

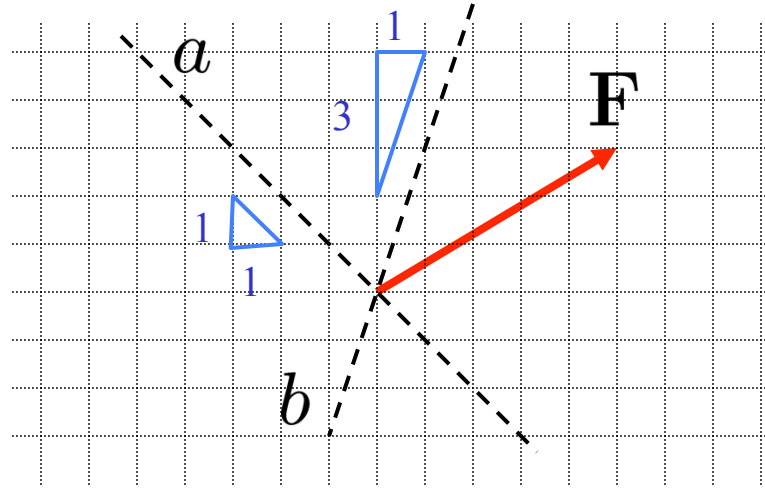
Today's topics:

- Moment of a Force
- Varignon's principle
- Couple

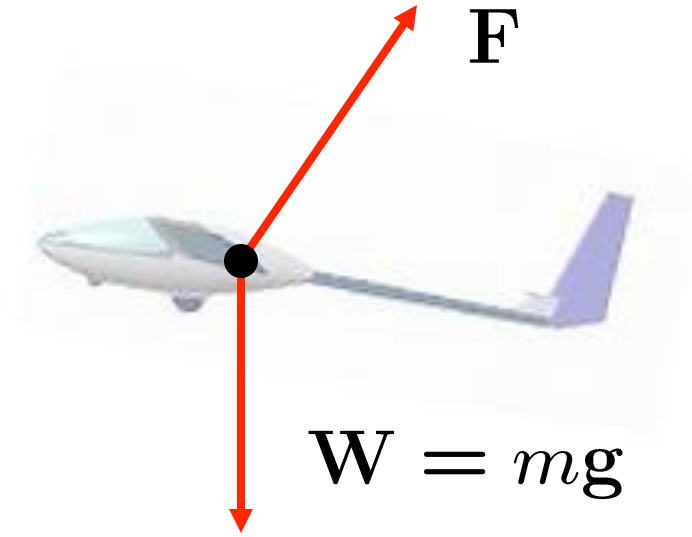
Book: Chapter 1, 2.1-2.4, 3.1-3.3, 4.1

Decomposition along non-orthogonal axes

$$\mathbf{F} = \begin{bmatrix} 5 \\ 3 \end{bmatrix}$$



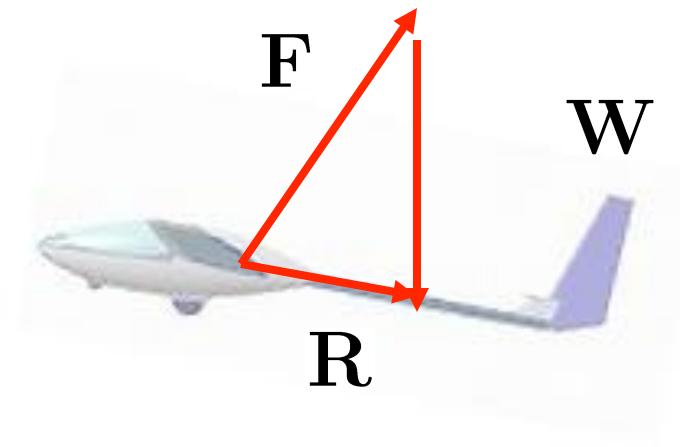
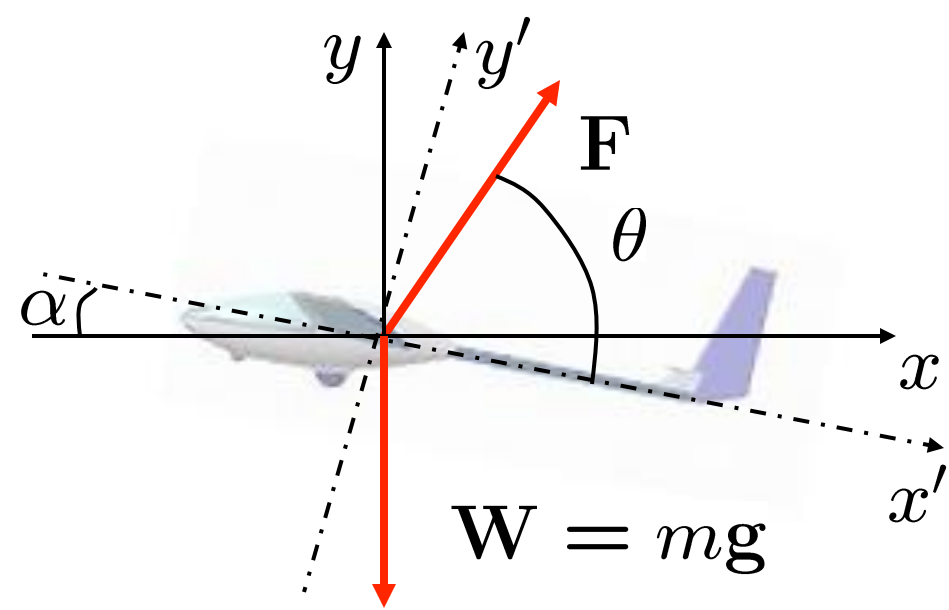
Model as particle



Resultant force (in case of a particle)

Single force that replaces all forces acting on a particle.

$$\mathbf{R} = \sum_{i=1}^n \mathbf{F}_i$$



Newton's laws (*Principia*, 1687)

- Law 1 A particle remains at rest or continues to move with uniform velocity (in a straight line with a constant speed) if there is no unbalanced force acting on it.
- Law 2 The acceleration of a particle is proportional to the vector sum of forces acting on it, and is in the direction of this vector sum.
- Law 3 The forces of action and reaction between interacting bodies are equal in magnitude, opposite in direction, and collinear (they lie on the same line)

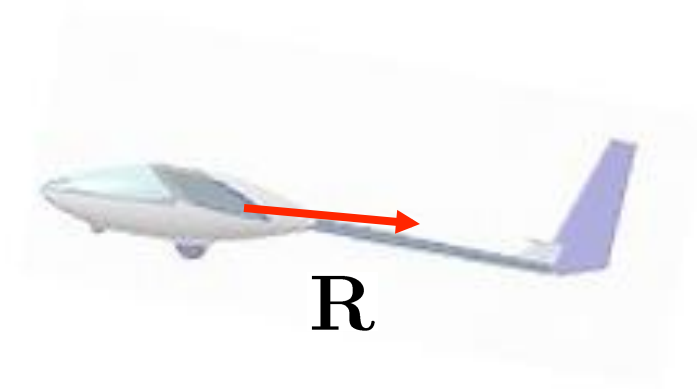
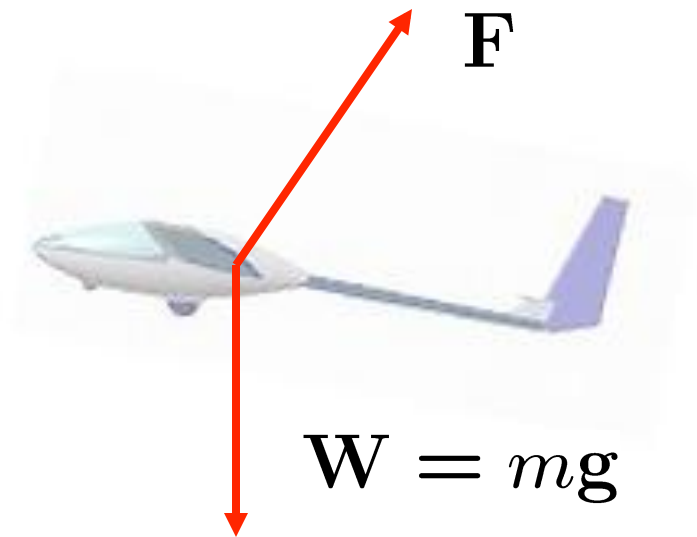
Static equilibrium (Newton's first law)

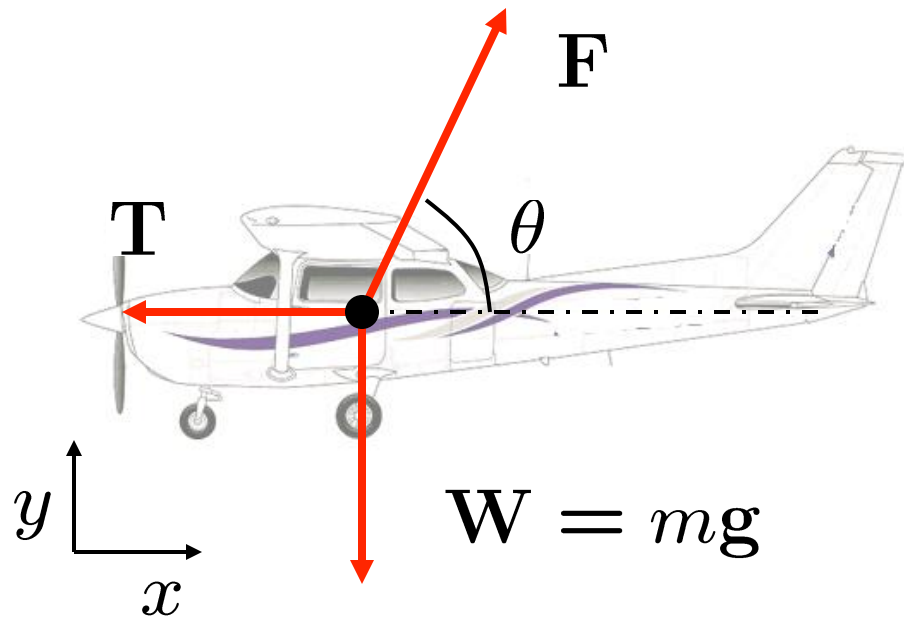
The resultant is equal to zero

$$\mathbf{R} = \mathbf{0}$$

Or, the sum of forces in x - and y -directions are zero

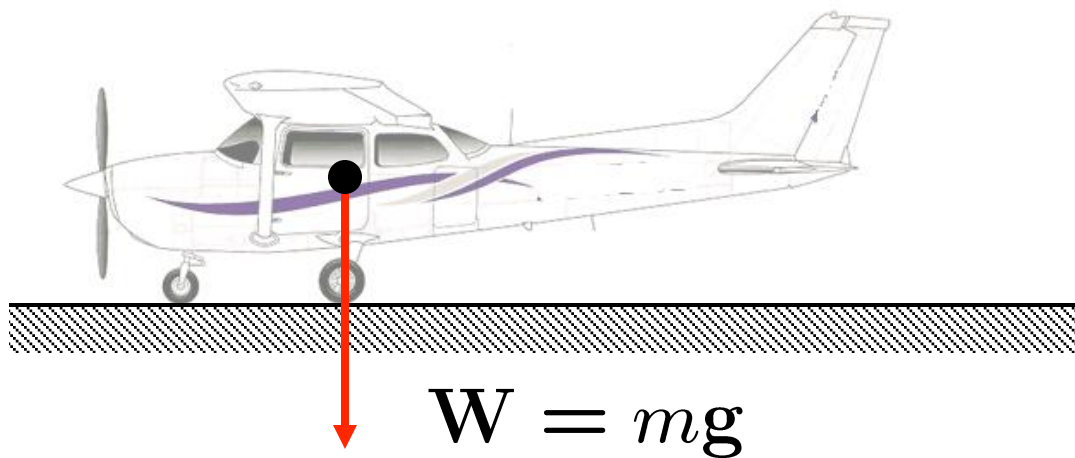
$$\sum F_x = 0 \qquad \sum F_y = 0$$





The plane is in static equilibrium
Model as a particle and calculate:

- Aerodynamic force \mathbf{F}
- Thrust \mathbf{T}



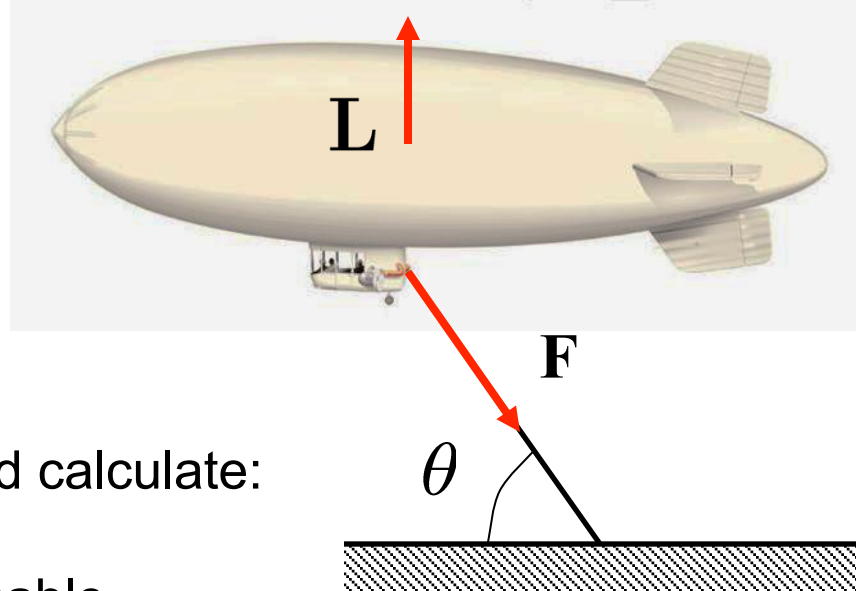
Equilibrium?

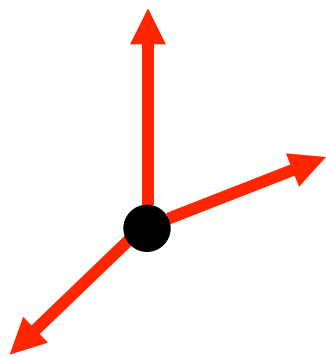
Blimp

Lift 2000 N
mass 150 kg
eff. wind load 100 N

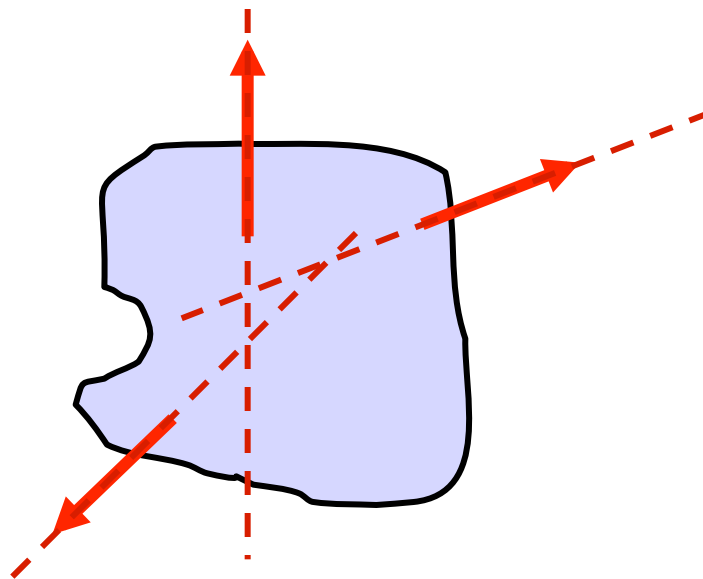
Consider as a particle and calculate:

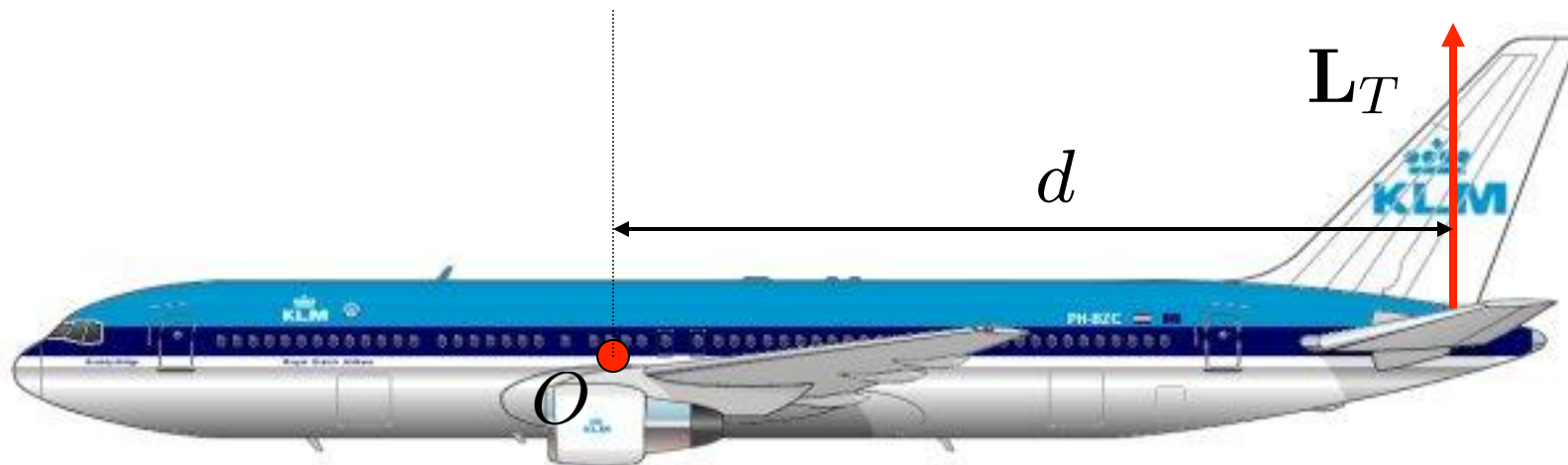
- angle θ
- Magnitude of force in cable

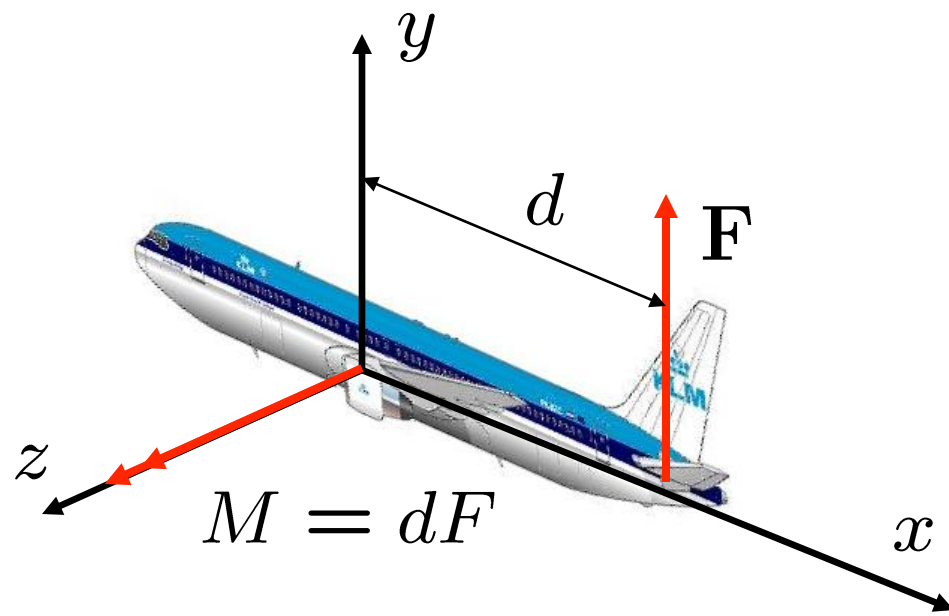


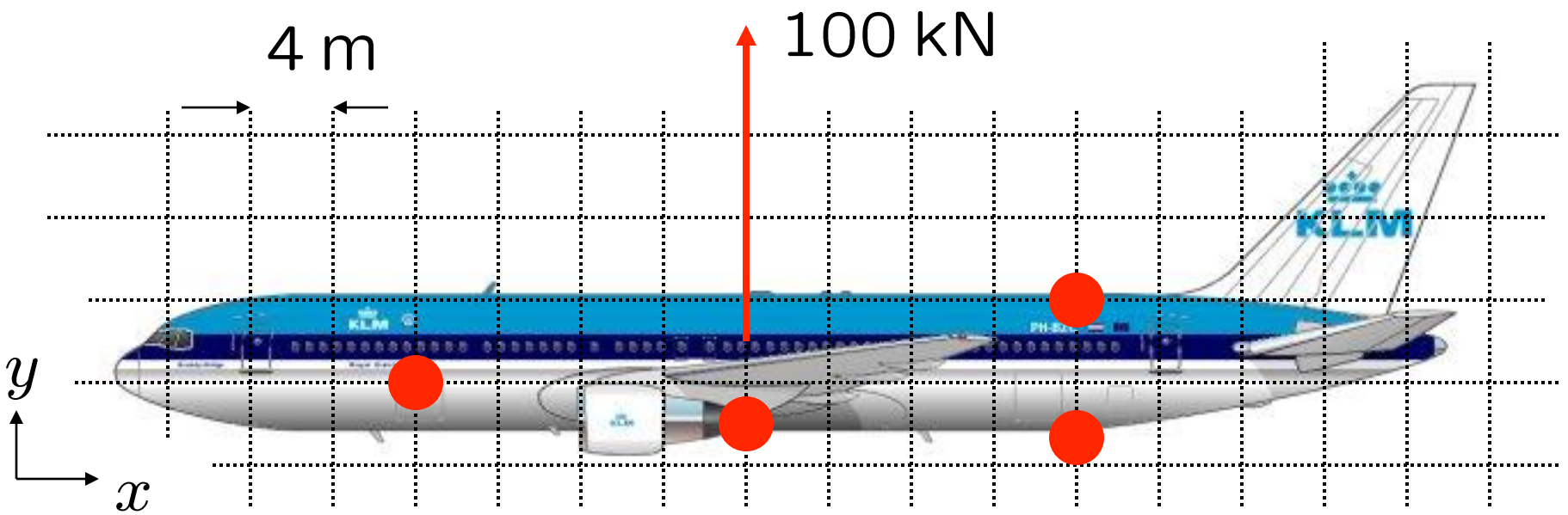


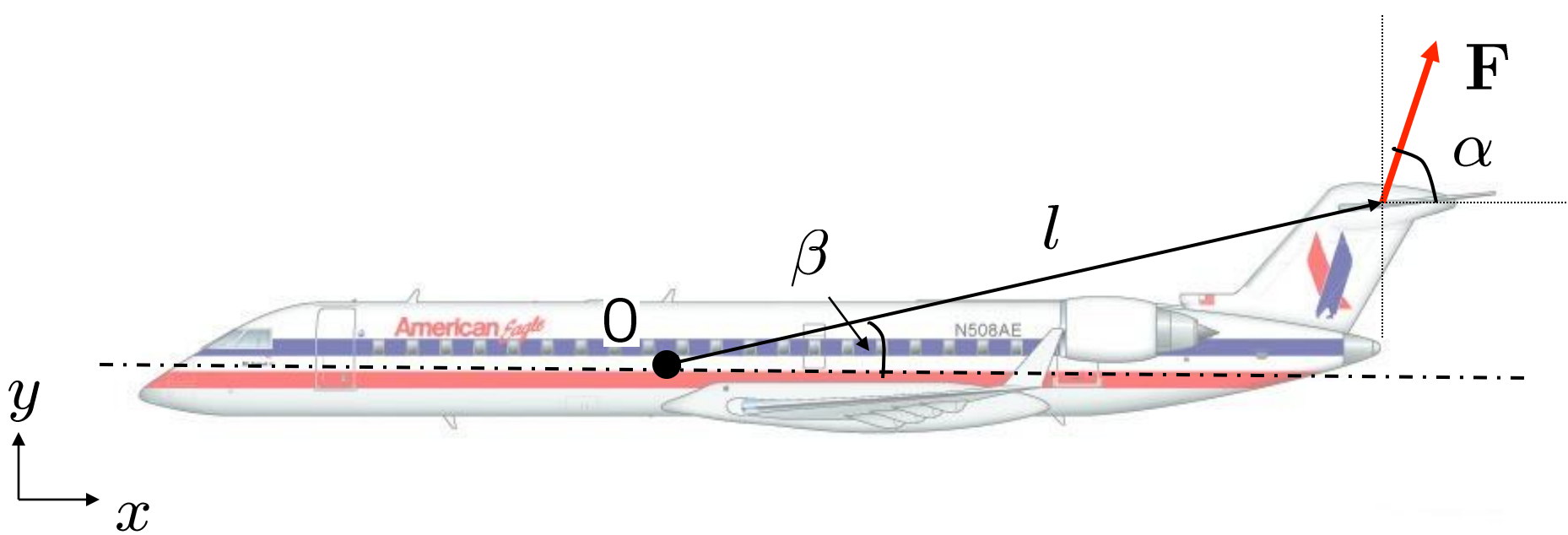
$$\sum \mathbf{F} = 0$$







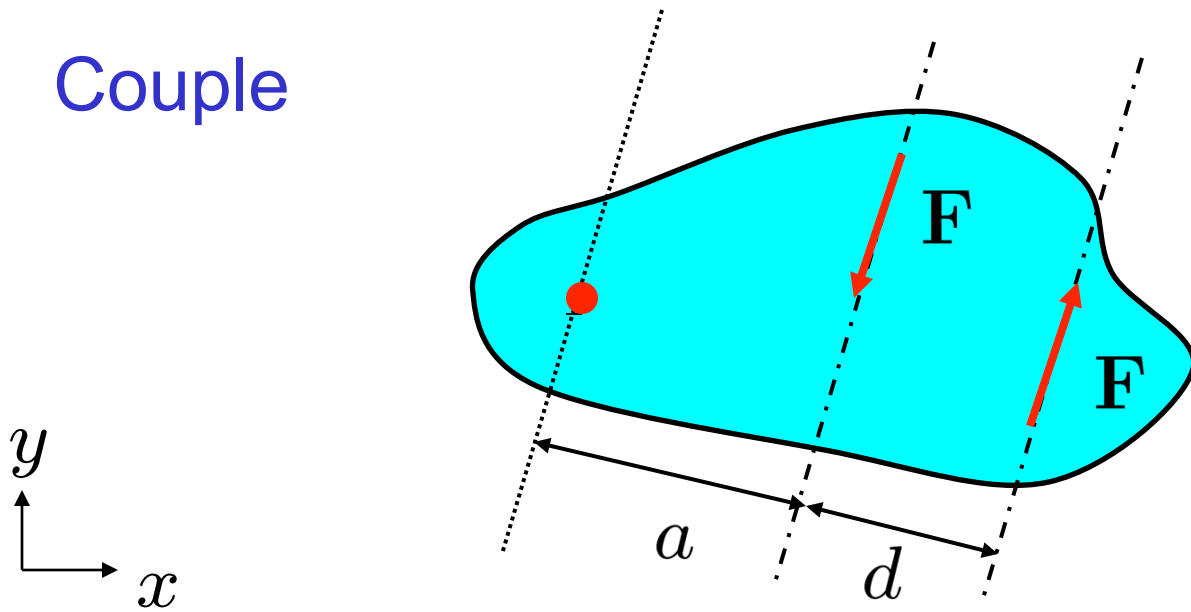




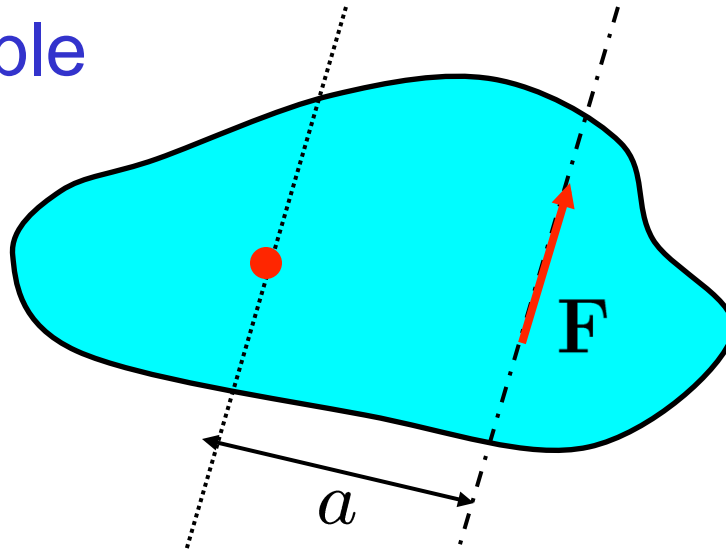
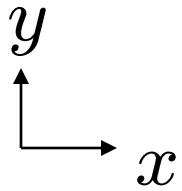
Varignon's principle

The moment of a force about any point is equal to the sum of the moments of the components of this force.

Couple



Force – couple systems

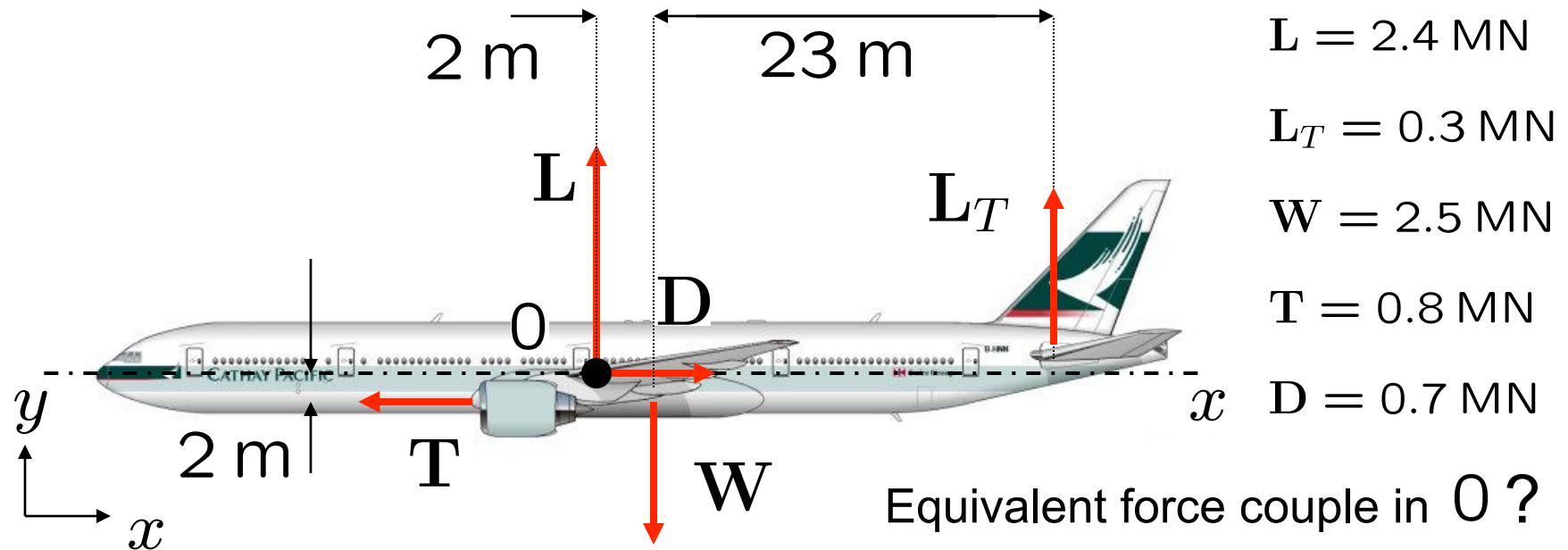


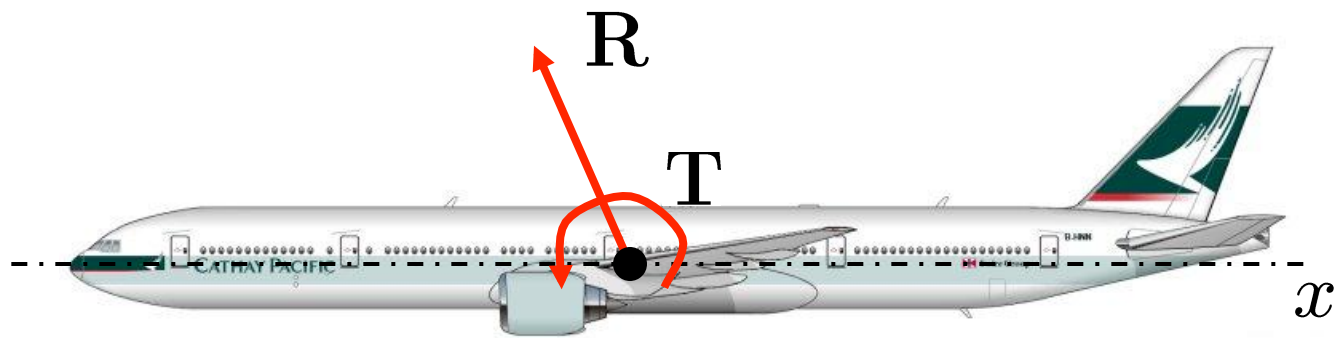
Equivalent force couple system

A single resultant force and a moment that replaces all forces and couples in a body

$$\mathbf{R} = \sum \mathbf{F}$$

$$\mathbf{M}_R = \sum (\mathbf{r} \times \mathbf{F})$$



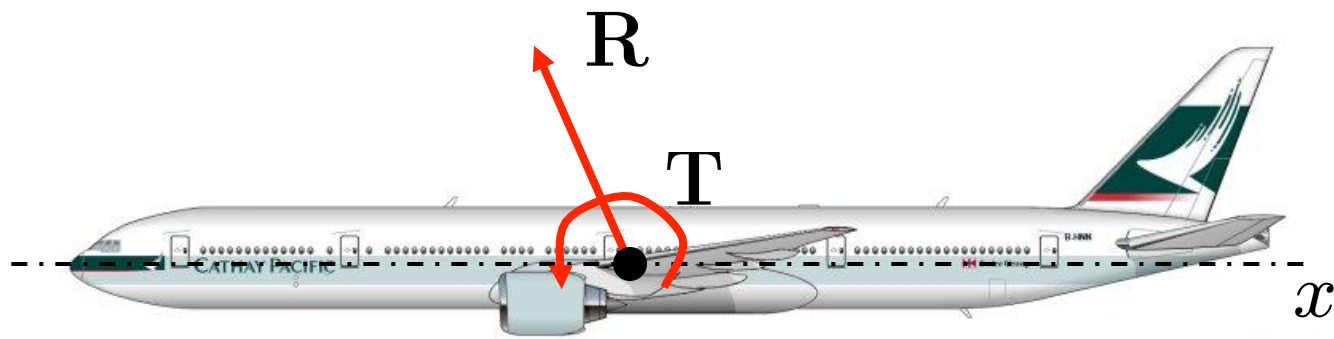


Resultant force

A single resultant force in a specific point that replaces all forces and couples in a body

$$\mathbf{R} = \sum \mathbf{F}$$

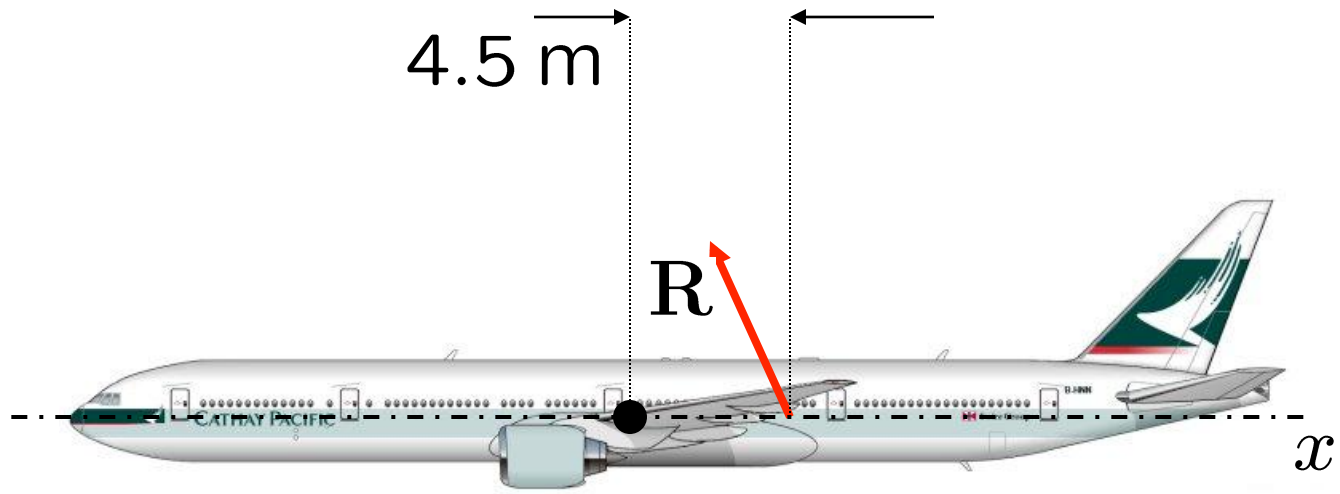
$$\mathbf{M}_R = \sum (\mathbf{r} \times \mathbf{F}) = \mathbf{0}$$

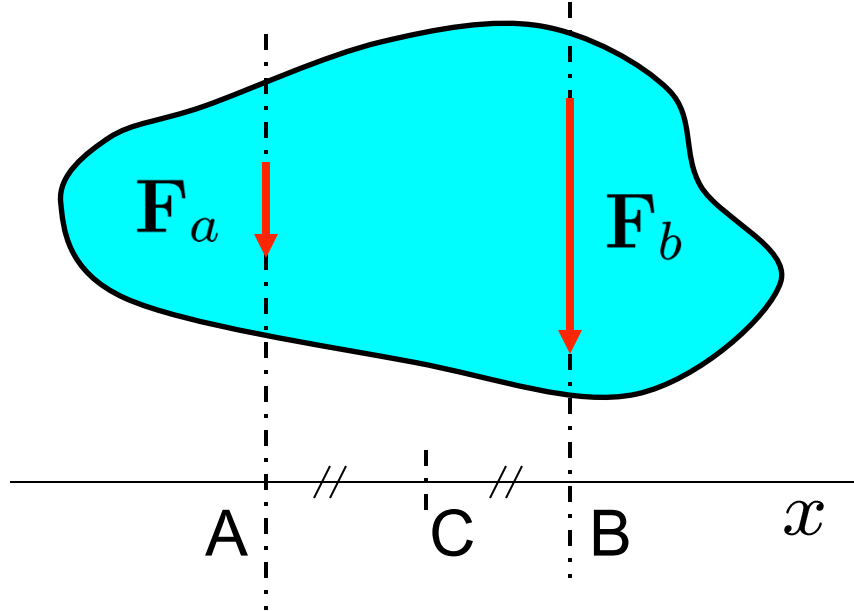


$$\mathbf{R} = \begin{bmatrix} -0.1 \\ 0.2 \end{bmatrix}$$

$$T = 0.9$$

Position of resultant force along x -axis

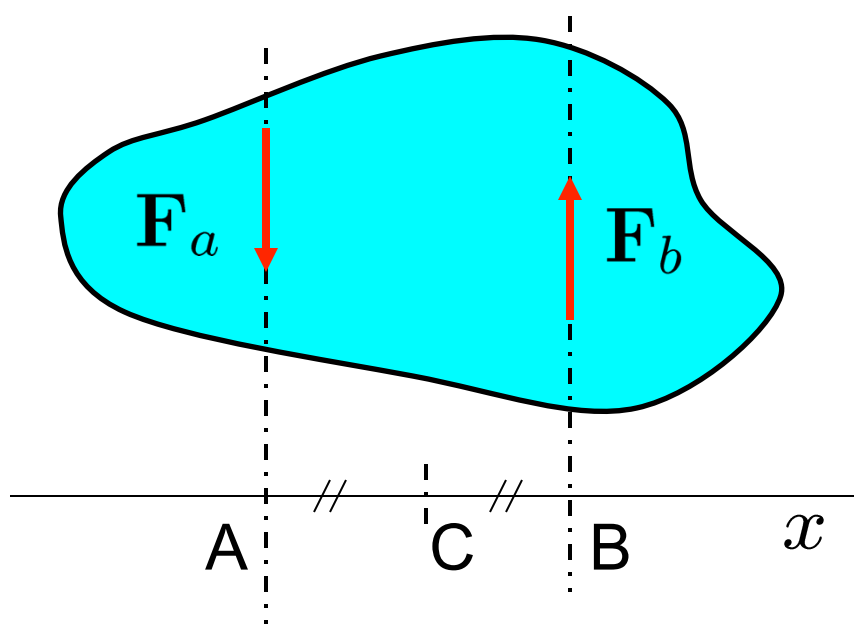




$$F_b > F_a$$

Where does the line of action of the resultant cross the x -axis?

- A) Close to A
- B) Close to B
- C) In C
- D) Somewhere else



$$F_b = F_a$$

Where does the line of action of the resultant cross the x -axis?

A) Close to A

B) Close to B

C) In C

D) It does not