Kite Engineering

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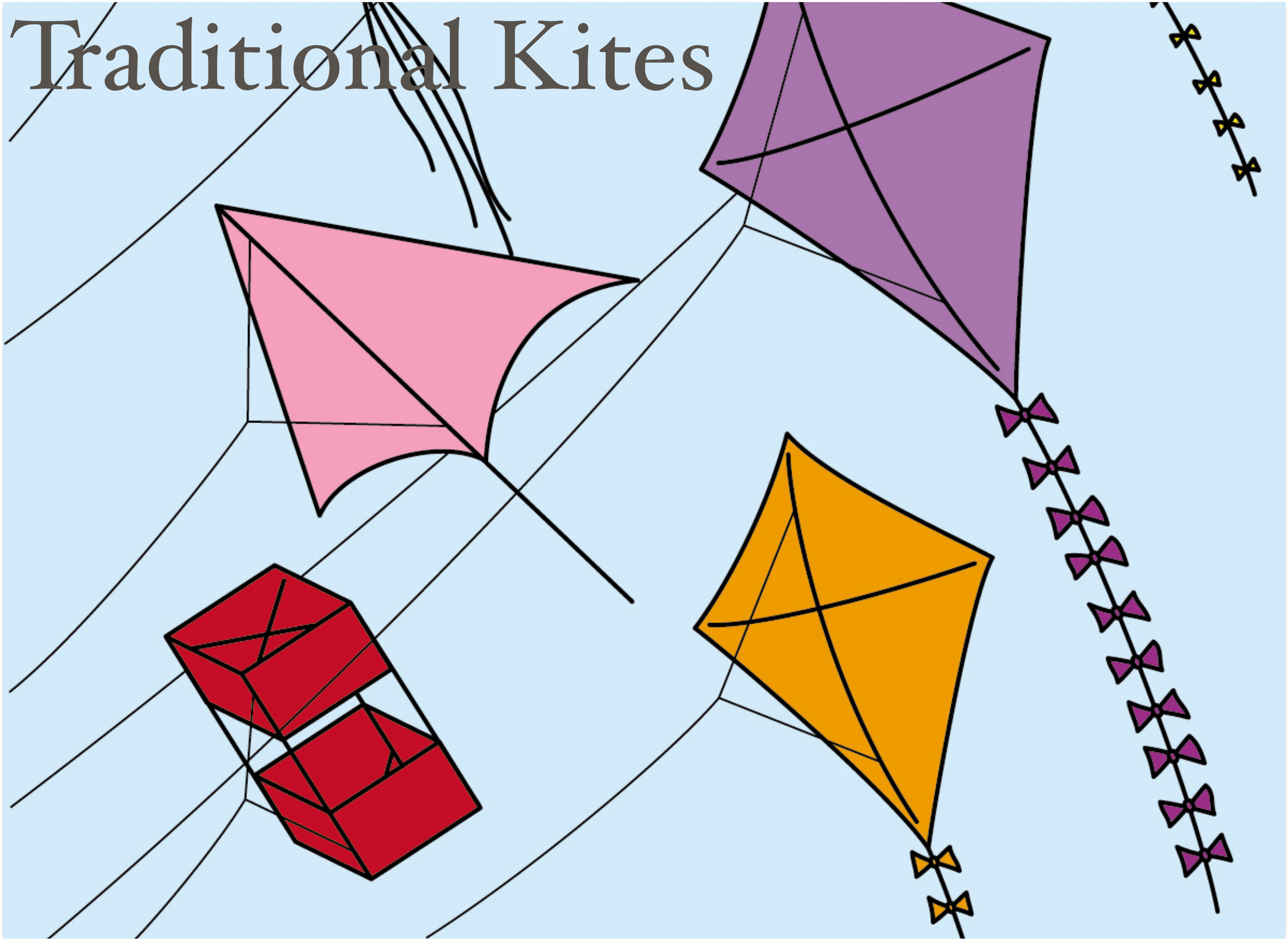
Quad kites!

History

- Kite technology > 2800 years old
- Origins in *China*
- Materials: bamboo and silk
- Flat kites (not bowed designs)
- Later decorated with strings and sometimes whistles
- For specific occasions/events and competitions

Introduced to the western world in 16-17th century

Traditional Kites

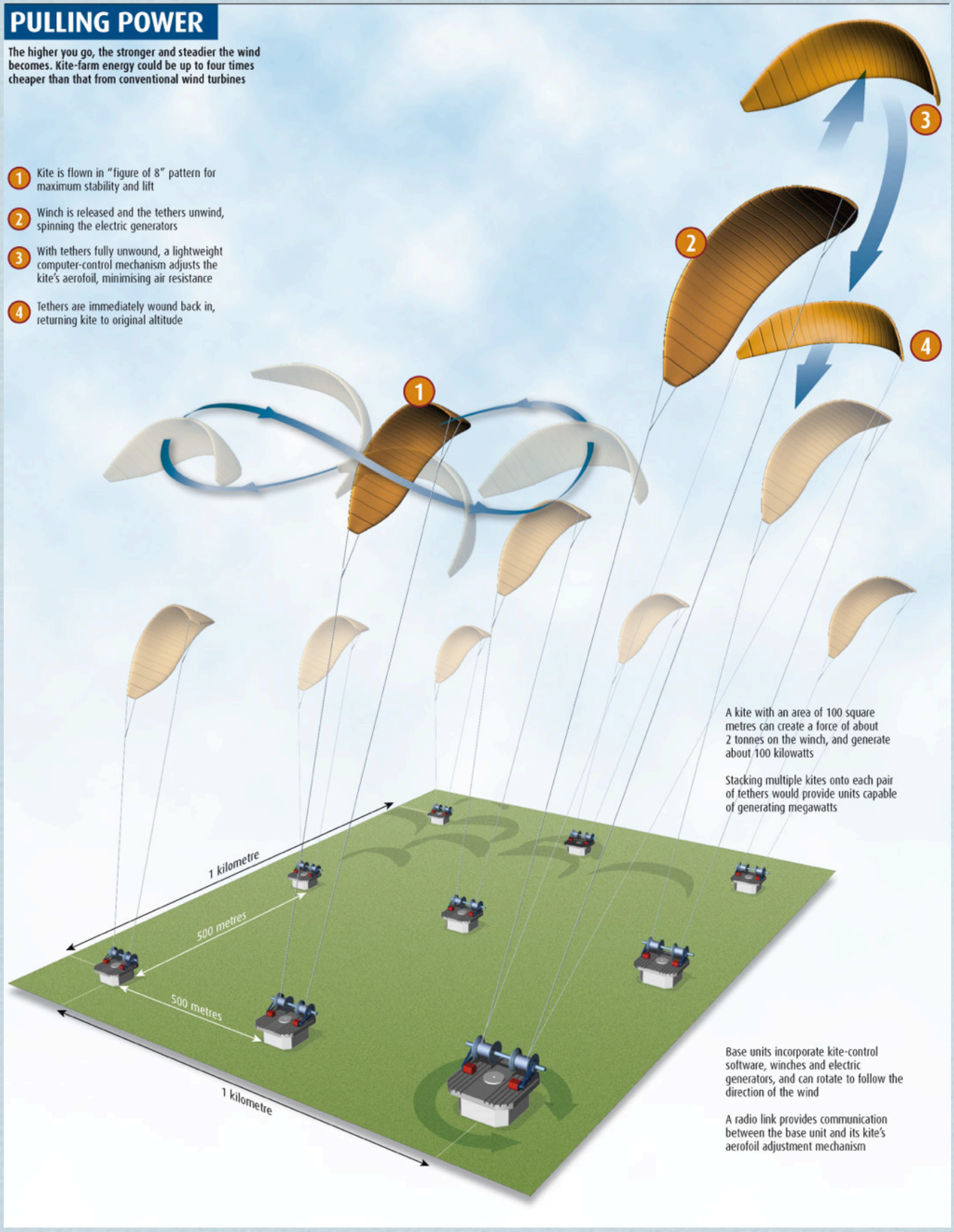


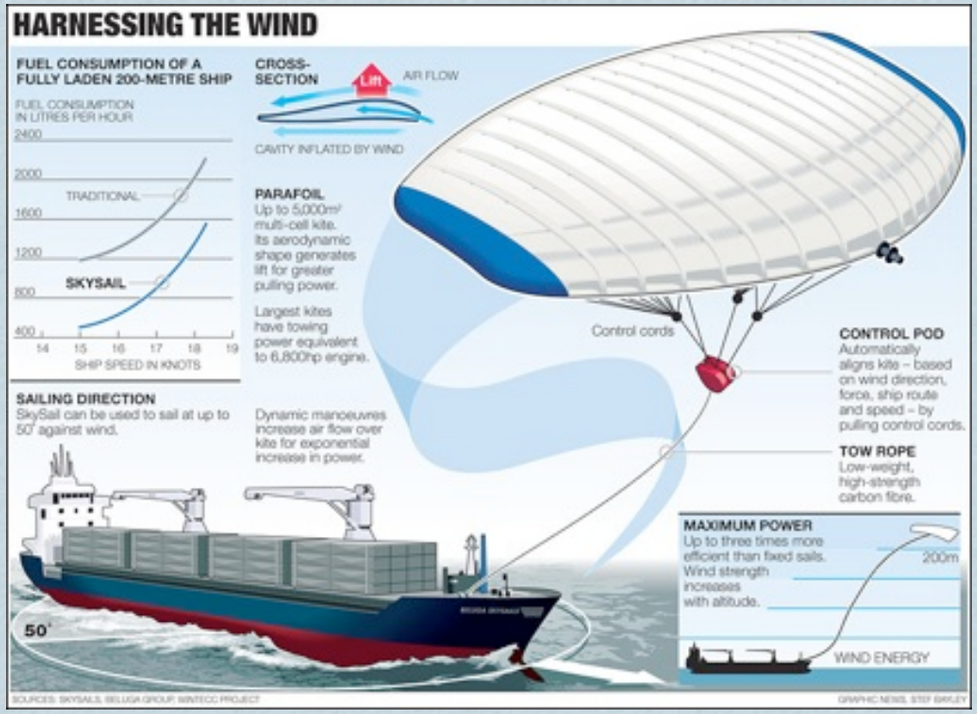
Modern Kite Types

- **Stunt Kites** used to perform tricks…
- 360, Axel, Backflip, Cartwheel, Cuckoo clock, Black hole, Helicopter, Walking, Pancake, Stall, Yoyo, etc.
- Also known as Sport Kites
- Typically dual or quad line kites
- For control of speed, direction and pull
- Can even go backwards and forwards!

Modern Kite Types

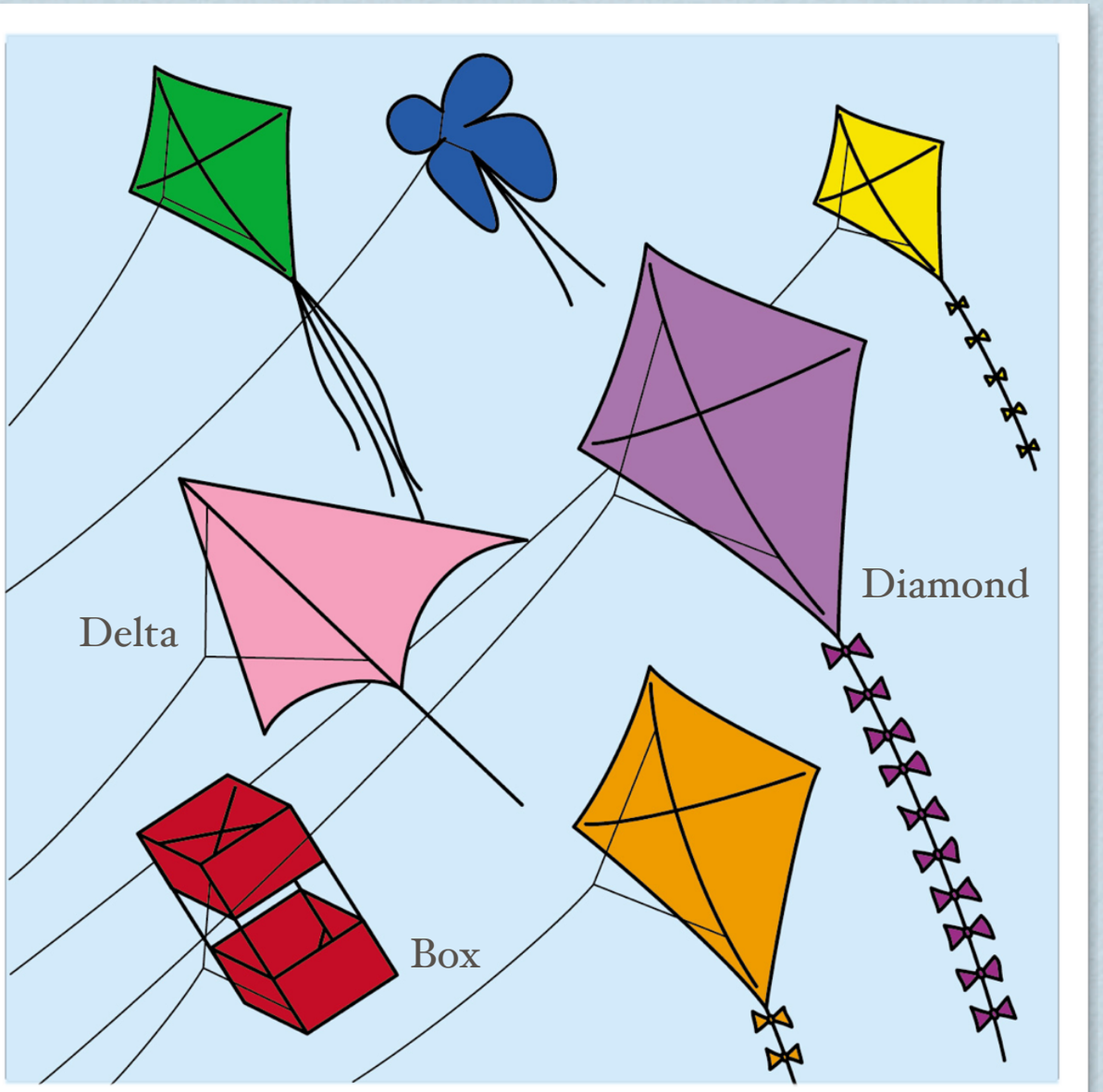
- **Power Kites** for different sort of entertainment…
- Buggying, kite sailing and kite jumping.
- Develop a tremendous pull in strong winds





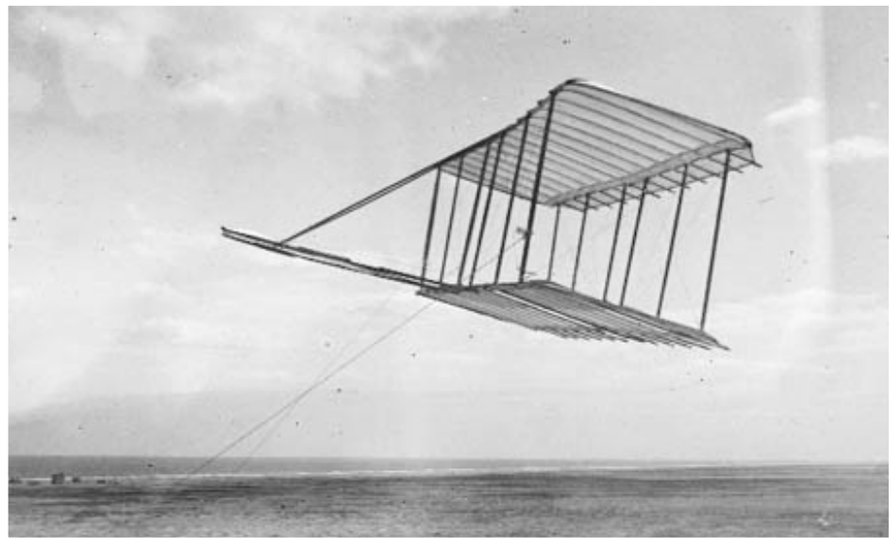
Energy from kites

Why do kites fly?



From kites to airplanes

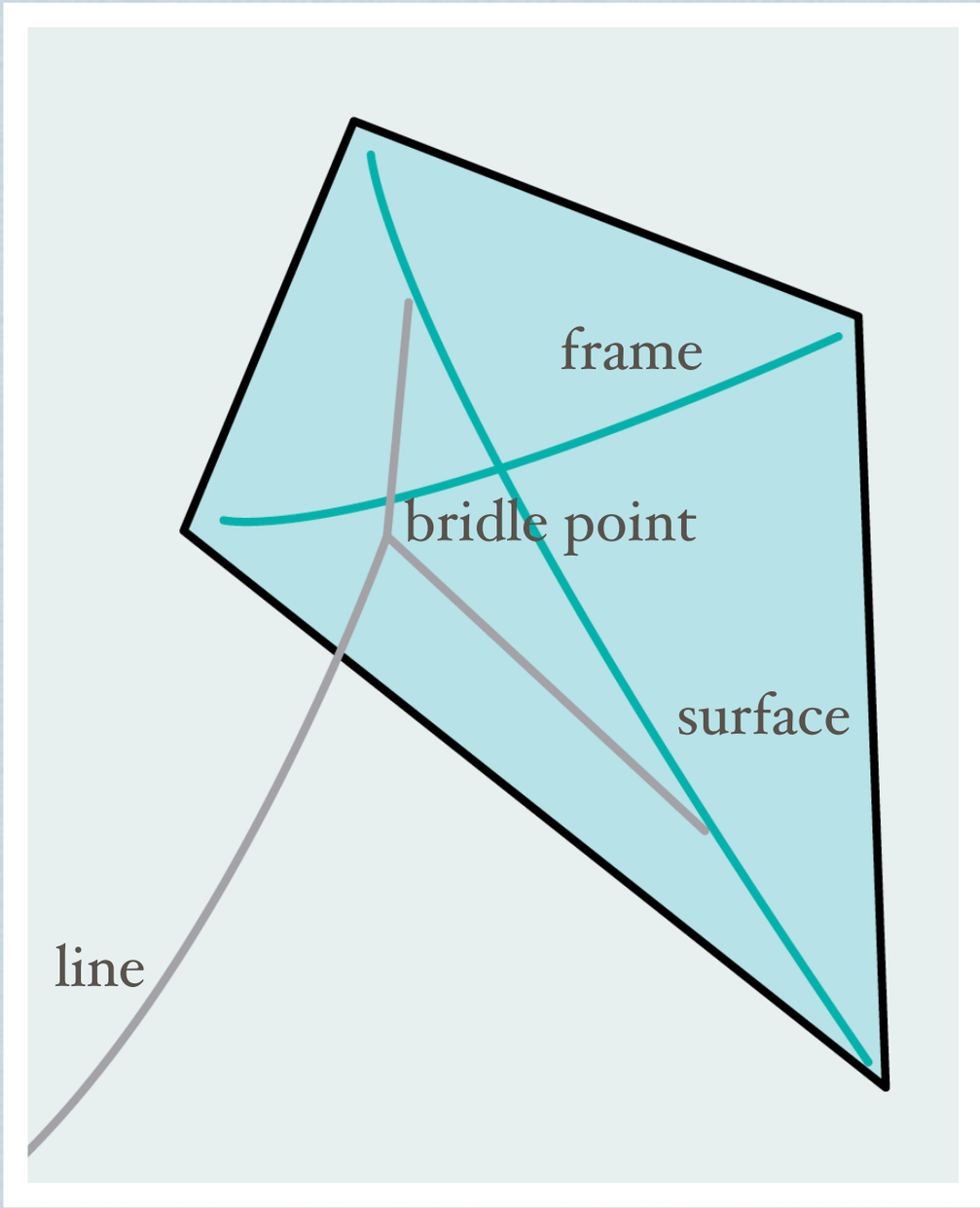
- Forces are the same as an airliner except for *thrust*.
- Like aircrafts, kites are heavier than air
- Rely on *aerodynamic forces* to fly
- Need to generate *lift* to overcome its weight
- Kites need to be light but strong



1900 Wright Brother Kite

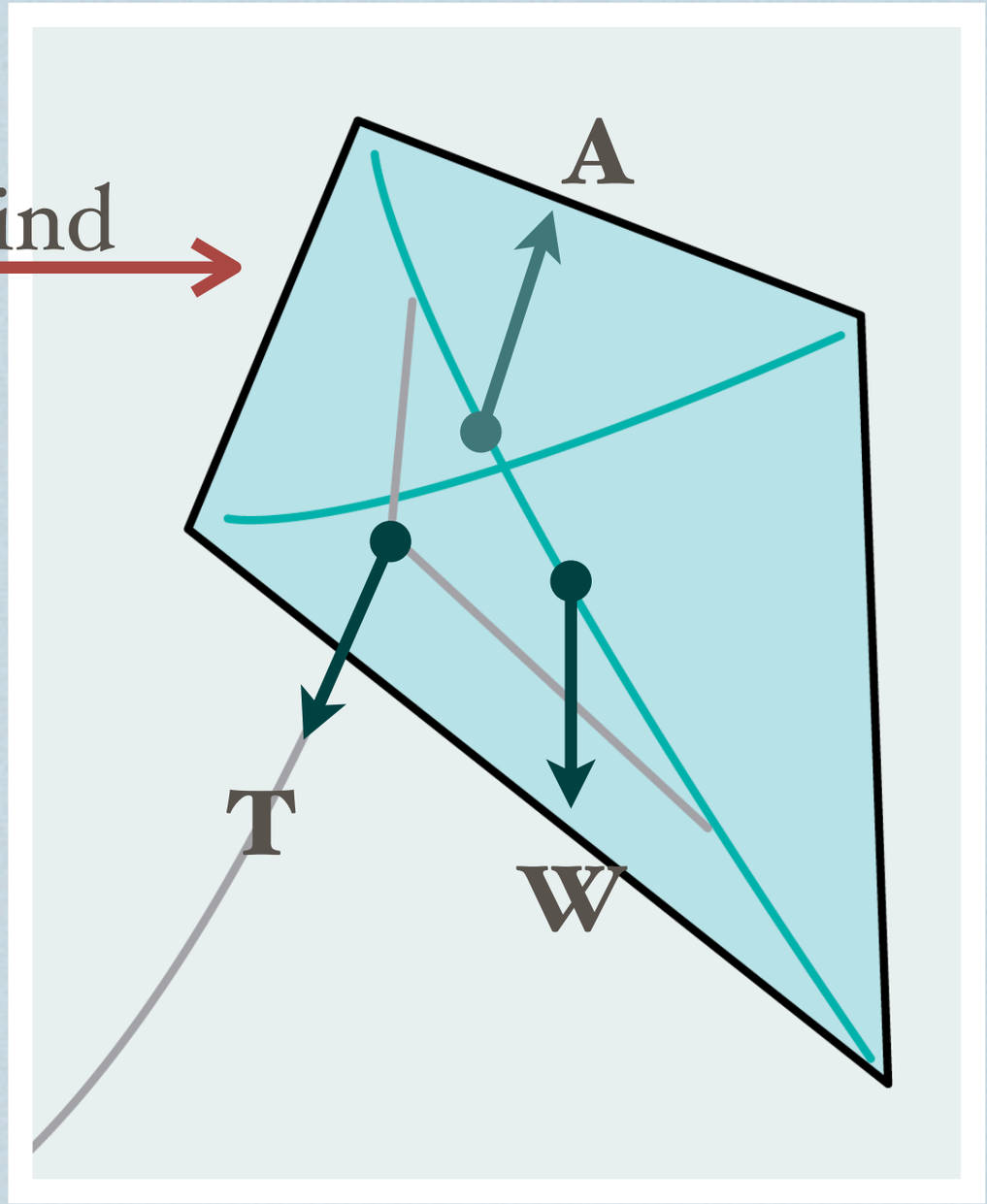
Kite components

- Kite surfaces generated aerodynamic forces for flight
- Rigid structures to support the surfaces and distribute the forces
- Control provided by the *line* and the *bridle*



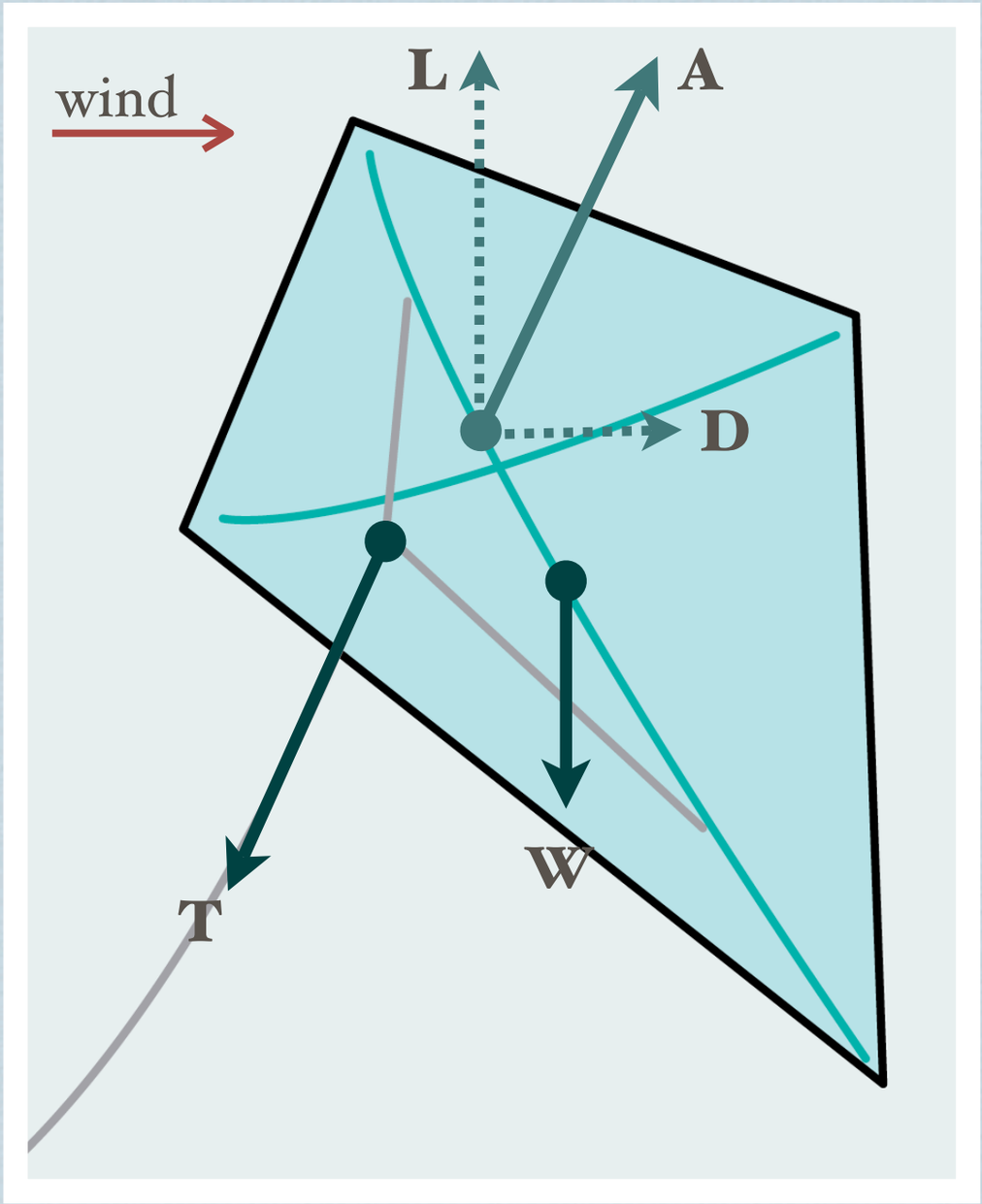
Forces on a kite

- Principle forces
- *Tension*, **T** in the line
- *Aerodynamic* force **A** away from the tension
- *Weight*, force **W** towards the center of the earth



Aerodynamic forces

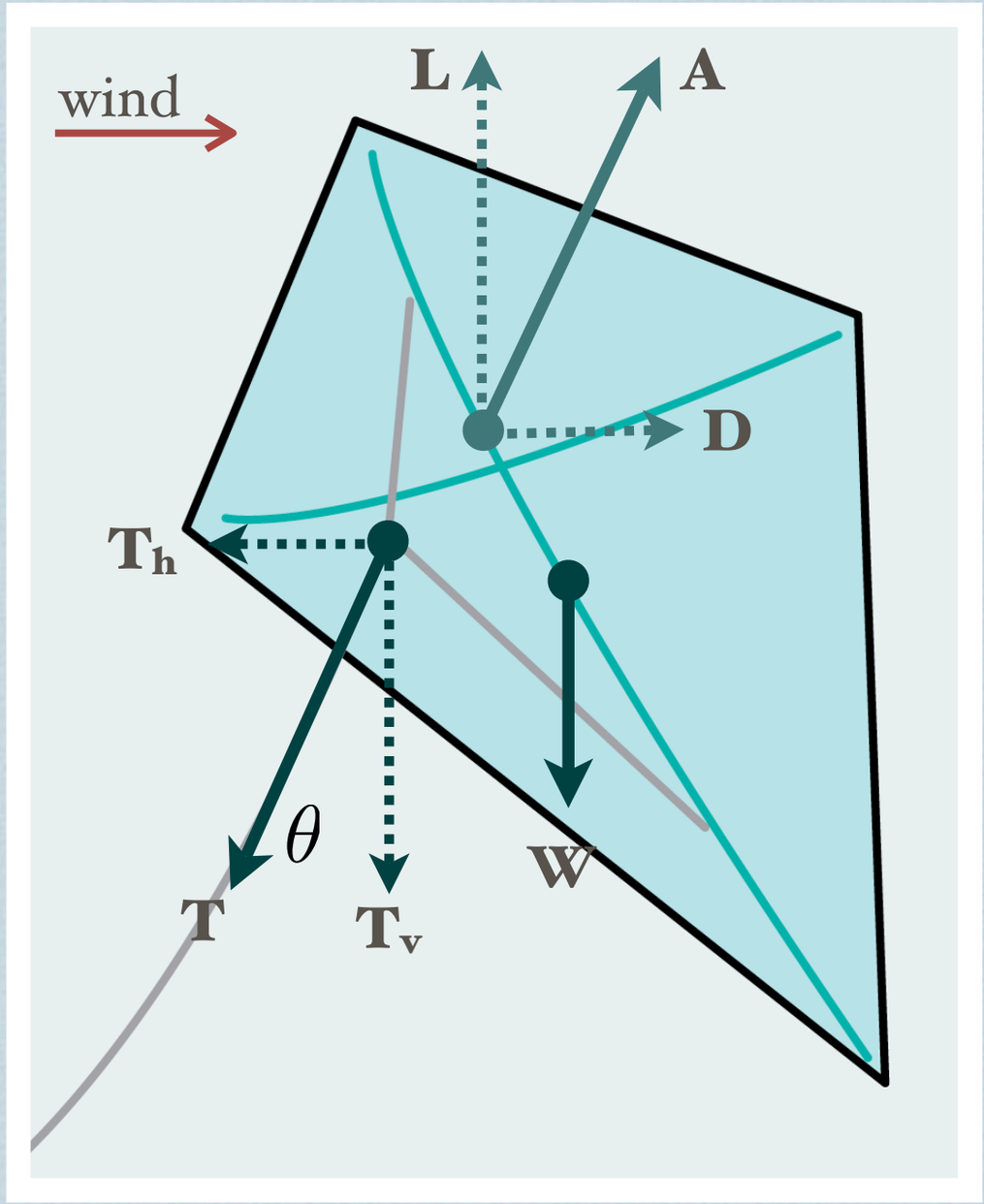
- Aerodynamic force broken down to its component forces
- *Lift*, **L** perpendicular to the wind
- *Drag* **D** parallel to the wind direction



Tension forces

- Tensions opposes the aerodynamic force and the weight
- $\mathbf{T_v}$ is the vertical component
- $\mathbf{T_h}$ is the horizontal component
- Related by the angle of the line

$$tan(\theta) = \frac{T_v}{T_h}$$



A stable flight

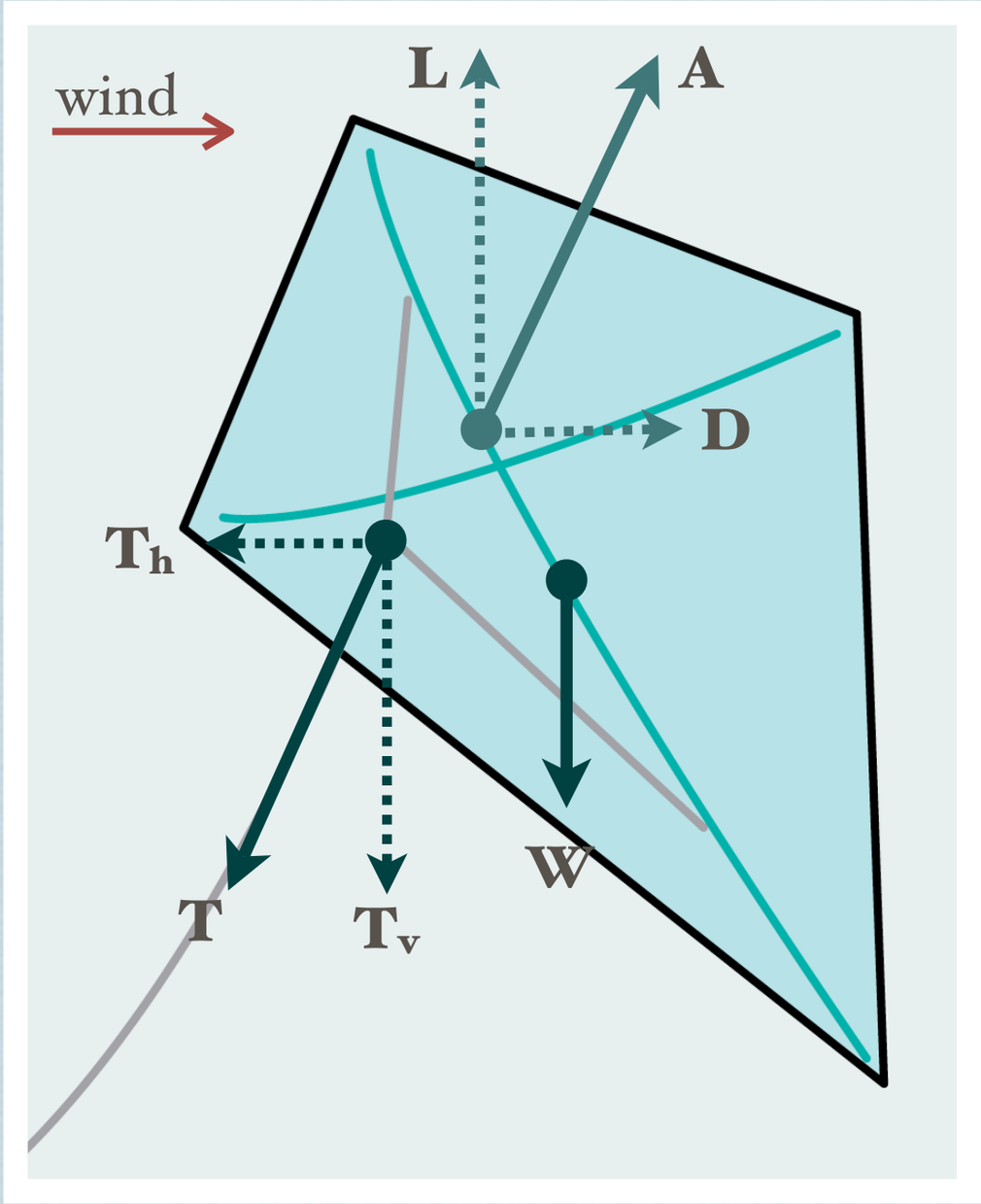
- When the kite is in stable flight the forces need to balance (Newton's laws of motion)

- Forces in vertical direction

$$T_v + W - L = 0$$

- Forces in horizontal direction

$$T_h - D = 0$$



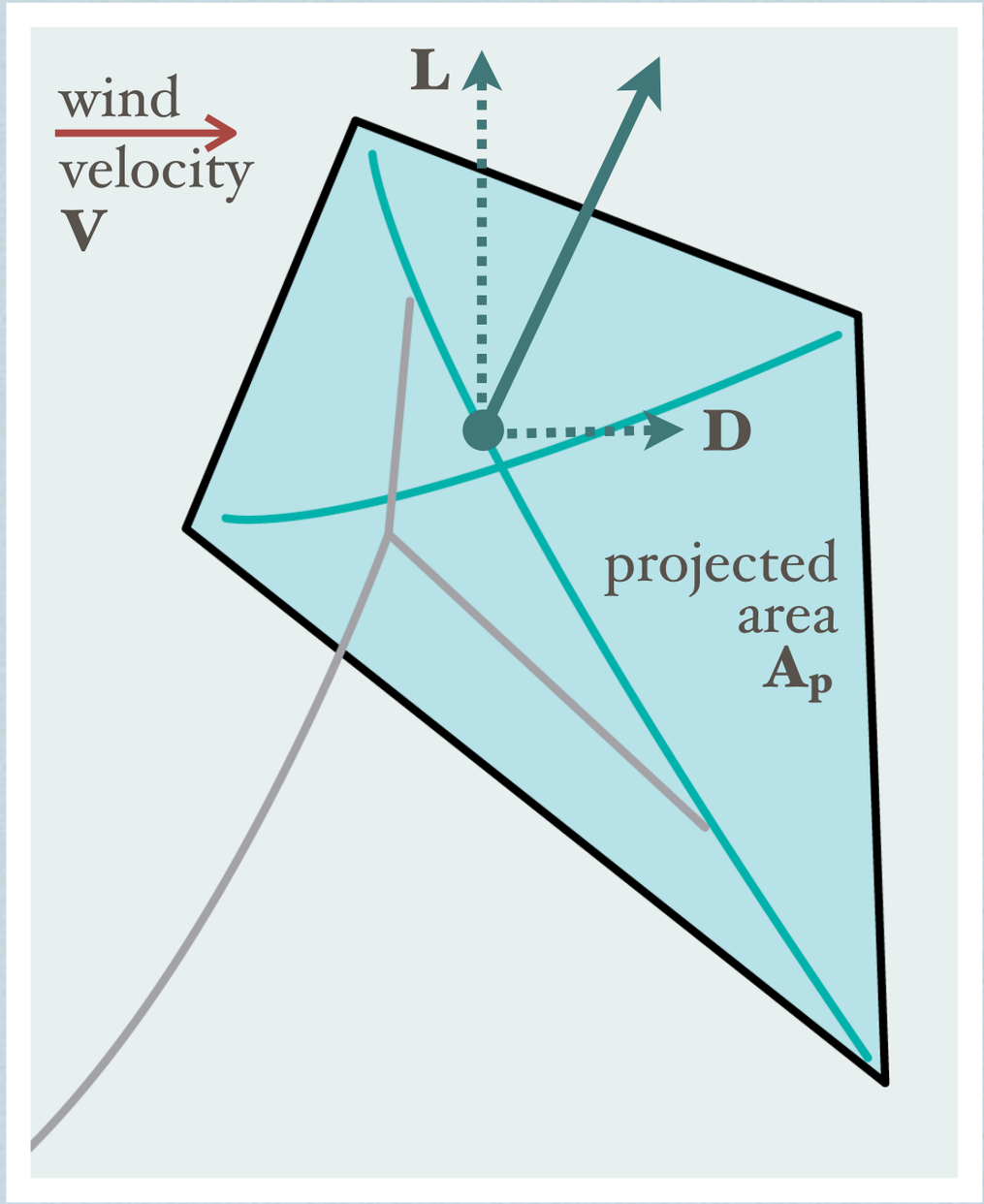
Aerodynamics of kites

- What do *Lift* and *Drag* depend on?
- Lift equation

$$L = C_L \frac{1}{2} \rho A_p V^2$$

- Drag equation

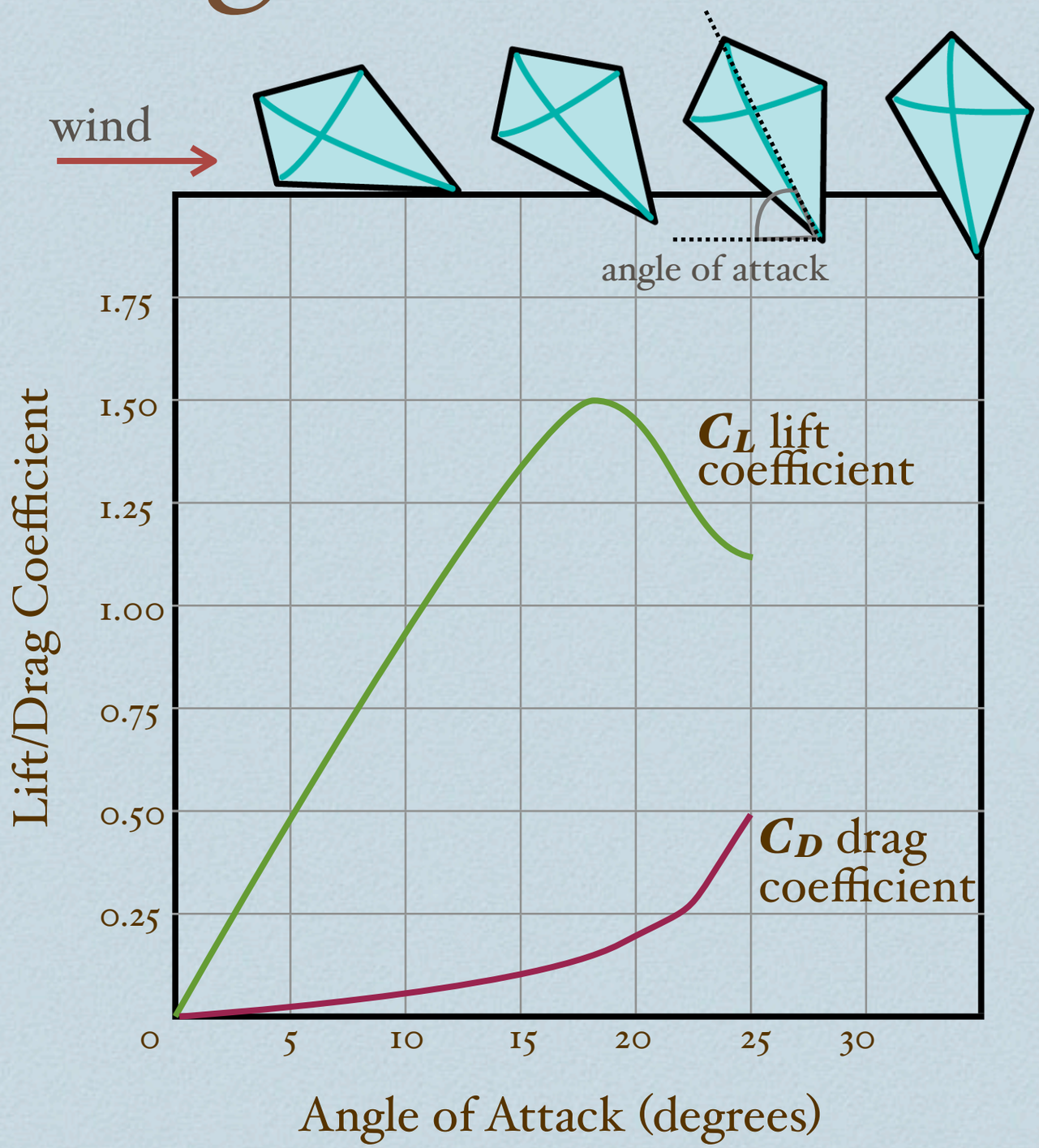
$$D = C_D \frac{1}{2} \rho A_p V^2$$



Lift and Drag coefficients

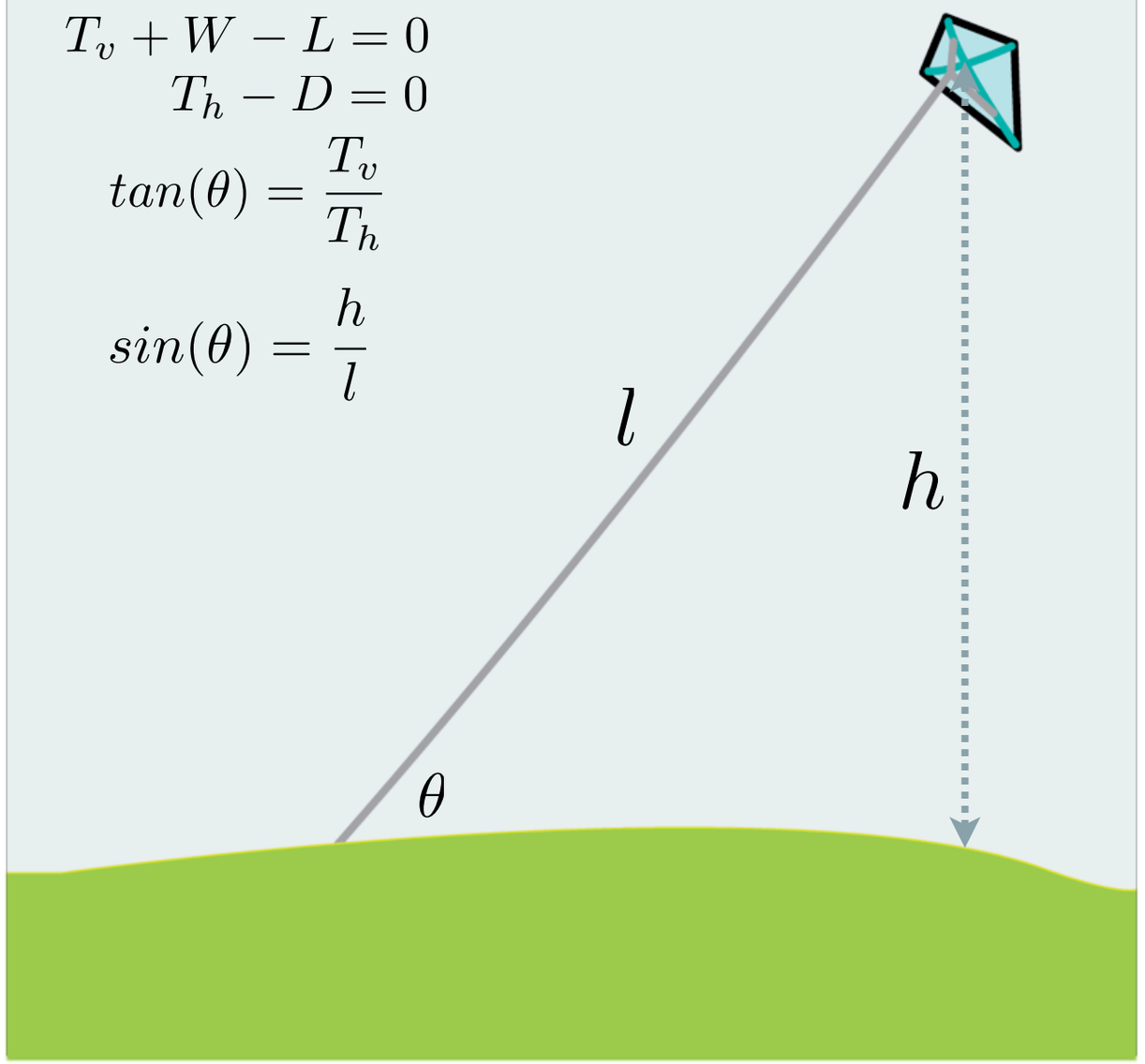
$$L = C_L \frac{1}{2} \rho A_p V^2$$

$$D = C_D \frac{1}{2} \rho A_p V^2$$

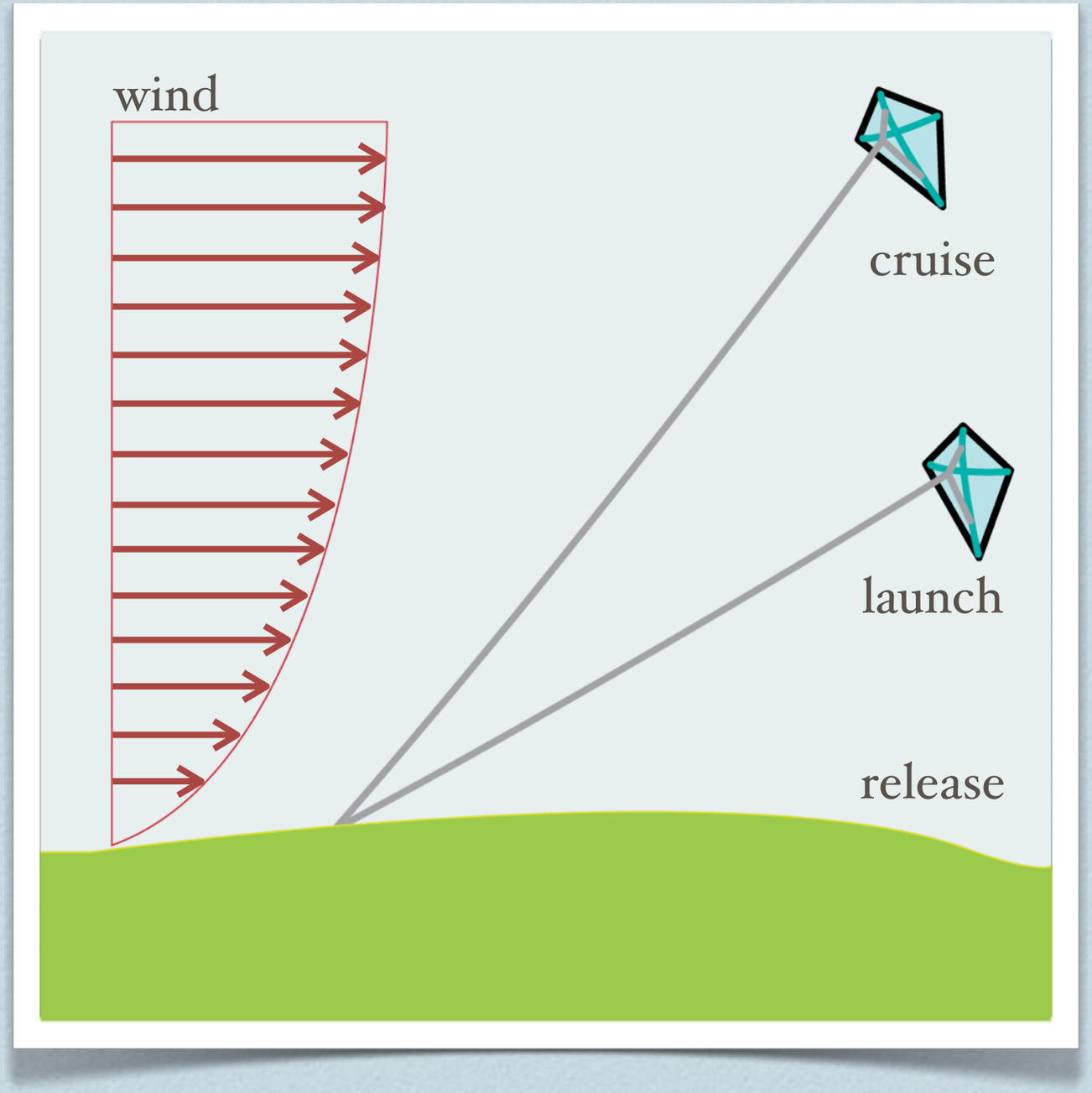


Stable height

$$T_v + W - L = 0$$
$$T_h - D = 0$$
$$tan(\theta) = \frac{T_v}{T_h}$$
$$sin(\theta) = \frac{h}{l}$$



Changes in lift and drag

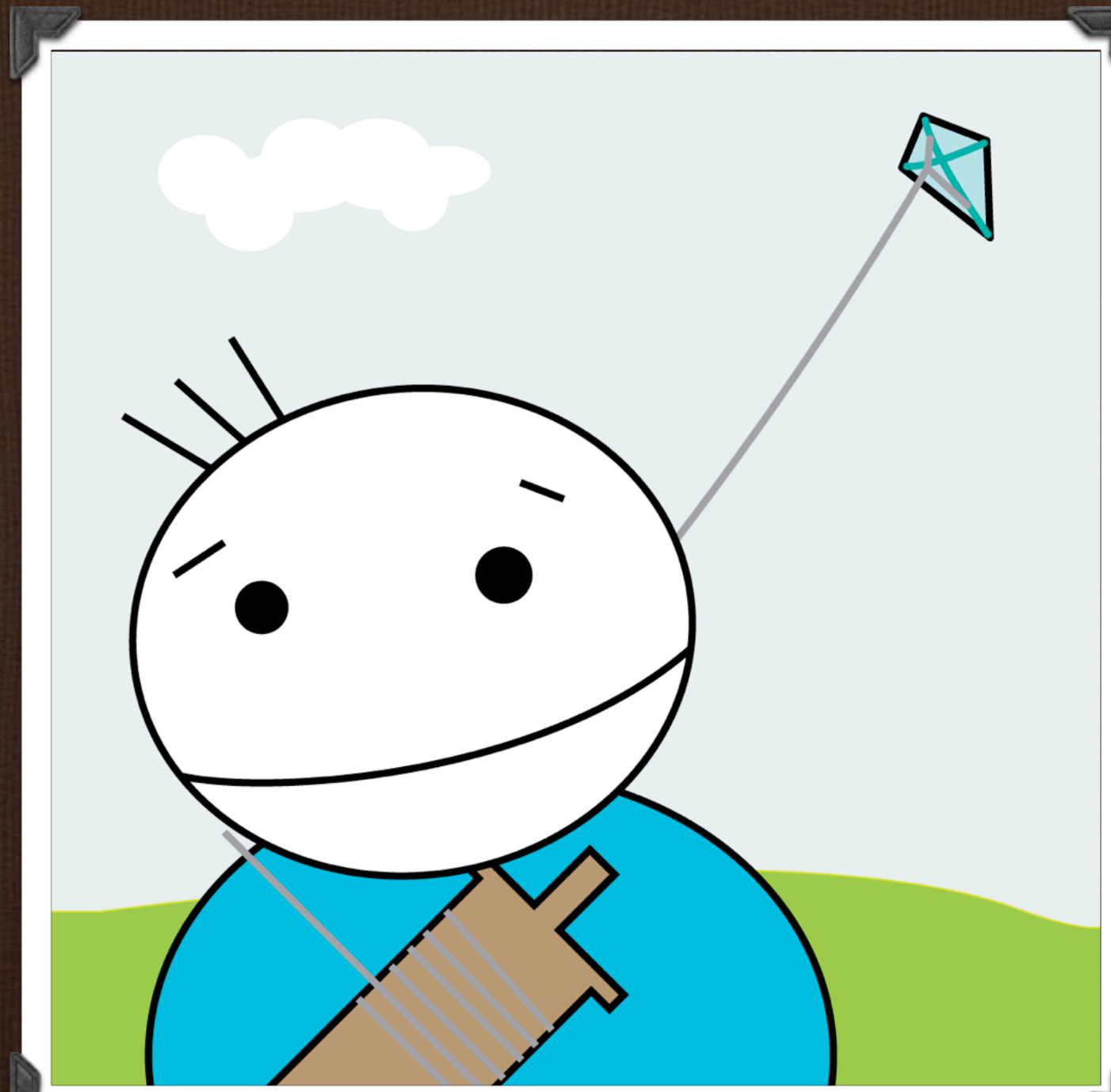


altitude determined by balance of forces

$$L = C_L \frac{1}{2} \rho A_p V^2$$

Tugging leads to climb

Extending the line leads to initial drop



References and resources

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http://pbskids.org/dragonflytv/show/kites.html