Glider Aerodynamics

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Glider Aerodynamics Terms

- Chamber
- Chord
- Relative Wind
- Angle of Attack
- Angle of Incidence
- Center of Pressure (Lift) and Center of Gravity
- Aspect Ratio (Span/Chord)
- Aileron, Elevator and Rudder controls
- Elevator Trim
- Bernoulli's Principle
Types of Gliders
And of Course.....
Glider Forces and Axes

Four Forces
- Lift
- Weight
- Drag
- Thrust

Three Axes
- Longitudinal - Roll
- Lateral - Pitch
- Vertical - Yaw
Lift or Weight? Drag or Thrust?

- What powers the glider thru the air?
- What causes the glider to speed up?
- What causes the glider to slow down?
- How are Lift, Drag and Weight related?
Soap Box Derby Car on Level Ground
Soap Box Derby Car on Incline Plane
What Powers a Glider? - Gravity

Frank and Ernest

Ernie! What are you doing up there?!!
Just floating around. I'm ignoring gravity today.

Ignoring gravity?!! That's absurd! You're not thinking logically at all!

What do you mean?

You're breaking the laws of physics -- gravity is not a choice! Now put some reason and common sense in your thinking!

Thud!

Are you thinking sensibly now?
Yes, but I liked it better when I was less grounded!

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Straight Gliding Flight
Glider Stability

- Longitudinal Stability – Static & Dynamic
  - Positive
  - Neutral
  - Negative
- Lateral Stability
  - Dihedral
- Directional Stability
  - Vertical Stabilizer – Weather vane effect
5 Effects of Turning Flight

- Adverse yaw
- Diving tendency
- Over-banking tendency
- Yaw against the turn
- Increase stall speed
45º Banked Flight

![Diagram of 45º Banked Flight with load factor calculations at various angles]

Load Factor:
- At 0º = 1.0
- 30º = 1.2
- 45º = 1.4
- 60º = 2.0

Resultant Load = 1.4G
Slips, Skids and Crabbing

▪ Forward Slip
  ◦ Controlling Glide Path
  ◦ With and Without Dive Brakes
  ◦ Longitudinal Axis alignment

▪ Side Slip
  ◦ Landing in a Crosswind
  ◦ Cross-wind Takeoff technique
  ◦ Longitudinal Axis alignment

▪ Turning Slips & Skids

▪ Crabbing Flight – coordinated turn into wind
  ◦ Cross-wind Correction in the Pattern
  ◦ Cross-wind Takeoff technique
Critical Angle of Attack
- Any Attitude
- Any Airspeed
- 0° Bank – 1.0 G – 0% Increase in Stall
- 30° Bank – 1.2 G – 10% Increase in Stall
- 45° Bank – 1.4 G – 18% Increase in Stall
- 60° Bank – 2.0 G – 41% Increase in Stall
Spins

- **Entry**
  - Uncoordinated Stall
  - Shallow Bank Skidding Turn

- **Recovery**
  - Ailerons Neutral
  - Full Opposite Rudder against the Rotation
  - Apply Positive and Brisk Forward Stick – may need full forward stick
  - After Spin Rotation Stops - Neutralize Rudder
  - Recover from Dive with Gentle Back Stick
Glide Ratio and the Polar Curve
Glide Ratio and Speed to Fly
Scenario

Problem
Pilot not controlling glider in turning flight

Themes
Bank increases during turns
Airspeed increases during turns
Airspeed decreases during turns
Scenario

The pilot will land on runway 36 out of a left hand pattern. The winds are 10 kts from 330. In these conditions the pilot starts the turn to final late, and the airspeed decreases.
Analyze Scenario

- Identify Pilot factors
  - Write 3 questions you will ask about pilot factors

- Identify Aircraft factors
  - Write 3 questions you will ask about aircraft factors

- Identify Environmental factors
  - Write 3 questions on environmental factors

- Identify External factors
  - Write 3 questions on External Factors
References

- Glider Flying Handbook
- Joy of Soaring
- [www.carrotworks.com](http://www.carrotworks.com)
- Pilots Handbook of Aeronautical Knowledge
The End
Scenarios and P.A.V.E.

- Cross Country Cruise Flight
- Final Glides
- Thermaling
- Reversing course on the Ridge
- PT3 Turn at 200’
- Normal Pattern turns to Base or Final
- High Speed Pass followed by a 180° Turn
Soap Box Derby Car on an Incline Plane

\[ F_{\text{norm}} = \blank \text{ N} \]

\[ F_{\text{frict}} = \blank \text{ N} \]

\[ F_{\parallel} = \blank \text{ N} \]

\[ F_{\perp} = \blank \text{ N} \]

\[ F_{\text{grav}} = \blank \text{ N} \]

\[ m = \blank \text{ kg} \]

\[ F_{\text{net}} = \blank \text{ N} \]

\[ \mu = \blank \]

\[ a = \blank \text{ m/s/s} \]