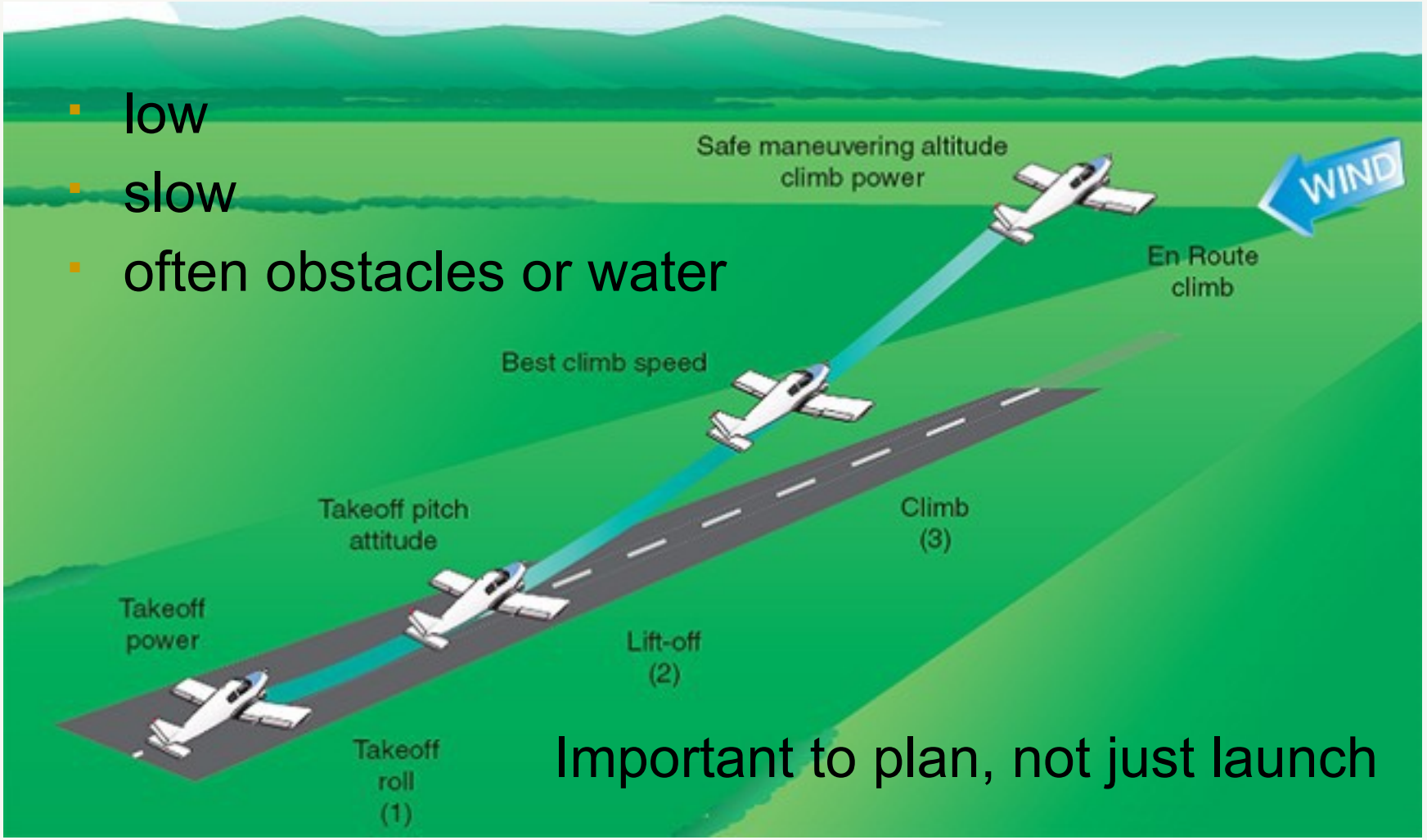
Ex. 16 – Take-off

What you will learn:

- ✓ How to perform safe and precise take-offs, considering:
  - your particular aircraft
  - wind
  - temperature, altitude, humidity
  - obstacles.

Why learn this:

- ✓ Take-off is a critical phase of flight



Links:

- ✓ You have already performed take-offs
- ✓ You have studied and performed climbs and climbing turns
- ✓ You have been controlling yaw on every flight
- ✓ You have practiced recognition of approach of unusual flight regimes (slow flight, stalls, spins, spirals) and how to take corrective action before an emergency situation develops
- ✓ You have experienced illusions created by drift and learned how to prevent them from influencing you.

Let's see how much you already know:

- How are the controls positioned when taxiing in a quartering headwind?
- What is the procedure for entering and holding a climb?
- What is best angle of climb and when would you use it?
- What is best rate of climb and when would you use it?
- What are the "three H's" that lower air density and impact your airplane's climb performance?
- What other factors can affect climb performance?
- What are the four ways the propeller may induce yaw?

Theories and Definitions:

Take-off Performance, Effects of:

- Head/Tail Wind
- Density Altitude
  - POH
  - Koch Chart
  - “rule of thumb”

Crosswind

Propeller-induced Yaw.

Take-off Performance C172

TAKEOFF DISTANCE

SHORT FIELD

SAMPLE!

CONDITION:
Flaps 10°
Full Throttle Prior to Brake Release
Paved, Level, Dry Runway
Zero Wind

How long are the runways at our airport?

Where can we find out the take-off performance figures for our airplane?

NOTES:
1. Short field technique as specified in Section 4.
2. Prior to takeoff from fields above 3000 feet elevation, the mixture should be leaned to give maximum RPM in a full throttle, static runup.
3. Decrease distances 10% for each 9 knots headwind. For operation with tailwinds up to 10 knots, increase distances by 10% for each 2 knots.
4. For operation on a dry, grass runway, increase distances by [illegible]

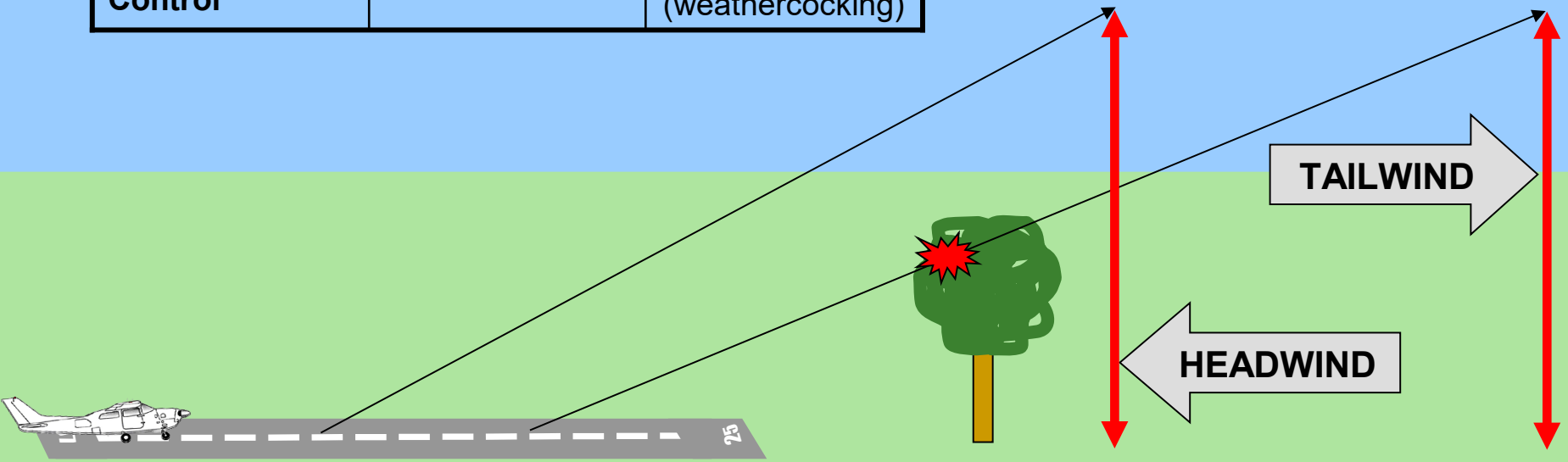
Do we need to use the short-field technique?

WEIGHT LBS	TAKEOFF SPEED KIAS		PRESS ALT FT	0°C		10°C		20°C		30°C		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
1670	50	54	S.L.	640	1190	695	1290	755	1390	810	1495	875	1605
			1000	705	1310	765	1420	825	1530	890	1645	960	1770
			2000	775	1445	840	1565	910	1690	980	1820	1055	1960
			3000	855	1600	925	1730	1000	1870	1080	2020	1165	2185
			4000	940	1775	1020	1920	1100	2080	1190	2250	1285	2440
			5000	1040	1970	1125	2140	1215	2320	1315	2525	1420	2750
			6000	1145	2200	1245	2395	1345	2610	1455	2855	1570	3125
			7000	1270	2470	1375	2705	1490	2960	1615	3255	1745	3590
			8000	1405	2800	1525	3080	1655	3395	1795	3765	1940	4195

Take-off Performance: Head/Tail Wind

	Headwind	Tailwind
Ground Run	shorter	longer
Ground Speed before Take-off	lower	higher (strain on landing gear)
Climb Angle	steeper	shallower
Directional Control	better	worse (weathercocking)

Where can we find out the effect of head/tail wind on take-off performance?



Effect of Head/Tail Wind: POH

TAKEOFF DISTANCE

SHORT FIELD

SAMPLE!

CONDITION:
Flaps 10°
Full Throttle Prior to Brake Release
Paved, Level, Dry Runway
Zero Wind

NOTES:
1. Short field technique as specified in Section 4.
2. Prior to takeoff from fields above 3000 feet elevation, the mixture should be leaned to give maximum RPM in a full throttle, static runup.
3. Decrease distances 10% for each 9 knots headwind. For operation with tailwinds up to 10 knots, increase distances by 10% for each 2 knots.
4. For operation on a dry, grass runway, increase distances by 15% of the "ground roll" figure.

WEIGHT LBS	TAKEOFF SPEED KIAS		PRESS ALT FT	0°C		10°C		20°C		30°C		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
1670	50	54	S.L.	640	1190	695	1290	755	1390	810	1495	875	1605
			1000	705	1310	765	1420	825	1530	890	1645	960	1770
			2000	775	1445	840	1565	910	1690	980	1820	1055	1960
			3000	855	1600	925	1730	1000	1870	1080	2020	1165	2185
			4000	940	1775	1020	1920	1100	2080	1190	2250	1285	2440
			5000	1040	1970	1125	2140	1215	2320	1315	2525	1420	2750
			6000	1145	2200	1245	2395	1345	2610	1455	2855	1570	3125
			7000	1270	2470	1375	2705	1490	2960	1615	3255	1745	3590
			8000	1405	2800	1525	3080	1655	3395	1795	3765	1940	4195

Take-off Performance: Density Altitude

The 3 Deadly H's

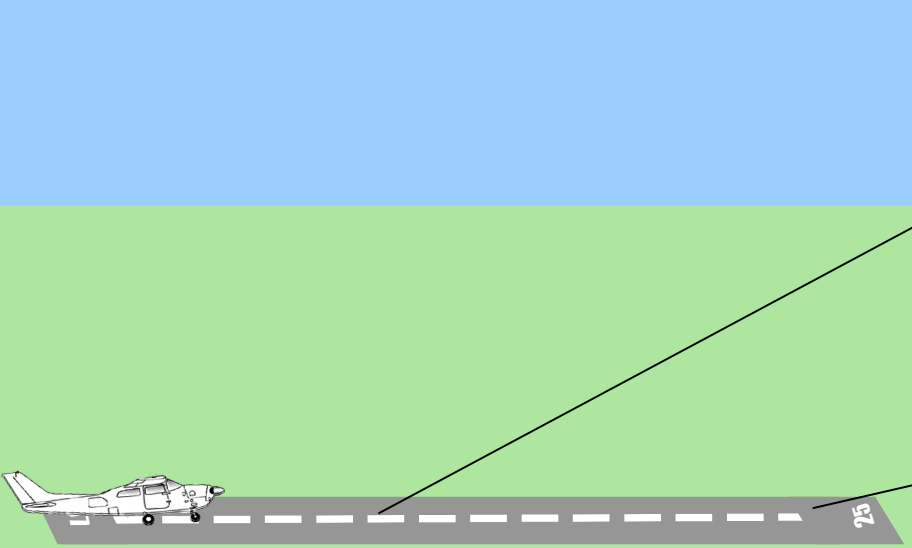
- **! HEIGHT**
- **! HEAT**
- **! HUMIDITY**

What effect to they have on air density?

What effect does low air density have on climb performance?

low altitude,
cold dry day

high altitude,
hot humid day



Where can we find out the effect of density altitude on take-off performance?

Effect of Density Altitude: POH

TAKEOFF DISTANCE

SHORT FIELD

SAMPLE!

CONDITION:
Flaps 10°
Full Throttle Prior to Brake Release
Paved, Level, Dry Runway
Zero Wind

What is PRESS ALT FT and how is it determined?

NOTES:
1. Short field technique as specified in Section 4.
2. Prior to takeoff from fields above 3000 feet elevation, the mixture should be leaned to give maximum RPM in a full throttle, static runup.
3. Decrease distances 10% for each 9 knots headwind. For operation with tailwinds up to 10 knots, increase distances by 10% for each 2 knots.
4. For operation on a dry, grass runway, increase distances by 15% of the "ground roll" figure.

WEIGHT LBS	TAKEOFF SPEED KIAS		PRESS ALT FT	0°C		10°C		20°C		30°C		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
1670	50	54	S.L.	640	1190	695	1290	755	1390	810	1495	875	1605
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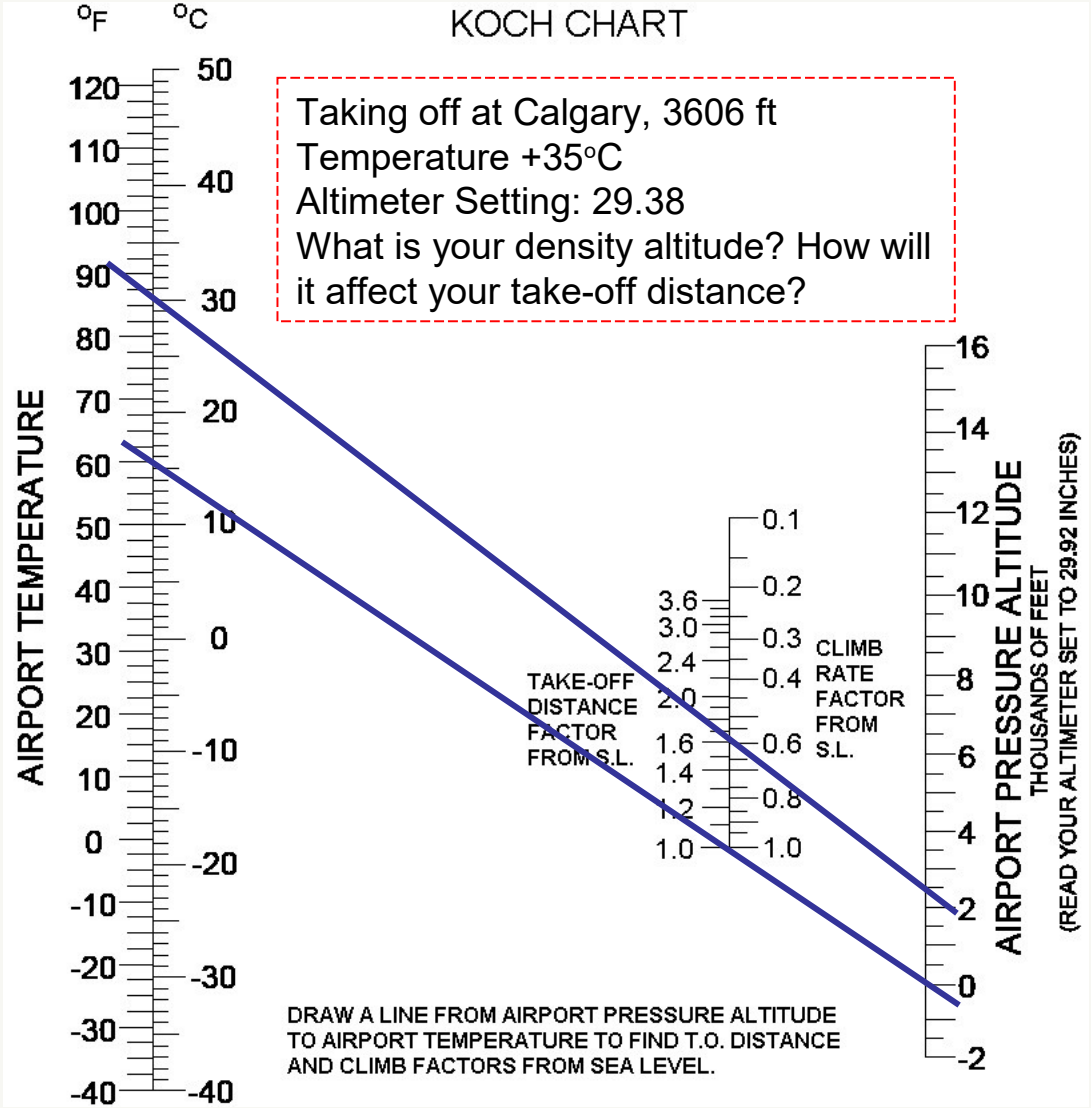
			8000	1405	2800	1525	3080	1655	3395	1795	3765	1940	4195

Altimeter setting 28.92, what is the pressure altitude at S.L.?

Effect of Density Altitude: Koch Chart



Taking off at Calgary, 3606 ft
Temperature +35°C
Altimeter Setting: 29.38
What is your density altitude? How will it affect your take-off distance?

Suppose normal take-off distance at standard temperature and pressure is 1000 feet.

What will be take-off distance at
* 30°C
* 2300' aerodrome elevation
* altimeter setting 29.72?

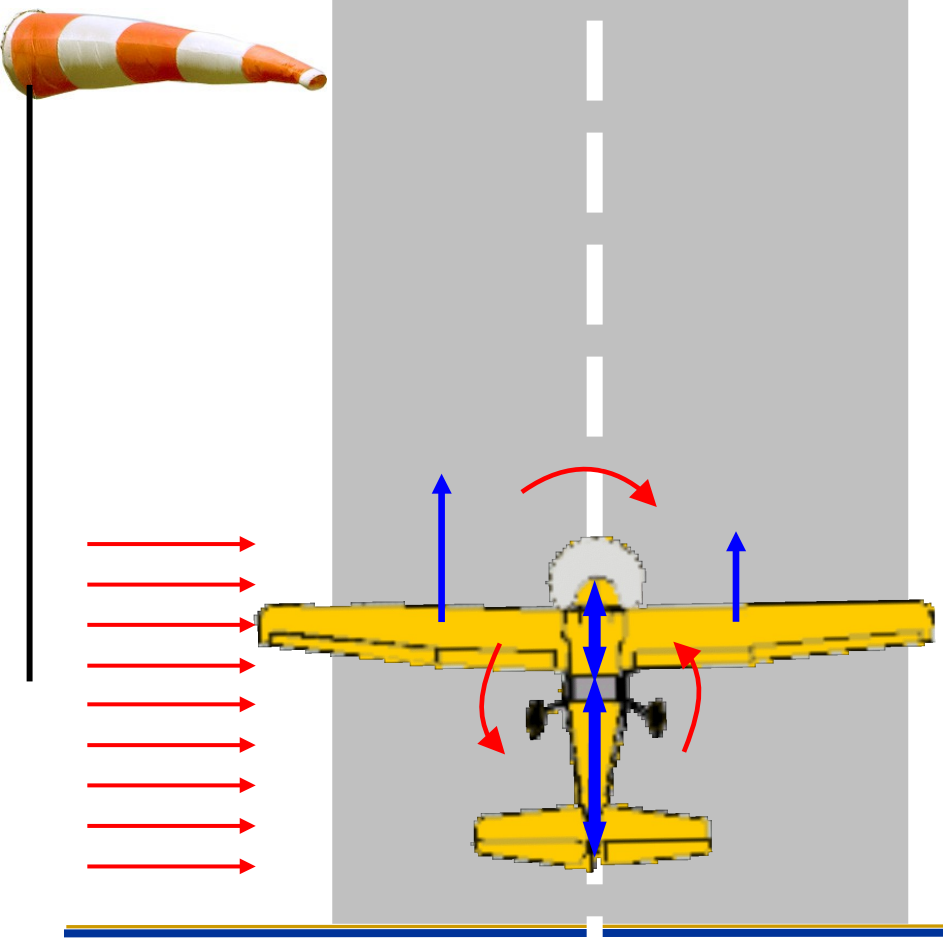
RULE OF THUMB

UP TO 3000'
1000 ft in density altitude
=
+10% of ground roll to total distance to clear 50' obstacle

ABOVE 3000'
1000 ft in density altitude
=
+20% of ground roll to total distance to clear 50' obstacle

Crosswind Take-offs

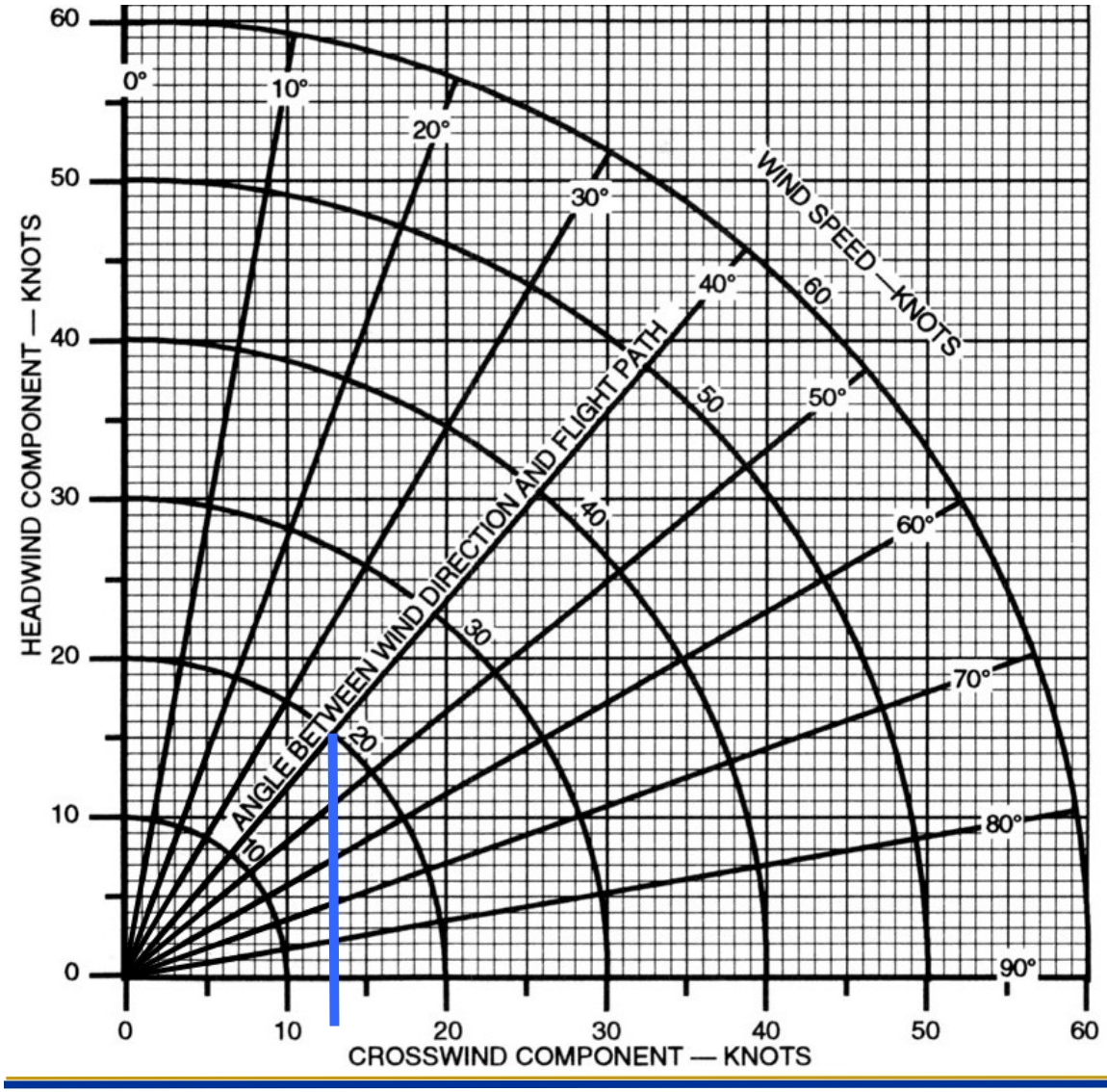
Can we always take off directly into the wind?



Effects of Crosswind on Directional Control

1. Weathercocking (plane wants to turn into the wind)
2. Plane is pushed sideways (strain on landing gear)
3. Into-wind wing produces more lift (due to dihedral as well as being more exposed to wind)

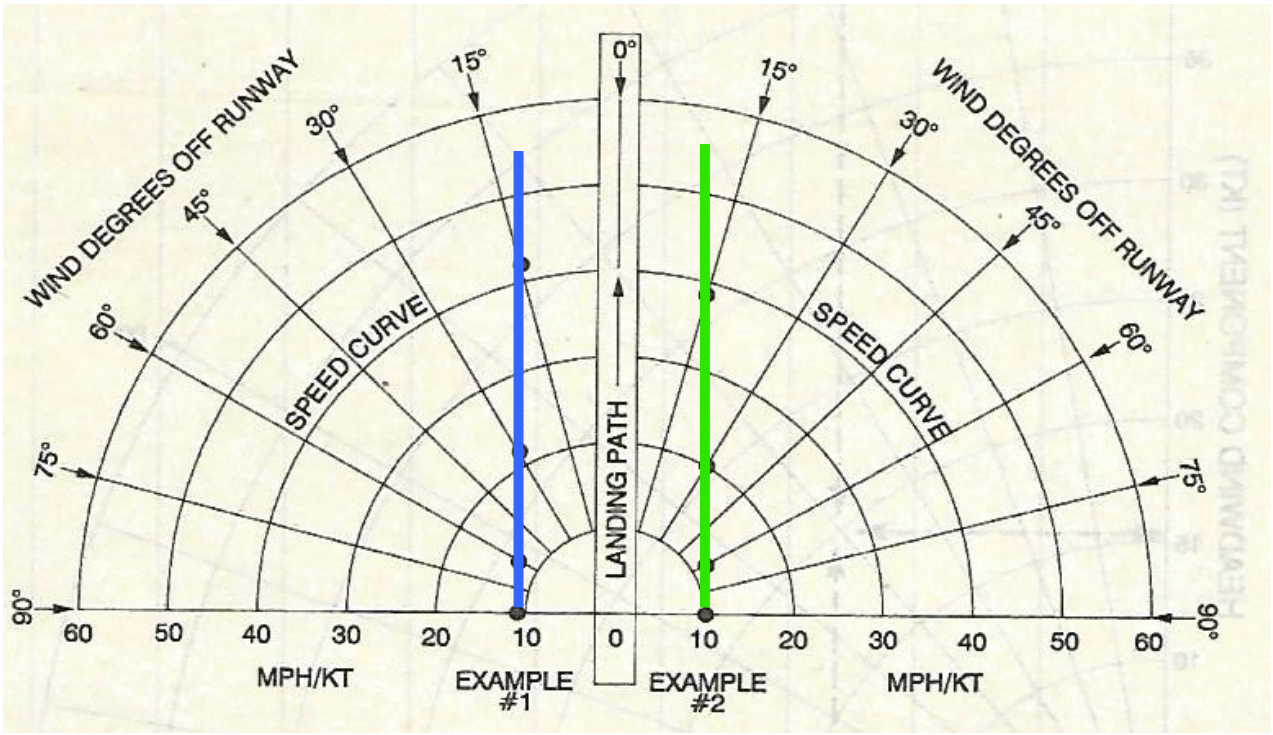
Determining Crosswind Component



Wind is at 20 knots, 40° angle with the runway. What is the crosswind component?

What is the maximum demonstrated crosswind component for your airplane?

Is it a legal limit?



Determining Crosswind Component taken from CFS General A75

Example#1 – Aircraft with a stalling speed of 60 MPH.		
Wind-degree Off Runway		Permissible Wind Speeds
90-degrees	(0.2x60 MPH stalling speed)	12 MPH
80-degrees	Using cross-wind graph	14 MPH
30-degrees	Using cross-wind graph	24 MPH
15-degrees	Using cross-wind graph	45 MPH
Example#2 - Aircraft with a stalling speed of 50 Kt.		
Wind-degree Off Runway		Permissible Wind Speeds
90-degrees	(0.2x50 Kt. stalling speed)	10 Kt
80-degrees	Using cross-wind graph	12 Kt
30-degrees	Using cross-wind graph	20 Kt
15-degrees	Using cross-wind graph	38 Kt

Crosswind Take-offs: Directional Control

- ✓ Use rudder to keep straight on take off
- ✓ In a crosswind, more rudder pressure
- ✓ Ailerons start fully deflected into the wind to prevent rolling tendency

How did we position ailerons when taxiing in a quartering headwind?

- ✓ Aileron gradually reduced as aircraft gains speed

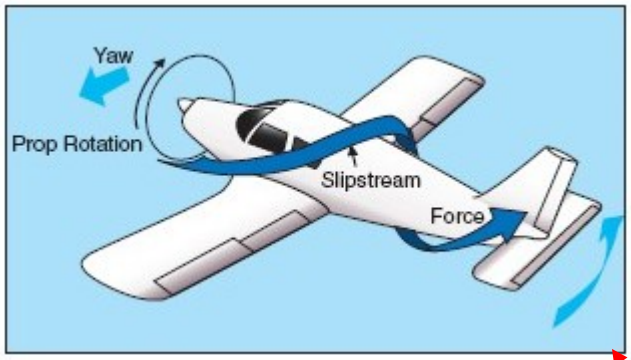
Why?

- ✓ After aircraft is airborne, turn into the wind

Why?

Propeller-Induced Yaw

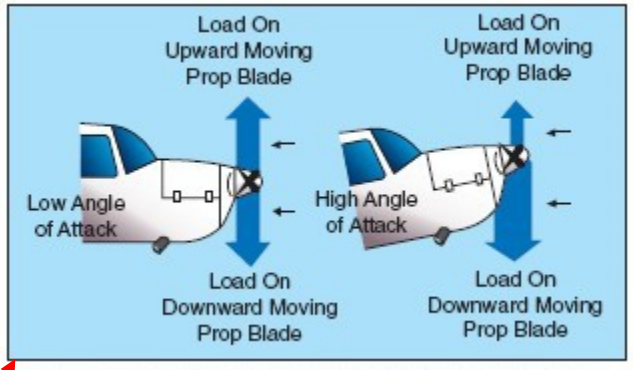
SLIPSTREAM



- slipstream pushes tail to the right
- plane wants to yaw to the left

Which rudder will you need on take-off and climb-out?

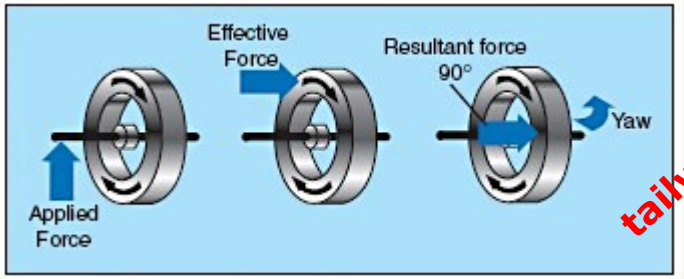
ASYMMETRIC THRUST



- at high angles of attack, down-going blade has more "bite" and creates more thrust
- left-yawing tendency

TAKE-OFF

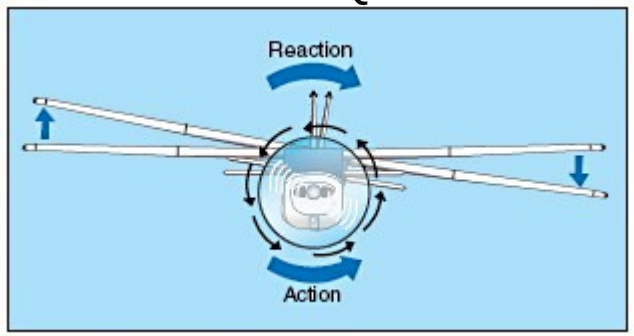
GYROSCOPIC PRECESSION



tailwheel a/c?

- spinning propeller acts as a gyroscope
- raising nose causes right-yawing tendency

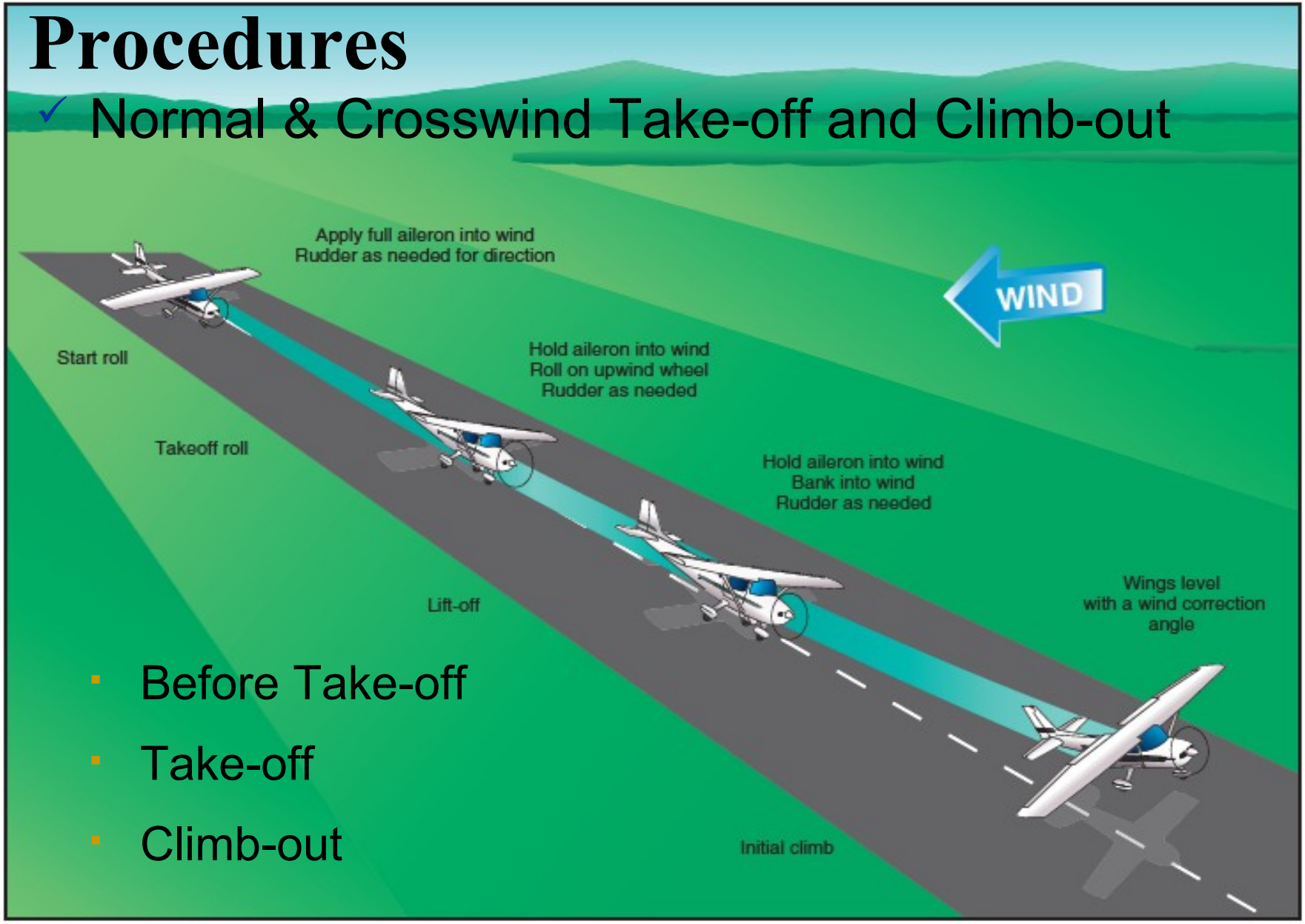
TORQUE



- reaction to prop rotation causes roll to the left
- pilot corrects with right aileron, causes adverse yaw to the left

Procedures

- ✓ Normal & Crosswind Take-off and Climb-out



- Before Take-off
- Take-off
- Climb-out

Figure 5-3. Crosswind takeoff roll and initial climb.

Before Take-off:

- ✓ Pre-take-off checklist

Where do you find the steps?

- ✓ Complete GO/NO GO briefing

Can you give a GO/NO GO briefing?

- ✓ Choose abort point
- ✓ Check windsock
- ✓ Verify that you are CLEARED to cross the hold short line ("cleared for take-off" or "line up runway 07")
- ✓ Verify no traffic about to land before taxiing onto the runway

Why do you need to do this at a controlled airport?

- ✓ Transponder on ALT.

Normal Take-off

- ✓ Line up with runway centerline
- ✓ At controlled airport: Verify CLEARED for take-off
- ✓ Feet off the brakes
- ✓ Full power, hand on the throttle Why?
- ✓ Look well ahead of you and keep plane pointing straight with rudder
- ✓ Confirm:
  - RPM at static maximum
  - oil temperature and pressure in the green
  - airspeed is alive
- ✓ At recommended rotation speed, smoothly raise the nose to approximately V_y attitude and hold it.

Normal Climb-out

- ✓ Climb out at V_y – normal climb
- ✓ Trim
- ✓ Control yaw with rudder
- ✓ Maintain track over extended runway centreline
- ✓ Post-take-off checks:
  - temperature & pressure in the green
  - landing light off
  - flaps up
  - VSI in the positive
  - full power
- ✓ Lower the nose every 500’ to check for traffic.

Crosswind Take-off

Same as normal, except:

- ✓ Control column into the wind
- ✓ Gradually reduce aileron deflection as plane accelerates
- ✓ At recommended rotation speed, smoothly raise the nose to approximately V_y attitude and hold it.

- ✓ Gusty crosswinds, ensure extra speed so gust can not make aircraft settle with drift on to the runway.
- ✓ Need a boot full of rudder in a strong crosswind

Crosswind Climb-out

- ✓ Once airborne, turn into crosswind to maintain track over extended center line

- ✓ Everything else same as normal take off:

  Climb out at V_y , rudder for yaw, check

  - temperature & pressure in the green
  - landing light off
  - flaps up
  - VSI in the positive
  - full power

- ✓ check for traffic.

Considerations

- ✓ Other Factors Affecting Take-off Performance
  - weight
  - runway slope
  - runway surface
  - control surface contamination
- ✓ Wind Shear
- ✓ Wake Turbulence.

Take-Off Performance: Weight

POH performance figures are for what weight?

- ✓ Less weight = shorter ground roll and take-off distance to 50 feet

Something you'll notice on your first solo flight!

- ✓ Dramatic difference in light aircraft!

Take-Off Performance: Runway Slope

- ✓ **Down slope – decreases take-off distance**
- ✓ **Up slope – increases take-off distance.**

What effect will runway down slope on take-off distance? Up slope?

Take-Off Performance: Runway Surface

What sort of runway surfaces may you encounter and what effect will they have on take-off performance?

- ✓ Rougher surface – increases take-off distance

Any mention of rough runways in the POH?

- ✓ Wet, slick runways – increase stopping distance (a factor when deciding on abort point)

- ✓ Runways with standing water, slush, loose snow: impact both deceleration and acceleration performance of the aircraft.

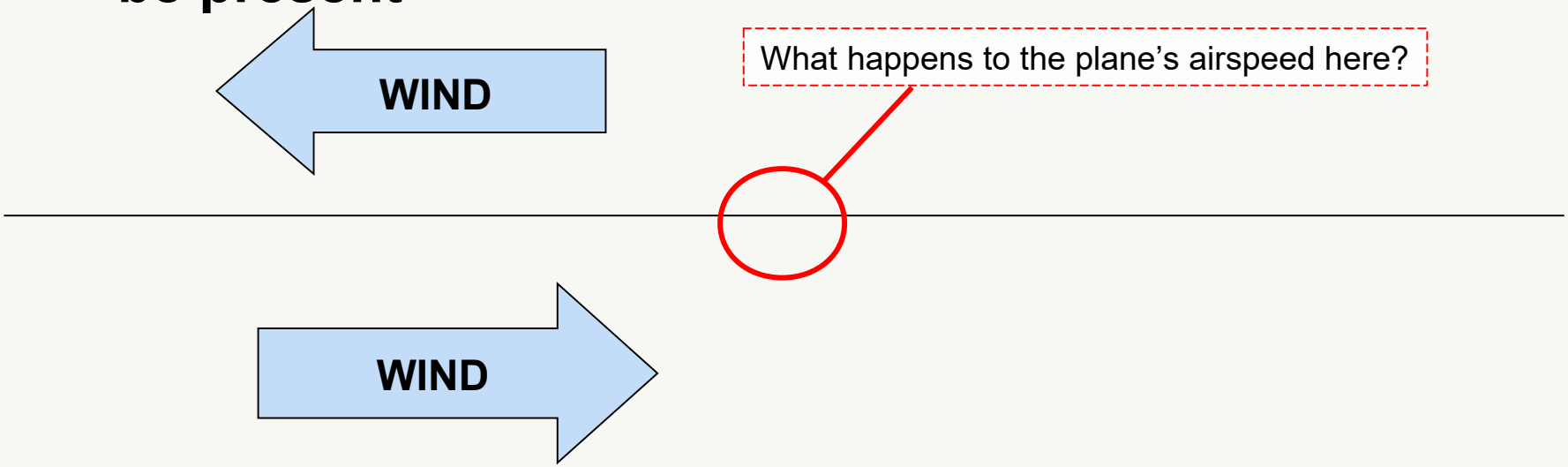
Take-Off Performance: Control Surface Contamination

What sort of control surface contamination might you encounter?

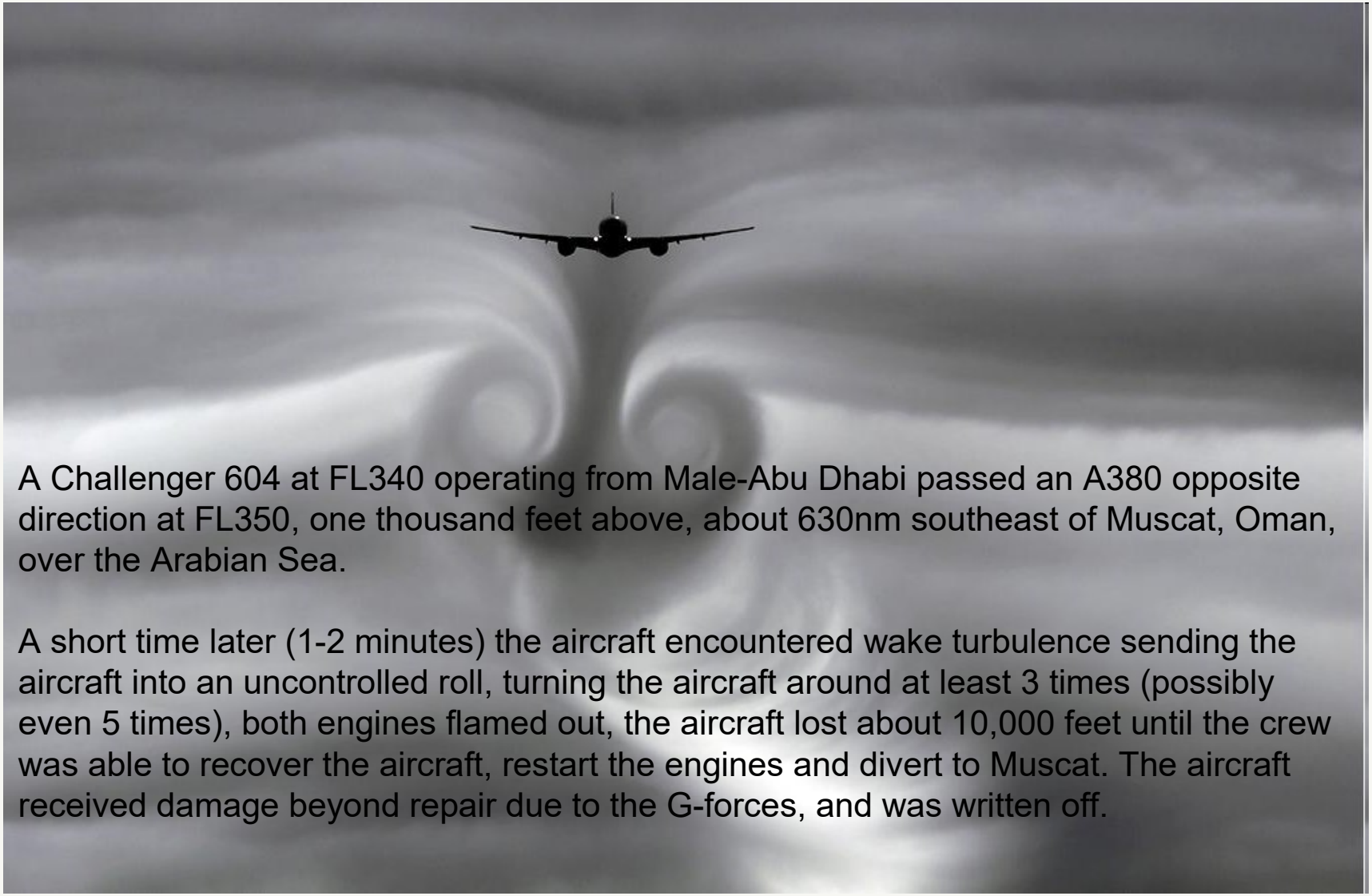
How does control surface contamination affect lift and drag (and thus take-off performance)?

Wind Shear

- ✓ **Wind shear = abrupt change in wind speed or direction** When may it be present?
- ✓ **Increase airspeed when wind shear is likely to be present**



Wake Turbulence



A Challenger 604 at FL340 operating from Male-Abu Dhabi passed an A380 opposite direction at FL350, one thousand feet above, about 630nm southeast of Muscat, Oman, over the Arabian Sea.

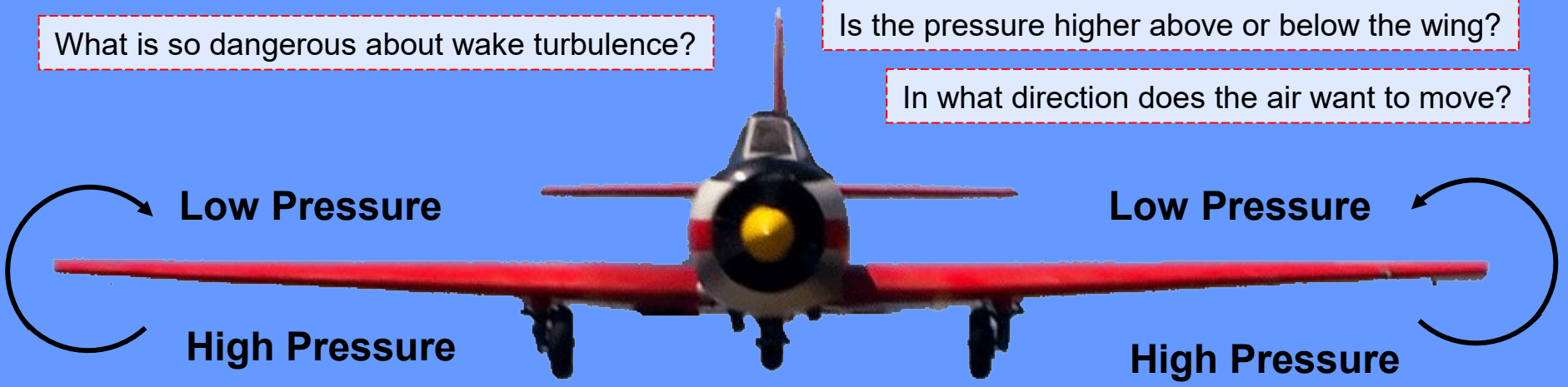
A short time later (1-2 minutes) the aircraft encountered wake turbulence sending the aircraft into an uncontrolled roll, turning the aircraft around at least 3 times (possibly even 5 times), both engines flamed out, the aircraft lost about 10,000 feet until the crew was able to recover the aircraft, restart the engines and divert to Muscat. The aircraft received damage beyond repair due to the G-forces, and was written off.

Wake Turbulence

What is so dangerous about wake turbulence?

Is the pressure higher above or below the wing?

In what direction does the air want to move?

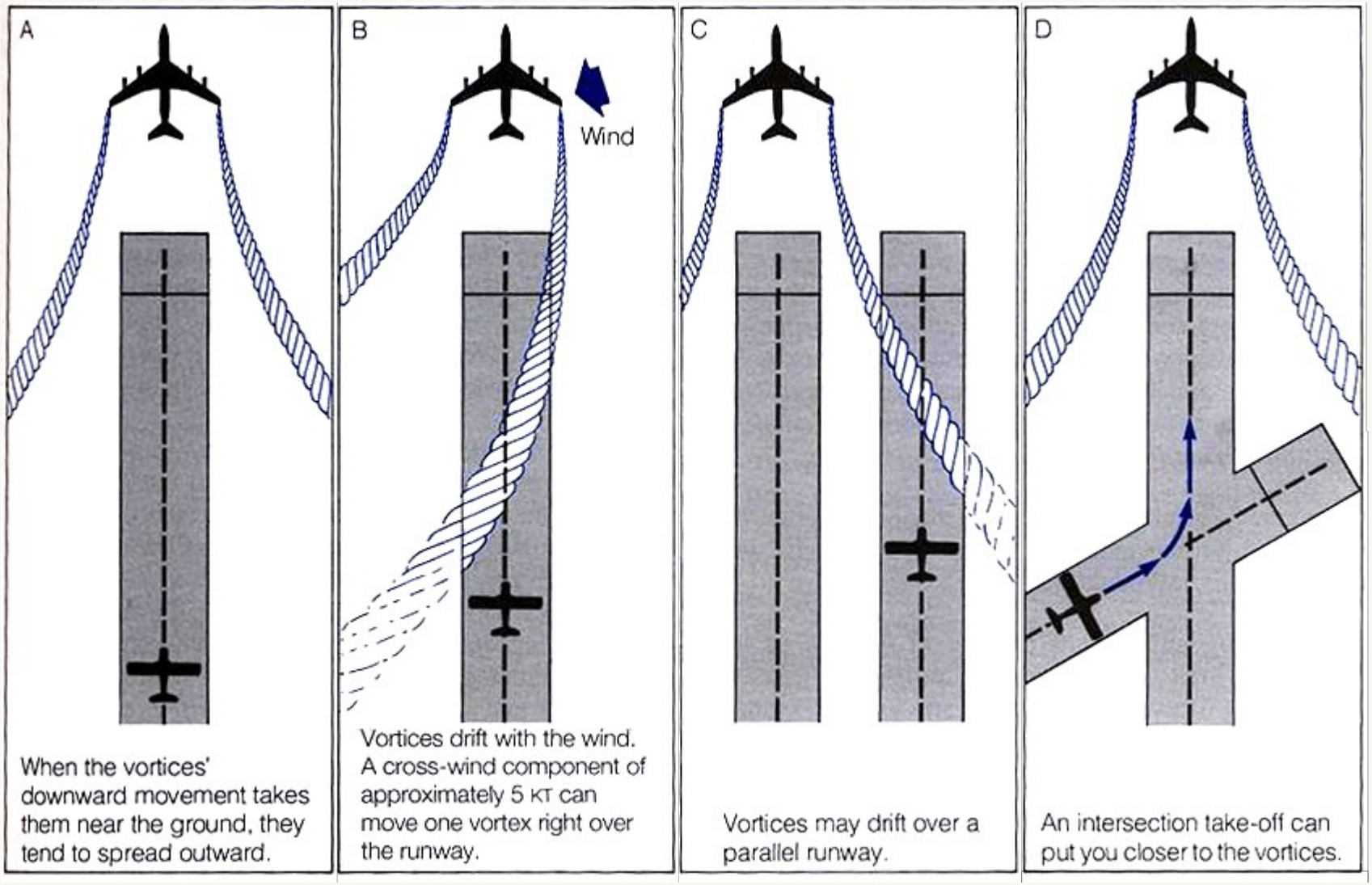


- ✓ **Wake turbulence – turbulence caused by wingtip vortices**
- ✓ **Strongest for planes that are heavy and slow**

When are planes slow?

- ✓ **Vortices start on rotation, stop on touchdown**
- ✓ **Drift downward and outward**

Wake Turbulence



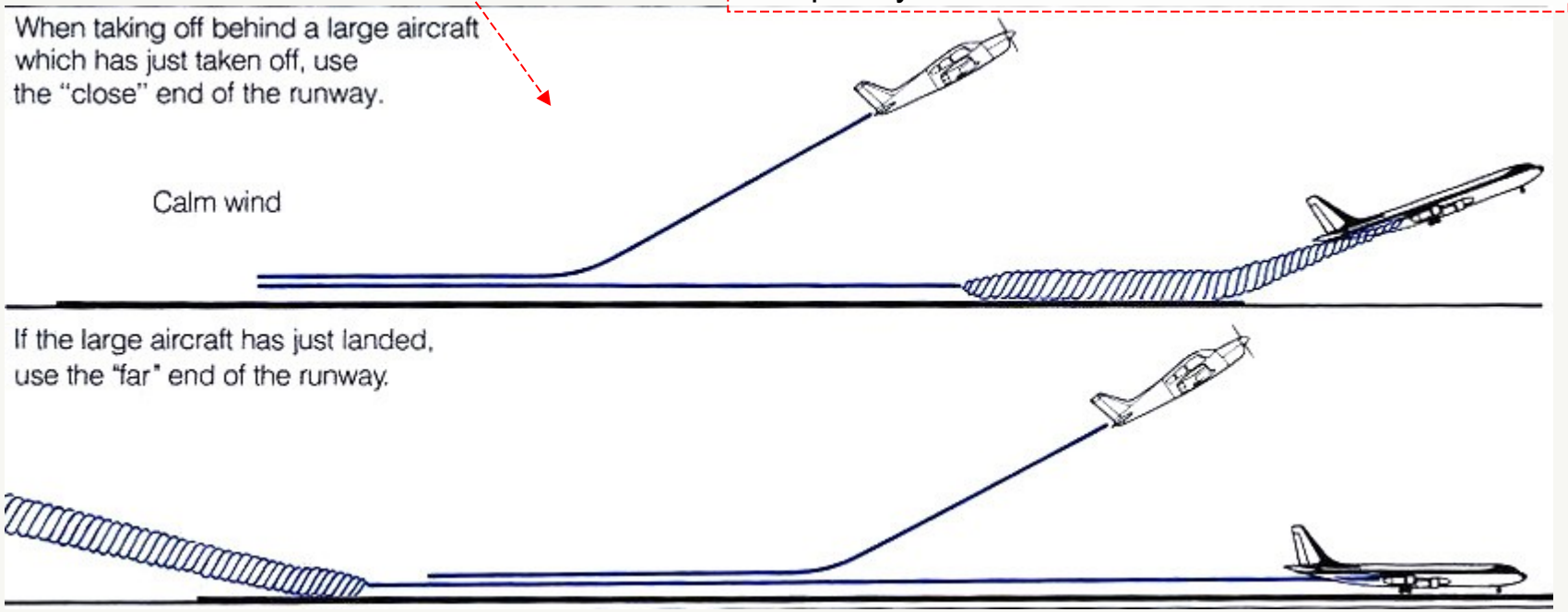
Wake Turbulence

What other options do you have for avoiding wake turbulence?

When taking off after a heavy plane that just took off before you, in which portion of the runway must you complete your take-off to avoid wake turbulence?

Are these realistic climb profiles?

When taking off after a heavy plane that just landed before you, in which portion of the runway must you complete your take-off to avoid wake turbulence?



SAFETY

- Hold short lines: only cross if cleared
- Verify no landing traffic before taxiing onto the runway
- Pick abort point for every take-off and be prepared to abort if not airborne by that point
- You have limited options in a take-off emergency: have a plan for dealing with trouble in any phase of take-off and climb-out (GO/NO GO briefing)
- Must be cleared for take-off at controlled airports
- Excessive pressure on nose-wheel may cause
  - front wheel shimmy
  - wheelbarrowing (poor directional control).

Review

- What is the procedure for normal take-off?
- What are the considerations for a crosswind take-off?
- Wind is 200 magnetic at 18 knots. Can we use runway 26 for take-off? What other options do we have?
- A Dash-8 just landed on 26, touching down at the 500' markers. You want to take-off from runway 26. How can you avoid the Dash-8's wake turbulence?
- Is it safe to take off with light frost on your wings and elevators?
- Can you give a sample GO/NO GO briefing?

Conclusion

- ✓ This is the first exercise in the segment of your training concentrating on take-offs, circuits and landings
- ✓ Make sure each flight you ever make is off to a good start!
- ✓ Today you learned about normal and crosswind take-offs. Later in your training we will build on this base and practice “specialty” take-offs (short-field and soft-field)

QUESTIONS?