

Performance and Limitations

Objective

Gain an intuitive understanding of how atmospheric conditions affect aircraft performance, and how to use our airplane's performance charts to compute specific performance numbers.

Motivation

Altitude, temperature, and pressure affect all aspects of our airplane's performance. All pilots need to understand how these factors affect the airplane, and what limitations are present in its design.

Instruction: Known to unknown, building on aerodynamics

Overview

- Air and density
 - Density altitude
 - International Standard Atmosphere
 - Types of altitude
 - Types of airspeed
 - How density affects performance
- Airplane performance charts
 - Performance scenario using Cessna charts
 - Other chart styles
- Additional aircraft limitations

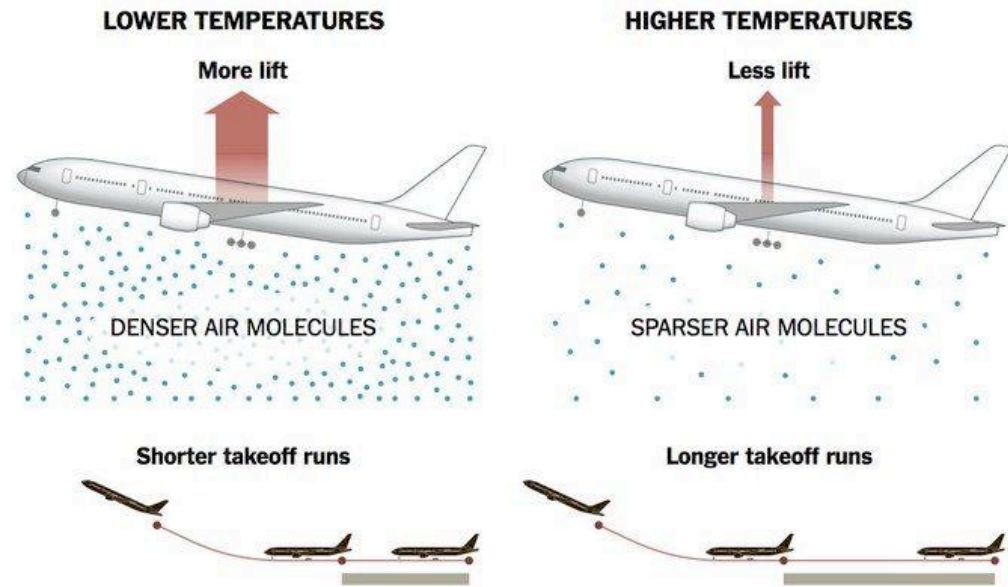
Performance Concepts

Air and Density

- Our airplane swims through the air, air molecules bounce off the airplane
 - As these air molecules are deflected downward, our airplane is forced upward
 - Our propeller pushes air backwards which pushes us forwards
 - Our engine "breaths" air from outside, burns that air with fuel to produce power

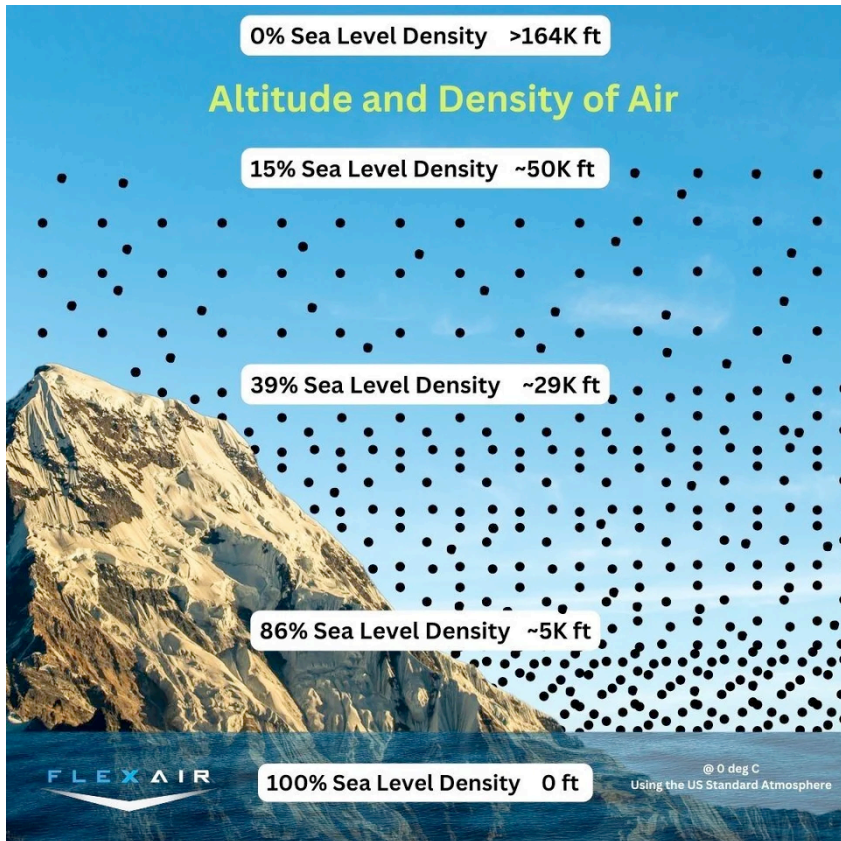
High and Low Air Density

- All of this depends on how close the air molecules are together
- Tightly spaced = more air to grab on to
 - Wings can produce more lift
 - Propeller can produce more thrust
 - Engines can produce more power
- Density constantly changes with
 - i. Pressure
 - ii. Temperature
 - iii. Humidity



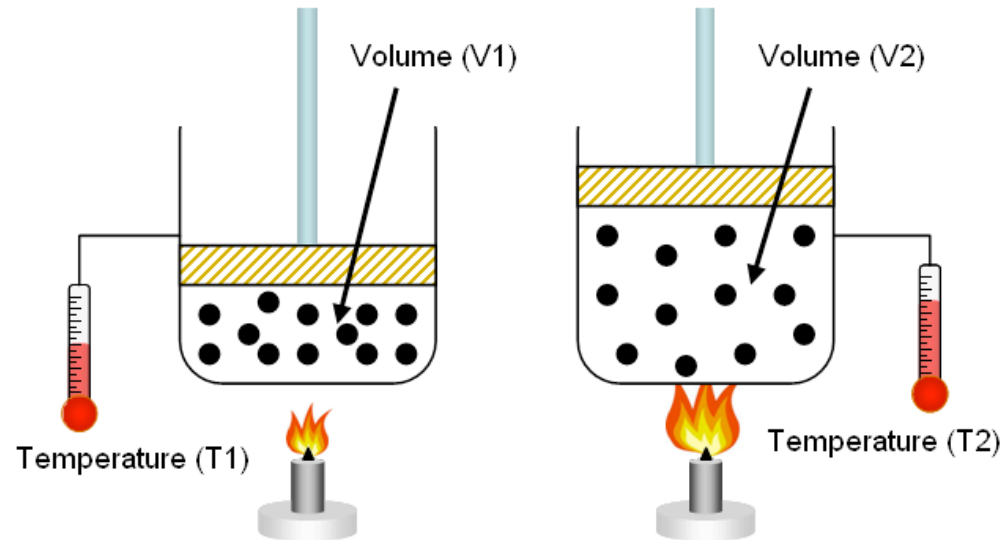
Source: National Oceanic and Atmospheric Administration | By The New York Times

Thing That Affect Density: Ambient Pressure (Variable #1)



- As we climb
 - Ambient pressure decreases
 - Air density decreases
 - Pressure decreases on average 1" Hg per 1000' (*pressure lapse rate*)
- The pressure outside varies from day to day
 - On high pressure days, air is more dense
 - On low pressure days, air is less dense

Things That Affect Density: Temperature (Variable #2)



- Hot air molecules bounce off each other more energetically
- This causes the molecules to spread out and become less dense
- Likewise, cold air molecules are less excited become more dense

Humidity: Temperature (Variable #3)

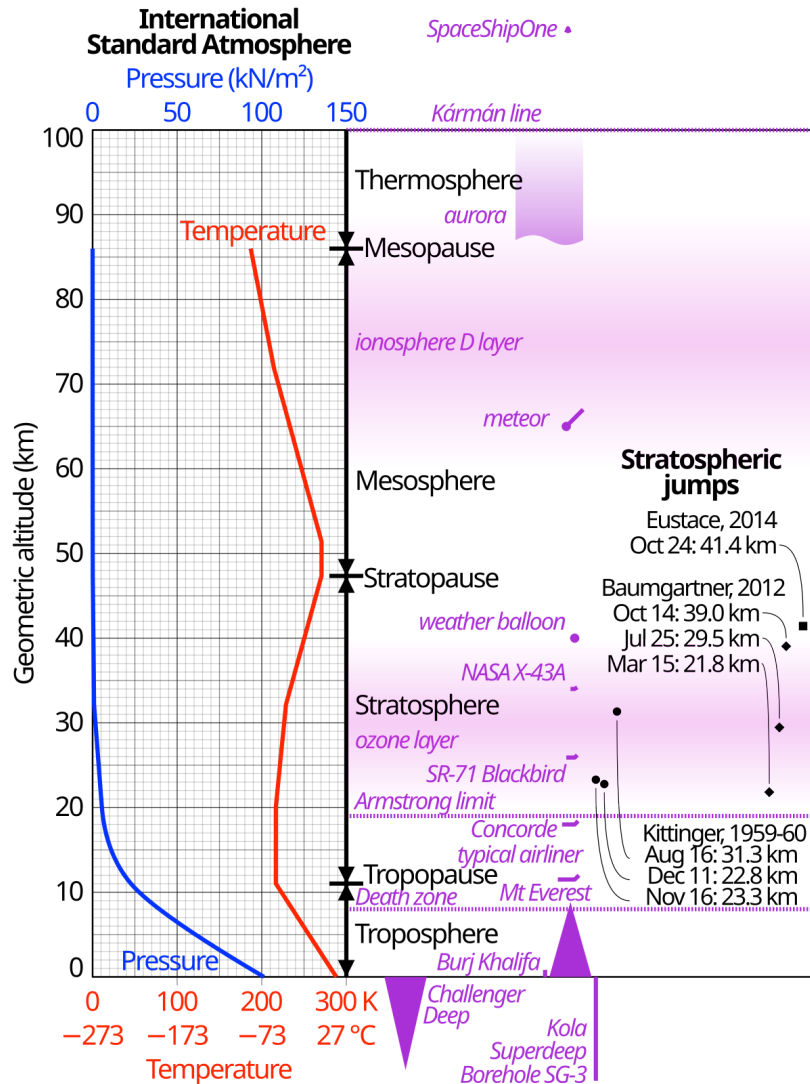


- Water vapor in the air also takes up space
- The higher the humidity, the lower the air density
- Effect of density is small relative to pressure and temperature
 - Usually omitted from performance charts and calculations

Rolling it All Up

- That's a lot of variables to consider
- What if there was one number that would combine the effects of:
 - Altitude
 - Ambient pressure
 - Temperature

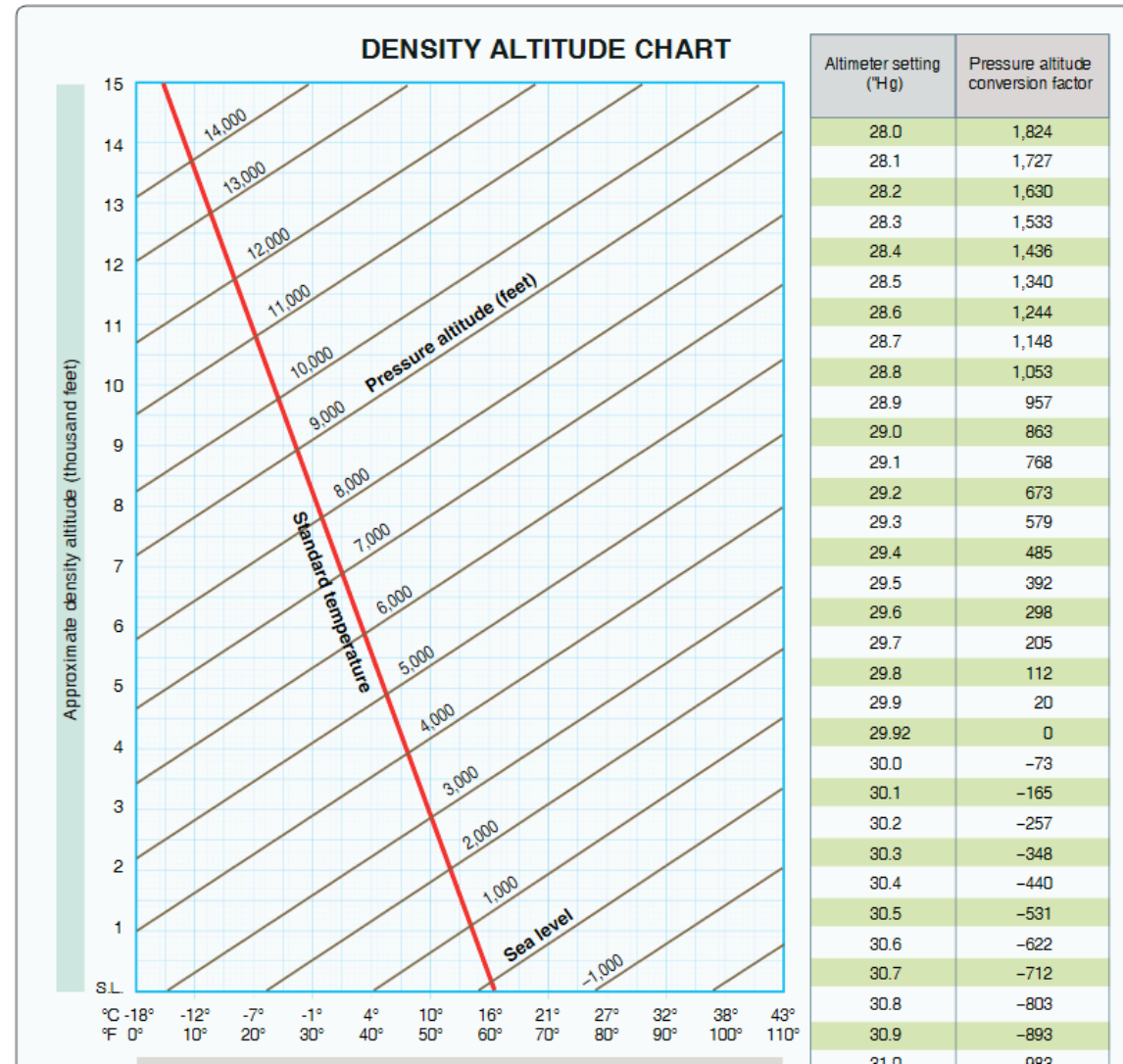
International Standard Atmosphere (ISA)



- What if we made a fake atmosphere with known conditions?
 - Density can be defined as an altitude in this atmosphere
- The higher the altitude, the lower our airplane's performance
- ISA Definitions
 - At sea level, the pressure is 29.92" Hg
 - Pressure lapses (reduces) at 1" Hg per 1000'
 - Temperature: 15° C at S.L.
 - Temperature lapse rate: 2°C per 1000' (to

Computing Density Altitude

Appendix 2



4000 ft. / 84° F, 29° C / 29.80" Hg

1. Start with field elevation: **4000 ft.**
2. Correct for Variable Ambient Pressure
 - $4000 + 112' = \mathbf{4112}$
 - *Pressure altitude*
3. Correct for Variable Temperature:
 - 4000' line & **29° F**
 - *~6700' density altitude*

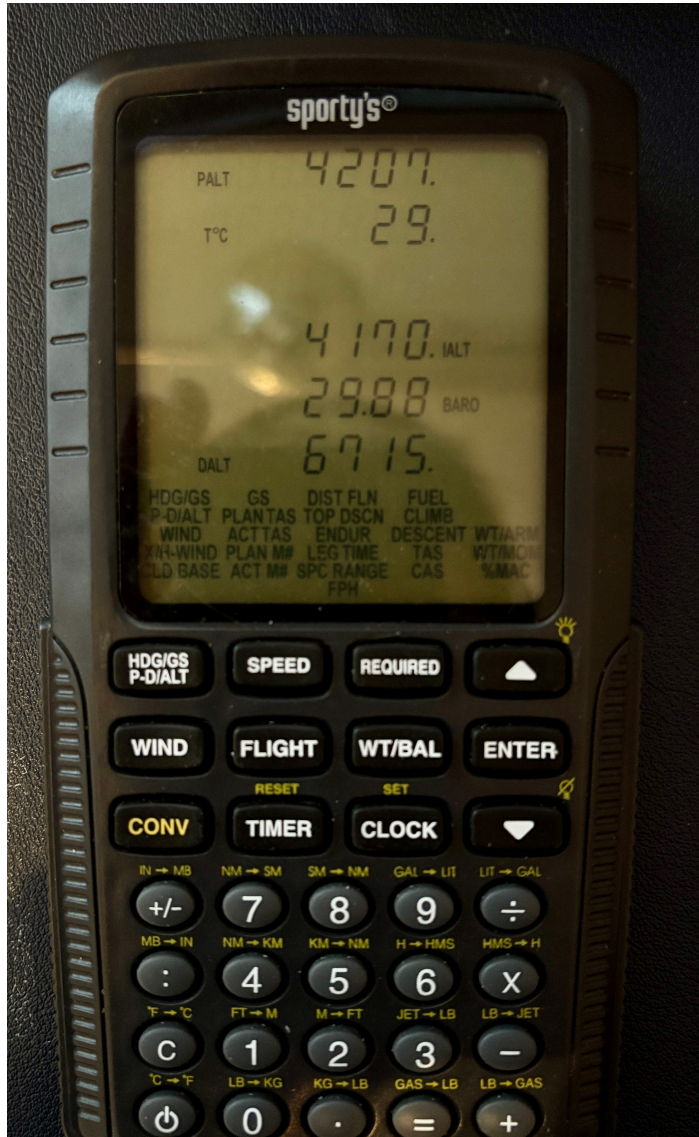
Notice higher temperature = Higher density altitude

Pressure altitude another way: Have the altimeter do the math



- As you rotate the Kollsman window the altimeter moves up and down at that same rate 1" per 1000'
- If we set our altimeter to 29.92" (the pressure of S.L. in the standard atmosphere), it will give us pressure altitude

Density Altitude with an Electronic 56-B



- P-D/ALT mode
- Set Indicated altitude - IALT
- Altimeter setting - BARO
- Outside temperature - T°C
- Gives
 - Pressure altitude PALT
 - Density altitude DALT

Review of Altitude Types

- Ambient pressure/Altimeter setting: Set in the Kollsman window
- **Indicated** altitude: Read directly off the altimeter
- **Pressure** altitude: Height in the ISA where current pressure is found
- **Density** altitude: Height in the ISA where the current pressure is found, plus any correction for temperature

Airspeed

Pitot Tube As A Molecule Counter



- More forward movement: More molecules we hit
- More air density: Molecules tightly spaced so more to hit
- Less air density: Molecules less tightly spaced, less to hit
- Tells us how many air molecules is moving over the wings

Types of Airspeed: Calibrated Airspeed



- The pitot tube is attached at a certain angle
- This might not be directly into the relative wind
- With a high angle of attack, the relative wind will be at a steeper angle
- To account for this, we compute **calibrated airspeed**
 - This is usually given in a table in the POH

Types of Airspeed: True Airspeed



- Adjusts the "molecule count" based on the air density
 - Uses the same 3 variables: Altitude, pressure, temperature
- True airspeed is the speed you're moving through the *air mass*

True Airspeed with an Electronic E6B



ACT TAS Mode

Pressure altitude (PALT): 4210'

Outside air temperature (OAT): 29°C

Calibrated airspeed (CAS): 118 knots

Result TAS is **130.1 knots**

- This means we're flying *faster* through the air mass than the airspeed indicator would have us believe.
- With no wind, we'd be moving 130 knots over the ground

Types Of Airspeeds



- **Indicated** airspeed (IAS): Read from altimeter
- **Calibrated** airspeed (CAS): Calibrated for position/instrument errors
 - At slow airspeeds this may be several knots off
- **True** airspeed (TAS): CAS corrected for altitude and nonstandard temperature
- **Ground** speed (GS): Actual speed over the ground
 - TAS adjusted for wind

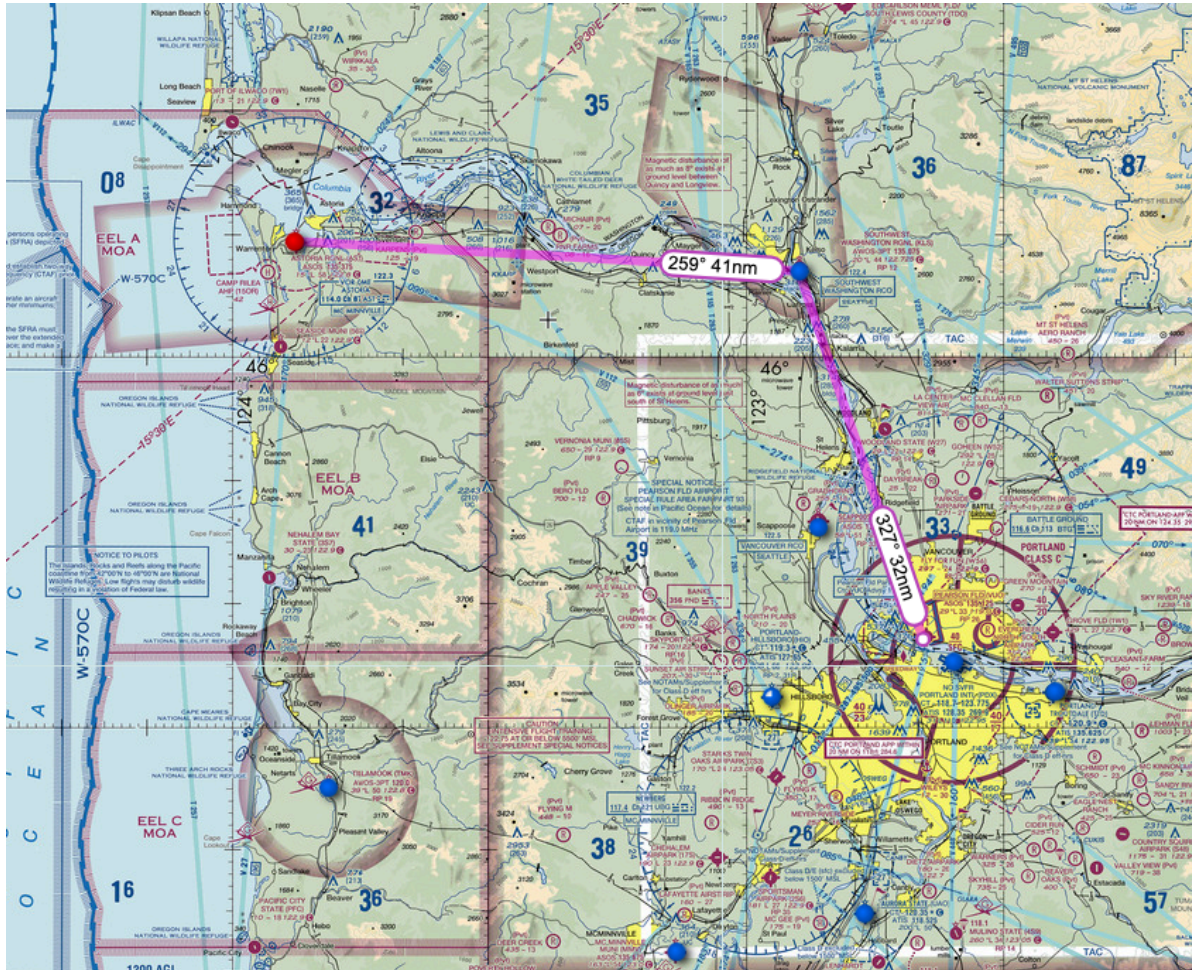
Knowledge Check

Assuming all other variables are the same:

- Where will an airplane have a longer takeoff roll, in Denver or in Orlando?
- Where will an airplane have a longer landing roll, when the temperature is 2° C or 30° C?
- Which aircraft will have a higher ground speed on takeoff, when the pressure is 20.79" or 30.44" Hg?
- When will our (normally-aspirated) airplane produce the most power, on the ground or at 8000 feet?

Performance Planning

Performance



On a real flight we want to know:

- How much runway distance we will use for takeoff
- How long the flight will take
- How much fuel we will burn
- How much landing distance we will use

CRUISE PERFORMANCE

PRESSURE ALTITUDE 2000 FEET

CONDITIONS:

3100 Pounds

Recommended Lean Mixture

Cowl Flaps Closed

NOTE

For best fuel economy, operate at the leanest mixture that results in smooth engine operation or at peak EGT.

		20°C BELOW STANDARD TEMP -9°C			STANDARD TEMPERATURE 11°C			20°C ABOVE STANDARD TEMP 31°C		
RPM	MP	% BHP	KTAS	GPH	% BHP	KTAS	GPH	% BHP	KTAS	GPH
2400	25	---	---	---	78	137	14.8	74	137	14.0
	23	74	131	14.0	70	131	13.3	66	130	12.6
	21	65	125	12.4	62	124	11.8	59	123	11.3
	19	57	117	10.9	54	116	10.5	51	115	10.0
2300	25	78	135	14.9	74	135	14.1	71	134	13.4
	23	70	129	13.3	67	128	12.7	63	128	12.1
	21	62	122	11.8	59	121	11.3	56	120	10.8
	19	54	114	10.4	51	113	10.0	49	112	9.6
2200	25	75	132	14.2	71	132	13.5	67	131	12.8
	23	67	126	12.7	64	126	12.1	60	125	11.5
	21	59	119	11.3	56	118	10.8	53	117	10.3
	19	51	111	9.9	49	110	9.5	46	108	9.1
2100	25	71	129	13.5	68	129	12.9	64	129	12.2
	23	64	123	12.1	60	123	11.5	57	122	11.0
	21	56	116	10.7	53	115	10.3	50	114	9.8
	19	48	108	9.5	46	106	9.1	43	104	8.7
	17	41	97	8.2	39	95	7.8	37	91	7.5

Aircraft Performance Charts

- Published in our POH/AFM
- Based on a new airplane, engine, and propeller
- Based on a test pilot flying with excellent technique (airspeed control, proper leaning)
- Formatted in a variety of ways
 - Some use pressure altitude + temperature (Cessnas)
 - Some use density altitude only

Takeoff Distance - Temperature

TAKEOFF DISTANCE MAXIMUM WEIGHT 3100 LBS

CONDITIONS:

Flaps 20°

2400 RPM and 31 Inches Hg Prior to Brake Release

Mixture Full Rich

Cowl Flaps Open

Paved, Level, Dry Runway

Zero Wind

SHORT FIELD

NOTES:

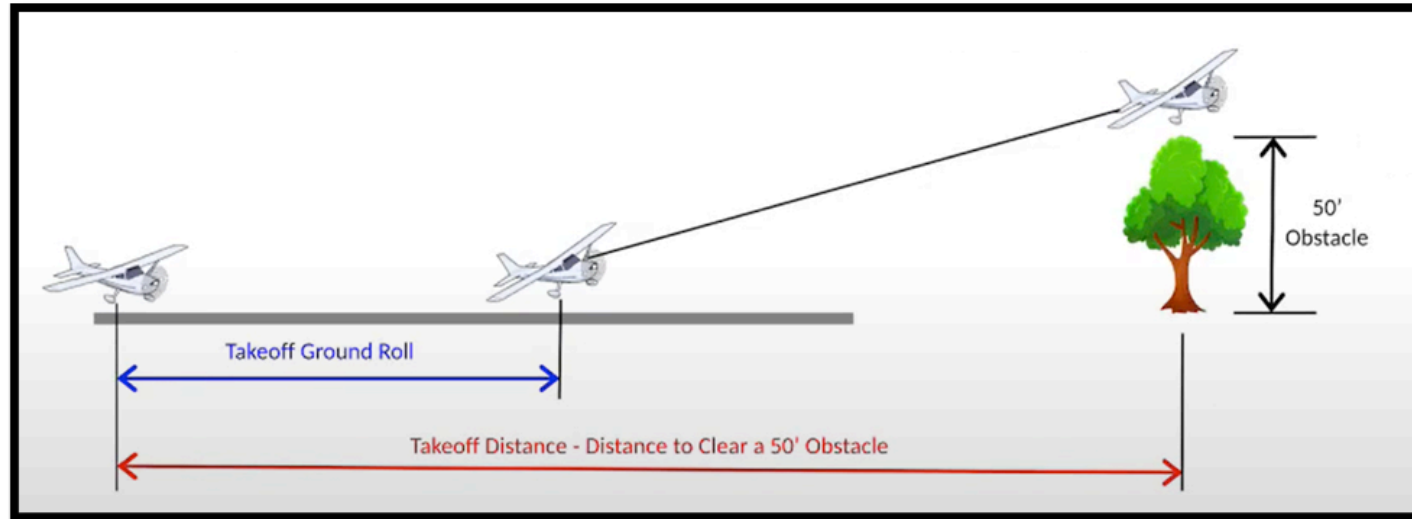
1. Short field technique as specified in Section 4.
2. Decrease distances 10% for each 9 knots headwind. For operation with tailwinds up to 10 knots, increase distances by 10% for each 2 knots.
3. For operation on a dry, grass runway, increase distances by 15% of the "ground roll" figure.

WEIGHT LBS	TAKEOFF SPEED KIAS		PRESS ALT FT	32°F 0°C		50°F 10°C		68°F 20°C		86°F 30°C		104°F 40°C	
	LIFT OFF	AT 50 FT		GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS
3100	49	58	S.L.	700	1310	760	1415	820	1535	890	1665	960	1805
			1000	750	1390	810	1505	880	1630	950	1770	1025	1925
			2000	800	1475	870	1600	940	1735	1015	1885	1100	2050
			3000	855	1570	930	1700	1005	1850	1090	2010	1175	2190
			4000	920	1670	995	1815	1080	1970	1165	2145	1260	2345
			5000	985	1780	1070	1935	1155	2110	1250	2300	1355	2510
			6000	1055	1900	1145	2070	1245	2260	1345	2465	1455	2700
			7000	1135	2035	1235	2220	1335	2425	1450	2650	1565	2910
			8000	1220	2180	1325	2385	1440	2605	1560	2855	1685	3140

Ground Roll

- S.L. at 0° C: 700'
- S.L. at 40° C: 960'
- **260 ft.** increase from temperature alone

Takeoff Distance - Ground Roll vs Obstacle Clearance



Takeoff Distance - Wind

TAKEOFF DISTANCE MAXIMUM WEIGHT 3100 LBS

CONDITIONS:

Flaps 20°

2400 RPM and 31 Inches Hg Prior to Brake Release

Mixture Full Rich

Cowl Flaps Open

Paved, Level, Dry Runway

Zero Wind

SHORT FIELD

NOTES:

1. Short field technique as specified in Section 4.
2. Decrease distances 10% for each 9 knots headwind. For operation with tailwinds up to 10 knots, increase distances by 10% for each 2 knots.
3. For operation on a dry, grass runway, increase distances by 15% of the "ground roll" figure.

WEIGHT LBS	TAKEOFF SPEED KIAS		PRESS ALT FT	32°F 0°C		50°F 10°C		68°F 20°C		86°F 30°C ✓		104°F 40°C	
	LIFT OFF	AT 50 FT		GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS
3100	49	58	S.L.	700	1310	760	1415	820	1535	890	1665	960	1805
			1000	750	1390	810	1505	880	1630	950	1770	1025	1925
			2000	800	1475	870	1600	940	1735	1015	1885	1100	2050
			3000	855	1570	930	1700	1005	1850	1090	2010	1175	2190
			4000	920	1670	995	1815	1080	1970	1165	2145	1260	2345
			5000	985	1780	1070	1935	1155	2110	1250	2300	1355	2510
			6000	1055	1900	1145	2070	1245	2260	1345	2465	1455	2700
			7000	1135	2035	1235	2220	1335	2425	1450	2650	1565	2910
			8000	1220	2180	1325	2385	1440	2605	1560	2855	1685	3140

Sea level, 20°C

18 knot headwind:

20% decrease

$820 * 0.8 = 656 \text{ ft.}$

4 knot tailwind:

20% increase

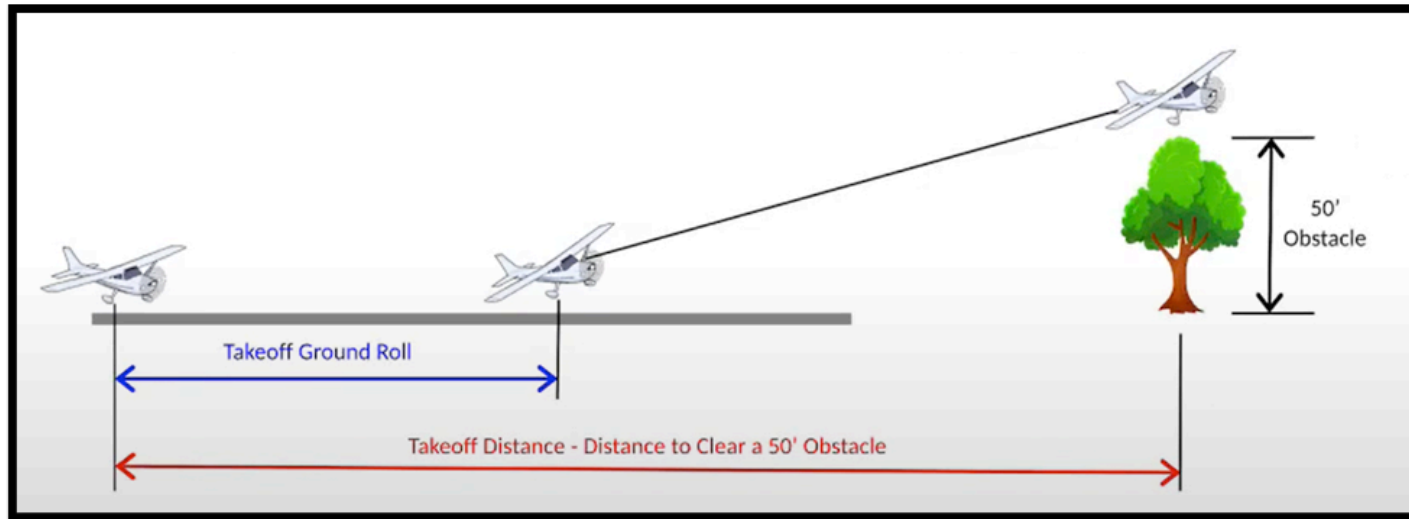
$820 * 1.2 = 984 \text{ ft.}$



Realistic Performance

- Takeoff performance
 - New engine, new propeller
 - Test pilot with excellent technique
- Landing performance
 - Excellent technique, energy management
 - No gusty winds, or gust factor
 - Maximum braking
- A safety factor helps in managing this discrepancy
 - We'll use a safety factor of **+50%** for takeoff and landing

Takeoff Distance - Safety Factor



Ground roll = **820 ft.**

Over 50' obstacle = **1535 ft.**

With 50% safety factor:

$820 * 1.5 = \mathbf{1230 \text{ ft.}}$

$1535 * 1.5 = \mathbf{2302 \text{ ft.}}$

Time, Distance, Fuel to Climb (Normal Climb) - Altitude

TIME, FUEL, AND DISTANCE TO CLIMB

NORMAL CLIMB - 95 KIAS

CONDITIONS:

Flaps Up
2400 RPM
24 Inches Hg
Mixture Full Rich
Cowl Flaps Open
Standard Temperature

NOTES:

- 1. Add 2.0 gallons of fuel for engine start, taxi and takeoff allowance.
- 2. Increase time, fuel and distance by 10% for each 7°C above standard temperature.
- 3. Distances shown are based on zero wind.

WEIGHT LBS	PRESSURE ALTITUDE FT	TEMP °C	RATE OF CLIMB FPM	FROM SEA LEVEL		
				TIME MIN	FUEL USED GALLONS	DISTANCE NM
3100	S.L.	15	500	0	0	0
	2000	11	500	4	1.4	6
	4000	7	495	8	2.8	13
	6000	3	485	12	4.3	20
	8000	-1	470	16	5.7	27
	10,000	-5	450	21	7.3	35

Airport: 4000'

Cruise: 8000'

16 - 8 = 8 minutes

5.7 - 2.8 = 2.9 gallons

27 - 13 = 14nm

Climb rate decreases as we ascend

Time, Distance, Fuel to Climb (Normal Climb) - Temperature

TIME, FUEL, AND DISTANCE TO CLIMB

NORMAL CLIMB - 95 KIAS

CONDITIONS:

Flaps Up
2400 RPM
24 Inches Hg
Mixture Full Rich
Cowl Flaps Open
Standard Temperature

NOTES:

1. Add 2.0 gallons of fuel for engine start, taxi and takeoff allowance.
2. Increase time, fuel and distance by 10% for each 7°C above standard temperature.
3. Distances shown are based on zero wind.

WEIGHT LBS	PRESSURE ALTITUDE FT	TEMP °C	RATE OF CLIMB FPM	FROM SEA LEVEL		
				TIME MIN	FUEL USED GALLONS	DISTANCE NM
3100	S.L.	15	500	0	0	0
	2000	11	500	4	1.4	6
	4000	7	495	8	2.8	13
	6000	3	485	12	4.3	20
	8000	-1	470	16	5.7	27
	10,000	-5	450	21	7.3	35
	12,000	-9	425	25	8.9	44

8 minutes, 2.9 gallons, 14nm

14°C above standard

20% increase

$8 * 1.2 = 9.6$ minutes

$2.9 * 1.2 = 3.5$ gallons

$14 * 1.2 = 16.8$ nm

+2 gal start/taxi/takeoff

$3.5 + 2 = 5.5$ gallons

Cruise Performance - Altitude and Temperature

CRUISE PERFORMANCE

PRESSURE ALTITUDE 2000 FEET

CONDITIONS:

3100 Pounds
Recommended Lean Mixture
Cowl Flaps Closed

NOTE

For best fuel economy, operate at the leanest mixture that results in smooth engine operation or at peak EGT.

		20°C BELOW STANDARD TEMP -9°C			STANDARD TEMPERATURE 11°C			20°C ABOVE STANDARD TEMP 31°C		
RPM	MP	% BHP	KTAS	GPH	% BHP	KTAS	GPH	% BHP	KTAS	GPH
2400	25	---	---	---	78	137	14.8	74	137	14.0
	23	74	131	14.0	70	131	13.3	66	130	12.6
	21	65	125	12.4	62	124	11.8	59	123	11.3
	19	57	117	10.9	54	116	10.5	51	115	10.0
2300	25	78	135	14.9	74	135	14.1	71	134	13.4
	23	70	129	13.3	67	128	12.7	63	128	12.1
	21	62	122	11.8	59	121	11.3	56	120	10.8
	19	54	114	10.4	51	113	10.0	49	112	9.6
2200	25	75	132	14.2	71	132	13.5	67	131	12.8
	23	67	126	12.7	64	126	12.1	60	125	11.5
	21	59	119	11.3	56	118	10.8	53	117	10.3
	19	51	111	9.9	49	110	9.5	46	108	9.1
2100	25	71	129	13.5	68	129	12.9	64	129	12.2
	23	64	123	12.1	60	123	11.5	57	122	11.0
	21	56	116	10.7	53	115	10.3	50	114	9.8
	19	48	108	9.5	46	106	9.1	43	104	8.7

CRUISE PERFORMANCE

PRESSURE ALTITUDE 10,000 FEET

CONDITIONS:

3100 Pounds
Recommended Lean Mixture
Cowl Flaps Closed

NOTE

For best fuel economy, operate at the leanest mixture that results in smooth engine operation or at peak EGT.

		20°C BELOW STANDARD TEMP -25°C			STANDARD TEMPERATURE -5°C			20°C ABOVE STANDARD TEMP 15°C		
RPM	MP	% BHP	KTAS	GPH	% BHP	KTAS	GPH	% BHP	KTAS	GPH
2400	25	---	---	---	79	148	15.1	75	148	14.3
	23	76	143	14.5	72	142	13.8	69	142	13.1
	21	69	136	13.1	66	136	12.5	62	135	11.9
	19	62	129	11.7	59	128	11.2	56	127	10.7
2300	25	80	146	15.2	76	146	14.5	72	145	13.7
	23	73	140	13.9	70	140	13.2	66	139	12.5
	21	66	134	12.5	63	133	12.0	60	132	11.4
	19	59	126	11.3	56	125	10.8	53	124	10.3
2200	25	77	143	14.6	73	143	13.9	69	142	13.2
	23	70	137	13.3	67	137	12.7	63	136	12.0
	21	63	131	12.0	60	130	11.5	57	129	10.9
	19	56	123	10.8	53	122	10.3	51	120	9.9
2100	25	74	140	14.0	70	140	13.3	66	139	12.6
	23	67	135	12.7	64	134	12.1	60	133	11.5
	21	60	128	11.5	57	127	11.0	54	125	10.5
	19	53	120	10.4	51	119	9.9	48	116	9.5

RANGE PROFILE

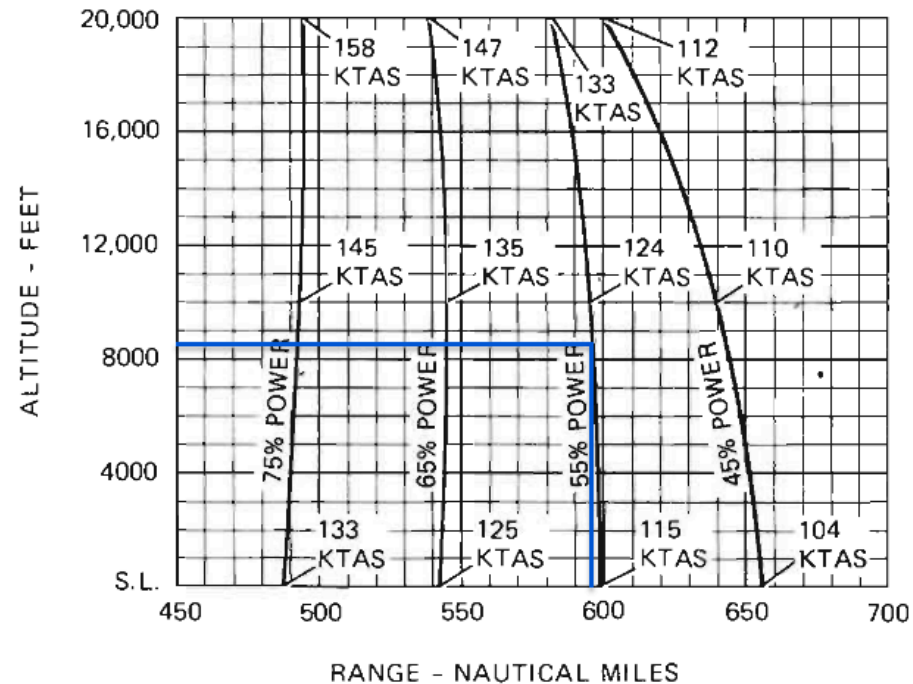
45 MINUTES RESERVE
65 GALLONS USABLE FUEL

CONDITIONS:

3100 Pounds
Recommended Lean Mixture for Cruise
Standard Temperature
Zero Wind

NOTE:

This chart allows for the fuel used for engine start, taxi, takeoff and climb, and the distance during a normal climb up to 12,000 feet and maximum climb above 12,000 feet.



ENDURANCE PROFILE

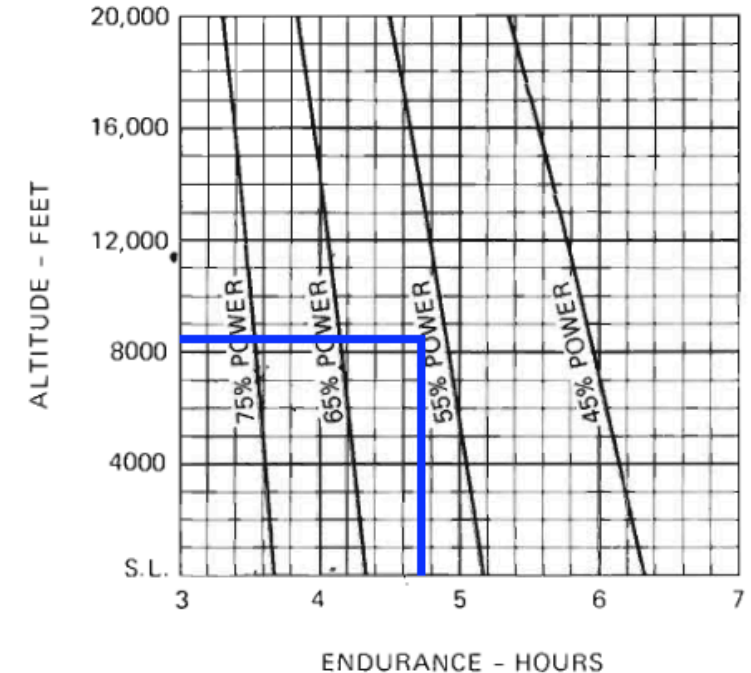
45 MINUTES RESERVE
65 GALLONS USABLE FUEL

CONDITIONS:

3100 Pounds
Recommended Lean Mixture for Cruise
Standard Temperature

NOTE:

This chart allows for the fuel used for engine start, taxi, takeoff and climb, and the time during a normal climb up to 12,000 feet and maximum climb above 12,000 feet.



Landing Distance (Short Field)

LANDING DISTANCE

SHORT FIELD

CONDITIONS:

Flaps FULL
Power Off
Maximum Braking
Paved, Level, Dry Runway
Zero Wind

NOTES:

- Short field technique as specified in Section 4.
- Decrease distances 10% for each 9 knots headwind. For operation with tailwinds up to 10 knots, increase distances by 10% for each 2 knots.
- For operation on a dry, grass runway, increase distances by 40% of the "ground roll" figure.
- If a landing with flaps up is necessary, increase the approach speed by 9 KIAS and allow for 40% longer distances.

WEIGHT LBS	SPEED AT 50 FT KIAS	PRESS ALT FT	0°C		10°C		20°C		30°C		40°C	
			GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS
2950	61	S.L.	560	1300	580	1335	600	1365	620	1400	640	1435
		1000	580	1335	600	1365	620	1400	645	1440	665	1475
		2000	600	1370	625	1405	645	1440	670	1480	690	1515
		3000	625	1410	645	1445	670	1485	695	1525	715	1560
		4000	650	1450	670	1485	695	1525	720	1565	740	1600
		5000	670	1485	695	1525	720	1565	745	1610	770	1650
		6000	700	1530	725	1575	750	1615	775	1660	800	1700
		7000	725	1575	750	1615	780	1665	805	1710	830	1750
		8000	755	1625	780	1665	810	1715	835	1760	865	1805

Headwind: 9 knots

Pressure altitude: S.L.

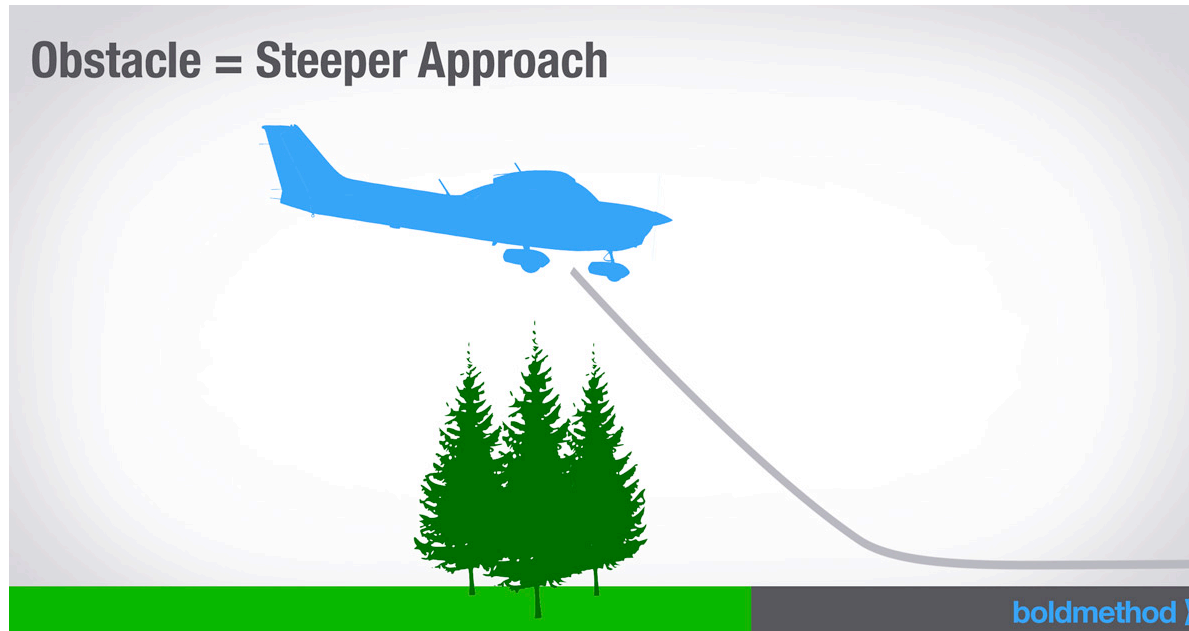
Temperature: 20°C

Decrease distances 10%

$0.9 * 600 = 540$ ft. ground roll

$0.9 * 1365 = 1231$ ft. over 50' obs.

Landing Distance (Short Field) - Safety Factor



540 ft. ground roll
1231 ft. over 50' obs.

Ground roll:

$$540 * 1.5 = \mathbf{810 \text{ ft}}$$

Over 50' obstacle:

$$1231 * 1.5 = \mathbf{1846 \text{ ft}}$$

FLAPS 25° TAKEOFF GROUND ROLL

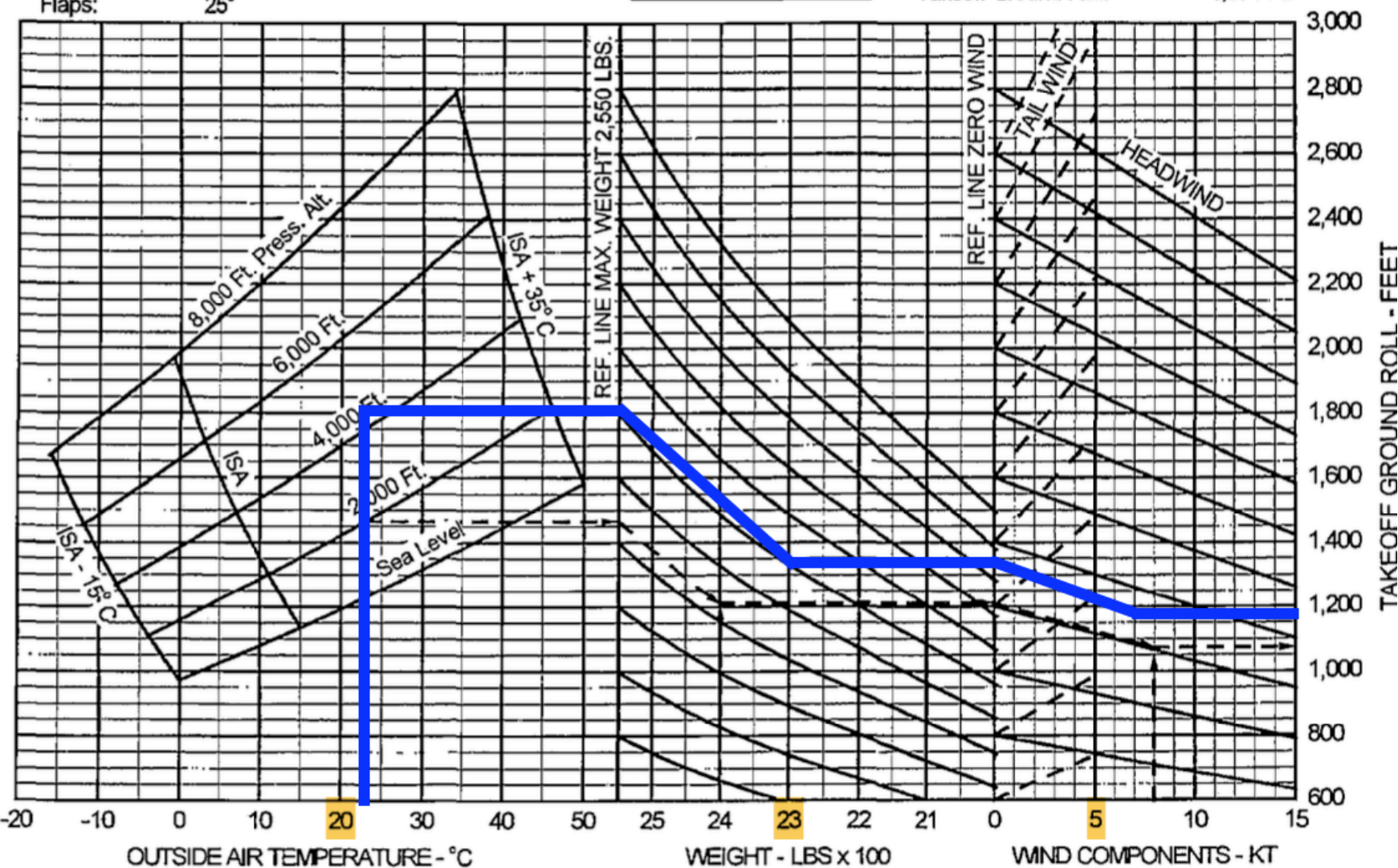
ASSOCIATED CONDITIONS

Power: FULL THROTTLE BEFORE BRAKE RELEASE
 Air Conditioner: OFF
 Runway: PAVED, LEVEL, & DRY
 Airspeed: REFER TO TABLE AT RIGHT
 Propeller: SENSENICH 76EM8S14-0-62
 Flaps: 25°

TAKEOFF SPEEDS KIAS	
WT	LIFTOFF
2,550	55
2,450	55
2,350	53
2,250	50

EXAMPLE

Depart Airport Pressure Alt: 2,000 Ft.
 Temperature: 23° C
 Gross Weight: 2,400 Lb.
 Headwind: 8 Kt.
 Takeoff Ground Roll: 1,071 Ft.



4100' press.
 altitude
 22° C
 2300 lbs.
 7 knots headwind
~1150 ft.

Differences between Actual and Estimated Performance



- Conditions are different from forecast
- Pilot technique
 - Takeoff
 - Landing
 - Engine leaning
- Age of engine, propeller, airframe
- Runway slope: Up or down
- Wet runway: Braking action

Limitations

Where do we find limitations?

CESSNA
MODEL T182

SECTION 2
LIMITATIONS

SECTION 2 LIMITATIONS

- POH limitations section
- Placards and markings
- Performance charts

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Engine Limitations

POWER PLANT LIMITATIONS

Engine Manufacturer: Avco Lycoming.

Engine Model Number: O-540-L3C5D.

Maximum Power: 235 BHP rating.

Engine Operating Limits for Takeoff and Continuous Operations:

Maximum Engine Speed: 2400 RPM.

Maximum Manifold Pressure: 31 in. Hg.

Maximum Cylinder Head Temperature: 500°F (260°C).

Maximum Oil Temperature: 245°F (118°C).

Oil Pressure, Minimum: 25 psi.

Maximum: 115 psi.

Fuel Pressure, Minimum: 3.0 psi.

Maximum: 30.0 psi.

Fuel Grade: See Fuel Limitations.

Oil Grade (Specification):

MIL-L-6082 Aviation Grade Straight Mineral Oil or MIL-L-22851

Ashless Dispersant Oil.

Airspeed Limitations

	SPEED	KCAS	KIAS	REMARKS
V _{NE}	Never Exceed Speed	175	178	Do not exceed this speed in any operation.
V _{NO}	Maximum Structural Cruising Speed	138	140	Do not exceed this speed except in smooth air, and then only with caution.
V _A	Maneuvering Speed: 3100 Pounds 2600 Pounds 2100 Pounds	110 100 90	111 101 90	Do not make full or abrupt control movements above this speed.
V _{FE}	Maximum Flap Extended Speed: To 10° Flaps 10° - FULL Flaps	138 95	140 95	Do not exceed these speeds with the given flap settings.
	Maximum Window Open Speed	175	178	Do not exceed this speed with windows open.



Load Factor Limits

FLIGHT LOAD FACTOR LIMITS

Flight Load Factors:

- *Flaps Up: +3.8g, -1.52g

- *Flaps Down: +2.0g

- *The design load factors are 150% of the above, and in all cases, the structure meets or exceeds design loads.

Operating Limits

MAXIMUM OPERATING ALTITUDE LIMIT

Certificated Maximum Operating Altitude: 20,000 Ft.

OTHER LIMITATIONS

FLAP LIMITATIONS

Approved Takeoff Range: 0° to 20°.

Approved Landing Range: 0° to FULL.

Maximum Demonstrated Crosswind Velocity:

Takeoff or Landing 15 KNOTS

High Temperatures

Is it advisable to fly when it's > 40°C?

TAKEOFF DISTANCE

MAXIMUM WEIGHT 3100 LBS

CONDITIONS:

Flaps 20°

2400 RPM and 31 Inches Hg Prior to Brake Release

Mixture Full Rich

Cowl Flaps Open

Paved, Level, Dry Runway

Zero Wind

SHORT FIELD

NOTES:

1. Short field technique as specified in Section 4.
2. Decrease distances 10% for each 9 knots headwind. For operation with tailwinds up to 10 knots, increase distances by 10% for each 2 knots.
3. For operation on a dry, grass runway, increase distances by 15% of the "ground roll" figure.

WEIGHT LBS	TAKEOFF SPEED KIAS		PRESS ALT FT	32°F 0°C		50°F 10°C		68°F 20°C		86°F 30°C		104°F 40°C	
	LIFT OFF	AT 50 FT		GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS
3100	49	58	S.L.	700	1310	760	1415	820	1535	890	1665	960	1805
			1000	750	1390	810	1505	880	1630	950	1770	1025	1925
			2000	800	1475	870	1600	940	1735	1015	1885	1100	2050
			3000	855	1570	930	1700	1005	1850	1090	2010	1175	2190
			4000	920	1670	995	1815	1080	1970	1165	2145	1260	2345
			5000	985	1780	1070	1935	1155	2110	1250	2300	1355	2510
			6000	1055	1900	1145	2070	1245	2260	1345	2465	1455	2700
			7000	1135	2035	1235	2220	1335	2425	1450	2650	1565	2910
			8000	1220	2180	1325	2385	1440	2605	1560	2855	1685	3140

Summary

- Performance concepts
 - Air and density
 - International Standard Atmosphere
 - Types of Altitude
 - Types of Airspeed
 - How density affects performance
- Airplane performance charts
 - Computing performance values using Cessna charts
- Airplane limitations