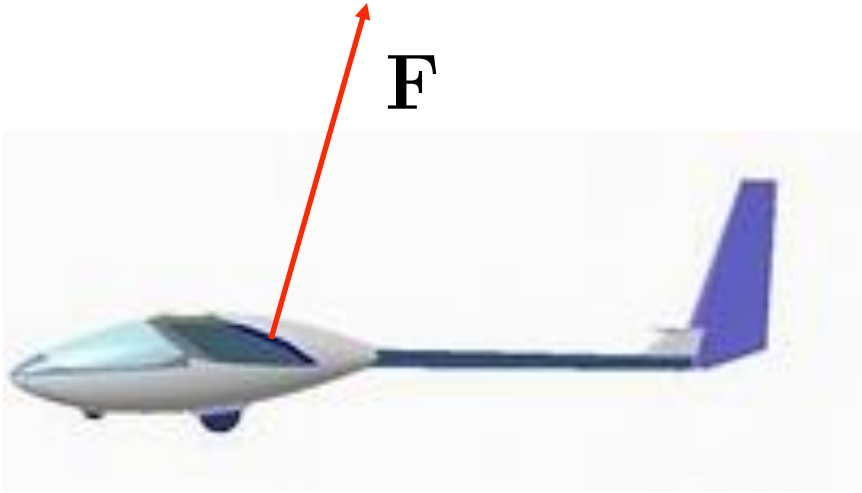
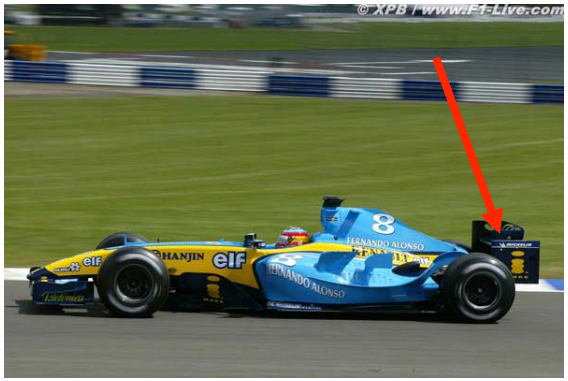
Today: Chapter 1, 2.1-2.4, 3.1-3.3

- Concept of a Force
- Force as a vector, decomposition of forces
- Some vector algebra
- Newton’s laws
- Equilibrium of Forces

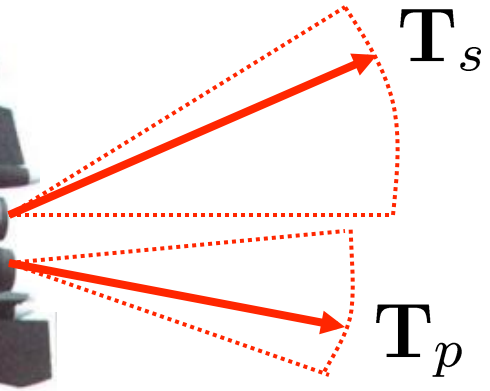
Aerodynamic force



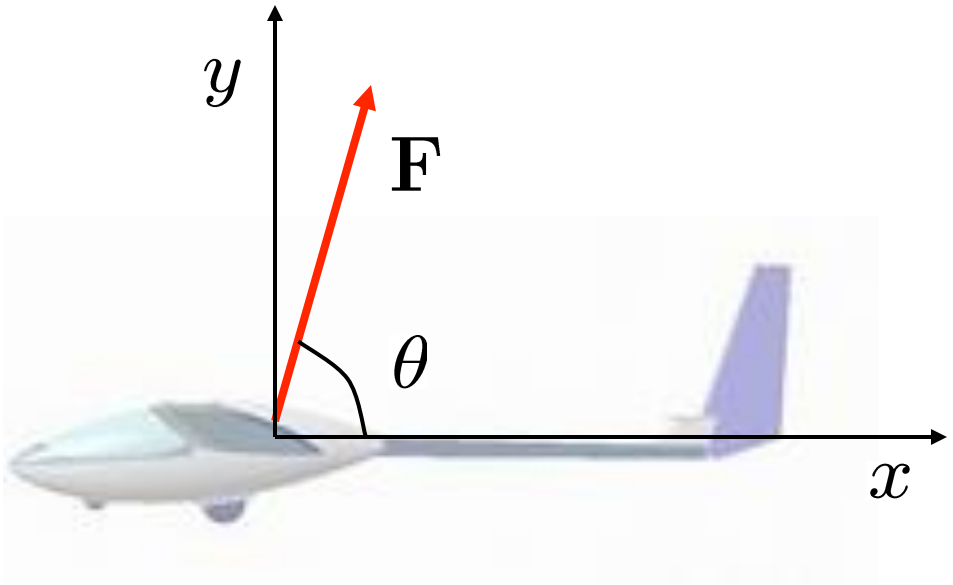
Vector: magnitude and direction



Sukhoi 37: Vectored thrust



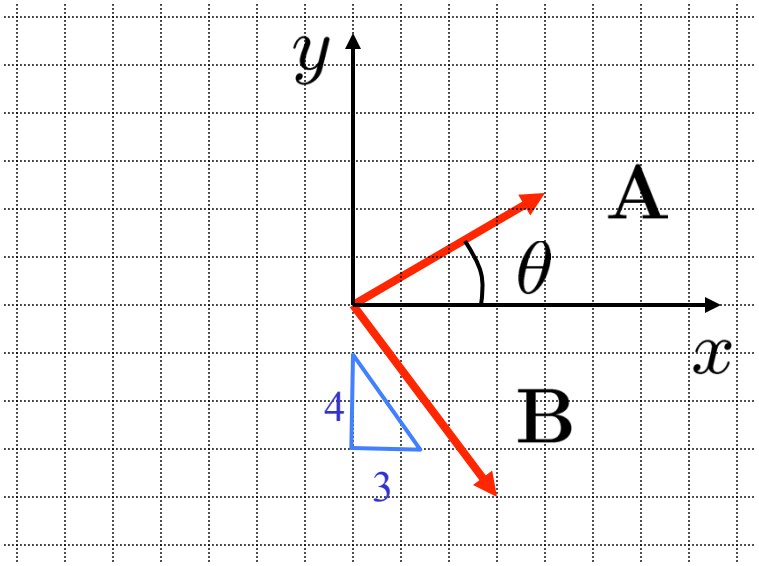
Coordinate system



$|\mathbf{A}| = 12\,\text{kN}$

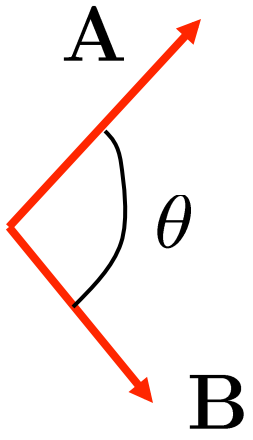
$\theta = 30°$

$|\mathbf{B}| = 20\,\text{kN}$



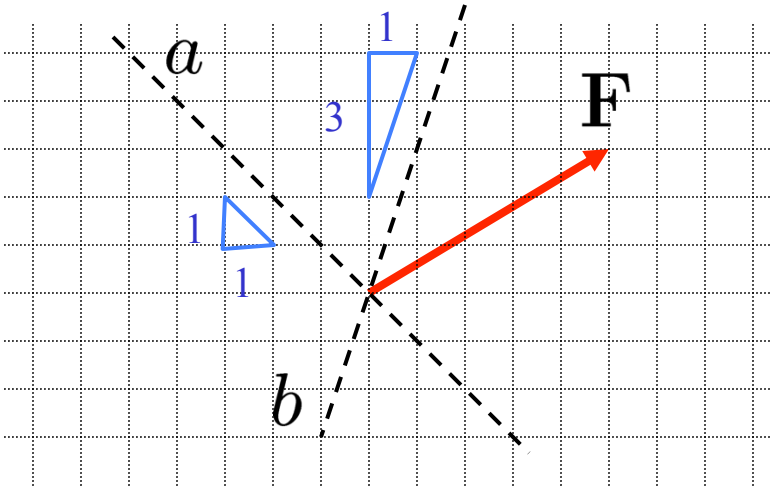
Scalar product

$$\mathbf{A} \cdot \mathbf{B} = A_x B_x + A_y B_y + \ldots = AB \cos\theta$$

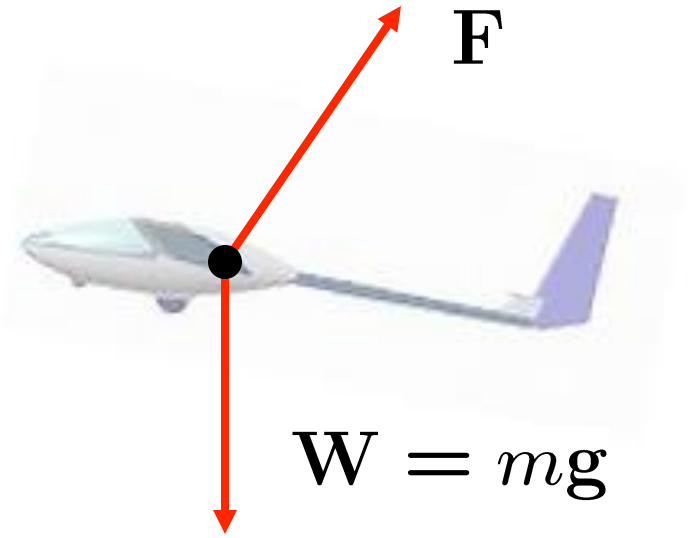


Decomposition along non-orthogonal axes

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



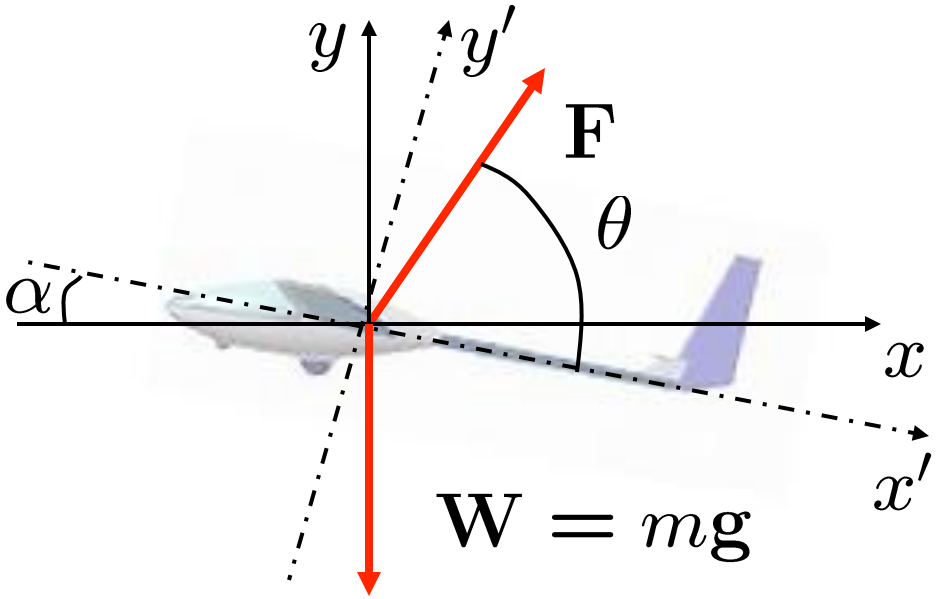
Model as particle

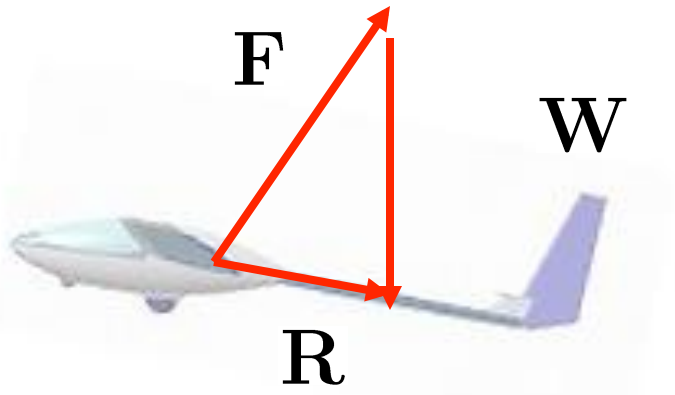


Resultant force (in case of a particle)

Single force that replaces all forces acting on a particle.

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


y
y′
F
θ
α
x
x′
W = mg


F
W
R

Newton's laws (*Principa*,1687)

-Law I 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)

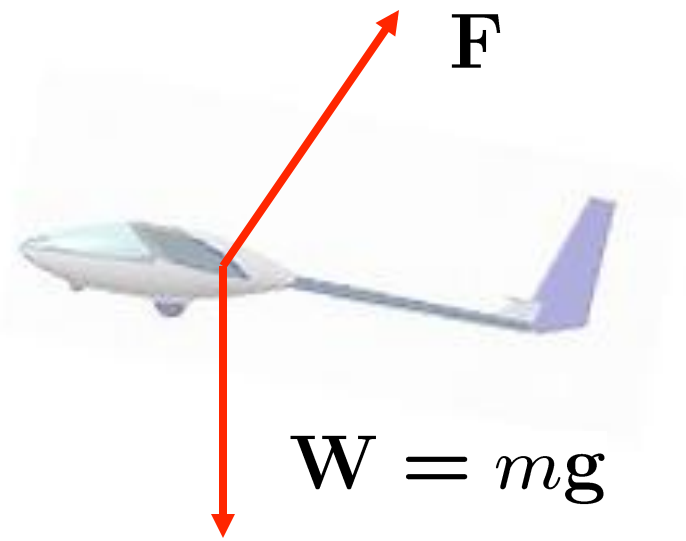
Static equilibrium (Newton's first law)

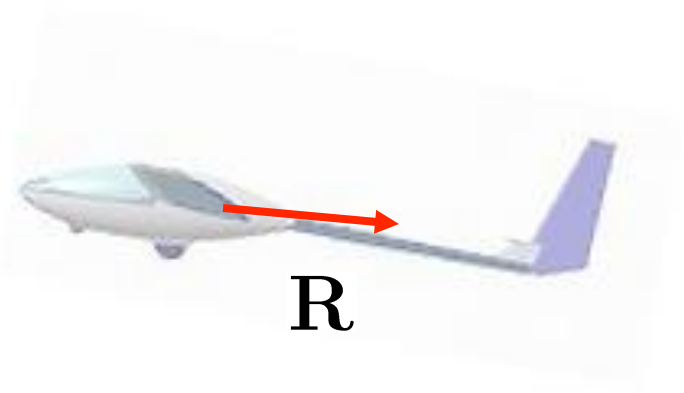
The resultant is equal to zero

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

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

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


F
W = mg


R