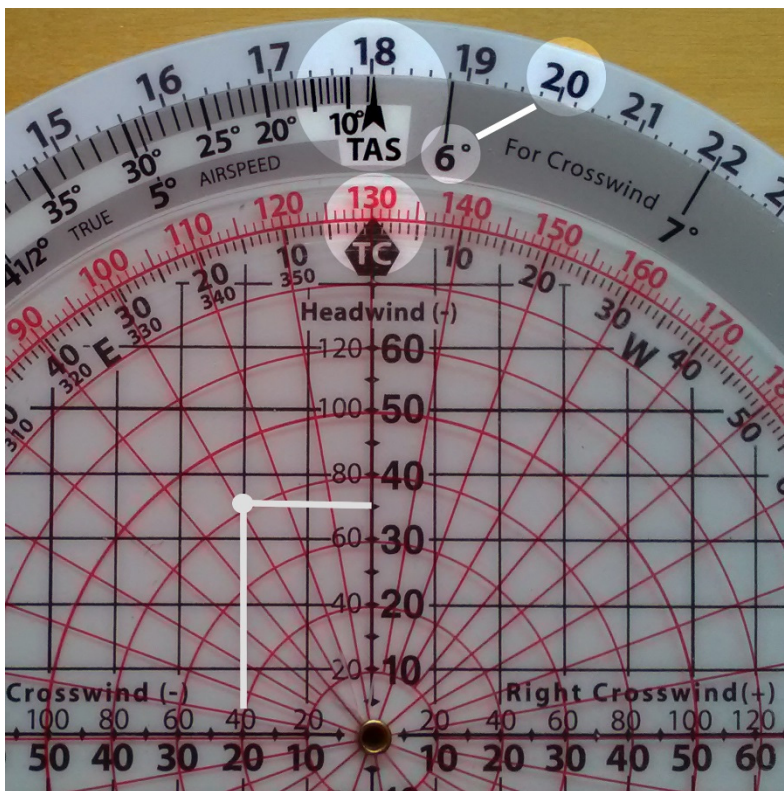
Figure 22. Set TAS, TC, and wind to find crab, MH and ground speed.

Sometimes the winds forecast is the same for the entire flight. In these cases, simply use the wind dot this manner, with the true course for each individual leg.

You should try these sample problems:
(Answers are on last page)

	True wind direction	Wind velocity	True course	TAS	True HDG	Ground speed
1.	240	38	300	165		
2.	040	43	150	140		
3.	330	25	020	180		
4.	110	18	260	225		

Determining Winds in Flight

The wind is never precise as forecasted. This mean you now and then have to calculate the actual wind during flight at the present position. If you have a GPS this makes it easier, but it is not necessary.

You need your ground speed, the true heading, true course and the true airspeed. In this example your true course is 180°, the true heading is 160°, your last known ground speed tells you 120 knots. The true airspeed is calculated to 140 knots. You can find the actual wind direction and velocity (see Figure 23).

1. Set 140 knots at the TAS on the wind side of your computer.

2. Set 180° at the True Course (TC) index.

3. Subtract the true heading from the true course to find the crab angle: 180 minus 160 = 20° crab. A true heading less than the true course indicates a left crab; therefore the wind is from the left.

4. The crab angle (20) is fairly high; therefore, use "effective" true airspeed. Find 20 on the effective scale and read directly above (132).

5. Determine the difference between effective true airspeed and actual ground speed, which will be the headwind or tailwind component you will find on the computer. In this example, 132 (ETAS) – 120 (GS) = 12 headwind.

6. From the 12 headwind figure, draw a line to the left (left crab indicates wind from the left).

7. Determine the crosswind component. Read the crosswind scale on the middle disk at 20 to find a 48 knots crosswind component. From the horizontal crosswind line at the 48 position draw a line upward.

8. Find the point of intersection of the two lines to determine the wind dot. Its position indicates we have an actual wind from 104 true at 48 knots (see Figure 24).

Many pilots use satellite navigation instruments in flyning. If you have this, the direct track readout you should use instead of the true heading. You need to correct for variation since the direct track information from the satellite navigation instrument is magnetic.
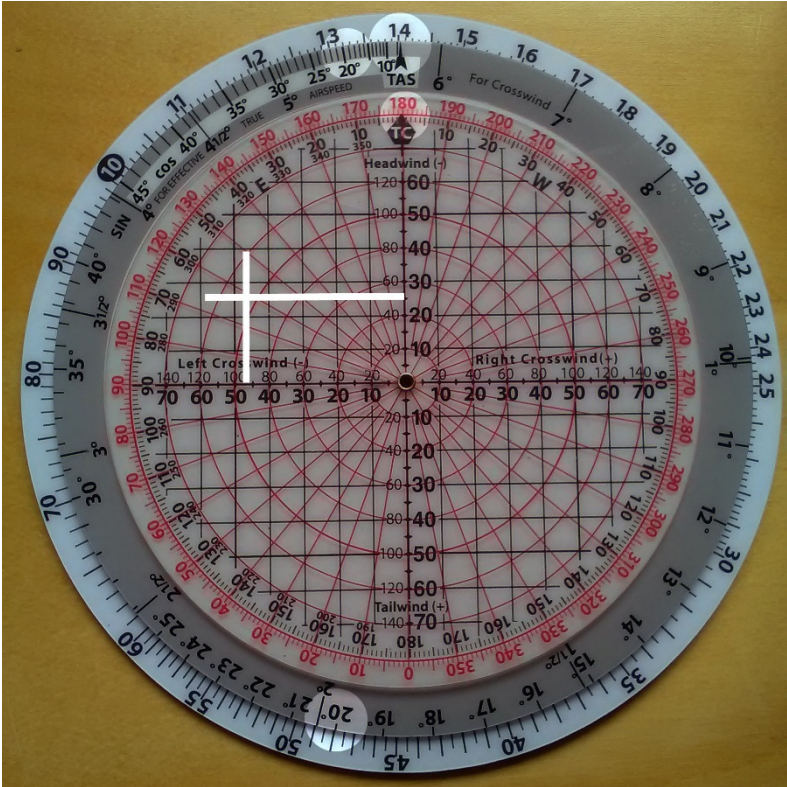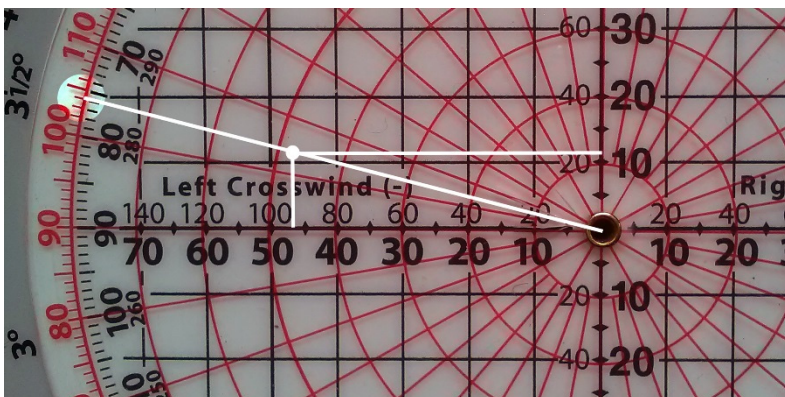
Figure 23.

Figure 24.

Sample problems:
(Answers are on the last page)

	True HDG	True course	TAS	Ground speed	Wind direction	Wind velocity
1.	320	315	140	128		
2.	175	160	150	115		

True Course and Ground Speed

True course (track) and ground speed may be found with airspeed, heading and wind information.

For example, given true airspeed 220 knots, magnetic heading 230°, variation 8° west, and wind at 120° true and 25 knots, find true course and ground speed (see Figure 25):

1. Place 220 above TAS index.

2. Place magnetic heading (230) above variation (8) on + side.

3. Place wind dot at intersection of 120 wind direction radial and 25 knot wind velocity circle. Read up to find 25 knot crosswind.

4. Find 25 knots crosswind component on outer scale. Note ≈ 7° WCA below. Since wind is from the left, true heading must be left of true course.

5. Rotate wind disc 7° (WCA) to the left and note new crosswind component of 24 knots (see Figure 26).

6. Note 24 knots crosswind component on outer scale, use 6° correction on inner scale.

7. Correct for 1° error in alignment of TC index and read TC now at true index (228°).

8. Look to the right of the wind dot to find a 7 knots tailwind component.

9. Add 7 knots tailwind to 220 knot TAS for 227 knots ground speed. (If WCA had been 10° or more the tailwind would be applied to the ETAS scale for an accurate ground speed.)
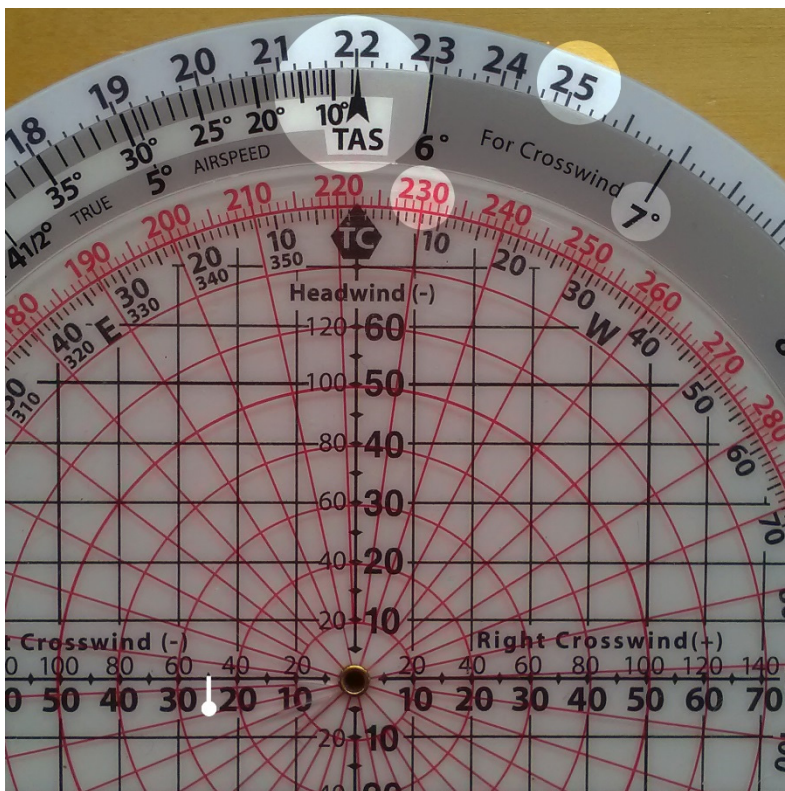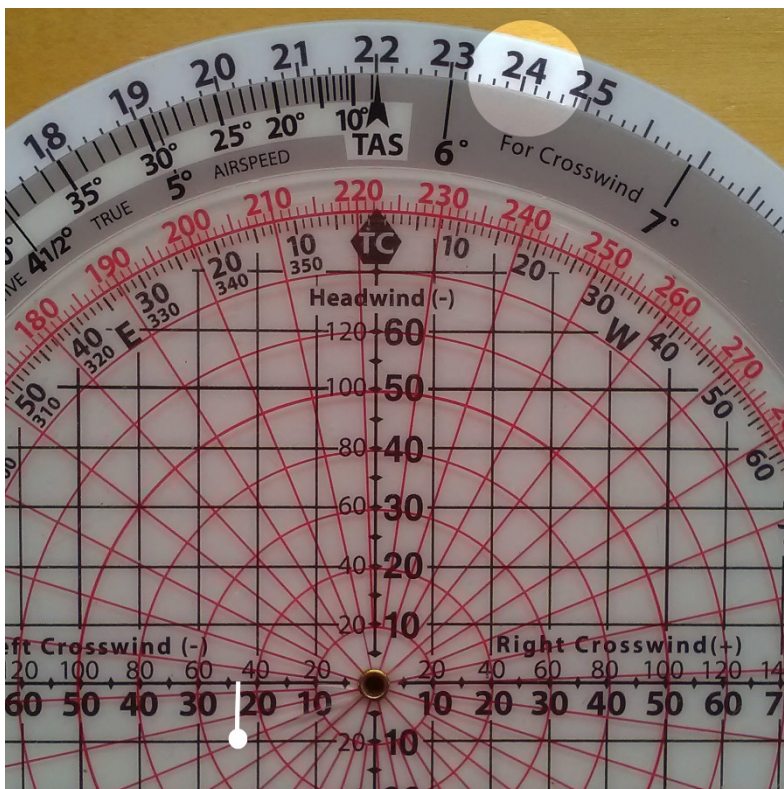
Figure 25.

Figure 26.

True Heading and True Airspeed

It is possible to find the true airspeed and the true heading when you are aware of your true course, the intended ground speed and the information about wind.

For example, true course is 160°, intended ground speed is 180 knots, and wind is 190° at 30 knots. Find true airspeed and true heading:

1. Place true course (160) above TC index.

2. Place wind dot on 190° radial at wind velocity circle for 30 knots.

3. Read 26 knot headwind on scale left of wind dot. Add headwind to intended ground speed for true airspeed of 206 knots.

4. Place 206 knots above TAS index. (Note: if the WCA is 10 or greater, the TAS must be positioned above the WCA on the effective true airspeed scale rather than the TAS index; then the crosswind component on the outer scale must be checked to make sure it wasn't changed in the move. If it has changed, the ETAS must be set above the correct WCA. In this example, the TAS index will indicate the correct TAS when the ETAS is set above WCA.)

5. Read 16 knots right crosswind giving a 4° WCA.

6. Add right crosswind (4) to true course (160) for 164° true heading. TH may also be read above 4° on the west variation scale.
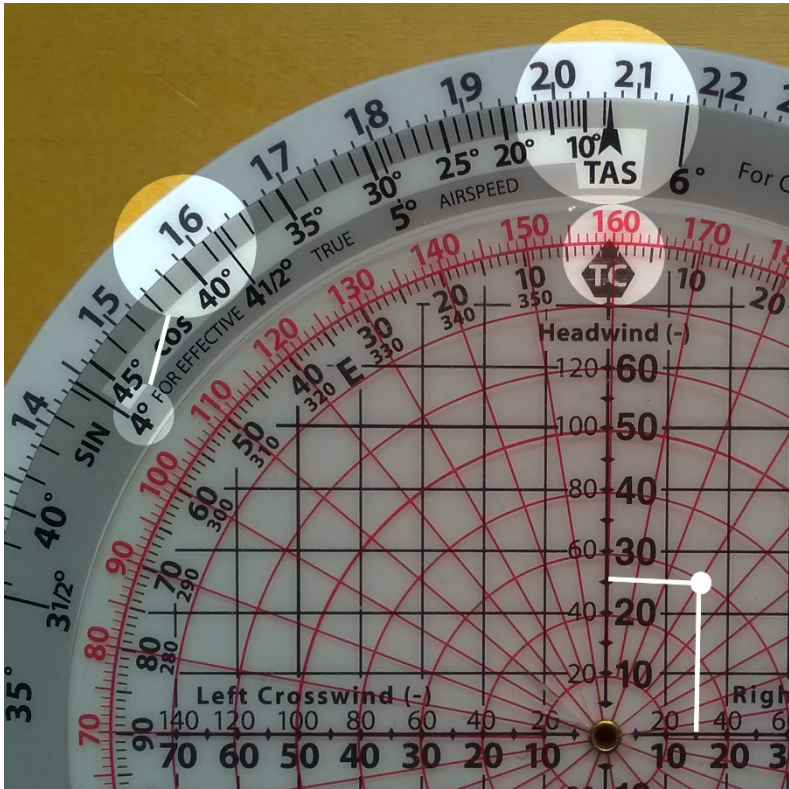
Figure 27.

Off-Course Correction

It is possible to determine the necessary correction you need to do to reach a certain destination. You need to know the miles flown so far, the miles off course and the miles to the destination.

For example, 40 miles flown, 5 miles off course, with 160 miles to the destination. Find the amount of correction you need to the heading:

1. *Set the miles flown (40) opposite the TAS index (see Figure 28).*

2. *Find the miles off course (5 depicted as 50 on the computer) on the outer scale and read the correction needed (7°). This is the number of degrees you must correct your heading to parallel your intended course.*

3. *Find the number of additional correction needed to reach your destination; place the miles to destination (160 depicted by 16 on the computer) opposite the TAS index (see Figure 29).*

4. *Find the miles off course (5 depicted as 50 on the computer) on the outer scale and read 18 on the inner scale. Additionally, it is also opposite a point between 1-1/2 and 2° on the scale containing the 18 (use 2).*

5. *Add the degrees correction necessary to parallel your course
   and the additional correction necessary to reach your
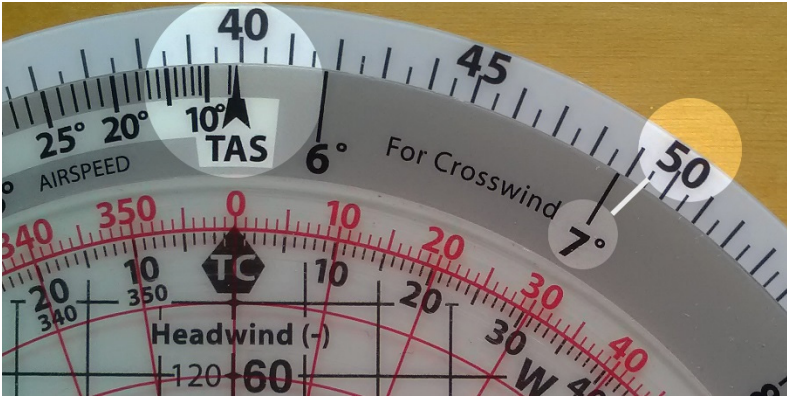   destination to get the total correction needed: 7 + 2 = 9°.*
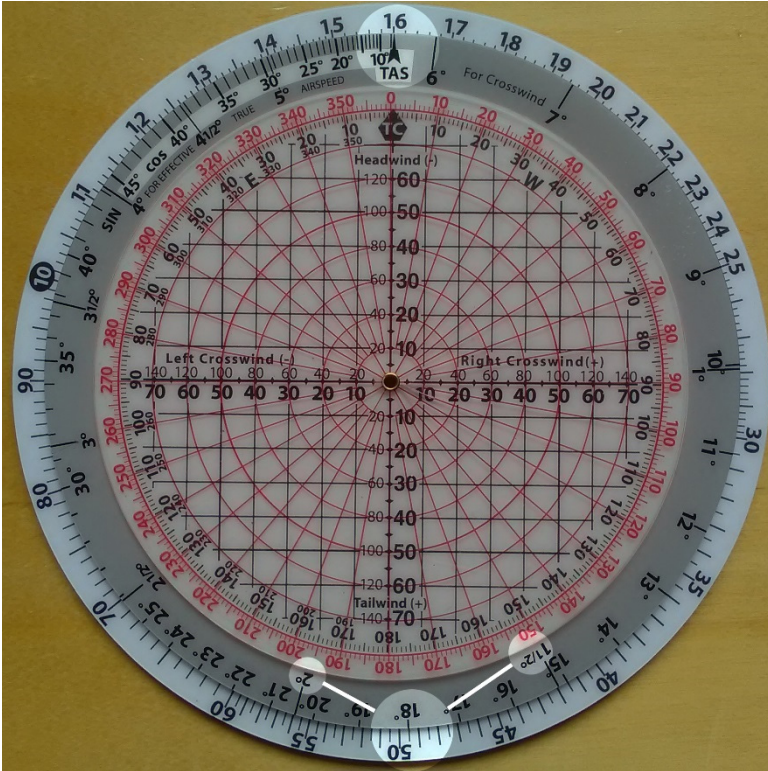

Figure 28.

Figure 29.

Remark:

In situations where you are of course to the right you must correct to the left. This is done by subtracting the necessary correction to your compass heading. If you are off course to the left, it is opposite and you must correct to the right. This is done by adding the necessary correction to your compass heading.

Answers to Sample Calculations

Basic Arithmetic, Page 11

1. 85
2. 720
3. 13.5
4. 60

Conversions, Page 14

1. 23 Statute Miles, 37 Kilometers
2. 41.7 Nautical Miles, 77.2 Kilometers
3. 59.4 Nautical Miles, 68.4 Statute Miles

Time, Speed, and Distance Problems, Page 21

1. 4 Hours and 12 Minutes
2. 138 Knots
3. 183 Nautical Miles
4. 110 Knots
5. 133 Nautical Miles

Feet Per Mile vs. Feet Per Minute, Page 23

1. 700 FPM
2. 415 FPM
3. 750 FPM

Fuel Consumption Problems, Page 25

1. 26 Gallons
2. 12.8 GPH
3. 4 Hours and 28 Minutes
4. 25 Gallons
5. 1 Hour and 50 Minutes

True Airspeed and Density Altitude, Page 29

1. *204 Knots TAS, 16,000' DA*
2. *276 Knots TAS, 20,500' DA*
3. *174 Knots TAS, 9,800' DA*

True Altitude, Page 36

1. *4,750' above ground, 9,750' True Altitude above sea level*
2. *7,300' above ground, 10,300' True Altitude above sea level*
3. *7,200' True Altitude*

Preflight Planning, Page 46

1. *288, 143*
2. *133, 149*
3. *014, 163*
4. *258, 240*

Determining Winds in Flight, Page 49

1. *002, 17*
2. *212, 49*

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