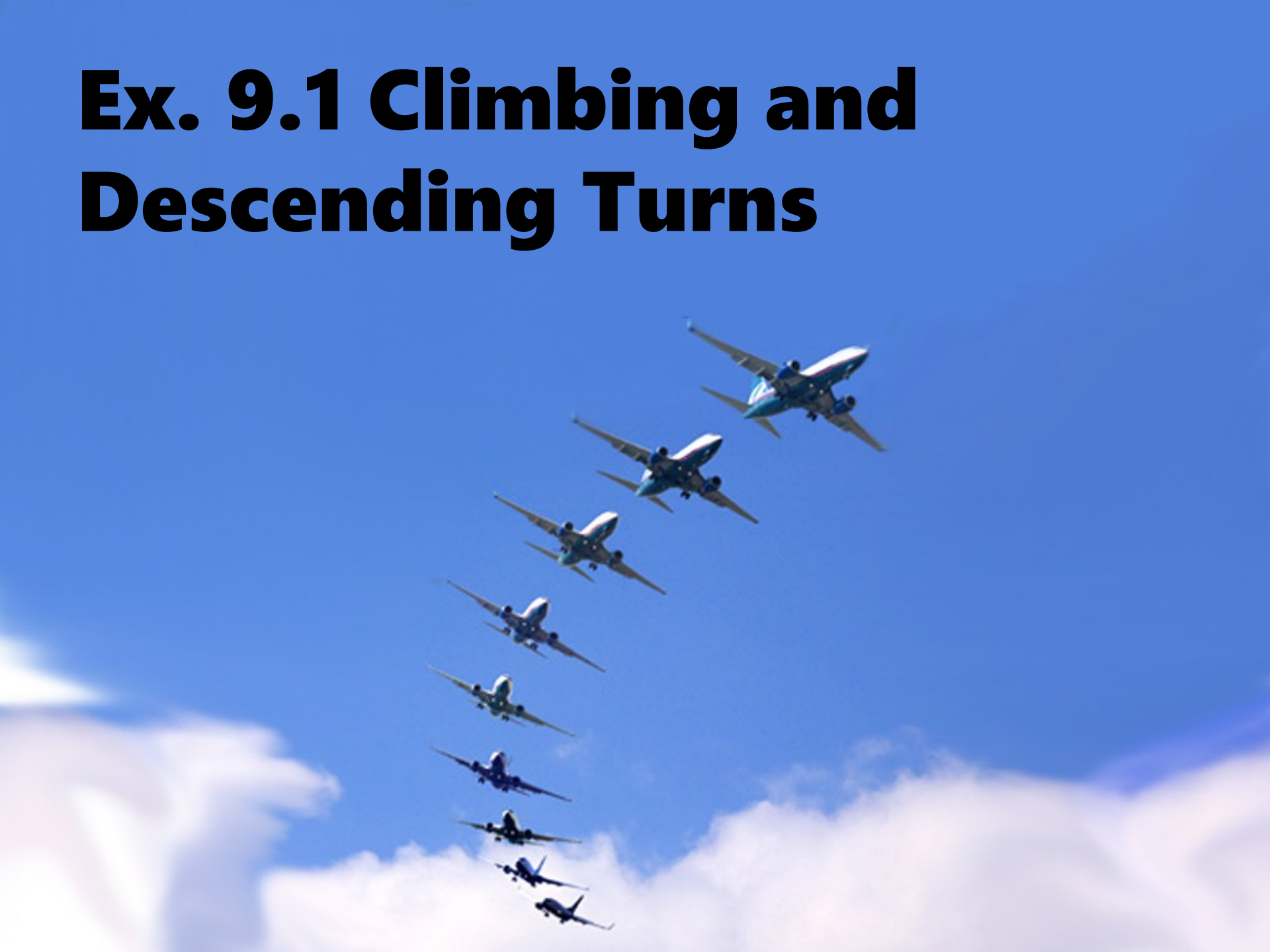
Ex. 9.1 Climbing and Descending Turns



Aim:

- ✓ How to perform climbing and descending turns
- ✓ .To enter and maintain a climb or descent whilst turning, or to maintain a turn from a climb or descent.

Why learn this:

- ✓ Differences from level turns
- ✓ Important to make precise and coordinated turns for:
  - Safety
  - passenger comfort
  - overall flying proficiency and accuracy.

Let’s see how much you already know:

- Q What are the four forces acting on an airplane in flight?
- Q In which direction does lift act?
- Q How does angle of attack affect lift?
- Q What types of drag affect an aircraft in flight?
- Q What is the relationship between lift and induced drag?

Theories and Definitions:

- ✓ What Makes a Plane Turn
- ✓ Types of Turns
- ✓ Instruments in a Turn

  - Attitude Indicator - Turn Coordinator
- ✓ Aerodynamic Effects in a Turn
  - Adverse Yaw
  - Pitch and Altitude
  - Load Factor.

Descending Turn

- The lower wing meets the airflow at a higher angle of attack creating more lift
- Upper wing moves faster and also creates more lift
- Two forces compensate one another so angle of bank remains the same

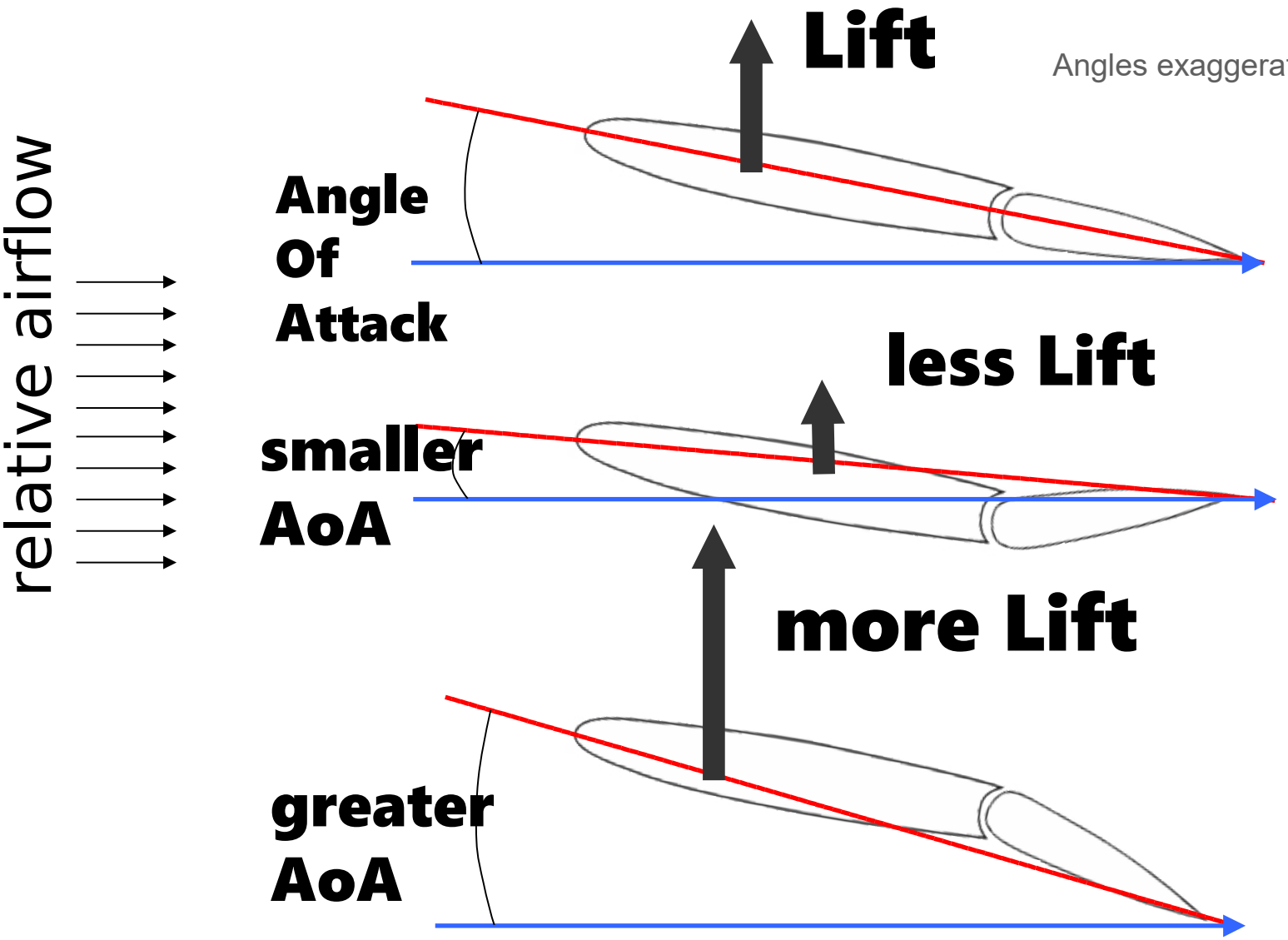
Climbing Turn

- The lower wing meets the relative airflow at a smaller angle of attack and creates less lift.
- Upper wing moves faster and creates more lift
- Two forces act to cause angle to increase

Overbank - Underbank

- In a climbing turn there is an overbank tendency- This means that the aircraft wants to steepen its bank angle. This must be resisted with a steady roll pressure constantly applied- "holding off bank".
- In a descending turn there may be an underbank tendency- This means that the aircraft may want to reduce its bank angle. This must also be resisted with a steady roll pressure constantly applied - "Holding on Bank".

What Makes a Plane Turn

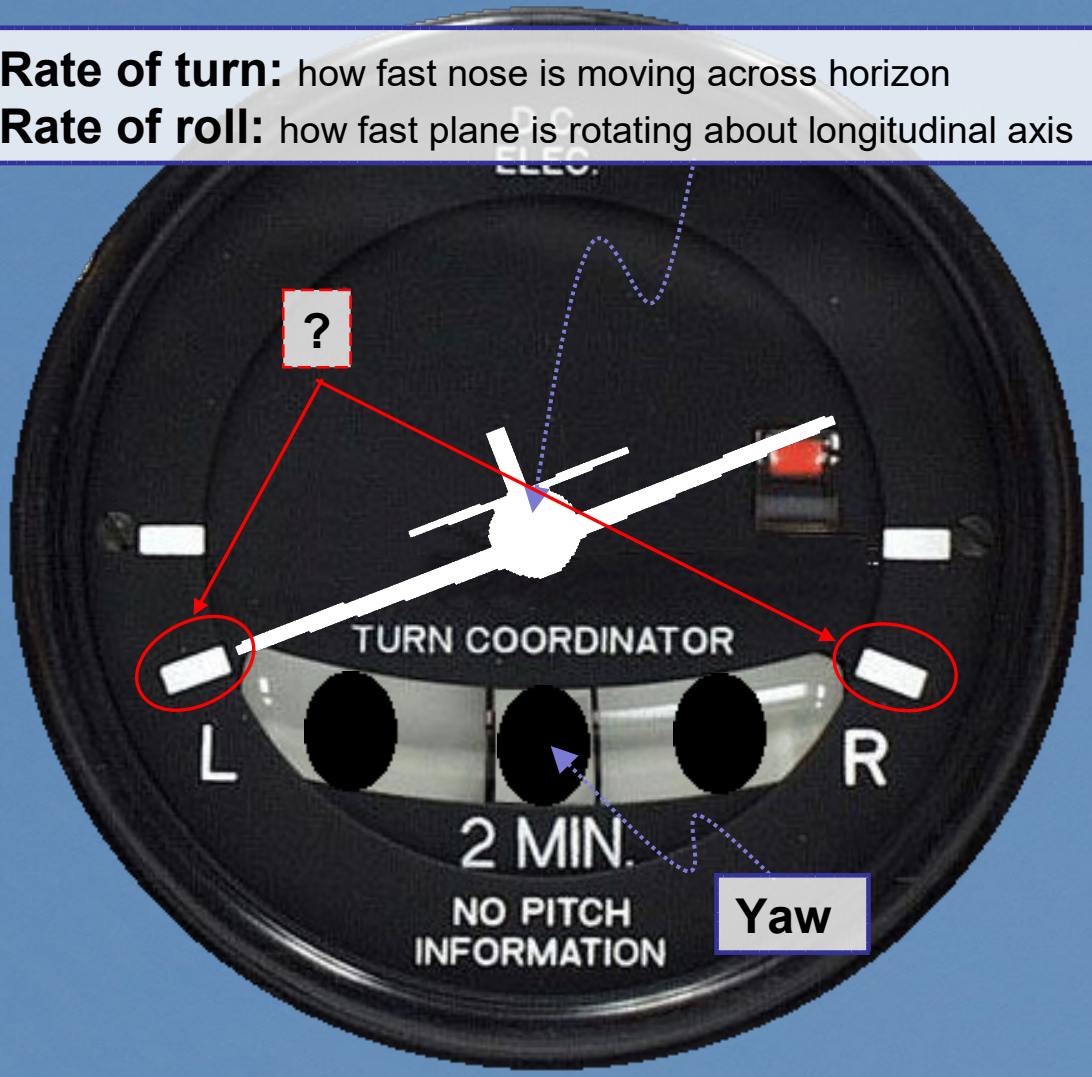


Attitude Indicator in a Turn

PRIMARY WAY TO MAINTAIN BANK ANGLE IS VISUAL!

Turn Coordinator in a Turn

Rate of turn: how fast nose is moving across horizon
Rate of roll: how fast plane is rotating about longitudinal axis



What information does the ball provide?

What information does the miniature airplane provide?

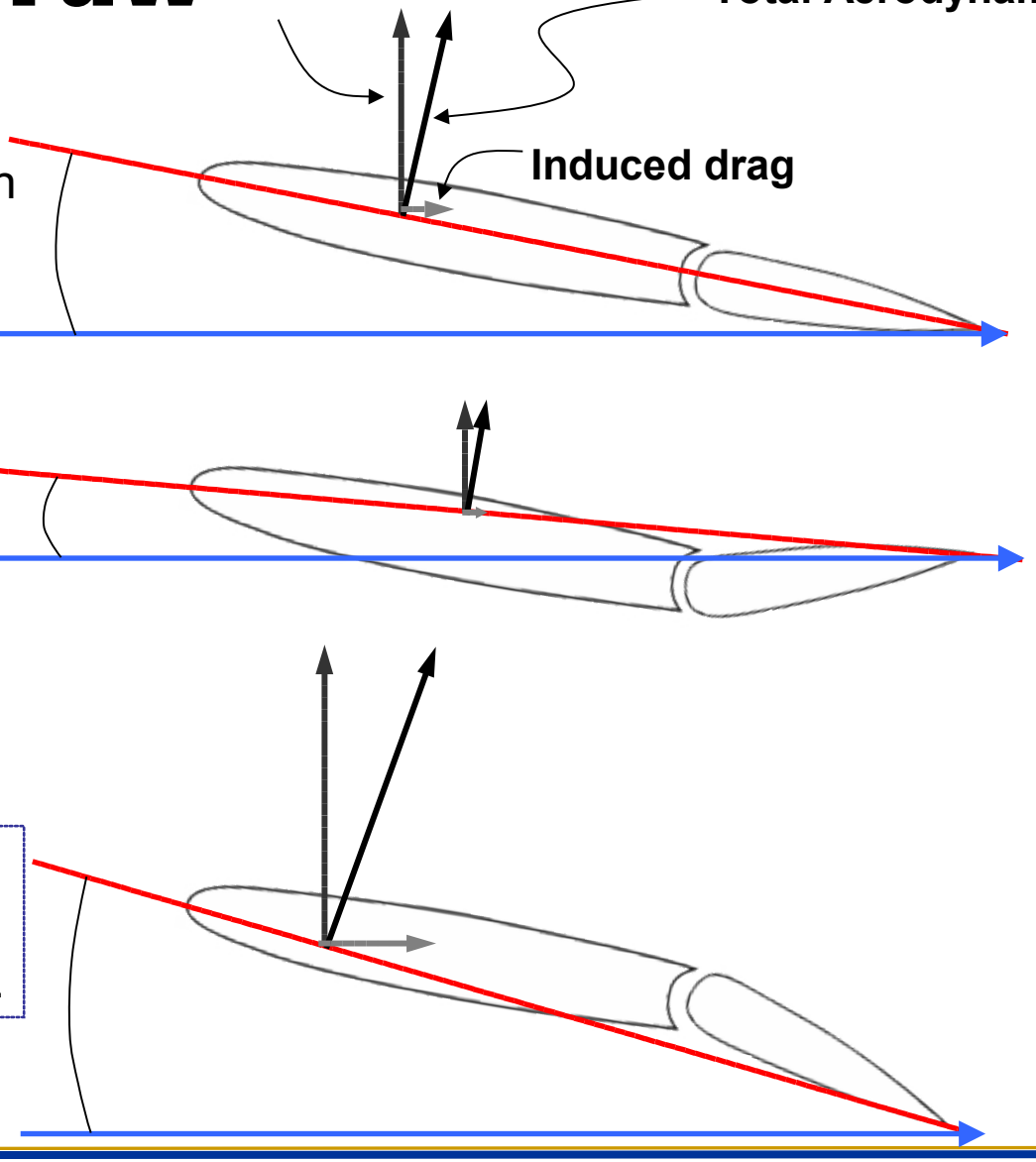
What kind of turn the plane is in? (Left, right? Coordinated, slipping, skidding?)

How long will it take to turn from heading 210 to heading 150 at rate one turn?

Rate One Turn
=
3 degrees per second

Adverse Yaw

is the natural and undesirable tendency for an aircraft to *yaw* in the opposite direction of a roll.



MORE LIFT
=
MORE INDUCED DRAG.

Procedures

- Level Turn
  - Entry
  - During (gentle & medium turns)
  - Recovery
- Climbing Turn
  - Entry
  - During
  - Recovery
- Descending Turn
  - Entry
  - During
  - Recovery.

Level Turn: Entry

- ✓ Look-out in direction of intended turn
- ✓ Turn yoke in direction of intended turn
- ✓ Anticipate and correct adverse yaw with rudder
- ✓ At desired angle of bank, return yoke close to neutral
- ✓ Correct change in yaw as necessary.

Gentle Level Turn:

Medium Level Turn:

Level Turn: Recovery

If you're turning from south to heading -090 at 20° angle of bank, at what heading should you start recovery?

Begin leveling out at half the angle of bank

Climbing Turn: Entry

- ✓ Cockpit check! Why?
- ✓ Look-out in direction of intended turn

Why should you establish climb before starting a turn?

- ✓ Attitude – Power – Trim to establish climb

Which rudder will you need?

- ✓ Anticipate and correct adverse yaw with rudder
- ✓ Propeller slipstream means climbing right turn needs a boot full of right rudder, climbing left turn, hardly any.

Gentle turns only if not flying a fighter jet
Not enough power

Climbing Turn: During

Keep good look-out (especially in direction of the turn)

- ✓ Maintain desired bank angle with aileron inputs
- ✓ Maintain pitch and airspeed with elevators
- ✓ Maintain coordinated flight with rudder.

Climbing Turn: During

Climbing Turn: Recovery

Begin leveling out at half the angle of bank

Continue to keep good look-out

What's the procedure?

Recover from Turn

- ✓ Correct yaw with rudder

What's the procedure?

Recover from Climb

- ✓ **Attitude**
- ✓ **Power**
- ✓ **Trim.**

Descending Turn: Entry

- ✓ Cockpit check!
- ✓ Look-out in direction of intended turn
- ✓ Power – Attitude – Trim to establish descent
- ✓ Anticipate and correct adverse yaw with rudder

Which rudder will you need?

No power on, but fin still offset for slipstream-left descending turn needs more rudder than right descending turn.

Descending Turn: During

Keep good look-out (especially in direction of the turn)

Maintain desired bank angle with aileron inputs

- ✓ **Maintain pitch and airspeed with elevators**
- ✓ **Maintain coordinated flight with rudder.**

Descending Turn: During

Descending Turn: Recovery

Begin leveling out at half the angle of bank

Continue to keep good look-out

What's the procedure?

Recover from Turn

- ✓ **Turn yoke in direction opposite the turn**
- ✓ **Correct yaw with rudder**
- ✓ **When plane is level, neutralize yoke**

What's the procedure?

Recover from Descent

- ✓ **Power**
- ✓ **Attitude**
- ✓ **Trim.**

Considerations

- ✓ Turn Radius and Rate
  - Effect of Bank Angle
  - Effect of Airspeed
- ✓ Rate One Turns.

Turn Radius & Rate: Effect of Bank Angle

Greater Bank Angle

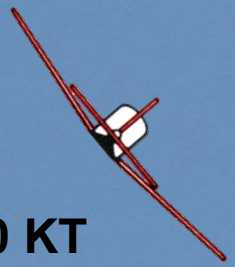
=

Smaller Turn Radius

Greater Rate of Turn

Which plane will have a smaller turn radius?

90 KT



90 KT

Turn Radius & Rate: Effect of Airspeed

Lower Airspeed

=

Smaller Turn Radius

Greater Rate of Turn

Which plane will have a smaller turn radius?

140 KT

70 KT

Rate One Turns

"Rule of Thumb"

bank angle for rate one turn

=

TAS/10 + 7 (knots)

140 KT

Both planes are doing a rate one turn. Which one will change heading by 90° first?

If you're flying at 90 knots, what should your bank angle be for rate one turn?

70 KT

SAFETY

Lift wing before turn to check your “blind spot”

- Look-out, especially in direction of turn
- Climbing turns
  - must be gentle (operating close to stall!)
  - set up climb first, turn second
- During descending turns avoid over speeding the plane
- Correcting yaw is critical in a turn!

Review

- Which way does the plane want to yaw after the yoke is deflected left, and why?
- Are the numbers on the Heading Indicator increasing or decreasing in a right turn?
- How can you use the Turn Coordinator to know whether the plane is slipping or skidding?
- What is the procedure for entering a climbing turn? Recovering?

Conclusion

- ✓ Now you know how to perform every basic manoeuvre of the airplane!
- ✓ This lesson builds a foundation for advanced (steep) turns
- ✓ Read for next lesson: Ex. 10, Range and Endurance

QUESTIONS?