GLIDER DESIGN PROJECT

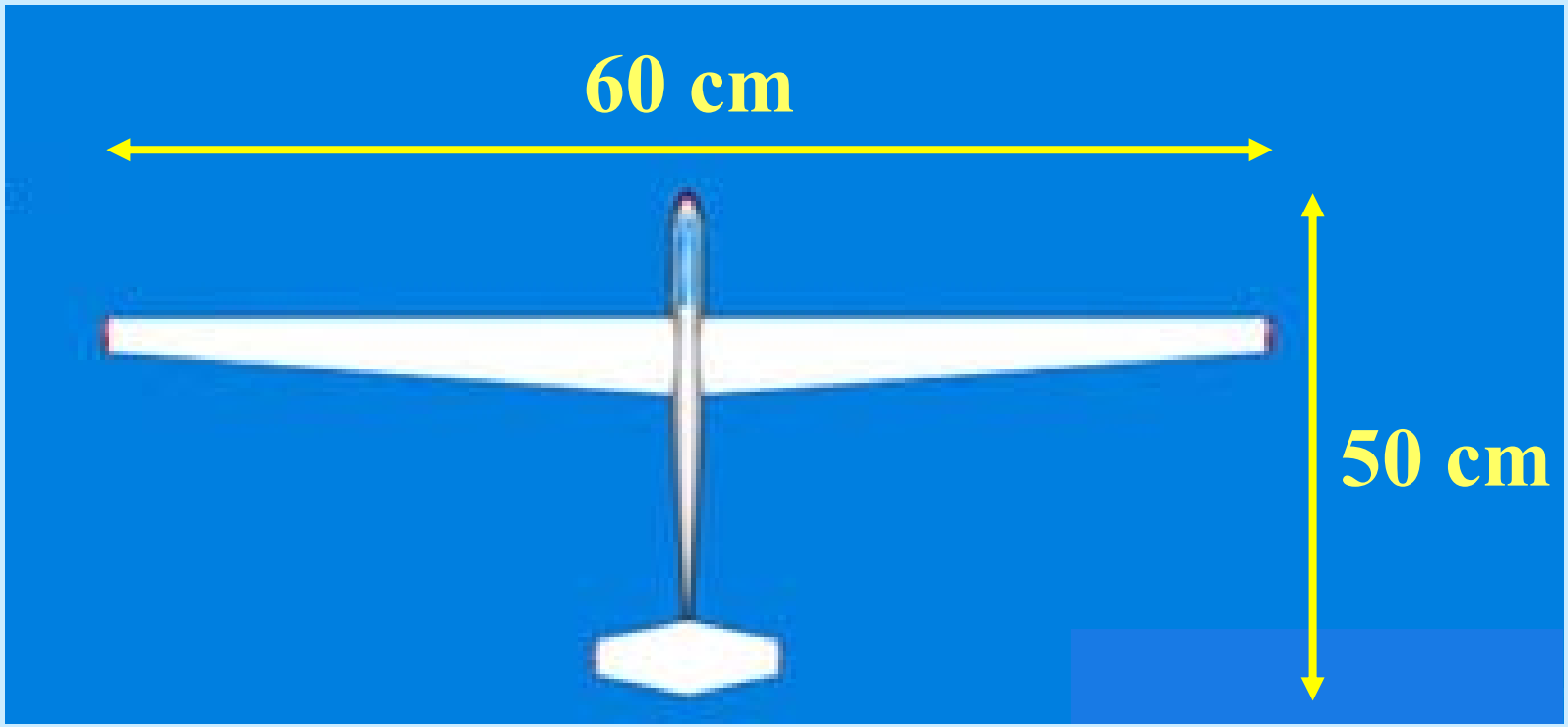
The Task

- To design, build and test a scale-model glider
- Designs will be judged on four criteria:
  - Distance travelled, D
  - Time of flight, T
  - The product $D \times T$
  - The quantity $D \times T \div M$
    where M is the glider mass

Design Requirements

The glider must:

- Have a wing span of no more than 60 cm
- Be no more than 50 cm long



Materials

- Thick foam board – 2 sheets ~33×8 cm
- Thin foam board – 2 sheets ~31×19.5 cm
- A4 paper – 4 sheets
- Drinking straws – 8
- Tissue paper – 1 sheet
- Masking tape
- Adhesive

Equipment

- Scissors
- Stanley knife
- Steel ruler
- Sand paper
- Radius aids
- Bluetack (for centre of gravity adjustment)

Objectives

To give a taste of what Engineering is all about:

- Problem solving
- Being creative – an Engineer is by definition an *ingenious* person
- Team work
- Rewarding
- Fun

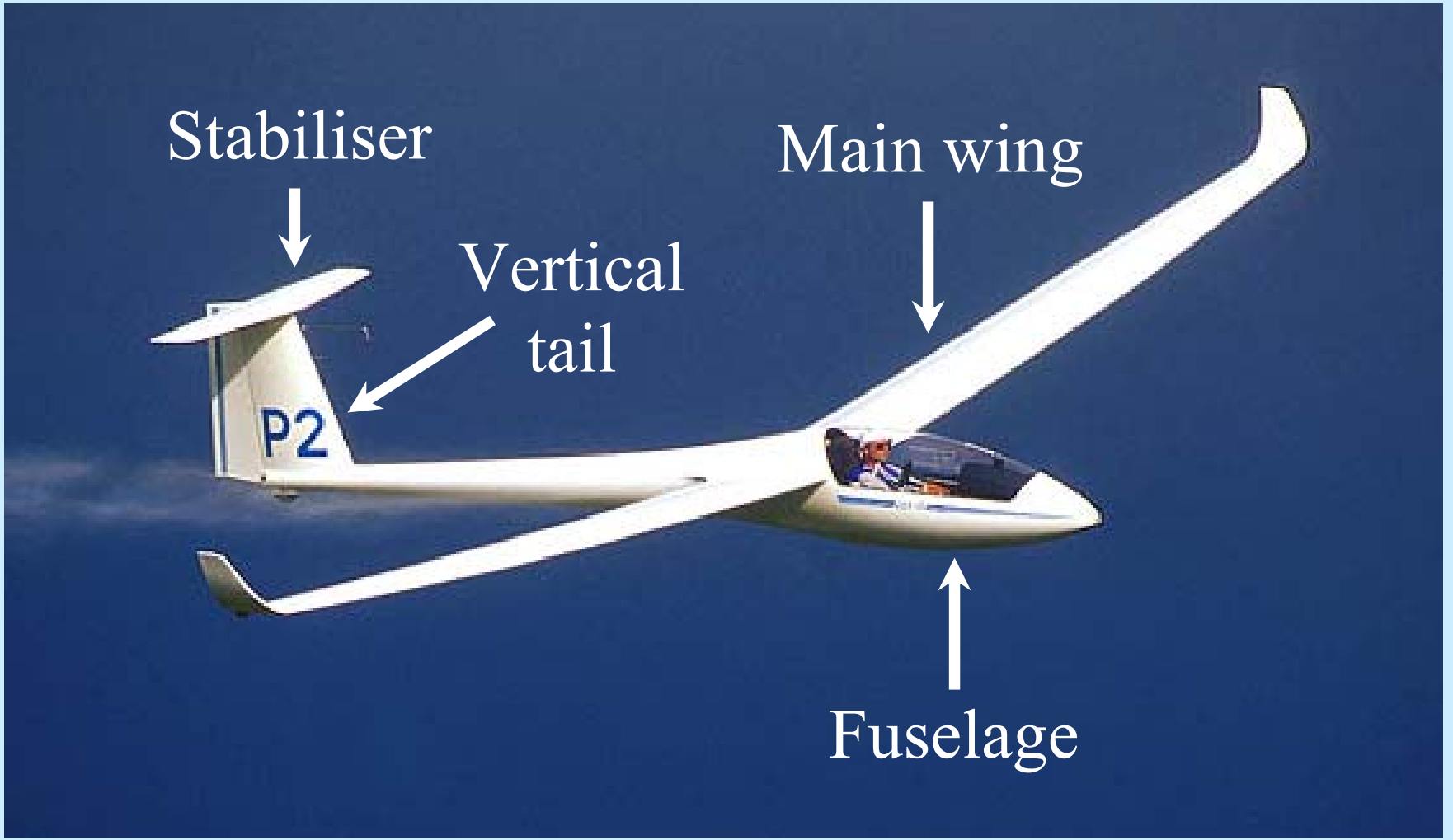
Project Timetable

Introduction to Design Task	10 minutes
Introduction to Glider Design	20 minutes
Design Session	15 minutes
Construction/Test Session	60 minutes
Final Test Session	15 minutes

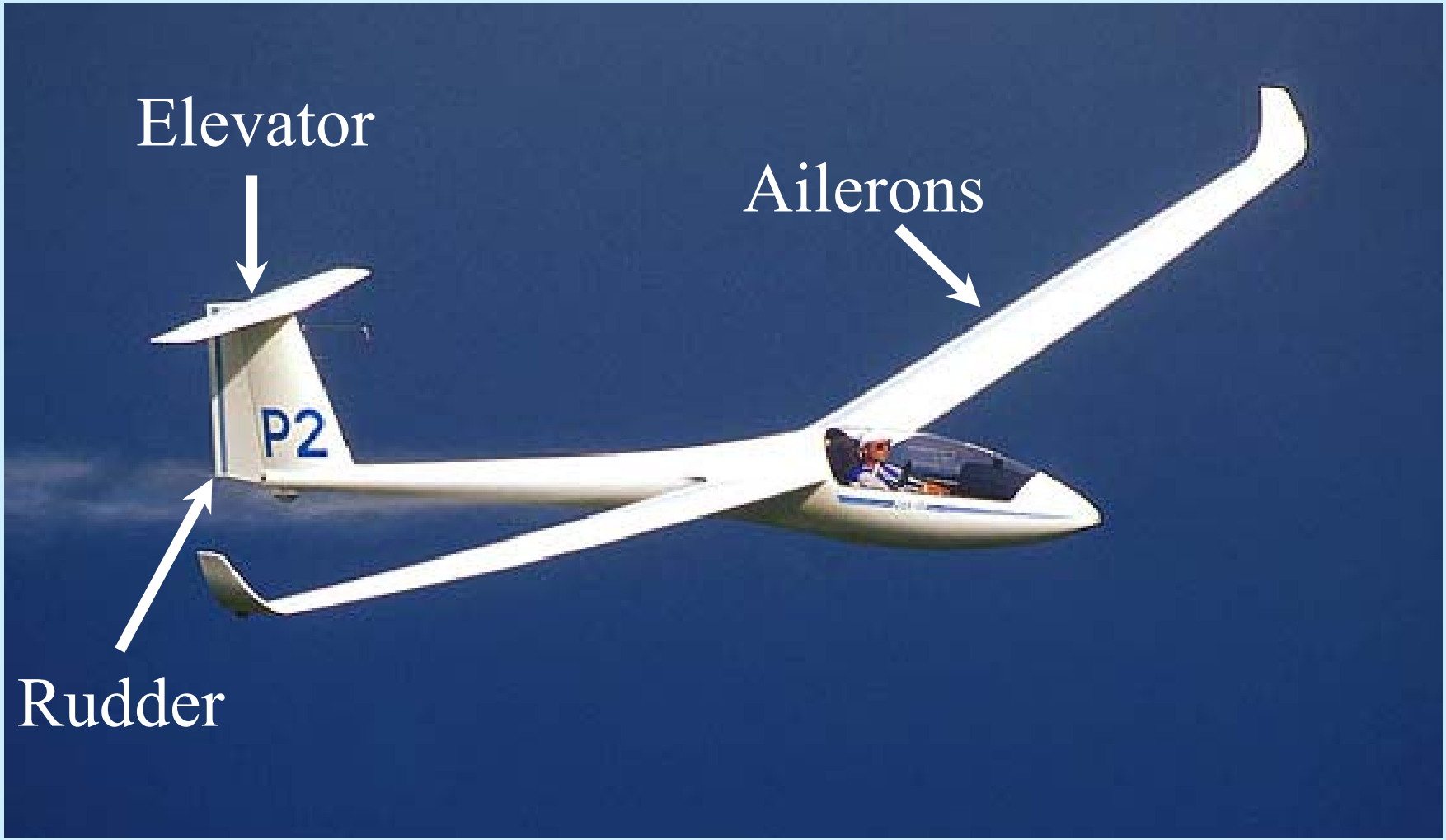
An Introduction to Glider Design

Geoff Parks

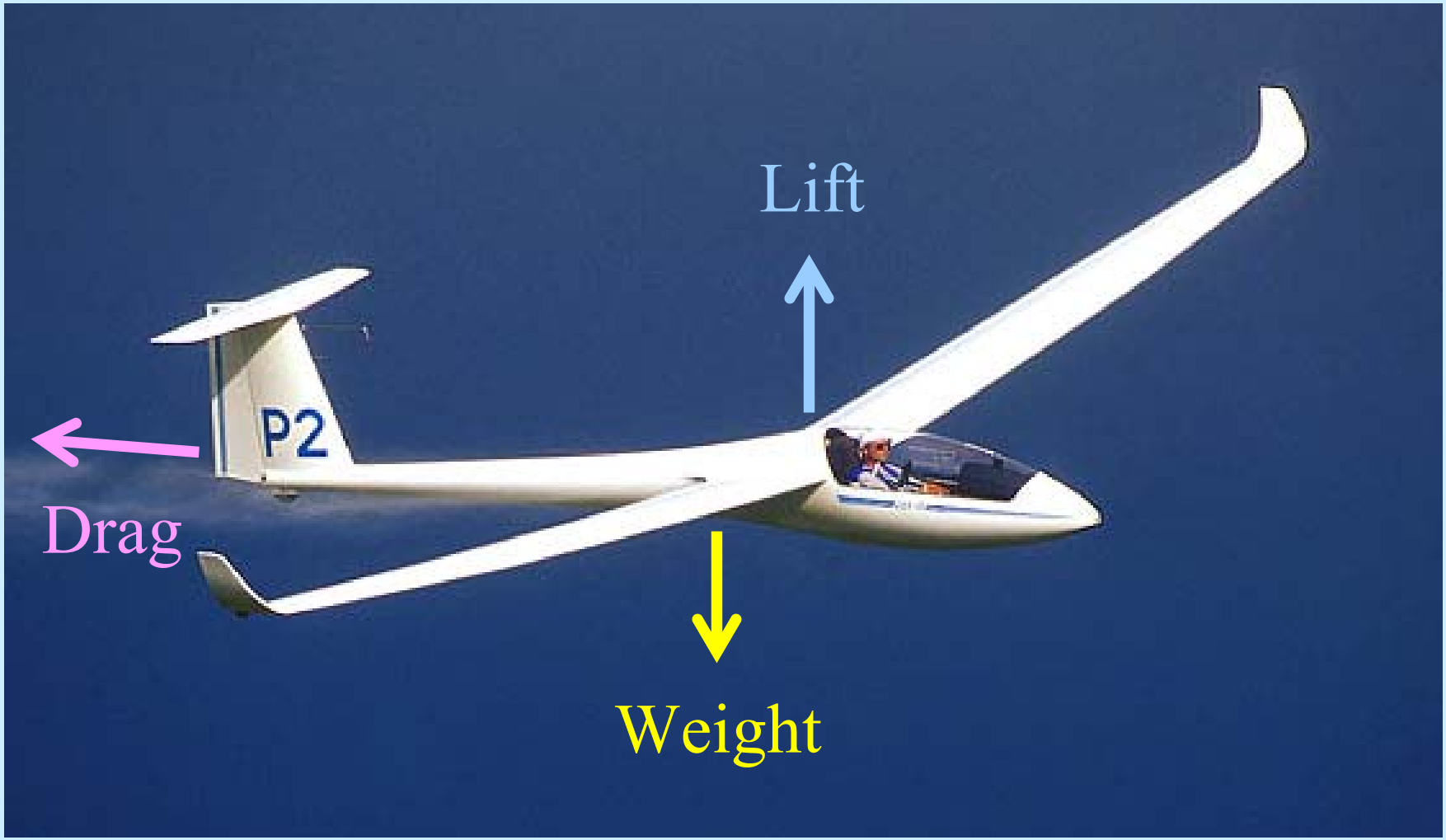
Glider Parts



Glider Control Surfaces



Forces on a Glider



Weight

- The weight of a glider is simply its mass multiplied by g, the acceleration due to gravity

$$W = Mg$$

Lift I

- The **Coanda Effect**: a fluid has a natural tendency to follow the shape of a body as it flows past it
- If the body is correctly shaped (airfoil shaped), this can be used to generate lift

Lift II

Fluid is deflected downwards by airfoil

$\therefore$ **Force** acts **downwards** on fluid

$\therefore$ **Force** acts **upwards** on airfoil

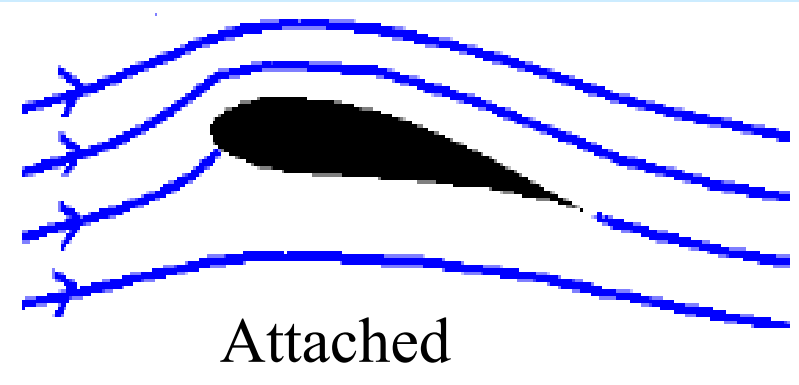
(by Newton's 3rd Law)

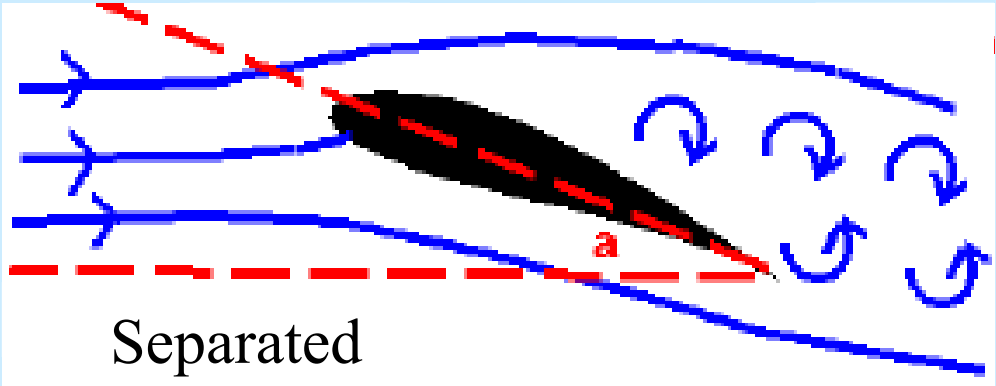
Lift III

The amount of lift depends on:

- Wing size – larger area → more lift
- Speed – higher speed → more lift
- Airfoil shape – more flow turning → more lift
- Airfoil angle of attack – larger angle of attack → more lift

Stall





- If the airfoil angle of attack (a) becomes too large and/or the flow speed becomes too large…
- The Coanda effect can break down, leading to flow separation
- This separation, known as **stall**, reduces lift

Drag I

There are two forms of drag:

- **Form Drag**
- **Induced Drag**

Form Drag depends on:

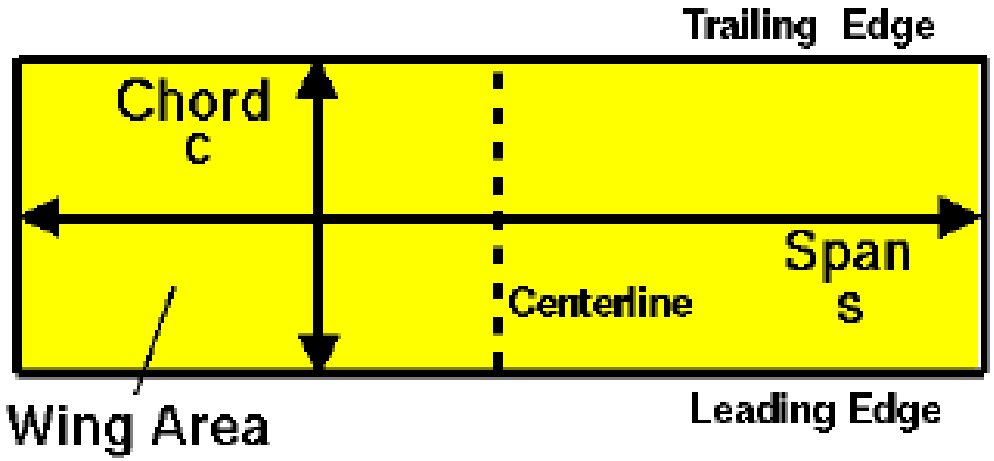
- The size of the object – larger projected area → more drag
- Speed – higher speed → more drag

Drag II

Induced Drag, *ID*, depends on:

- The amount of lift, *L*
- Wing aspect ratio, *AR*

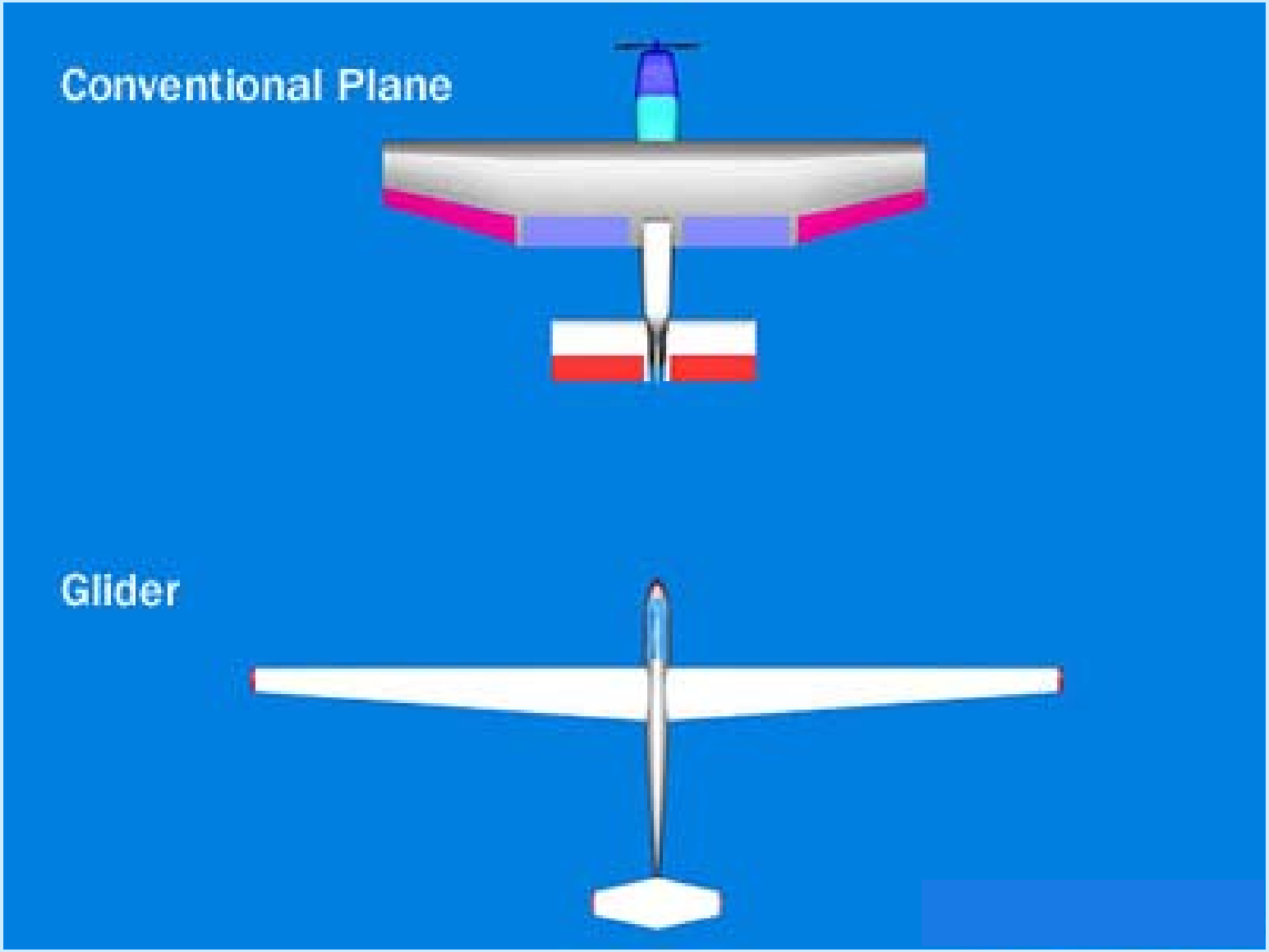
$$ID \propto L^2 \div AR$$



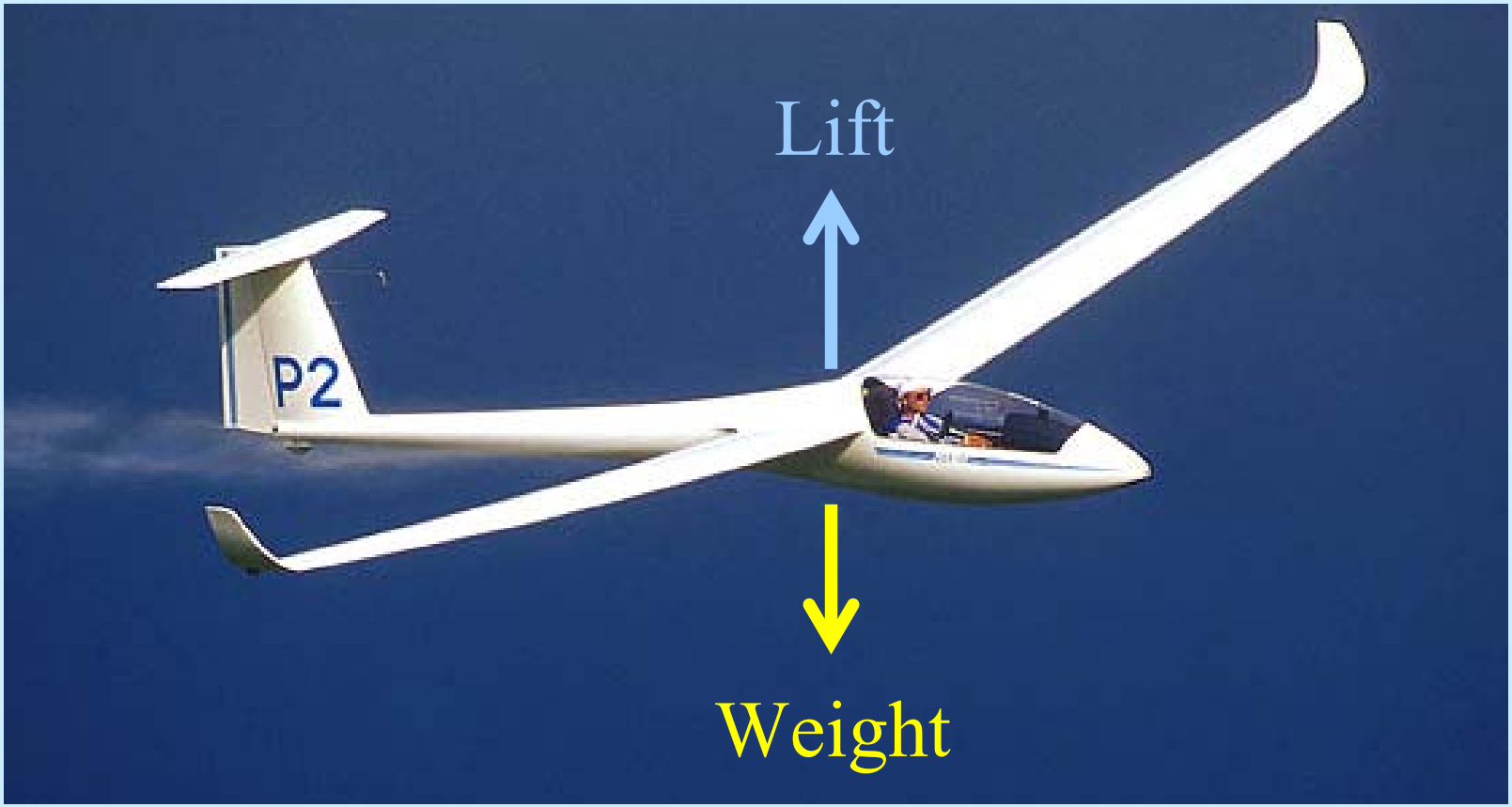
$$\text{Aspect Ratio} = AR$$

$$AR = \frac{s^2}{A} = \frac{s}{c}$$

Typical Glider Profile



Lines of Action



- To maximise flight distance, the lines of action of the lift and weight must coincide

Design Tips I

- Tape pieces of thin board onto the glider to act as ailerons, elevator and rudder; you can then slightly bend these to help trim your glider and direct it in flight.
- Add *dihedral* to the wing tips by making the outer portions of the wing angle upwards.

Design Tips II

- Make the wings moveable – so you can slide them fore and aft along the fuselage to find their optimal position.
- Round the leading edges of all surfaces and “point” the trailing edges.