Cross Country Flight Planning Based on Cessna 172M

Essentials

You will need:

- Plotter
- E6B (Digital or Analog)
- EFB (Electronic Flight Bag)(optional)
- VFR Sectional (Electronic or Digital)
- Pencil
- Pick a place you want to go…

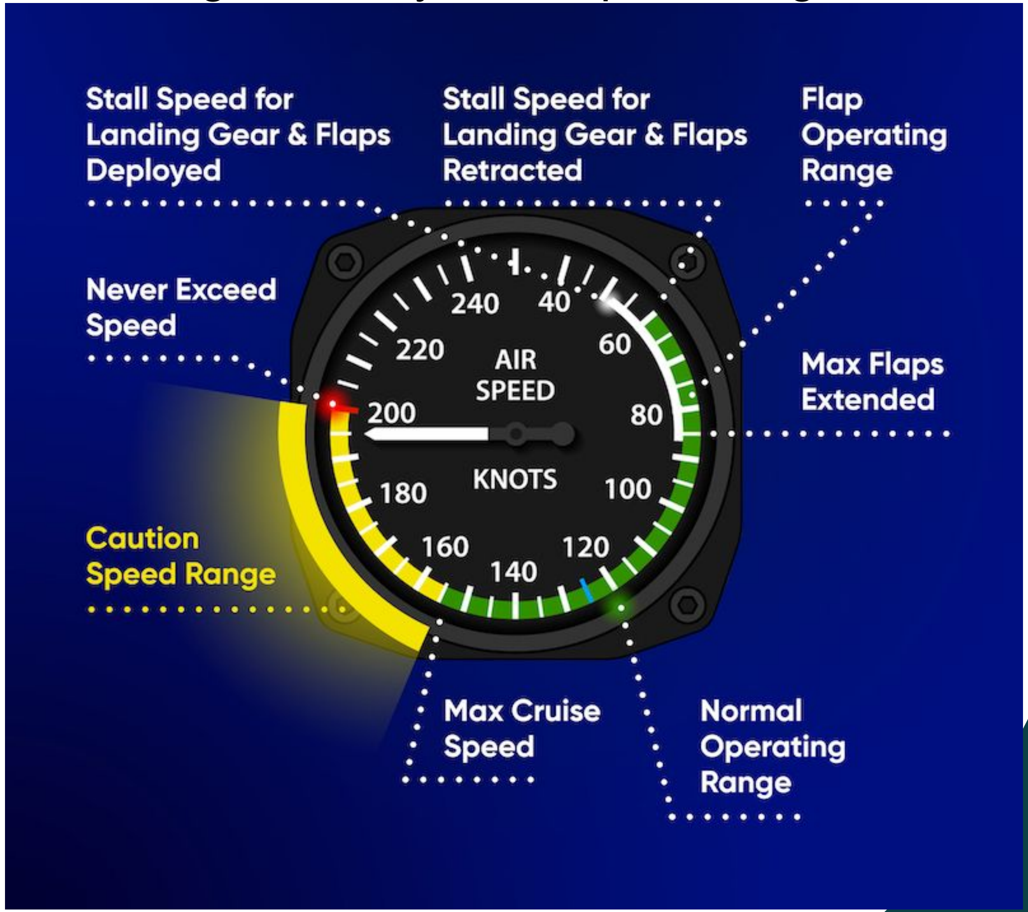
Definitions

- **TC—**True Course. Direction of the line connecting two desired points, drawn on the chart and measured clockwise in degrees from TN on the mid-meridian
- **WCA—**Wind Correction Angle - Determined from the wind triangle. (Added to TC if the wind is from the right; subtracted if wind is from the left)
- **TH—**True Heading - Direction measured in degrees clockwise from TN, in which the nose of the plane should point to remain on the desired course
- **VAR –** Variation **-** obtained from the isogonic line on the chart (added to TH if west; subtracted if east)
- **MH—**Magnetic Heading an intermediate step in the conversion (obtained by applying variation to TH)
- **DEV –** Deviation - obtained from the deviation card on the aircraft (added to or subtracted from MH, as indicated)
- **Compass Heading—**reading on the compass (found by applying deviation to MH) that is followed to remain on the desired course
- **Total Distance—**obtained by measuring the length of the TC line on the chart (using the scale at the bottom of the chart)
- **GS—**obtained by measuring the length of the TC line on the wind triangle (using the scale employed for drawing the diagram)
- **ETE —**Estimated Time enroute. Total distance divided by GS
- **Fuel Rate—**predetermined gallons per hour used at cruising speed

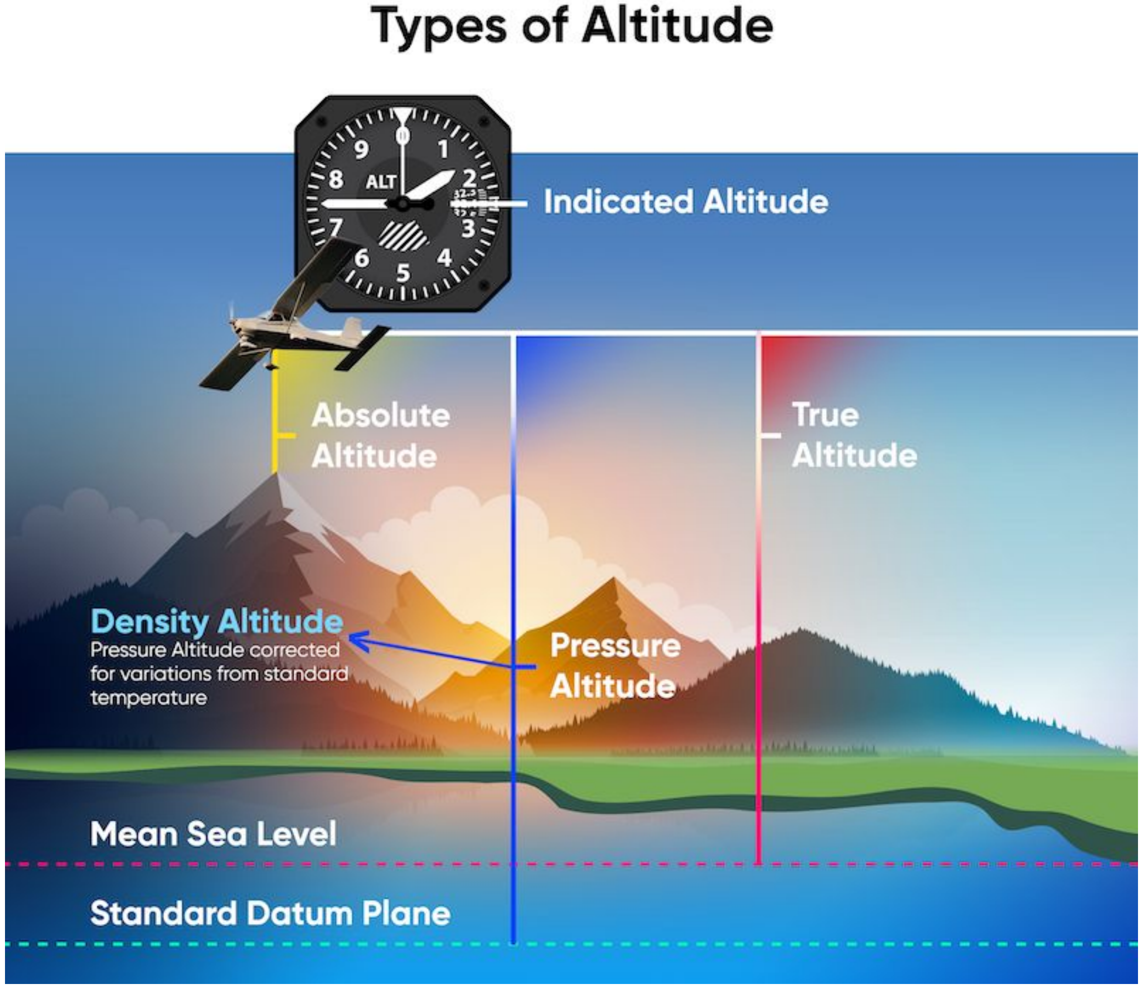
Airspeed Definitions

- KIAS – Knots Indicated Airspeed
- KTAS – Knots True Airspeed
- KCAS – Knots Calibrated Airspeed
- KEAS – Knots Equivalent Airspeed
- MPH – Miles Per Hour
- Indicated airspeed – read off the instrument
- Calibrated airspeed – indicated airspeed corrected for instrument errors
- Equivalent airspeed – calibrated airspeed corrected for high-speed compression errors
- True airspeed – calibrated or equivalent airspeed corrected for pressure altitude and temperature
- Ground speed – true airspeed corrected for wind

Don't Forget about your Airspeed ranges……



Altitude Definitions



- Indicated altitude: altimeter reading
- Absolute altitude: above ground level
- True altitude: above sea level
- Pressure altitude: above the standard datum plane
- Density altitude: air density expressed as an altitude

- Flight level: Pressure altitude in 100s of feet
- Transition Altitude - (TA) is the altitude above sea level at which pilots change the altimeter setting from the local to the standard setting and switch from using altitudes to flight levels.
- Transition level (TL) is the lowest flight level above the transition altitude, at which a pilot must switch from the standard to the local altimeter setting and start referring to altitude in feet.

Basic Rates & Formulas

Some Basic Formulas

TC ± WCA = TH ± VAR = MH ± DEV = CH

- Time T = D/GS
- Distance D = GS X T
- GS = D/T
- PA= 1000x (Current Setting - 29.92) + 4053 (field elevation)
- DA= Pressure Altitude in Feet + (120 x [OAT°C – ISA Temperature °C])
- Weight x Arm = Moment
- Moment / Weight = Arm

Basic Rates

- Temperature: 3.5 °F or 2 °C per thousand feet up to 36,000 feet
  - Standard Temperature at sea level: 15 °C or 59 °F
- Pressure: 1 "Hg per 1,000 feet of altitude gain to 10,000 feet
  - Standard Pressure at sea level: 29.92 inHg 1013.25 hPa

PA & DA
Must - Knows

Pressure Altitude

PA= 1000x (Current Setting - 29.92) + 4053 (field elevation)

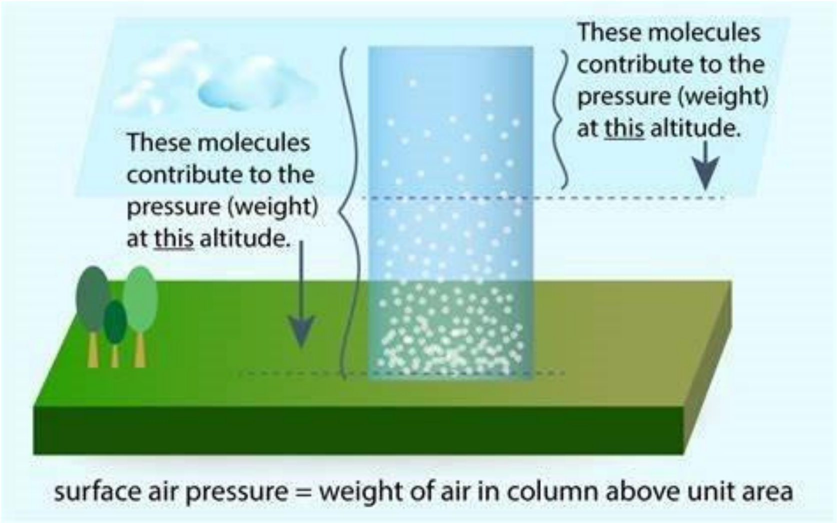
Pressure altitude is the height above the standard datum plane (SDP). Pressure corrected for non-standard pressure

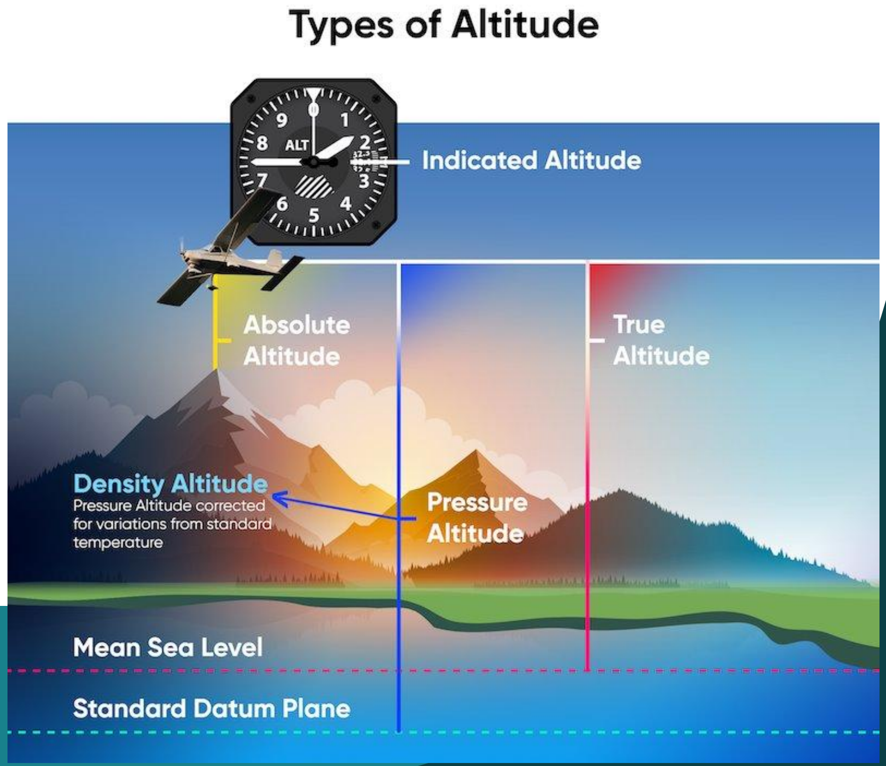
Pressure altitude is the Indicated Altitude you read on your altimeter when it is set to 29.92 Hg —the altitude in the standard atmosphere corresponding to the sensed pressure on a standard day.

Pressure varies from day to day at the Earth's surface - the bottom of the atmosphere. This is, in part, because of unequal heating of the earth surface. Resulting in High and Low pressure systems.

The SDP is a theoretical level at which the pressure of the atmosphere is 29.92 inches of mercury (Hg) and the weight of air is 14.7 psi. As you climb, the weight of air molecules decreases because you lose 1inch of mercury (HG) per 1000 ft.

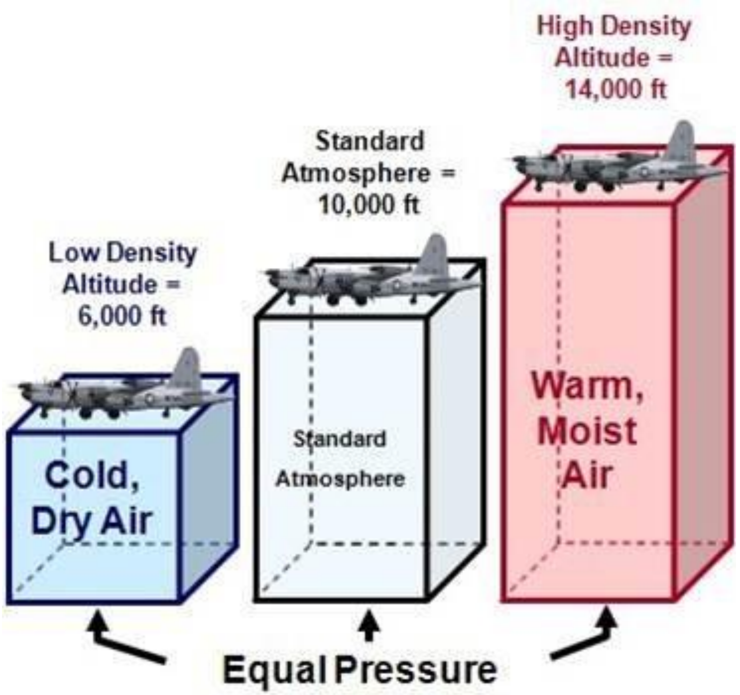
Pressure altitude is important as a basis for determining aircraft performance, as well as for assigning flight levels to aircraft operating at above 18,000 feet.





Density Altitude

DA= Pressure Altitude in Feet + (120 x [OAT°C – ISA Temperature °C])



But DIFFERENT in TEMPERATURE

- **Density altitude is pressure altitude corrected for nonstandard temperature.**

Low Density Altitude, molecules are more densely compacted

- **More dense air, the aircraft feels like its flying a low altitude**
- Caused by low altitude, low temperature, high pressure, and low humidity
- **Results:**
  - The propeller produces more thrust
  - Wing generates more lift
  - More power is produced
  - Great performance

- **High Density Altitude,** molecules are more spaced out
  - *Remember* - For every 1k ft climb, we lose 2ºC
  - **Less dense, aircraft feels like its flying higher altitude**
  - Caused by high altitude, high temp, high pressure, high humidity
  - **As air becomes less dense, it reduces:**
    - Power, because the engine takes in less air
    - Thrust, because the propeller is less efficient in thin air
    - Lift, because the thin air exerts less force on the airfoils

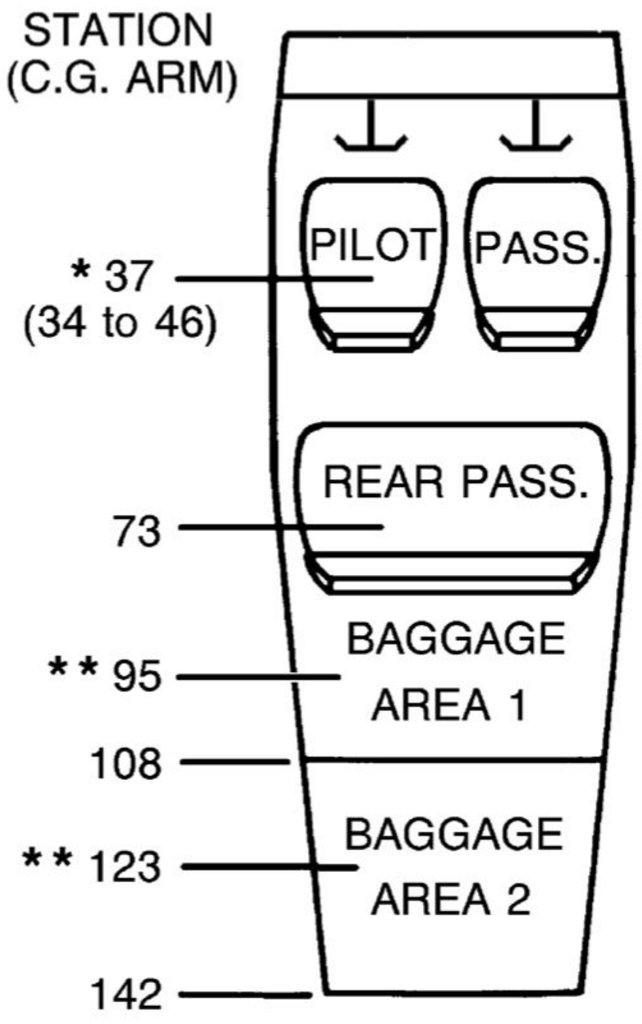
- **Under standard conditions**, pressure altitude and density altitude identify the same level.

Weight & Balance

Datum

A set point on the airplane from which all relative distances are measured.

Datum location depends on airplane, each model will be different (reference POH), for our Cessna 172, the datum is the firewall.



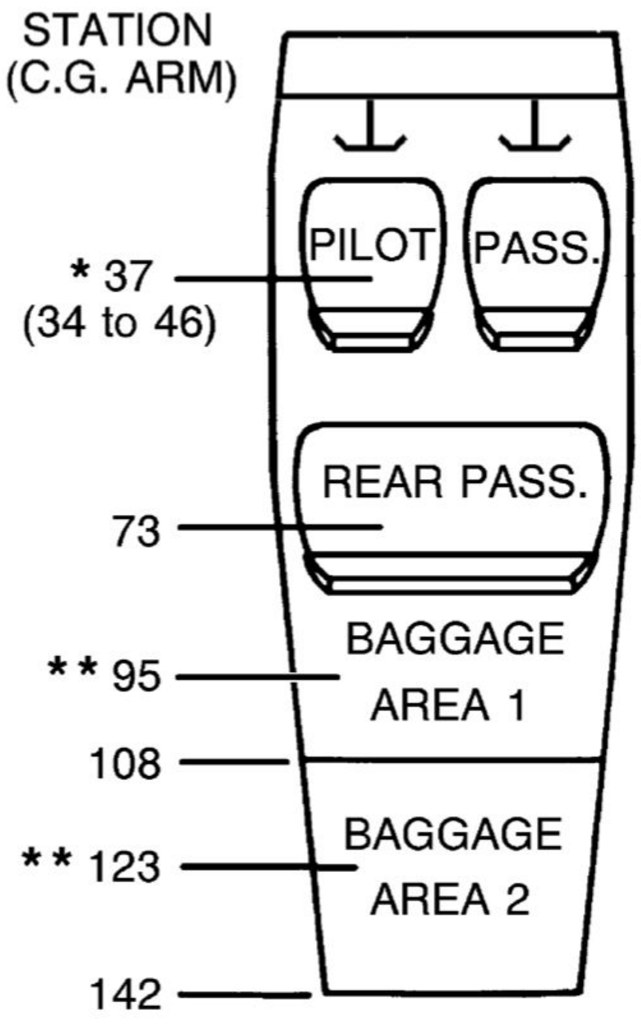
Arm

The distance *from* the datum.

The longer the arm, the further from the datum the position is.

Usually expressed in inches aft of datum.

Stations are set points in the aircraft where weight in the aircraft will be (ie- front seat, rear seat, baggage areas).



Moment

A product of a ***weight multiplied by the arm***.

Expressed in pound-inches. Sometimes may be divided by 100 or 1000- called ***moment index.***

Total moment is the weight of the airplane multiplied by the distance between the datum and the center of gravity.

$$\text{Weight} \times \text{Arm} = \text{Moment}$$

Center of Gravity (CG)

The point about which the aircraft would balance if it were possible to suspend it at that point

Typically expressed as inches from the datum. May also be seen expressed as a percent of mean aerodynamic chord (MAC)

Mean aerodynamic chord: the average distance from the leading edge to the trailing edge of the wing

Effect of Weight & Balance on Performance: Weight

Takeoff and Landing: Heavier airplanes require more runway to takeoff and require more runway to land

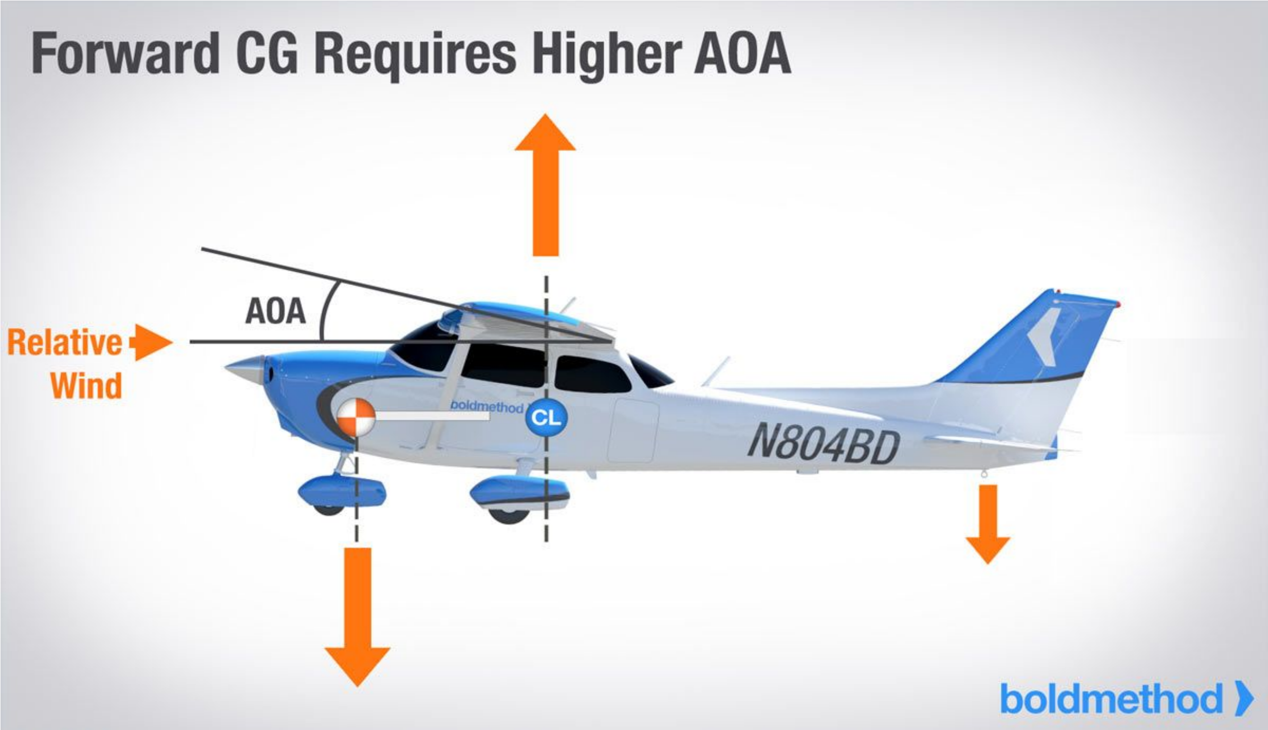
Stall Speeds: Heavier airplanes will stall at a higher airspeed. The reason is because when the airplane is flying with more weight, the wing has to fly at a greater angle of attack (AOA). This results in the stall occuring at a higher airspeed

Load Factor: Maximum and minimum structural loads are only computed for allowable ranges of airplane weights. Exceeding these weights may lead to structural failure in flight

Maneuvering Speed: Heavier airplane, higher AOA, Lighter airplane, lower AOA. A lighter airplane's wing will produce more lift before it stalls, so the maneuvering speed is set lower. A heavier airplane will have a higher maneuvering speed.

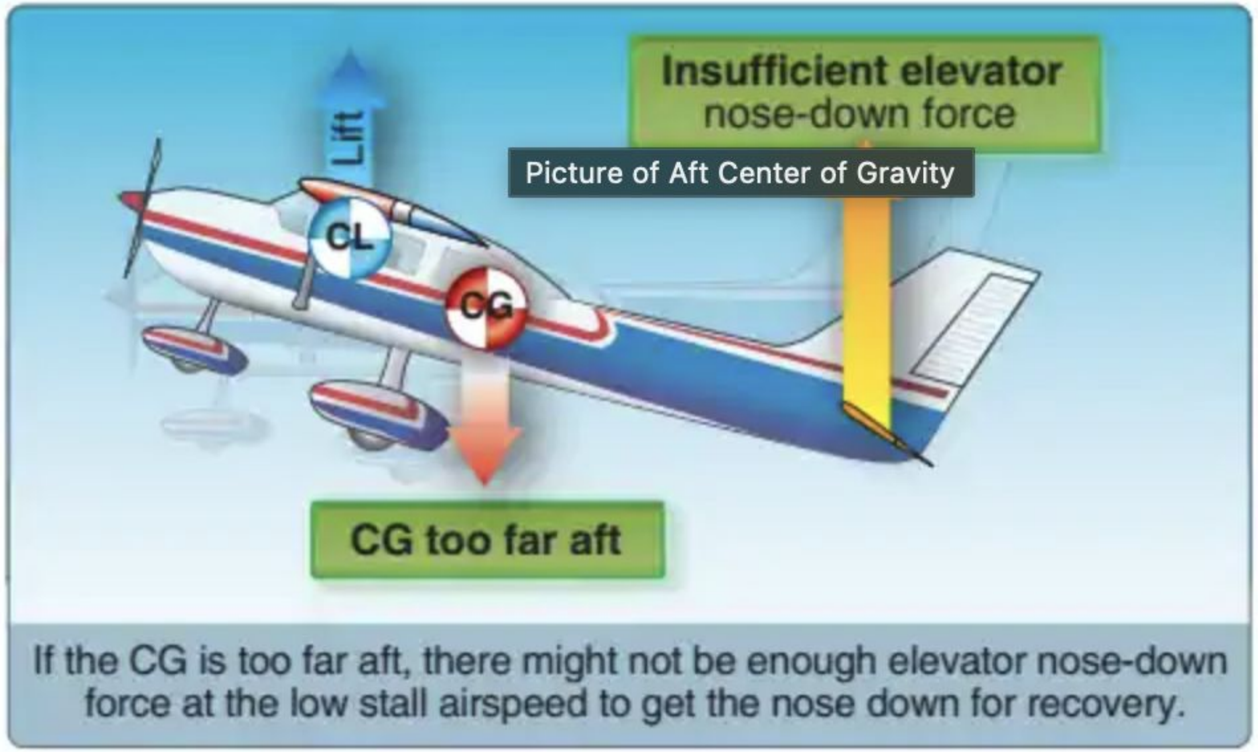
Effects of Forward Center of Gravity

- Increased longitudinal stability (pitch stability)
- Lower cruise speed: Wing flies at a higher AOA to create more lift to counter added downward force produced by the tail, therefore wing produces more induced drag
- Higher stall speed: Wing flies at a higher AOA to ‘hold up’ heavier nose. This results in the wing stalling at a higher airspeed



Effects of Aft Center of Gravity

- Decreased Longitudinal stability (pitch)
    - (CG is closer to the CL)
- Higher cruise speed- Wing doesn't have to produce as much lift as forward CG since the tail is not having to provide as much downward force
- Lower stall speed
- Poor stall/spin recovery



Weight & Balance Sheet

Glass Cockpit Aviation Takeoff Data Sheet			
Date:		Aircraft ID:	
Plot 1:		Pilot 2:	
Weight & Balance Calculations			
Item	Weight (lbs)	Arm - CG (in)	Moment (lbs-in)
Basic Empty Weight			
Front Seats			
Rear Seats			
Baggage 1			
Baggage 2			
Zero Fuel Weight			
Fuel (6lb/gal)			
Ramp Weight (max 2300lbs)			
Fuel Start, Taxi, and Run-Up 1.4 gal			
Takeoff Weight (max 2300lbs)			
Estimated Fuel Burn			
Estimated Landing Weight (max 2300lbs)			
Current Conditions			
ATIS Information:		Crosswind Component:	
Time of ATIS Information:		Headwind Component:	
Surface Wind:		Airport Elevation:	
Temperature:		Pressure Altitude:	
Altimeter Setting:		Density Altitude:	
Performance Data			
Expected Runway:		Runway Length:	
Takeoff Dist. (ground roll):		Takeoff Dist. (50' Obstacle):	
VR (Short Field):		Landing Dist. (50' Obstacle):	
Obstacle Speed:		Approach Speed:	
VX:		Landing Dist. (ground roll):	
VY:		VA: (at existing weight):	
Multi Engine Only			
VXSE:		SE Service Ceiling:	
VYSE:		SE Absolute Ceiling:	
VY Gear Down & Rate):		SE Climb Rate & Field Elev.:	
Drift Down Rate:		Accelerate Stop Dist.:	

- Basic Empty Weight – includes unusable fuel, oil, and the empty airplane
- Ramp weight = Basic Empty Weight +Front Seats + Rear Seats + Baggage +Baggage
- Takeoff Weight = Ramp Weight – Fuel to start, taxi, and Runup
- Landing Weight = Takeoff Weight – Estimate Fuel burn

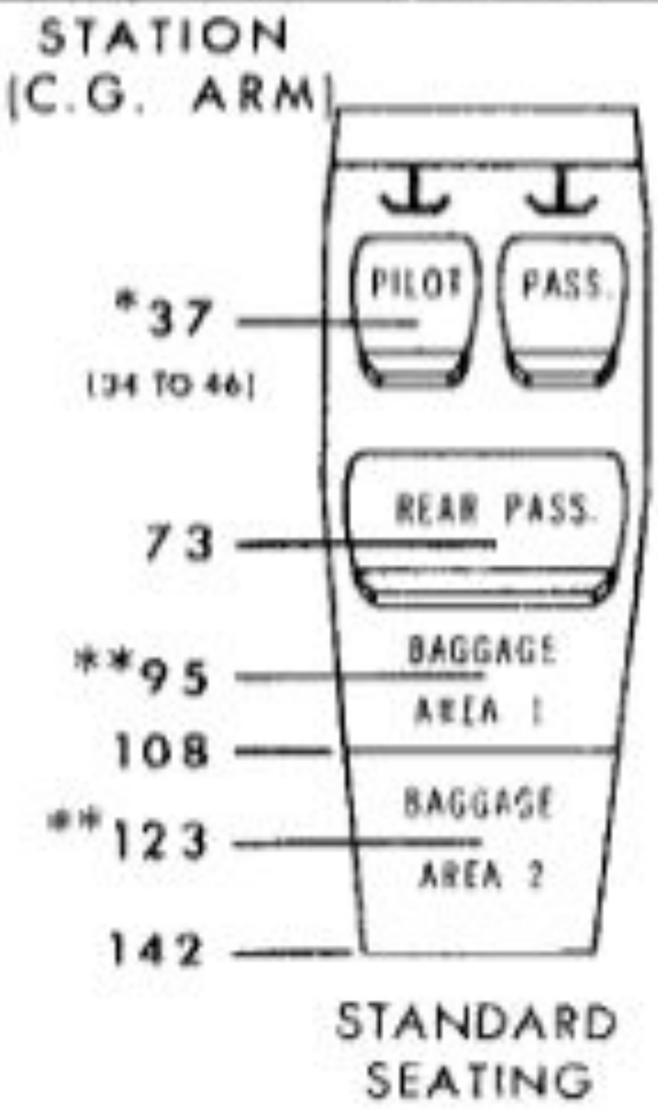
Pilots Operating Handbook

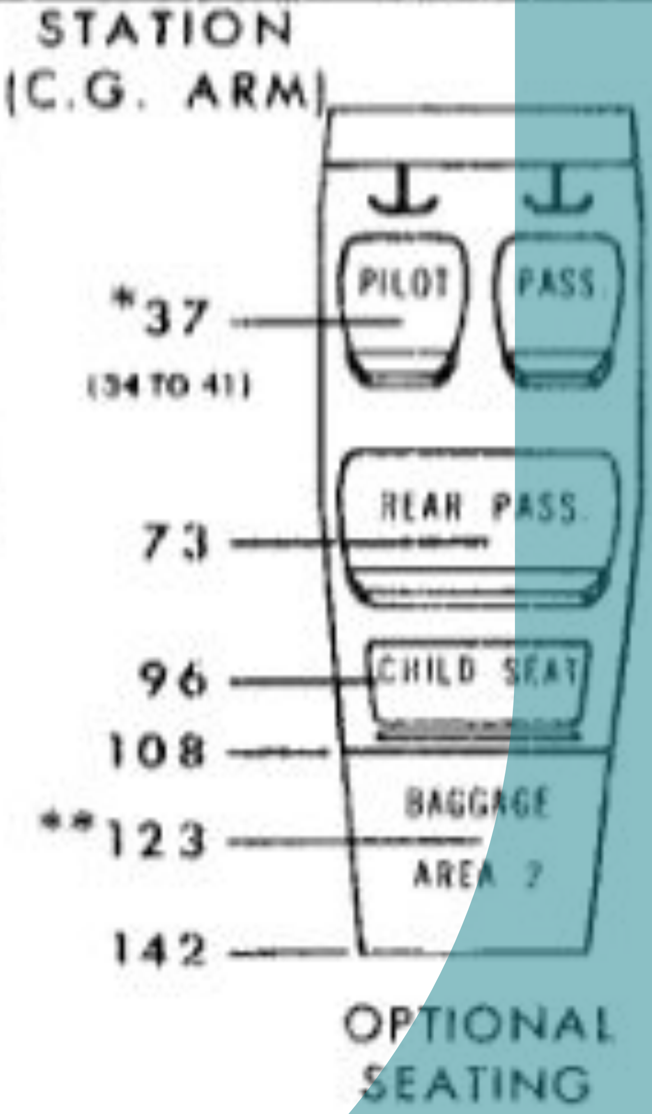
LOADING ARRANGEMENTS

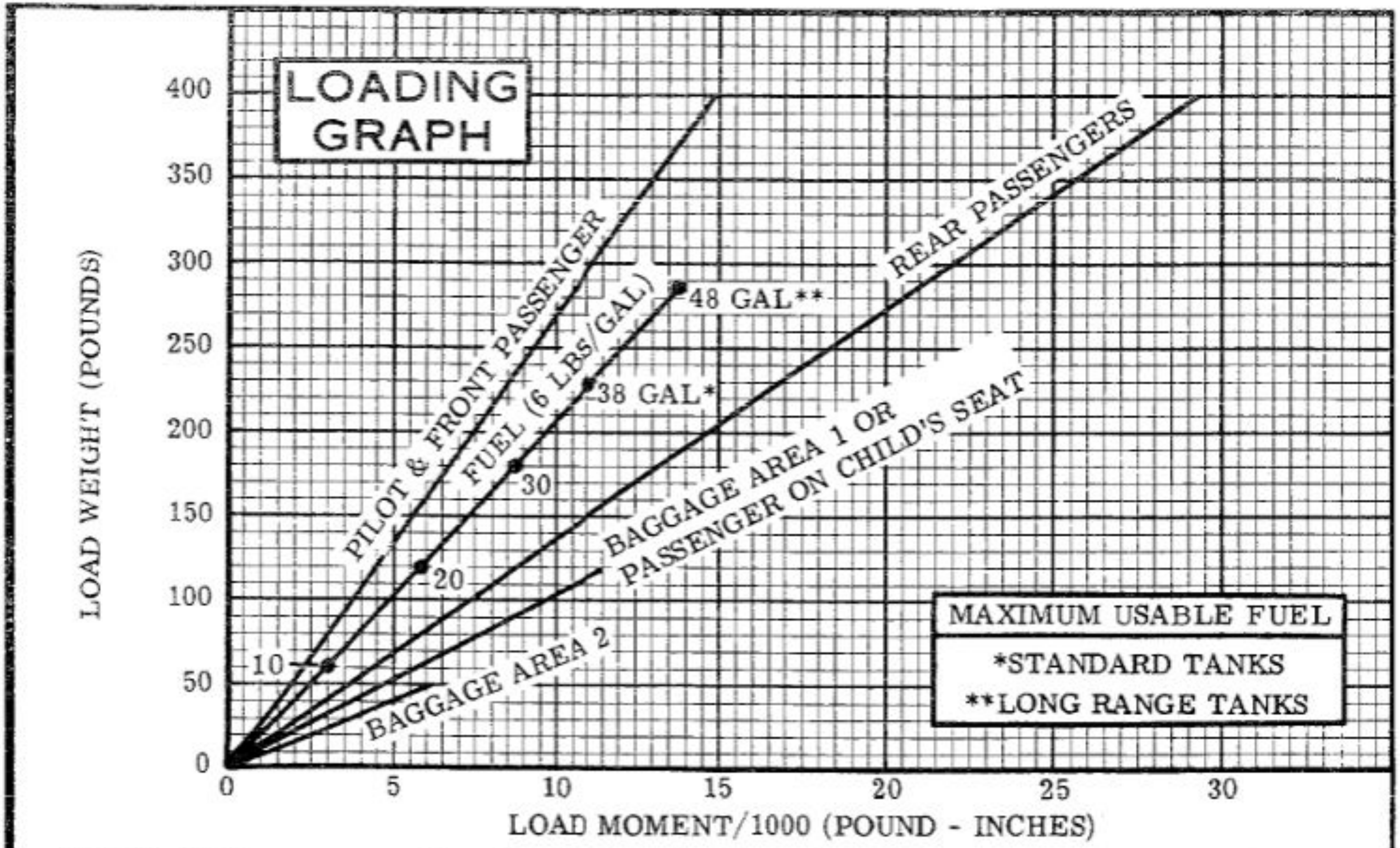
* Pilot or passenger center of gravity on adjustable seats positioned for average occupant. Numbers in parentheses indicate forward and aft limits of occupant center of gravity range.

** Arm measured to the center of the areas shown.

NOTE: The rear cabin wall (approximate station 108) or aft baggage wall (approximate station 142) can be used as convenient interior reference points for determining the location of baggage area fuselage stations.

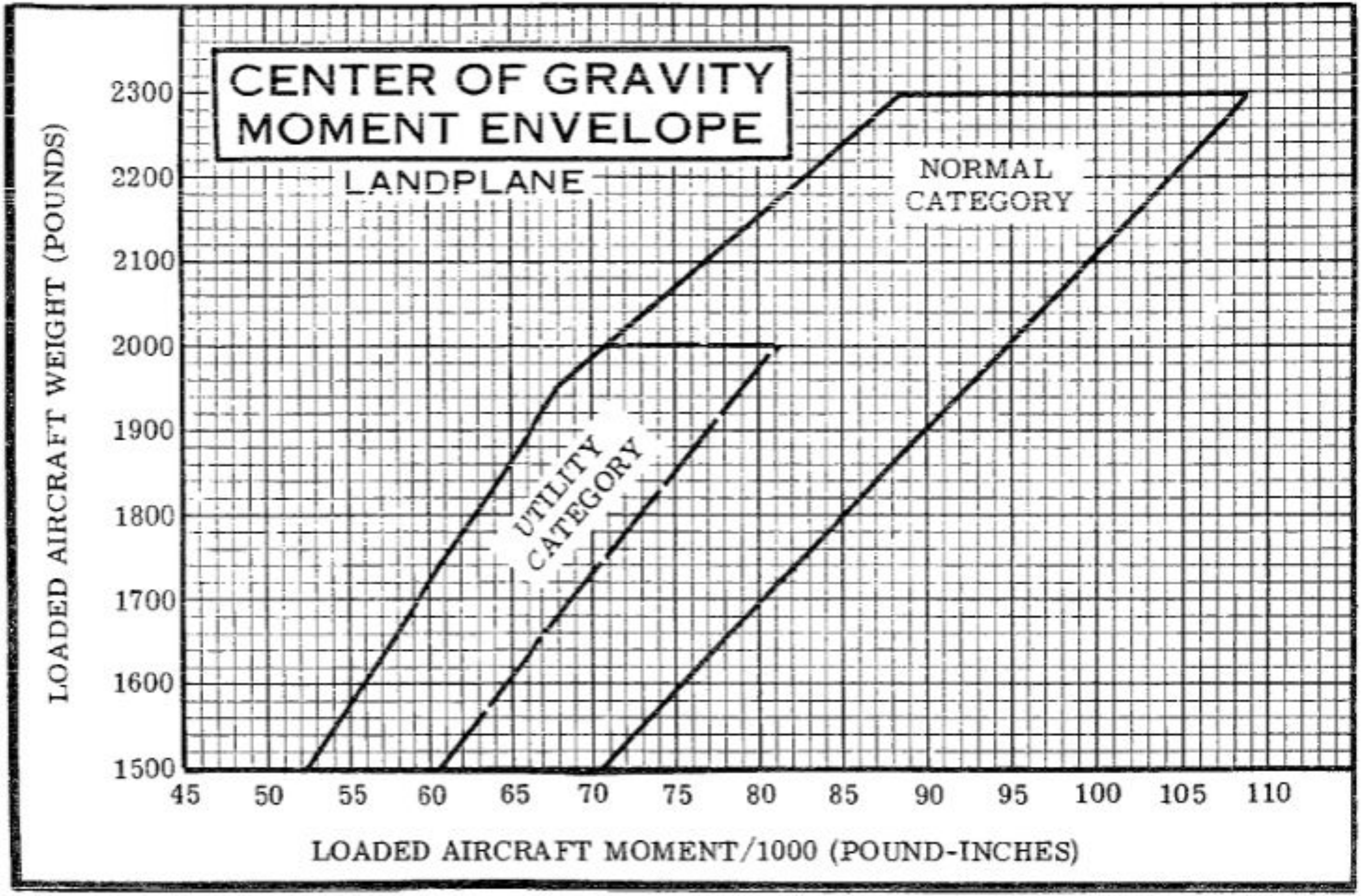






NOTES: (1) Line representing adjustable seats shows the pilot or passenger center of gravity on adjustable seats positioned for an average occupant. Refer to the Loading Arrangements diagram for forward and aft limits of occupant c.g. range.

(2) Engine Oil: 8 Qts. = 15 Lbs. at -0.2 Moment/1000.



CENTER OF GRAVITY
MOMENT ENVELOPE
LANDPLANE
NORMAL
CATEGORY
UTILITY
CATEGORY
LOADED AIRCRAFT WEIGHT (POUNDS)
2300
2200
2100
2000
1900
1800
1700
1600
1500
45
50
55
60
65
70
75
80
85
90
95
100
105
110
LOADED AIRCRAFT MOMENT/1000 (POUND-INCHES)

AIRSPEED CORRECTION TABLE												
	IAS	40	50	60	70	80	90	100	110	120	130	140
FLAPS UP	CAS	53	58	64	72	79	88	97	107	117	127	137
FLAPS DOWN	CAS	49	55	63	72	81	90	100	•	•	•	•

Figure 6-1.

STALL SPEEDS — MPH CAS

	CONDITION	ANGLE OF BANK 0°	20°	40°	60°
2300 LBS. GROSS WEIGHT	FLAPS UP	57	59	65	81
	FLAPS 10°	52	54	59	74
	FLAPS 40°	49	51	56	69

POWER OFF — AFT CG

TAKE-OFF DATA

TAKE-OFF DISTANCE FROM HARD SURFACE RUNWAY WITH FLAPS UP

GROSS WEIGHT POUNDS	IAS AT 50' MPH	HEAD WIND KNOTS	AT SEA LEVEL & 59°F		AT 2500 FT. & 50°F		AT 5000 FT. & 41°F		AT 7500 FT. & 32°F	
			GROUND RUN	TOTAL TO CLEAR 50 FT OBS	GROUND RUN	TOTAL TO CLEAR 50 FT OBS	GROUND RUN	TOTAL TO CLEAR 50 FT OBS	GROUND RUN	TOTAL TO CLEAR 50 FT OBS
2300	68	0	865	1525	1040	1910	1255	2480	1565	3855
		10	615	1170	750	1485	920	1955	1160	3110
		20	405	850	505	1100	630	1480	810	2425
2000	63	0	630	1095	755	1325	905	1625	1120	2155
		10	435	820	530	1005	645	1250	810	1685
		20	275	580	340	720	425	910	595	1255
1700	58	0	435	780	520	920	625	1095	765	1370
		10	290	570	355	680	430	820	535	1040
		20	175	385	215	470	270	575	345	745

NOTES:
1. Increase distance 10% for each 25°F above standard temperature for particular altitude.
2. For operation on a dry, grass runway, increase distances (both "ground run" and "total to clear 50 ft. obstacle") by 7% of the "total to clear 50 ft. obstacle" figure.

MAXIMUM RATE-OF-CLIMB DATA

GROSS WEIGHT POUNDS	AT SEA LEVEL & 59°F			AT 5000 FT. & 41°F			AT 10,000 FT. & 23°F			AT 15,000 FT. & 5°F		
	IAS MPH	RATE OF CLIMB FT/MIN	GAL. OF FUEL USED	IAS MPH	RATE OF CLIMB FT/MIN	FROM S. L. FUEL USED	IAS MPH	RATE OF CLIMB FT/MIN	FROM S. L. FUEL USED	IAS MPH	RATE OF CLIMB FT/MIN	FROM S. L. FUEL USED
2300	91	645	1.0	85	435	2.6	80	230	4.8	73	20	11.5
2000	88	840	1.0	81	610	2.2	75	380	3.6	68	155	6.3
1700	83	1085	1.0	77	825	1.9	70	570	2.9	64	315	4.4

NOTES:
1. Flaps up, full throttle, mixture leaned for smooth operation above 3000 ft.
2. Fuel used includes warm up and take-off allowance.
3. For hot weather, decrease rate of climb 20 ft./min. for each 10°F above standard day temperature for particular altitude.

CRUISE PERFORMANCE
SKYHAWK

Gross Weight- 2300 Lbs.
Standard Conditions
Zero Wind Lean Mixture

NOTE: Maximum cruise is normally limited to 75% power. Cruise speeds for the standard Model 172 are 1 to 3 MPH lower than shown with the maximum difference occurring at higher powers.

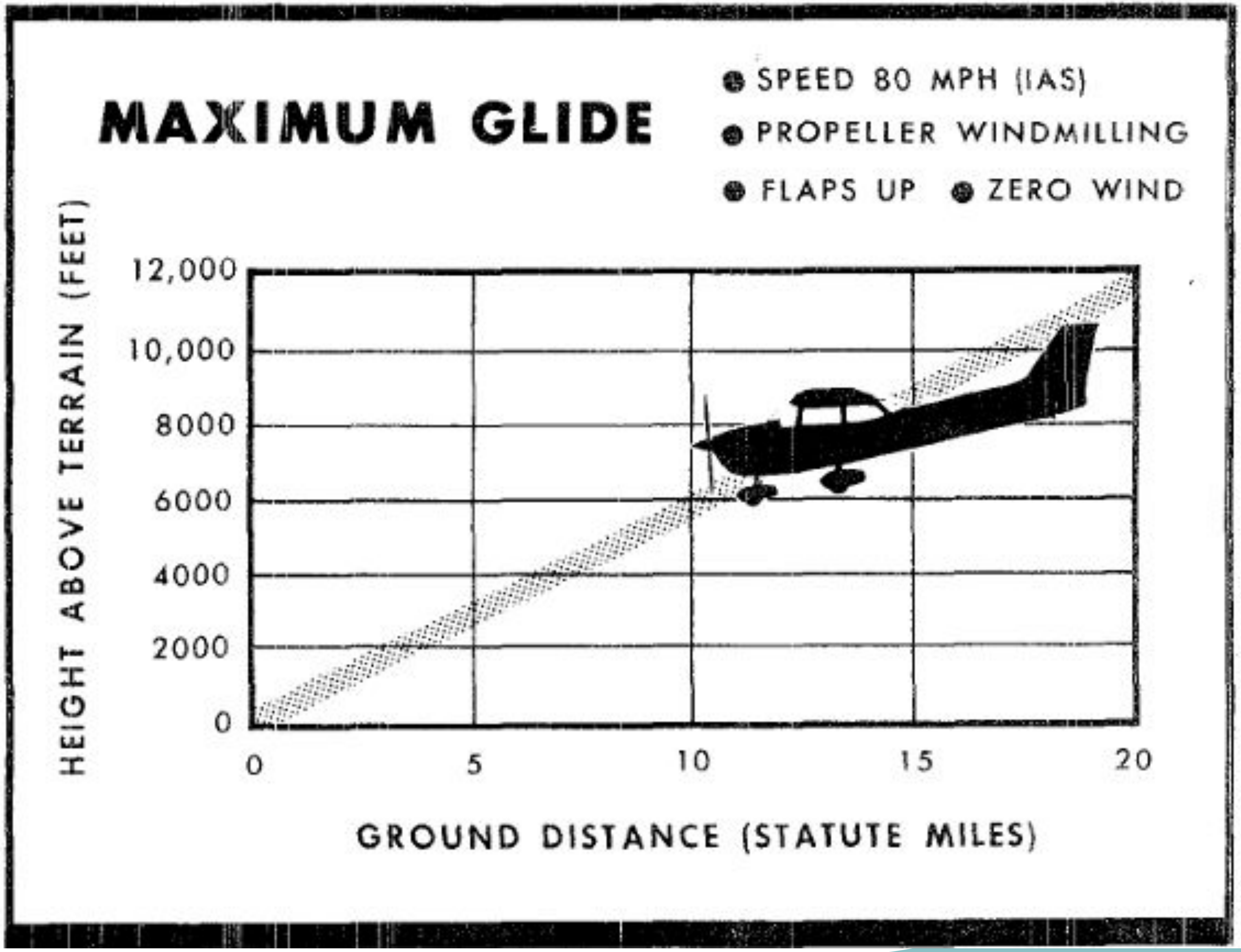
ALTITUDE	RPM	% BHP	TAS MPH	GAL/ HOUR	38 GAL (NO RESERVE) ENDR. HOURS	38 GAL (NO RESERVE) RANGE MILES	48 GAL (NO RESERVE) ENDR. HOURS	48 GAL (NO RESERVE) RANGE MILES
2500	2700	87	139	9.6	3.9	545	5.0	690
	2600	78	133	8.6	4.4	590	5.6	745
	2500	70	128	7.7	4.9	630	6.2	795
	2400	63	122	7.1	5.3	655	6.7	825
	2300	57	116	6.6	5.7	665	7.2	840
	2200	51	109	6.2	6.1	665	7.7	840
5000	2700	81	138	8.9	4.3	585	5.4	740
	2600	73	133	8.1	4.7	630	6.0	795
	2500	66	128	7.4	5.1	655	6.5	830
	2400	60	121	6.8	5.6	675	7.0	850
	2300	54	114	6.4	5.9	675	7.5	855
	2200	48	107	6.0	6.3	675	8.0	850
7500	2700	76	138	8.4	4.5	630	5.7	795
	2600	69	133	7.6	5.0	660	6.3	835
	2500	63	126	7.1	5.4	675	6.8	855
	2400	57	119	6.6	5.8	685	7.3	865
	2300	51	112	6.2	6.1	685	7.8	865
10,000	2700	72	138	7.9	4.8	665	6.1	840
	2600	66	131	7.3	5.2	685	6.6	860
	2500	59	124	6.8	5.6	695	7.1	875
	2400	54	117	6.4	6.0	700	7.5	880
	2300	48	110	6.0	6.3	700	8.0	880
12,500	2650	65	132	7.2	5.3	695	6.6	880
	2500	56	122	6.5	5.8	710	7.3	895
	2400	51	115	6.2	6.2	710	7.8	895

LANDING DATA

LANDING DISTANCE ON HARD SURFACE RUNWAY
NO WIND – 40° FLAPS – POWER OFF

GROSS WEIGHT LBS.	APPROACH IAS MPH	AT SEA LEVEL & 59°F		AT 2500 FT. & 50°F		AT 5000 FT. & 41°F		AT 7500 FT. & 32°F	
		GROUND ROLL	TOTAL TO CLEAR 50' OBS.	GROUND ROLL	TOTAL TO CLEAR 50' OBS.	GROUND ROLL	TOTAL TO CLEAR 50' OBS.	GROUND ROLL	TOTAL TO CLEAR 50' OBS.
2300	70	520	1250	560	1310	605	1385	650	1455

NOTES: 1. Reduce landing distance 10% for each 5 knot headwind.
2. For operation on a dry, grass runway, increase distances (both "ground roll" and "total to clear 50 ft. obstacle") by 20% of the "total to clear 50 ft. obstacle" figure.


MAXIMUM GLIDE
SPEED 80 MPH (IAS)
PROPELLER WINDMILLING
FLAPS UP
ZERO WIND
HEIGHT ABOVE TERRAIN (FEET)
12,000
10,000
8000
6000
4000
2000
0
0
5
10
15
20
GROUND DISTANCE (STATUTE MILES)

CRUISE.

Normal cruising is done between 65% and 75% power. The power settings required to obtain these powers at various altitudes and outside air temperatures can be determined by using your Cessna Power Computer or the OPERATIONAL DATA, Section VI.

Cruising can be done more efficiently at high altitudes because of lower air density and therefore higher true airspeeds for the same power. *This is illustrated in the Maximum Cruise Speed Performance table*, which shows performance at 75% power at various altitudes.

To achieve lean mixture fuel consumption figures shown in Section VI, the mixture should be leaned as follows: pull mixture control out until RPM peaks and begins to fall off, then enrichen slightly back to peak RPM.

Carburetor ice, as evidenced by an unexplained drop in RPM, can be removed by application of full carburetor heat. Upon regaining the origi-

MAXIMUM CRUISE SPEED PERFORMANCE

75% POWER

ALTITUDE	RPM	TRUE AIRSPEED
Sea Level	2500	128
4000 Feet	2600	133
8000 Feet	2700	138

nal RPM (with heat off), use the minimum amount of heat (by trial and error) to prevent ice from forming. Since the heated air causes a richer mixture, readjust the mixture setting when carburetor heat is to be used continuously in cruise flight.

The use of full carburetor heat is recommended during flight in heavy rain to avoid the possibility of engine stoppage due to excessive water ingestion or carburetor ice. The mixture setting should be readjusted for smoothest operation.

In extremely heavy rain, the use of partial carburetor heat (control approximately 2/3 out), and part throttle (closed at least one inch), may be necessary to retain adequate power. Power changes should be made cautiously followed by prompt adjustment of the mixture for smoothest operation.

AIRSPEED LIMITATIONS (CAS).

The following is a list of the certificated calibrated airspeed (CAS) limitations for the aircraft.

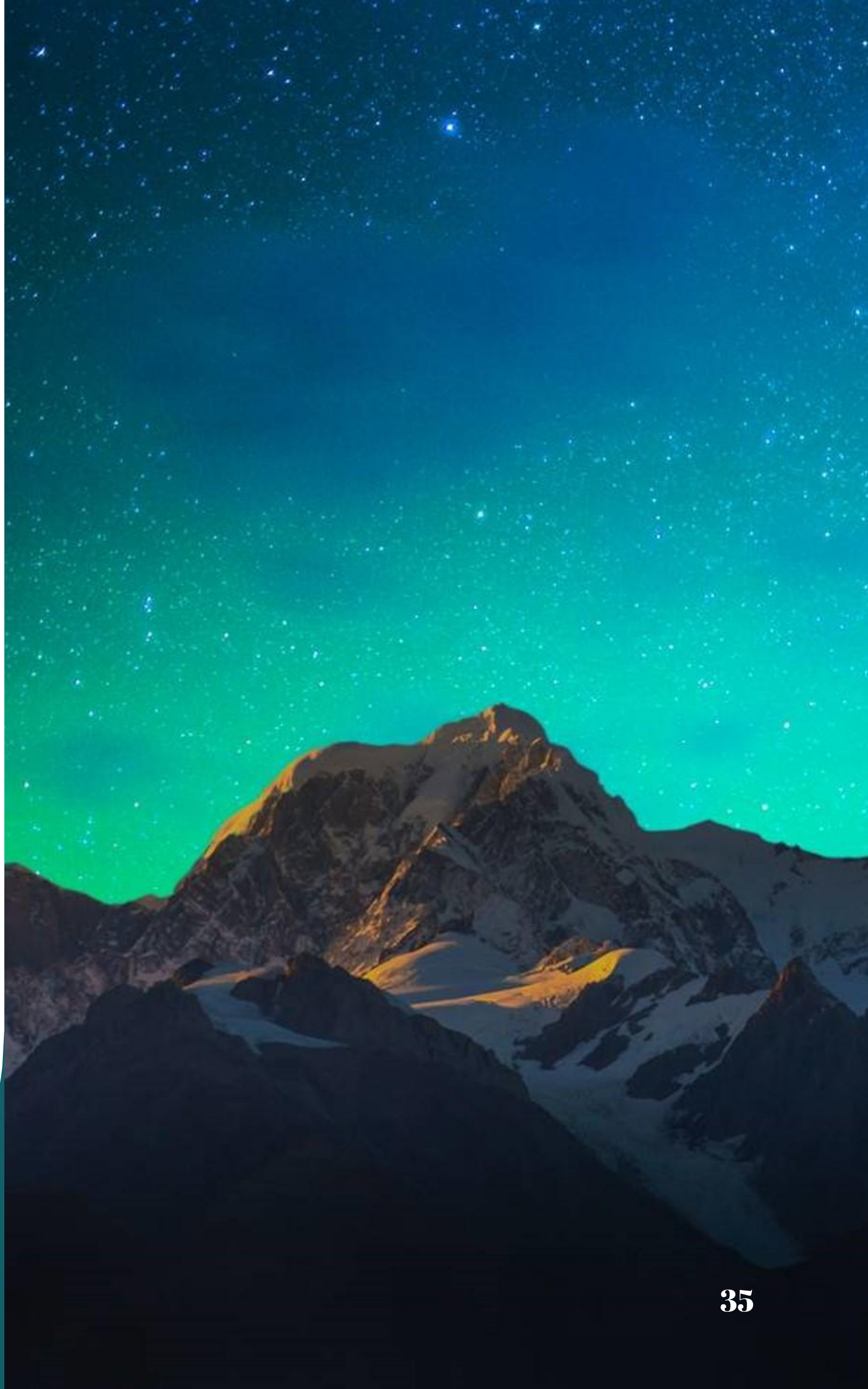
Never Exceed Speed (glide or dive, smooth air)	182 MPH
Maximum Structural Cruising Speed	145 MPH
Maximum Speed, Flaps Extended	100 MPH
*Maneuvering Speed	112 MPH

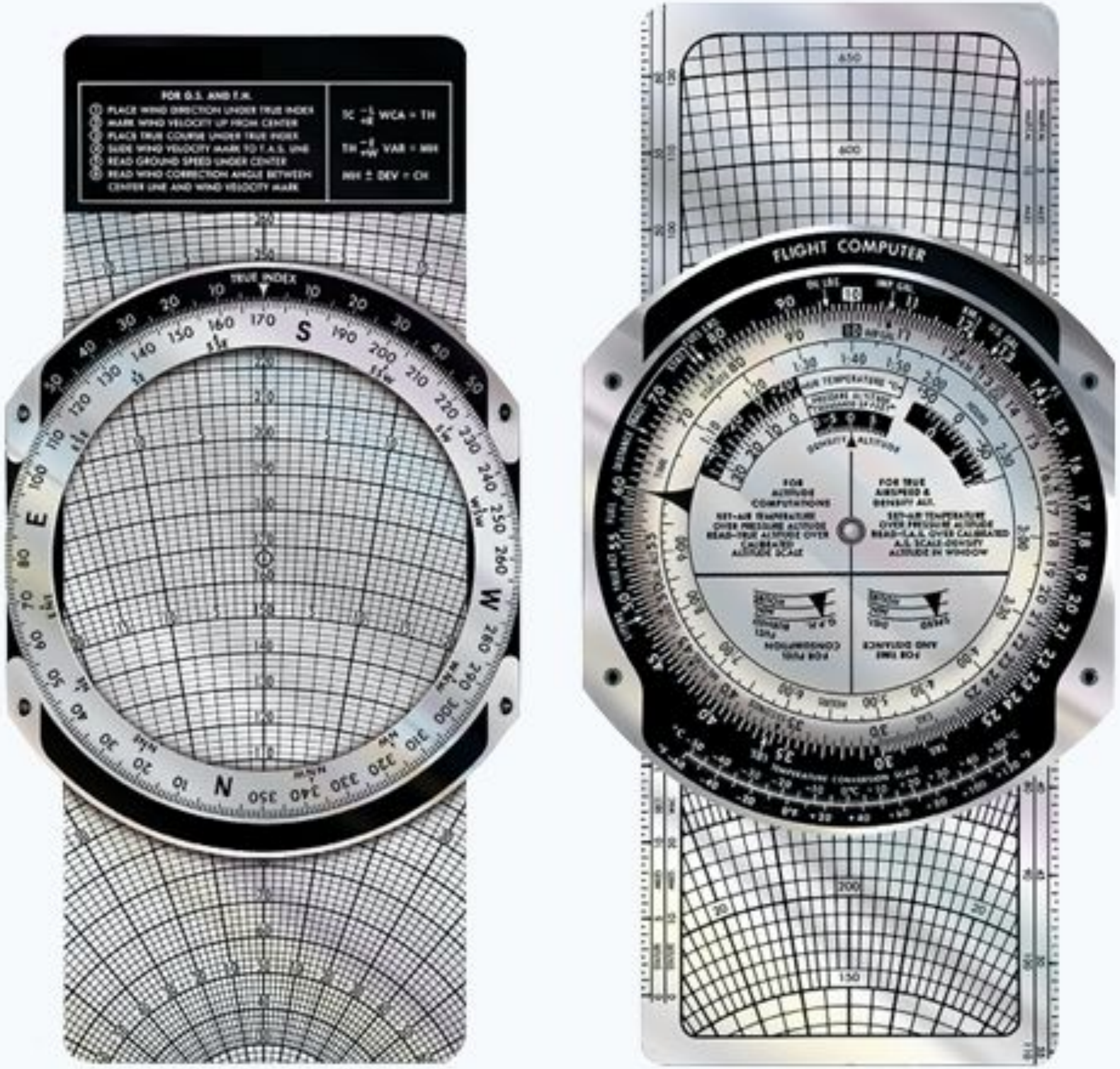
*The maximum speed at which you may use abrupt control travel.

Dead Reckoning vs Pilotage

Dead Reckoning is navigation solely by means of computations based on time, airspeed, distance, and direction. The products derived from these variables, when adjusted by wind speed and velocity, are heading and GS.

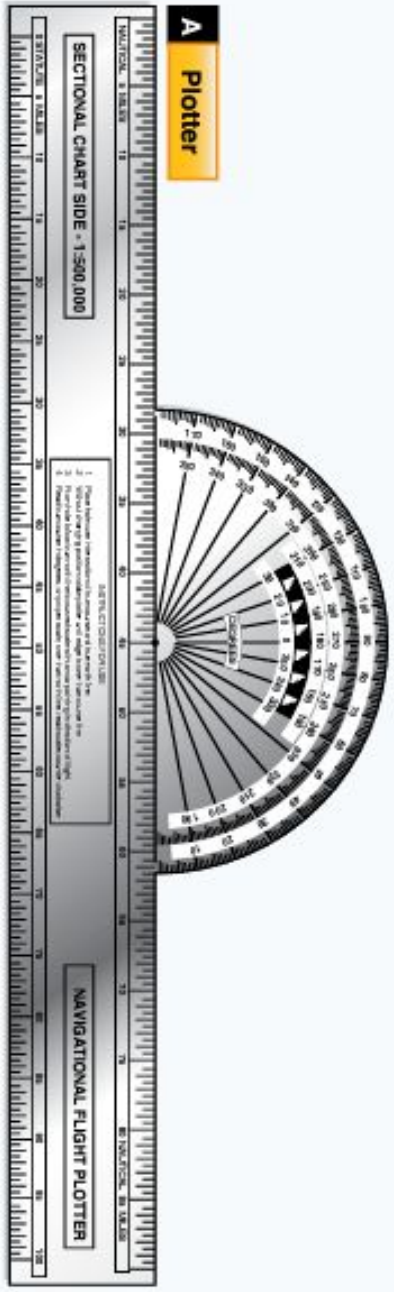
Pilotage is navigation by reference to landmarks or checkpoints. It is a method of navigation that can be used on any course that has adequate checkpoints, but it is more commonly used in conjunction with dead reckoning and VFR radio navigation.





B Mechanical flight computer

C Electronic flight computer



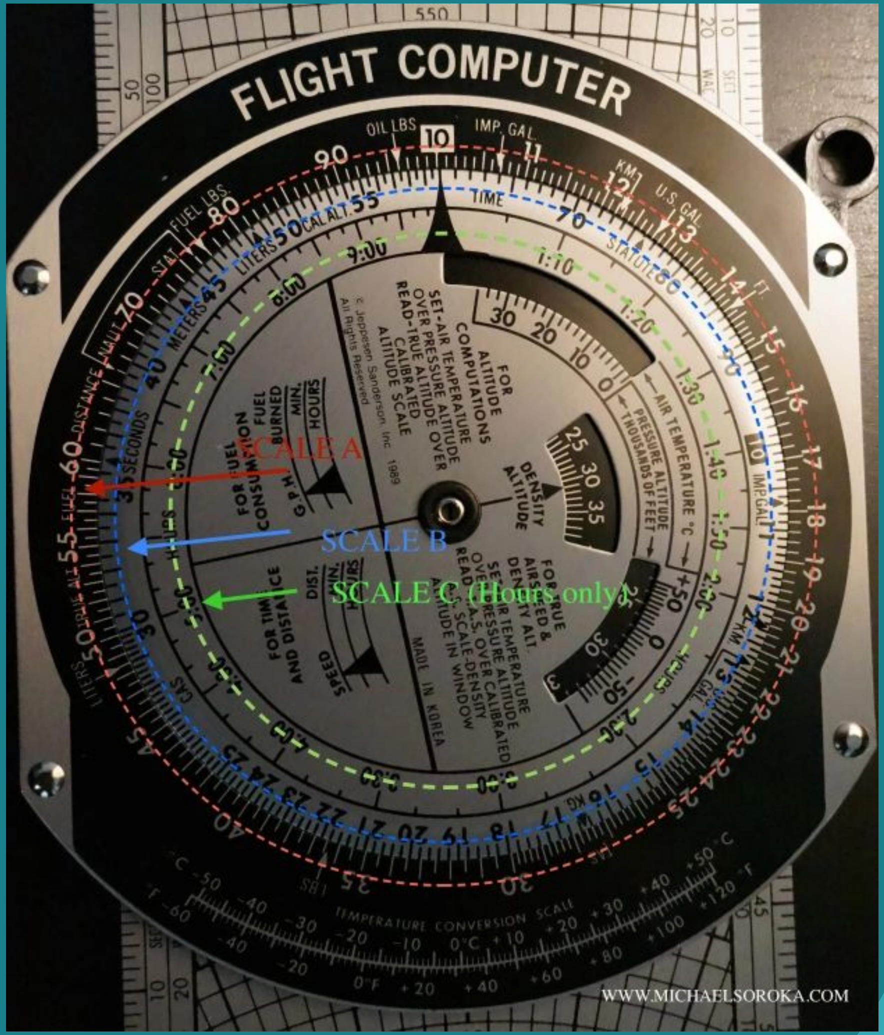
A Plotter

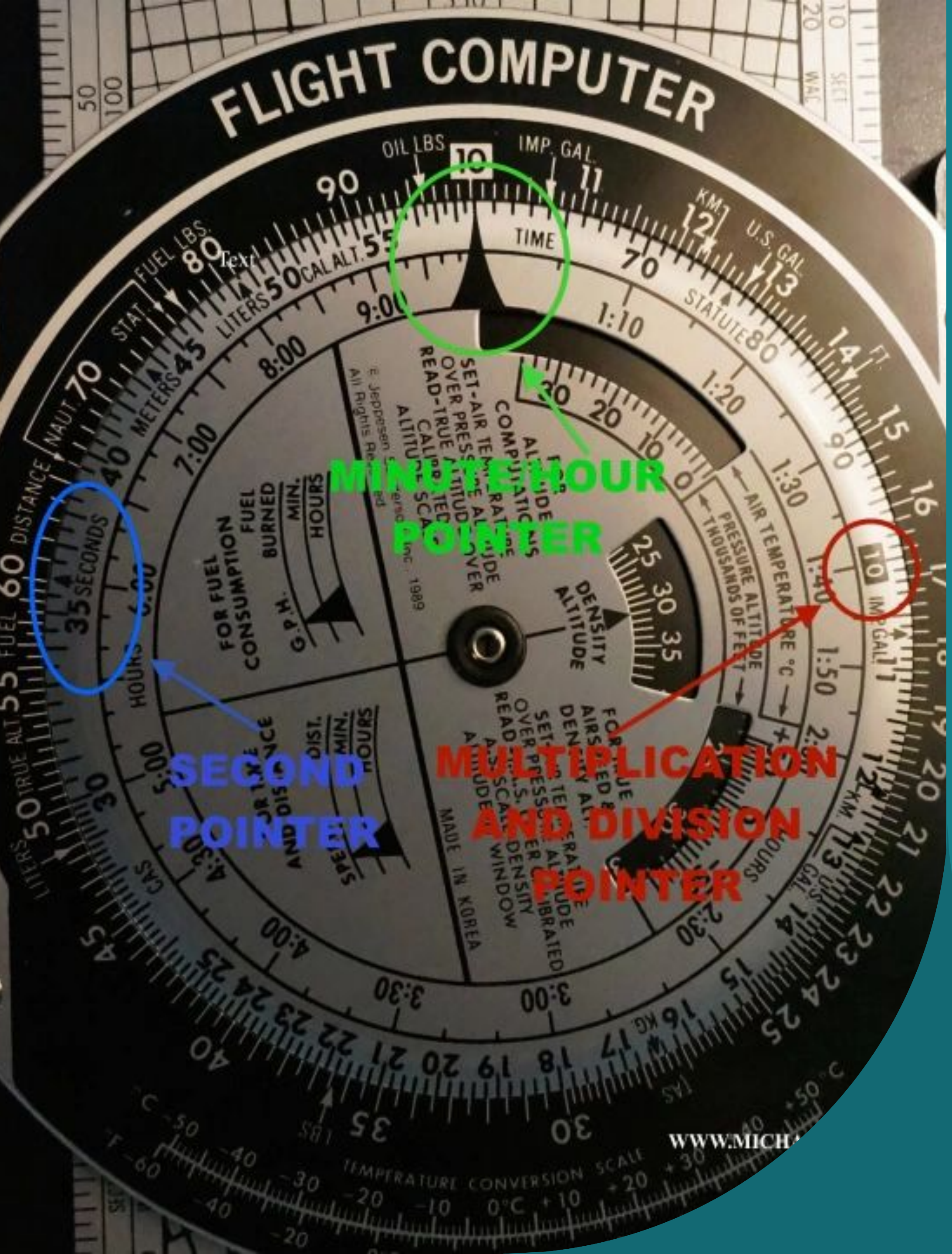
The Manual E6B

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





Manual E6B: Pointers

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

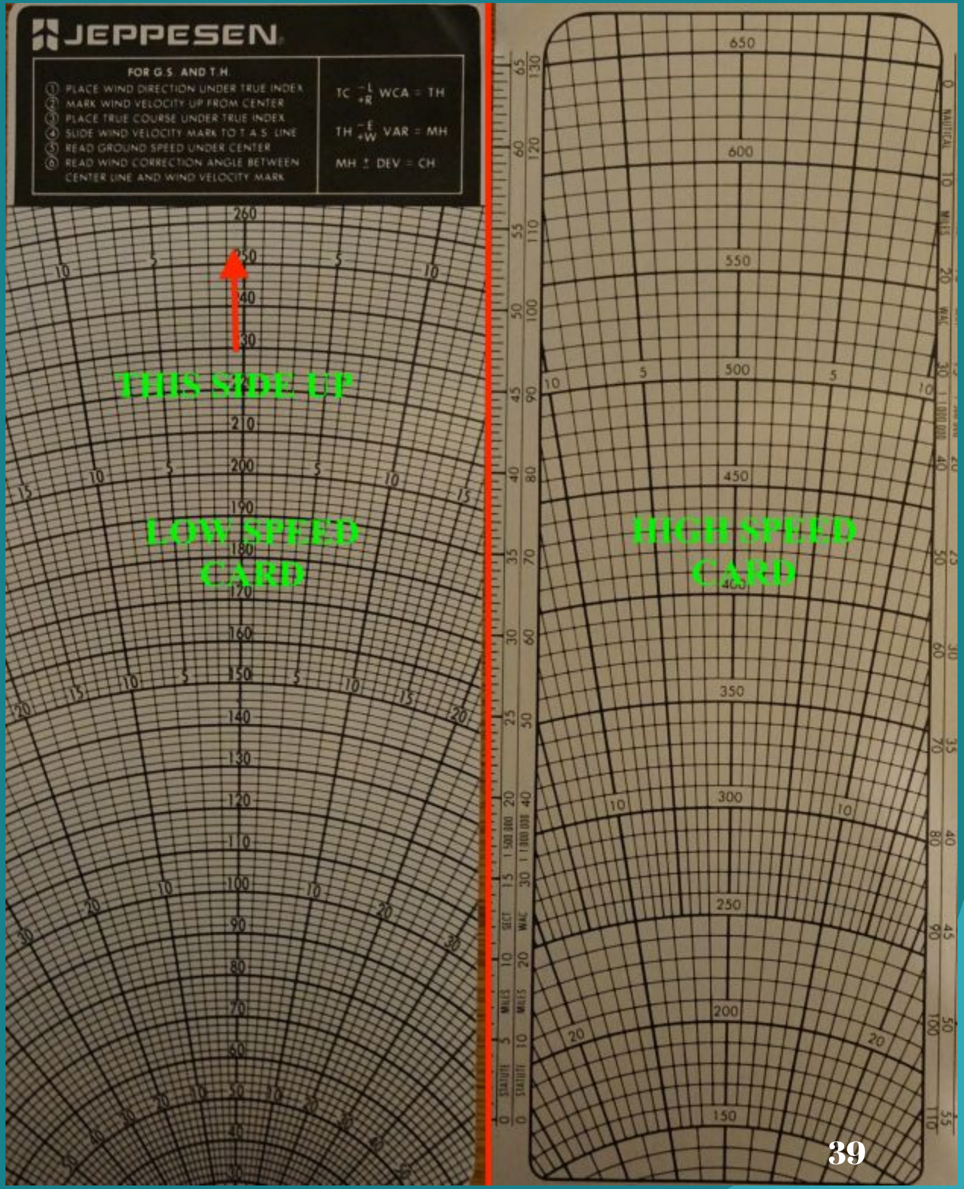
MULTIPLICATION AND DIVISION POINTER – This tiny pointer that extends from the center of the "10" in a black box is used to perform multiplication and division problems like 5 × 7 or 22 × 37.5.

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.

The Windage side of the E6B

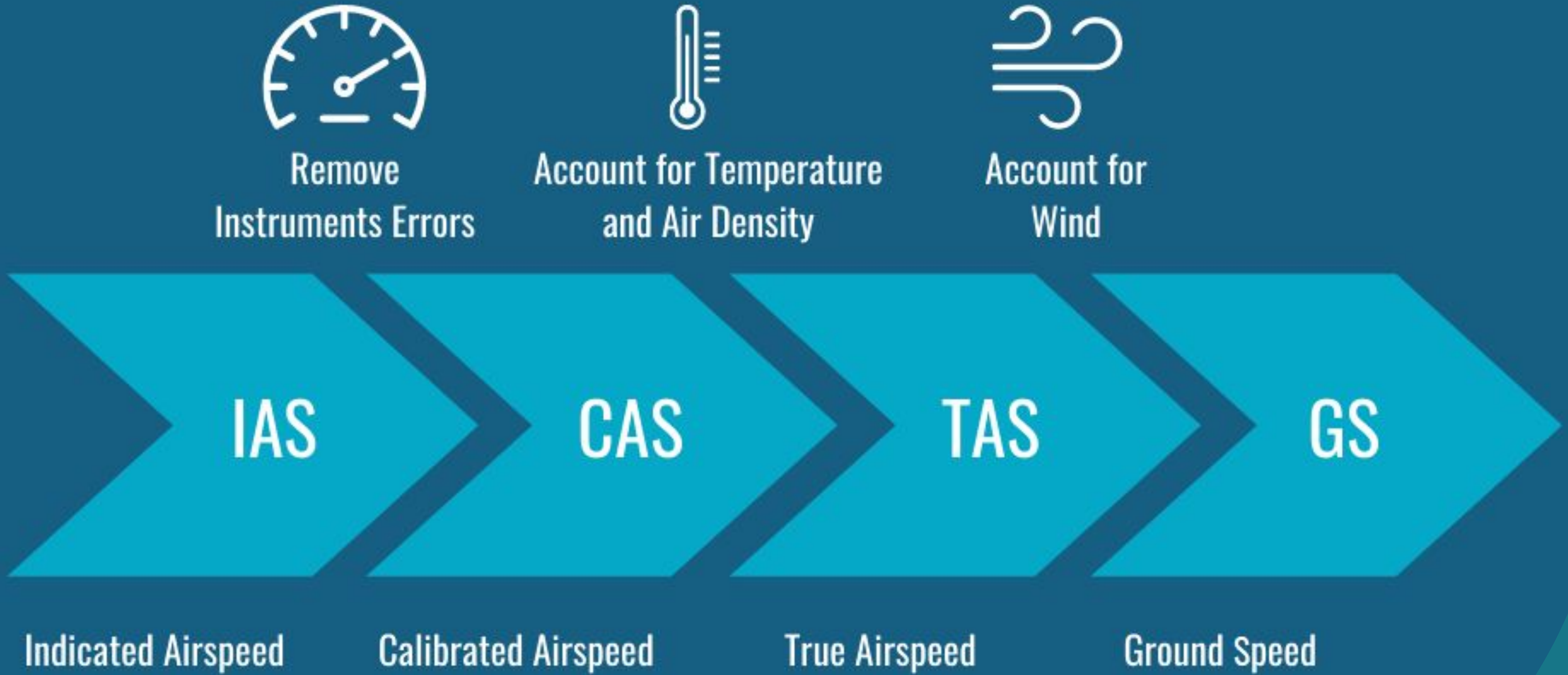
On the backside of the E6B, you will notice a rotating dial and a metal slider. The metal slider is reversible and has one side for low speed aircraft (like light training planes) and one side for high speed aircraft (like jets). Before getting started, make sure you are using the correct side and that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



Navigation Log

[Jeppesen Navigation Log]

Airspeed Conversions


Remove Instruments Errors
Account for Temperature and Air Density
Account for Wind
IAS
CAS
TAS
GS
Indicated Airspeed
Calibrated Airspeed
True Airspeed
Ground Speed

Indicated Airspeed (IAS)

- The direct instrument reading obtained from the Airspeed Indicator (ASI), uncorrected for variations in atmospheric density, installation error, or instrument error.

- The Airspeed Indicator (ASI) measures the difference between the static pressure from the aircraft's static ports, and the ram pressure (dynamic + static) from the pitot tube. This difference is the dynamic pressure, which translates into a reading.

- Manufacturers use this airspeed as the basis for determining aircraft performance.

- Takeoff, landing, and stall speeds listed in the Aircraft Flight Manual (AFM) / Pilot's Operating Handbook (POH) are IAS and do not normally vary with altitude or temperature.

Calibrated Airspeed (CAS)

Calibrated Airspeed is Indicated Airspeed (IAS) corrected for installation error and instrument error.

Although manufacturers attempt to keep airspeed errors to a minimum, it is not possible to eliminate all errors throughout the airspeed operating range.

At certain airspeeds and with certain flap settings, the installation and instrument errors may total several knots. This error is generally greatest at low airspeeds.

In the cruising and higher airspeed ranges, IAS and CAS are approximately the same.

You can find the calibrated airspeed for your airplane in the calibration chart of the aircraft manual.

Calibrated airspeed is the same as true airspeed when you are flying at sea level under International Standard Atmosphere (ISA) conditions.

The POH for CAS

AIRSPEED CORRECTION TABLE												
	IAS	40	50	60	70	80	90	100	110	120	130	140
FLAPS UP	CAS	53	58	64	72	79	88	97	107	117	127	137
FLAPS DOWN	CAS	49	55	63	72	81	90	100	•	•	•	•

Figure 6-1.

True Airspeed (TAS)

True Airspeed is Calibrated Airspeed (CAS) corrected for altitude and nonstandard temperature.

Because air density decreases with an increase in altitude, an aircraft has to be flown faster at higher altitudes to cause the same pressure difference between pitot impact pressure and static pressure.

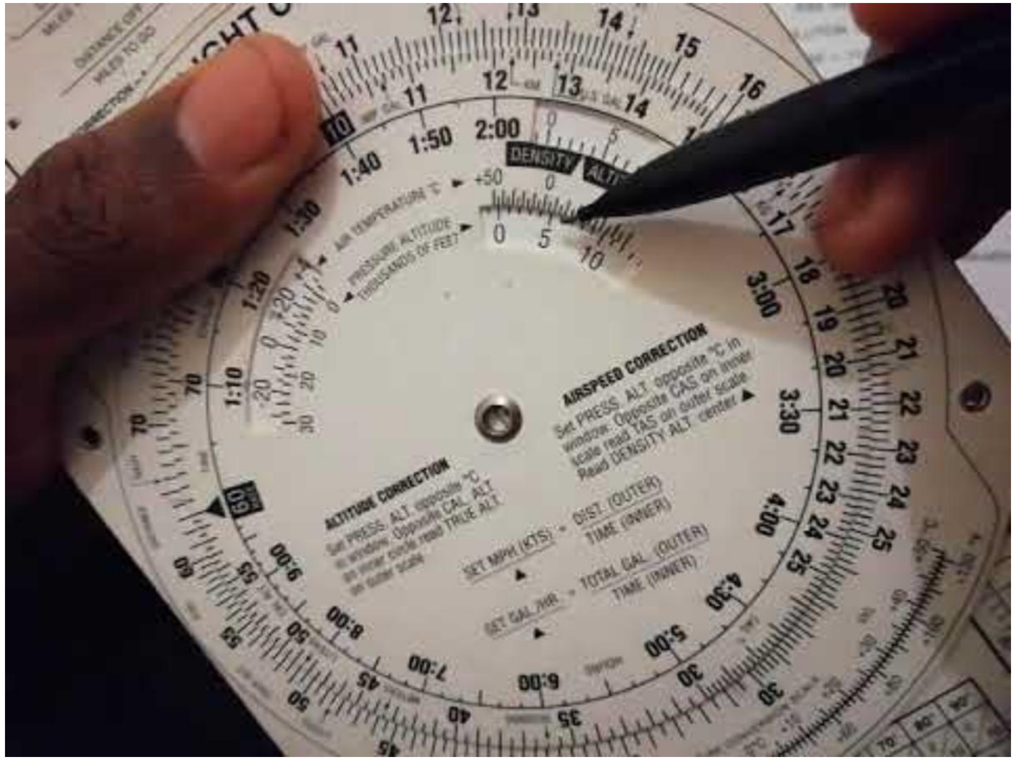
Therefore, for a given CAS, TAS increases as altitude increases; or for a given TAS, CAS decreases as altitude increases.

A pilot can find TAS by two methods. The most accurate method is to use a conventional or electronic flight computer.

A second method, which is a rule of thumb, provides the approximate TAS. Simply add 2 percent to the CAS for each 1,000 feet of altitude. At 10,000 feet, you are flying approximately 20% faster than your indicated airspeed.

The TAS is used for flight planning and when filing a flight plan.

E6B to get TAS

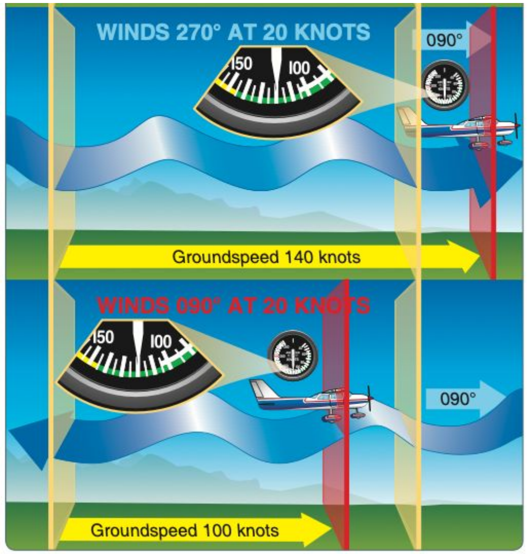


- Calculating True Airspeed
- To calculate your true airspeed (TAS), set your pressure altitude across from the temperature in Celsius in the air temperature window in the center of the E6B.
- If needed, use the temperature conversion chart at the bottom of the instrument that can be used to convert Fahrenheit into Celsius.
- Opposite the calibrated airspeed (CAS) on the B scale note the true airspeed (TAS) on the A scale.

More info on How to Use your manual E6B

Ground Speed

- Groundspeed is the actual speed of the airplane over the ground. It is the True Airspeed (TAS) adjusted for wind.
- While not an airspeed, GS is important for navigation and has a major impact on the time it takes to get to a destination.
- GS decreases with a headwind and increases with a tailwind.



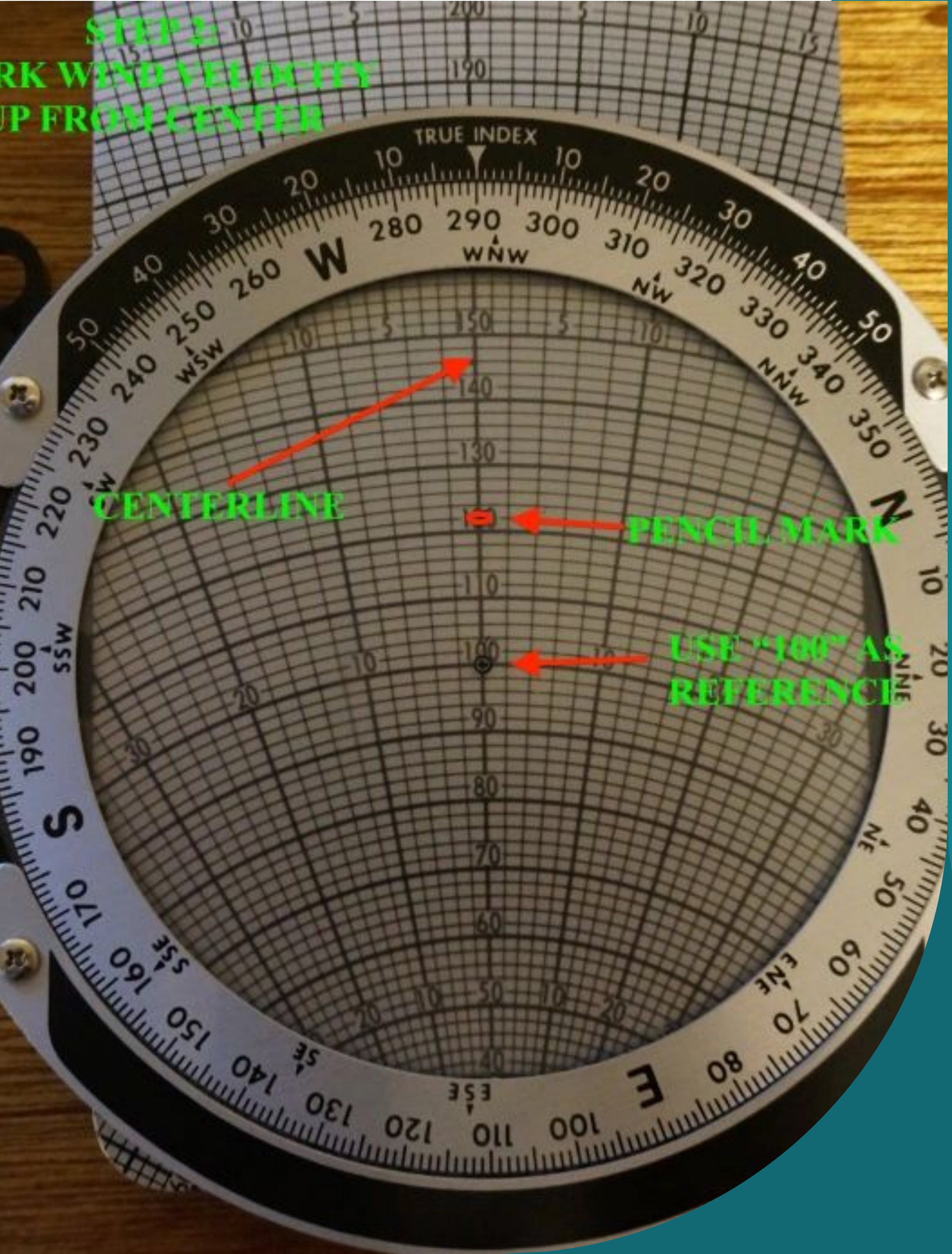
Calculating Knots / MPH: Groundspeed

- Calculating ground speed, be it in knots or mph, can be done by finding the distance traveled and the time it took to travel that distance. This is known as a ground speed check. To do this, you need to know the distance from ground checkpoint to ground checkpoint. This information is written down in the nav log. The pilot obtains this information by measuring the distance on the sectional by using the nautical miles scale on either the plotter or on the ruler marked sides of the E6B.

- Let's say the aircraft is over Big Lake and your next checkpoint is College Campus. You measured the distance and have determined it is 15 nm. You started the timer in the aircraft when you were over Big Lake. When you reached College Campus, you note it took 8 minutes to get there.
- Line up 15 on the A scale over the 8.0 on the B scale.

- Now note the pointer is lined up with 11.2 on the A scale. Here's where we use some common sense again—11 mph or 11 knots wouldn't make sense—but a ground speed of 112, does, and that's the answer.

[Flying Magazine on Flight Planning Calculations]



Crab Angle & Ground Speed Adjusted for Wind

For this example, we will use:

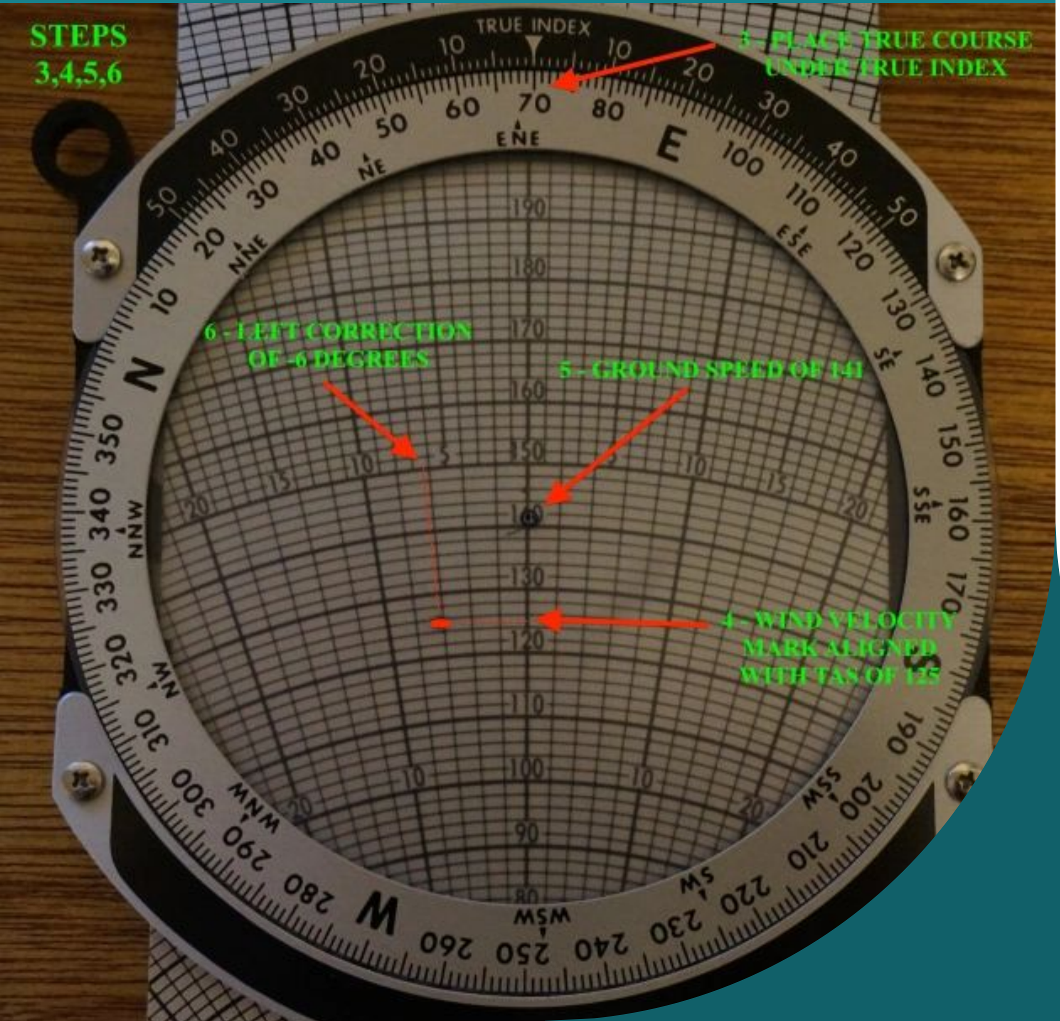
True Airspeed of 125kts

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.
    1. 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.
    2. 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”.

Crab Angle & Ground Speed Adjusted for Wind Cont.



- 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**.

Course & Heading Conversions

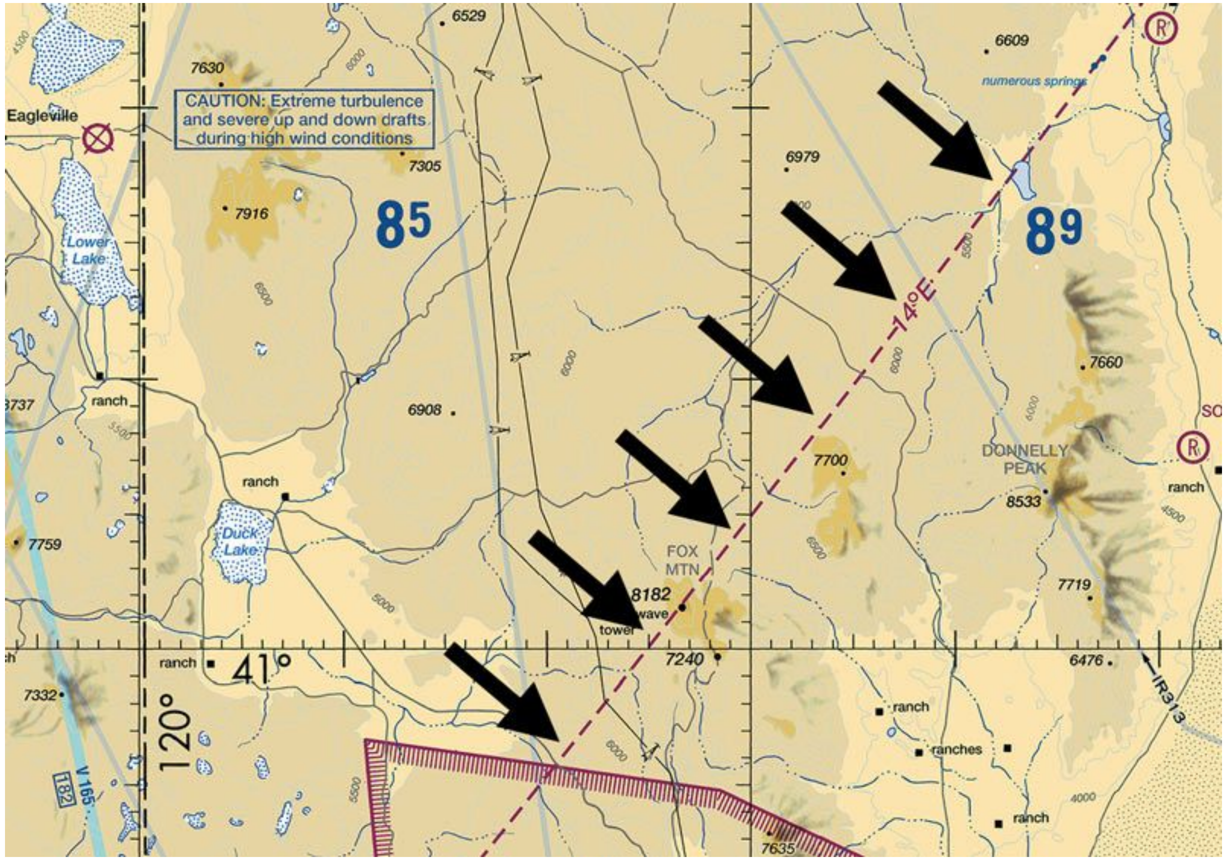
TC ± WCA = TH

- TC—True Course. Direction of the line connecting two desired points, drawn on the chart and measured clockwise in degrees from TN on the mid-meridian
- WCA (wind correction angle) is achieved by taking True Course and adding or subtracting based on E6B calculations of where the wind will blow you. This will give you True Heading. We apply this before variation because the winds aloft are true, not magnetic.

Remember:

- Wind adjustment converts course to heading.
- Variation adjustment converts true to magnetic
- Deviation adjusts for errors in the compass caused by airplane systems.

TH ± VAR = MH



Magnetic variation around us is 14 degrees E, so we subtract 14 from True Course to get Magnetic Course or -14 from True Heading to get Mag Heading. These lines are long dashed magenta strewn across the sectional charts.

Remember:

- Wind adjustment converts course to heading.
- Variation adjustment converts true to magnetic
- Deviation adjusts for errors in the compass caused by airplane systems.

MH ± DEV = CH

Correcting for deviation as laid out by the compass deviation card gives you your course heading.

- Think of it this way, you adjust your heading indicator every 15mins, so, if you lose your heading indicator you have a compass to follow.

Remember:

- Wind adjustment converts course to heading.
- Variation adjustment converts true to magnetic
- Deviation adjusts for errors in the compass caused by airplane systems.

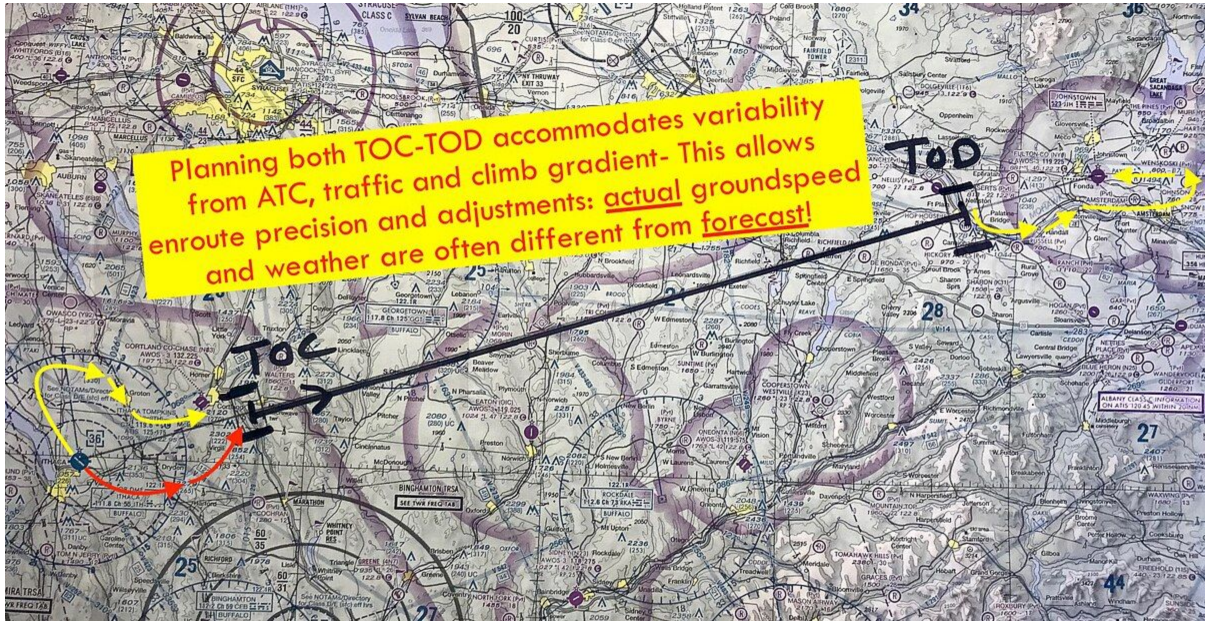
TOC, Climb, & TOD

Reminder.... VFR Cruising Altitudes

If your magnetic course (ground track) is:	And you are more than 3,000 feet above the surface but below 18,000 feet MSL, fly:	And you are above 18,000 feet MSL to FL 290, fly:
0° to 179°	Odd thousands MSL, plus 500 feet (3,500; 5,500; 7,500, etc.)	Odd Flight Levels plus 500 feet (FL 195; FL 215; FL 235, etc.)
180° to 359°	Even thousands MSL, plus 500 feet (4,500; 6,500; 8,500, etc.)	Even Flight Levels plus 500 feet (FL 185; FL 205; FL 225, etc.)

Top of Climb

- Use winds aloft chart to get winds and temperature for climb out to utilize the 2/3rds rule of TOC
- Utilize the POH climb charts to get time fuel and distance



MAXIMUM RATE-OF-CLIMB DATA

	AT SEA LEVEL & 59°F			AT 5000 FT. & 41°F			AT 10,000 FT. & 23°F			AT 15,000 FT. & 5°F		
GROSS WEIGHT POUNDS	IAS MPH	RATE OF CLIMB FT/MIN	GAL. OF FUEL USED	IAS MPH	RATE OF CLIMB FT/MIN	FROM S. L. FUEL USED	IAS MPH	RATE OF CLIMB FT/MIN	FROM S. L. FUEL USED	IAS MPH	RATE OF CLIMB FT/MIN	FROM S. L. FUEL USED
2300	91	645	1.0	85	435	2.6	80	230	4.8	73	20	11.5
2000	86	840	1.0	81	610	2.2	75	380	3.6	68	155	6.3
1700	83	1085	1.0	77	825	1.9	70	570	2.9	64	315	4.4

NOTES:
1. Flaps up, full throttle, mixture leaned for smooth operation above 3000 ft.
2. Fuel used includes warm up and take-off allowance.
3. For hot weather, decrease rate of climb 20 ft./min. for each 10°F above standard day temperature for particular altitude.

[Flight Planning CFI Notebook]

CRUISE PERFORMANCE
SKYHAWK

Gross Weight- 2300 Lbs.
Standard Conditions
Zero Wind Lean Mixture

NOTE: Maximum cruise is normally limited to 75% power. Cruise speeds for the standard Model 172 are 1 to 3 MPH lower than shown with the maximum difference occurring at higher powers.

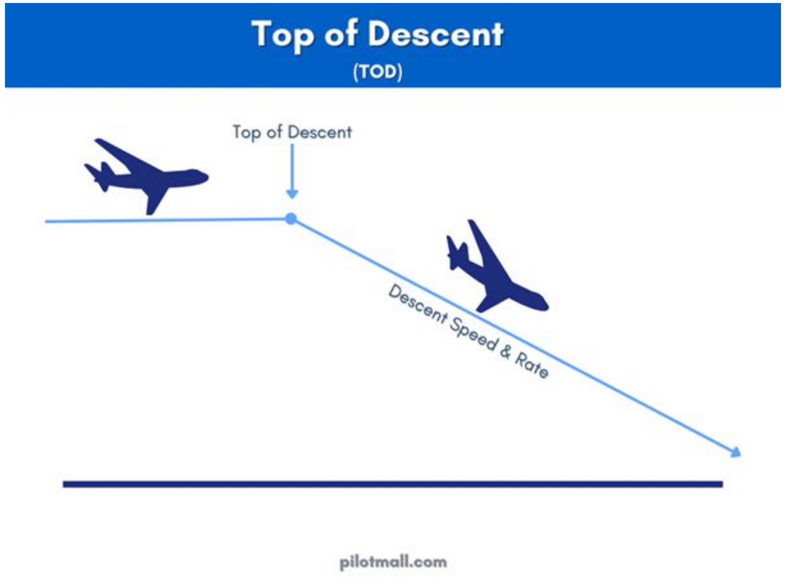
					38 GAL (NO RESERVE)		48 GAL (NO RESERVE)	
ALTITUDE	RPM	% BHP	TAS MPH	GAL/ HOUR	ENDR. HOURS	RANGE MILES	ENDR. HOURS	RANGE MILES
2500	2700	87	139	9.6	3.9	545	5.0	690
	2600	78	133	8.6	4.4	590	5.6	745
	2500	70	128	7.7	4.9	630	6.2	795
	2400	63	122	7.1	5.3	655	6.7	825
	2300	57	116	6.6	5.7	665	7.2	840
	2200	51	109	6.2	6.1	665	7.7	840
5000	2700	81	138	8.9	4.3	585	5.4	740
	2600	73	133	8.1	4.7	630	6.0	795
	2500	66	128	7.4	5.1	655	6.5	830
	2400	60	121	6.8	5.6	675	7.0	850
	2300	54	114	6.4	5.9	675	7.5	855
	2200	48	107	6.0	6.3	675	8.0	850
7500	2700	76	138	8.4	4.5	630	5.7	795
	2600	69	133	7.6	5.0	660	6.3	835
	2500	63	126	7.1	5.4	675	6.8	855
	2400	57	119	6.6	5.8	685	7.3	865
	2300	51	112	6.2	6.1	685	7.8	865
10,000	2700	72	138	7.9	4.8	665	6.1	840
	2600	66	131	7.3	5.2	685	6.6	860
	2500	59	124	6.8	5.6	695	7.1	875
	2400	54	117	6.4	6.0	700	7.5	880
	2300	48	110	6.0	6.3	700	8.0	880
12,500	2650	65	132	7.2	5.3	695	6.6	
	2500	56	122	6.5	5.8	710	7.3	
	2400	51	115	6.2	6.2	710	7.8	

Cruise

- Measure the mileage and utilize time fuel distance calculations with the Cruise chart in the POH (example to the left)

- Time T = D/GS
- Distance D = GS X T
- GS = D/T

Top of Descent



- Time = [Current ALT - Final ALT] / Descent Rate
- Distance = [Current ALT - Final ALT] / Descent Rate x Ground Speed / 60
- Or
- base it on 1000 fpm descent rate. Since on average you will be travelling around 2 miles/minute (120 kts, certainly close enough for this purpose), take the altitude to lose and multiply by 2. ie 4000 ft = 8 nm
- Or
- 3 to 1 formula. This means that it takes 3 NM to descend 1,000 feet. If an airplane is at FL 310 and the approach gate or initial approach fix is at 6,000 feet, the initial descent requirement equals 25,000 feet (31,000–6,000).

Flight Planning Considerations

Flight Planning Considerations

Day before flight:

- 1. Gather current charts, A/FD, navigation log, POH performance data, flight computer, etc.
- 2. Spread out charts and eyeball approximate route of flight considering the following:
- • Route: Try to choose the most direct route but consider terrain during the climb, en route and descent. Use victor airways, obvious landmarks, and navigation aids if available. Make sure there are easily identified checkpoints along the route. Power lines, private airports, and train tracks are usually not easily identifiable!
- • Airspace: Avoid restricted airspace and MOA's. Plan for appropriate clearances, weather minima, and equipment required for class B, C, & D airspaces.
- • Terrain: Make sure you don't have terrain along your proposed route that is higher than the aircraft's service ceiling. For safety make sure you have at least 2000 foot obstacle/terrain clearance.
- • Airports: Make sure there are appropriate (runway lengths & available services) airports for needed, planned or unplanned stops.
- • Fuel: Do you need a fuel stop? At what fuel indication would you divert for fuel? How much are you landing with? Does your destination have fuel services and available 24 hours?
- • Emergencies: In case of an in-flight emergency make sure there are suitable landing sites (on and off airport). Don't fly long distances over lakes or open water.
- • Night: Cities and highways are most of your visual references at night. Be especially alert to mountainous terrain, instrument conditions, airport lighting availability, and emergency landing sites. Pack a flashlight, extra batteries, and emergency supplies.

Flight Planning Considerations Cont.

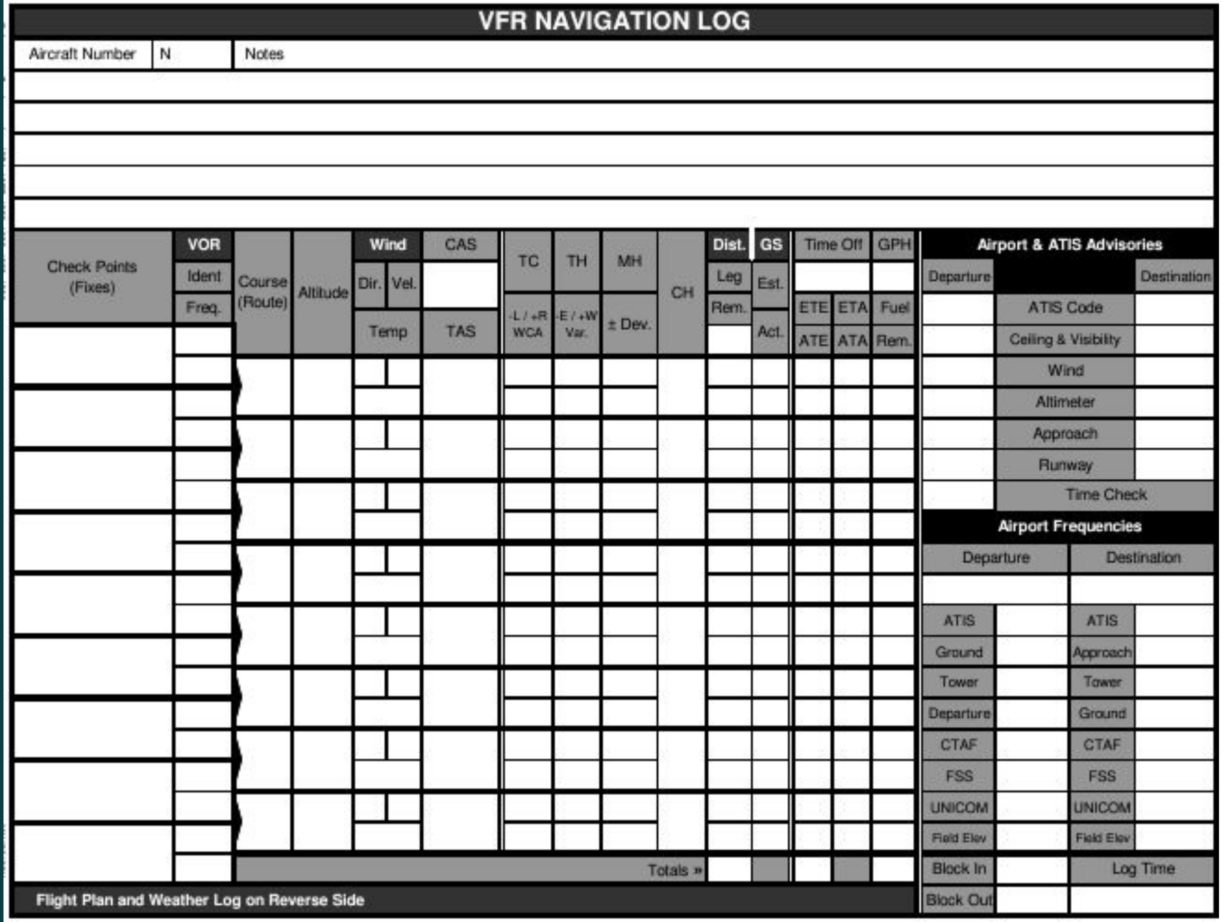
- 3. Use plotter and pencil to draw intended route of flight. 4
- . In your navigation log, begin to enter the structure of the flight plan. Some of the details will be added later with current weather. For now, start with the departure airport in the first “Checkpoint” box.
- 5. The first checkpoint should be an easily identifiable point approximately 10-15 miles from the departure airport. It usually goes along with the “Top of Climb.” The Top of Climb is the point at which the airplane reaches its initial cruising altitude. This point is determined from the climb performance charts in the POH. The Top of Climb will be determined when you get the weather for the flight, as it is determined by winds and temperatures.
- 6. Identify and mark an “X” at each checkpoint along the route. The check points should be evenly spaced along the route and have clearly visible references (freeways, airports, tall towers, cities, etc.). The route should have checkpoints approximately every 15-20 miles. If your airplane’s airspeed indicator is in MPH instead of KTS, you should use statute miles for distance but will need to convert winds aloft from KTS to MPH.
- 7. In the “Checkpoint” box enter or draw a description for each checkpoint you identified, i.e. intersection of roads, which airport, height of tower, etc. and the distance to the next checkpoint.
- 8. If the checkpoint is identified by a VOR, NDB, cross radials, etc., enter each Nav Aid name, Frequency, OBS setting, and note whether there will be a “To” or “From” indication.
- 9. If communications are required (transitioning airspace, flight following, flight service station, etc.), write who you’ll need to contact and the frequency in the “Comm” and “Freq” box.
- 10. For each checkpoint, enter the Route and Altitude you plan to fly to each checkpoint and enter that information in the “Route” and “Alt” boxes.
- 11. Use plotter to find the True Course you’ll fly to each checkpoint and enter the value in the “TC” box. Use longitude lines and try to measure the True Course near the midpoint of the leg.
- 12. After you find the True Course to the checkpoints, use the plotter to find the distance between checkpoints and enter the value in the “Leg Dist” box. Make sure you use the correct scale (Sectional or VFR Terminal, NM or SM). You can do this for each checkpoint except for the Top of Climb (Because you don’t know where this is yet) and the checkpoint following the Top of Climb.
- 13. Use the chart to find the Magnetic Variation for each leg and enter that information in the “Mag Var” box. If the variation is not a whole number (i.e. 13° 30"), round to nearest number.
- 14. Choose Altitude in reference to Magnetic Course (E is odd +500’ from 0-179° and W is even + 500’ from 180-359°), Winds Aloft, Airspace, Duration of Flight, Performance, Terrain, Emergencies etc.
- 15. List airport information and draw small diagram. Write important info like “Twy A closed,” which you found in NOTAMs. Draw traffic patterns in relation to which direction you will be arriving from. This helps you determine how to enter the pattern for whichever runway is in use.

Flight planning Considerations Cont.

Day of the flight:

- 1. Go to www.aviationweather.gov . Under the “Tools” tab, select “Standard Briefing” and review all.
- 2. Use METARs, TAFs, and Winds Aloft to calculate takeoff, climb, en route and decent performance, WCA, and GS. * Remember that winds aloft are given in True Course and in Knots. Convert to magnetic and/or miles per hour if needed.
- 3. Refer to NOTAMs, TFRs, Area Forecast, Prog charts, Airmets, Sigmets, Convective Sigmets, Pireps, and TAFs en route to determine if flight can be accomplished.
- 4. Calculate when/where TOC will occur and complete flight plan boxes for ground speed, time, fuel burn, and magnetic heading. Calculate when you will need to begin decent to TPA (TOD).
- 5. Once you have determined Mag Heading (MH) and know which airplane you will fly, calculate Compass Heading (CH) by applying Deviation from the “Compass Deviation Card” of that airplane.
- 6. Do your Performance Sheet and your Weight & Balance for each leg.
- 7. Calculate Groundspeed, CH, MH, time between waypoints, time enroute, fuel consumption, fuel required, etc. Note which power setting (RPM) you selected for cruise so you set it in flight.
- 8. Finalize your Sectional Chart by marking the route of flight in color (e.g. yellow marker). Circle your checkpoints in a different color.
- 9. File your flight plan and obtain a weather briefing. Review NOTAMs, TFRs, and all pertinent data.
- 10. If you are a student pilot, get endorsement(s) from your Flight Instructor and leave a copy with them

VFR NAVLOG


VFR NAVIGATION LOG
Aircraft Number N Notes
Check Points (Fixes) | VOR Ident Freq. | Course (Route) | Altitude | Wind Dir. Vel. Temp | CAS TAS | TC | TH | MH | -L / +R WCA | -E / +W Var. | ± Dev. | CH | Dist. Leg Rem. | GS Est. Act. | Time Off ETE ATE | ETA ATA | GPH Fuel Rem.
Totals »
Airport & ATIS Advisories
Departure | Destination
ATIS Code
Ceiling & Visibility
Wind
Altimeter
Approach
Runway
Time Check
Airport Frequencies
Departure | Destination
ATIS | ATIS
Ground | Approach
Tower | Tower
Departure | Ground
CTAF | CTAF
FSS | FSS
UNICOM | UNICOM
Field Elev | Field Elev
Block In | Log Time
Block Out
Flight Plan and Weather Log on Reverse Side

- First, remember that this log is for your use. No sense in filling it with so much info it is unreadable. Second, flight planning is done primarily to calculate fuel, time, distance, and navigation to get from one place to another.
- Now let's talk about the boxes: what they mean and how to use them.
- The top section can be used for performance and is fairly self-explanatory. You'll get this information from the POH, but use temperatures and pressures from the day of the flight.
- Checkpoints: Your departure airport should be the first checkpoint. TOC (top of climb) is generally the second checkpoint. If you make a turn before TOC, then enter a location or landmark where the turn will be made and move TOC to the third checkpoint box. Checkpoints should be noted approximately every 10-15 minutes (approx 15-20 miles).
- VOR Freq/Ident: If you are using VORs for navigation, either on airways or as checkpoints, enter the VORs frequency in the top half of the box and the name of the station (i.e. SNS, SJC, etc.) in the bottom half of the box.
- Course: Magnetic course determines our altitude (E is odd + 500', W is even + 500') and is also what VORs use. Magnetic course is derived by taking true course +/- magnetic variation (TC – VAR = MC)