Class III: Introduction to Aerospace Engineering

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History of flight

1. What?
   - Heavier than air powered controlled flight
2. When?
   - December 17, 1903
3. Who?
   - Wilbur and Orville Wright
4. How?
   - Wood, fabric, 12hp piston engine, twin prop, skids
5. Where?
   - Kitty Hawk, USA
6. Why?
   - May not always have an answer
7. Story
   - Bicycle shop..... paragraph narrating the story

What is flight?

- If I throw a stone does it fly?
- If I drop a feather?
- I drop a parachute?
- I throw or launch a glider?

What do all of these objects have in common?
The only power they have available is the initial total energy (potential + kinetic) supplied to them by the launch/throw.

Why does an airplane fly?

Important Fundas from Eng Mech.

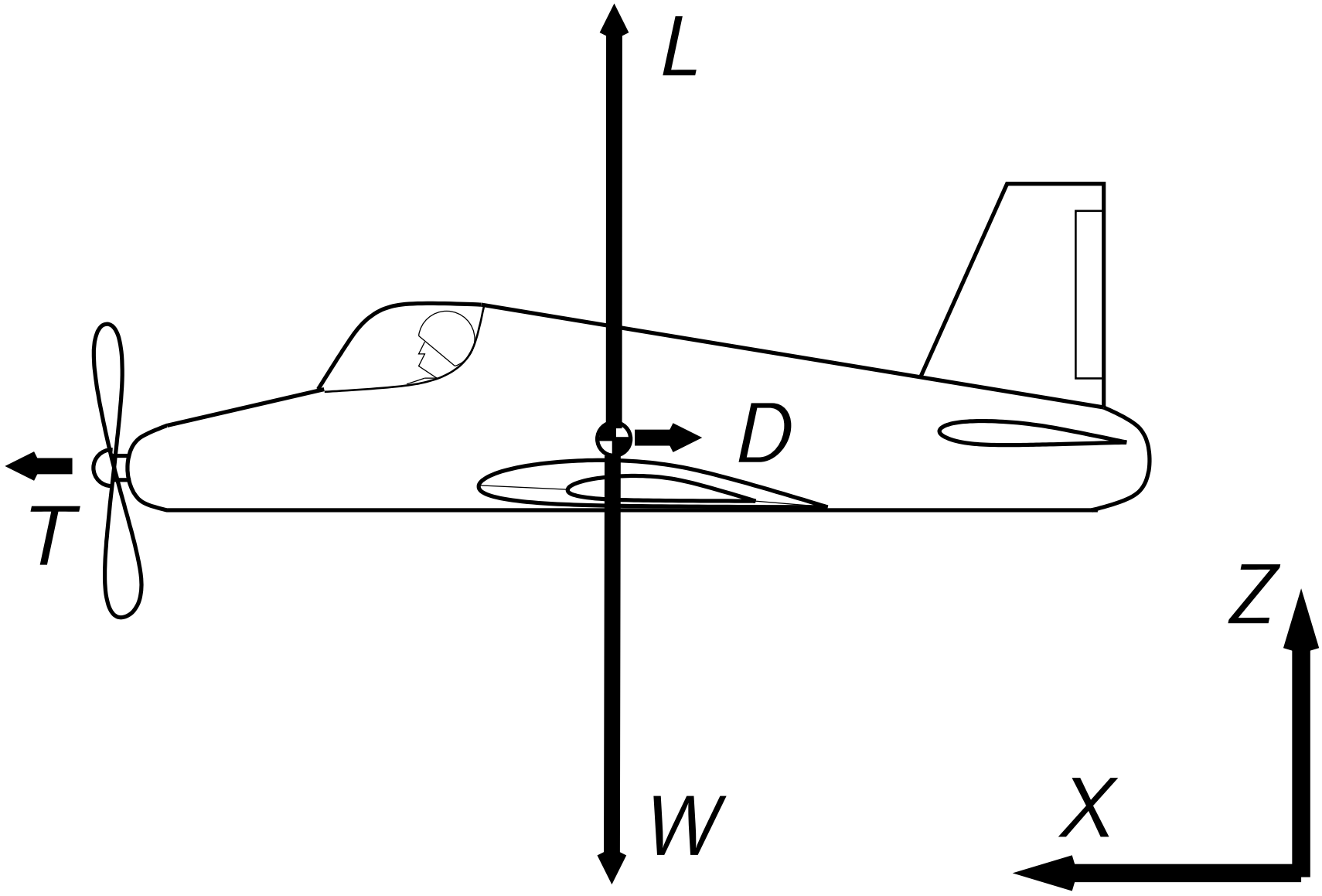
$$\sum \vec{F} = 0 \tag{1}$$

and

$$\sum \vec{M} = 0 \tag{2}$$

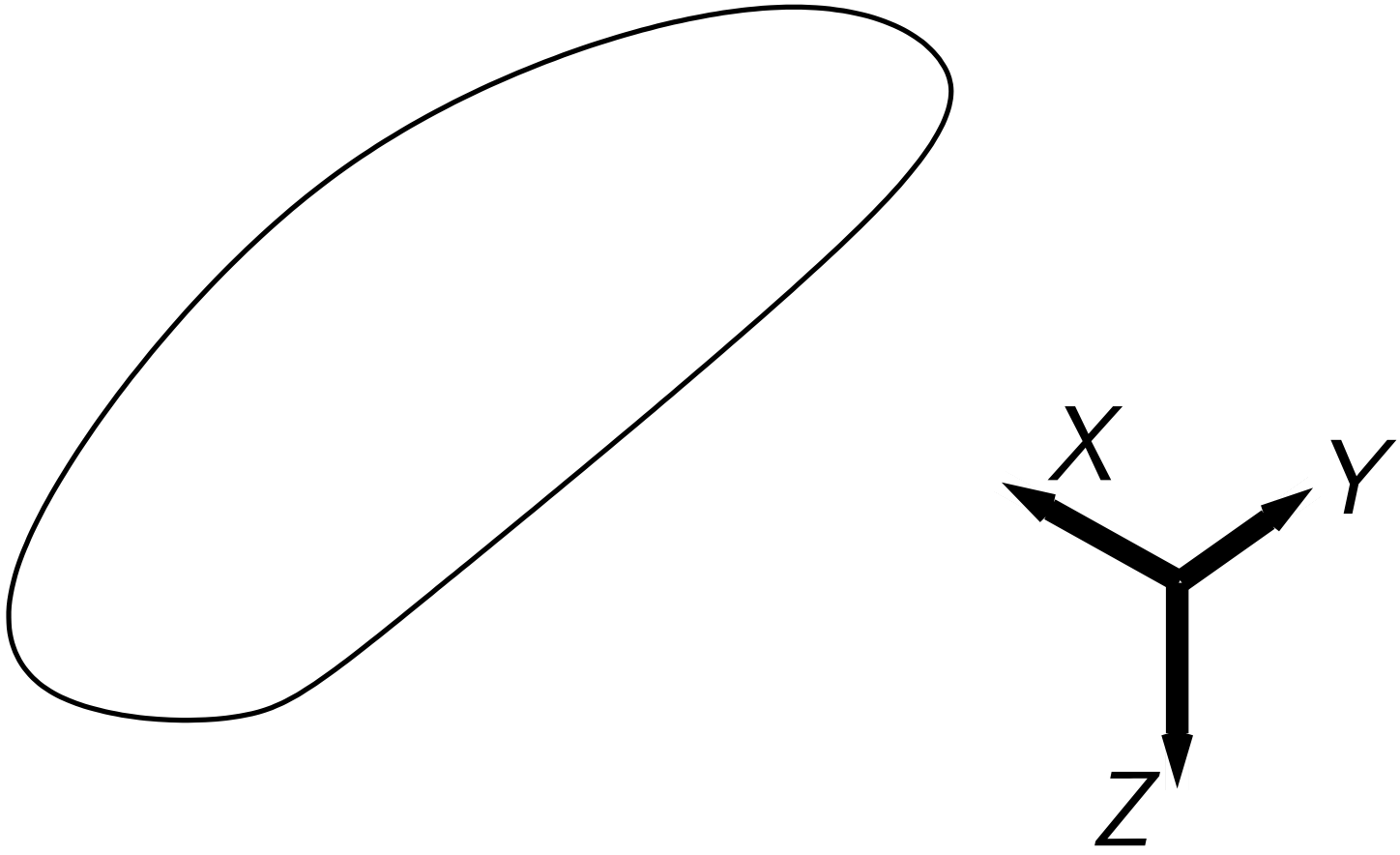
An Antonov An-225 has a maximum takeoff weight of 640,000 kg.

Straight & Level Flight



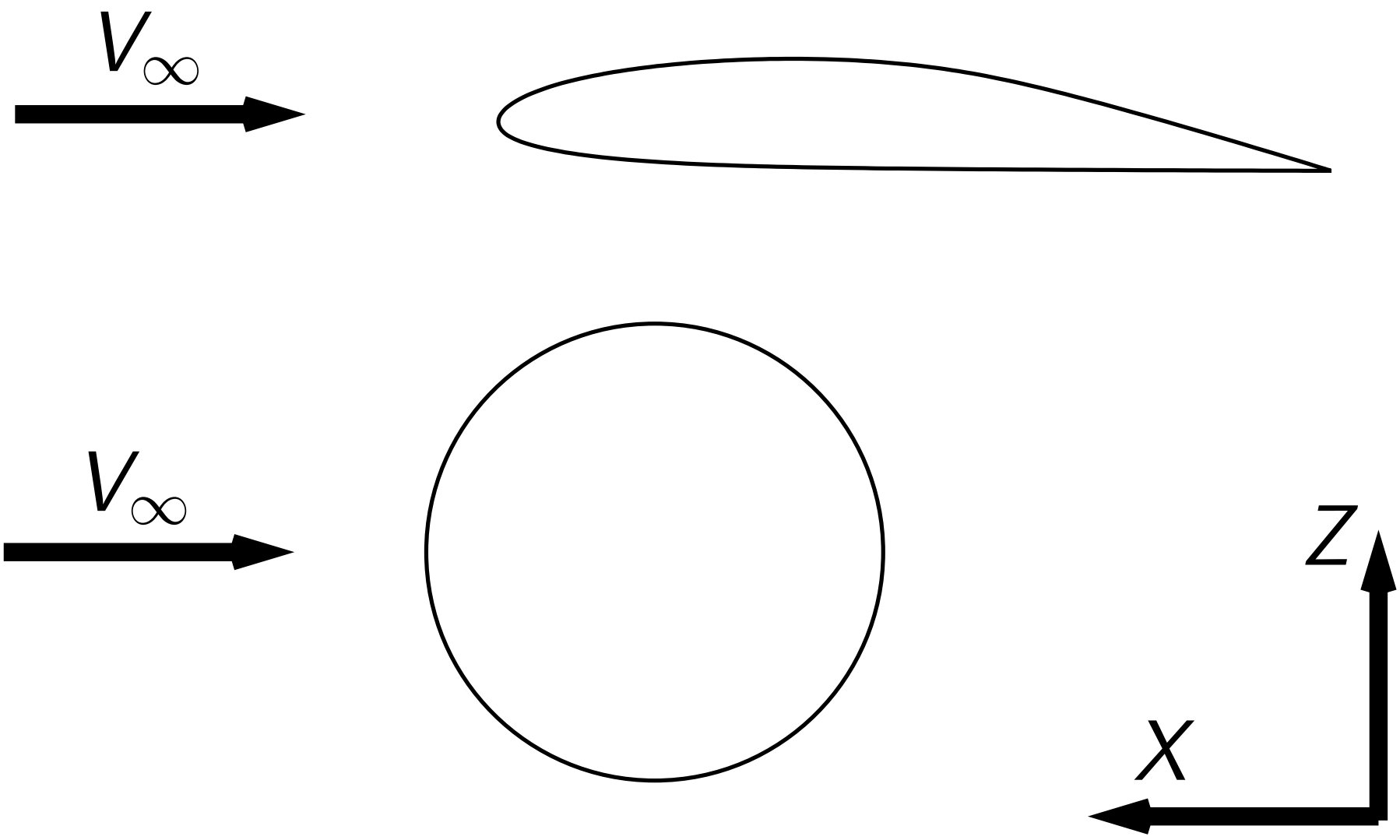
Drag D is parallel to direction of flight, L is perpendicular

3D Airfoil

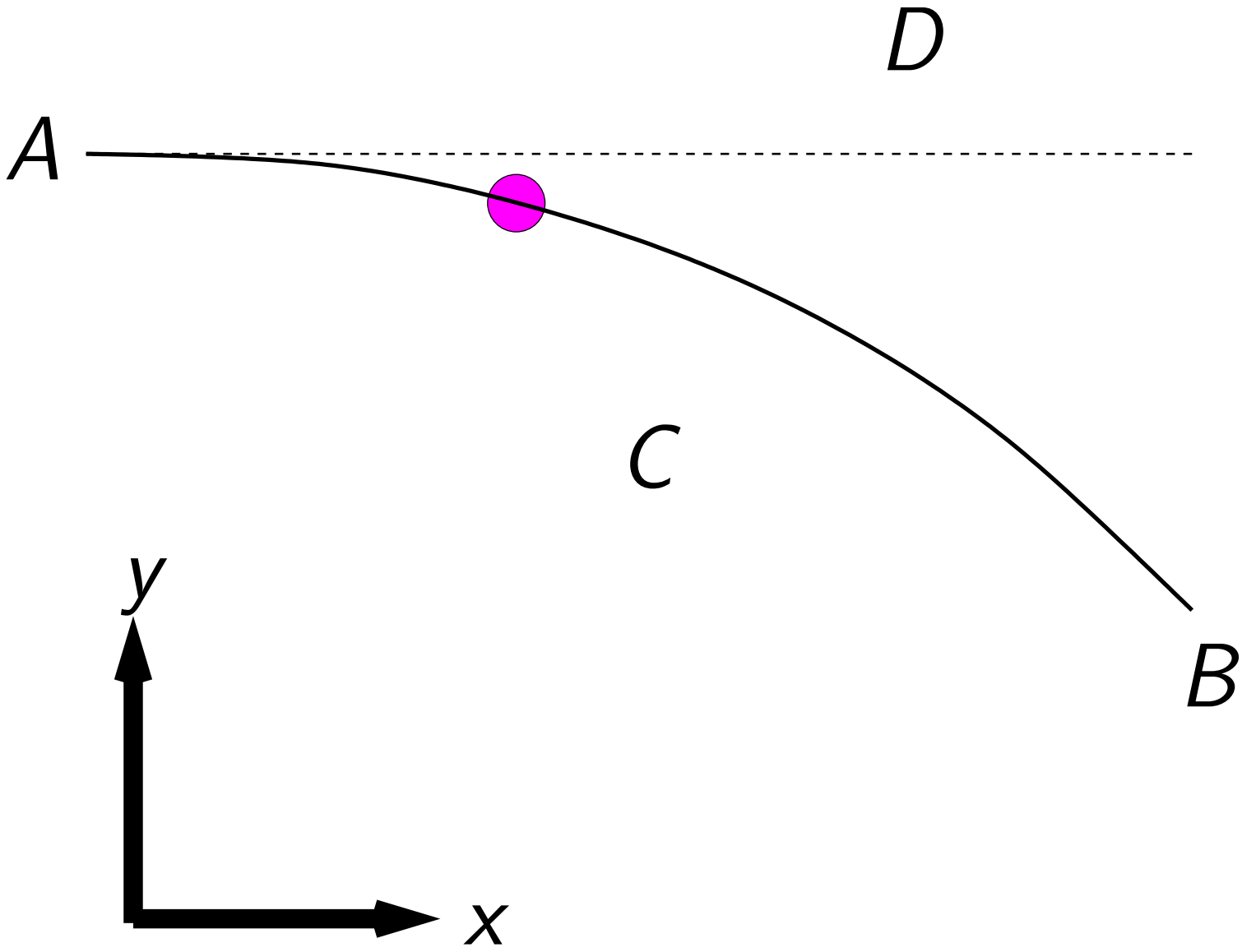


Large lift L for small drag D

Airfoil cross-section / Circular Cylinder

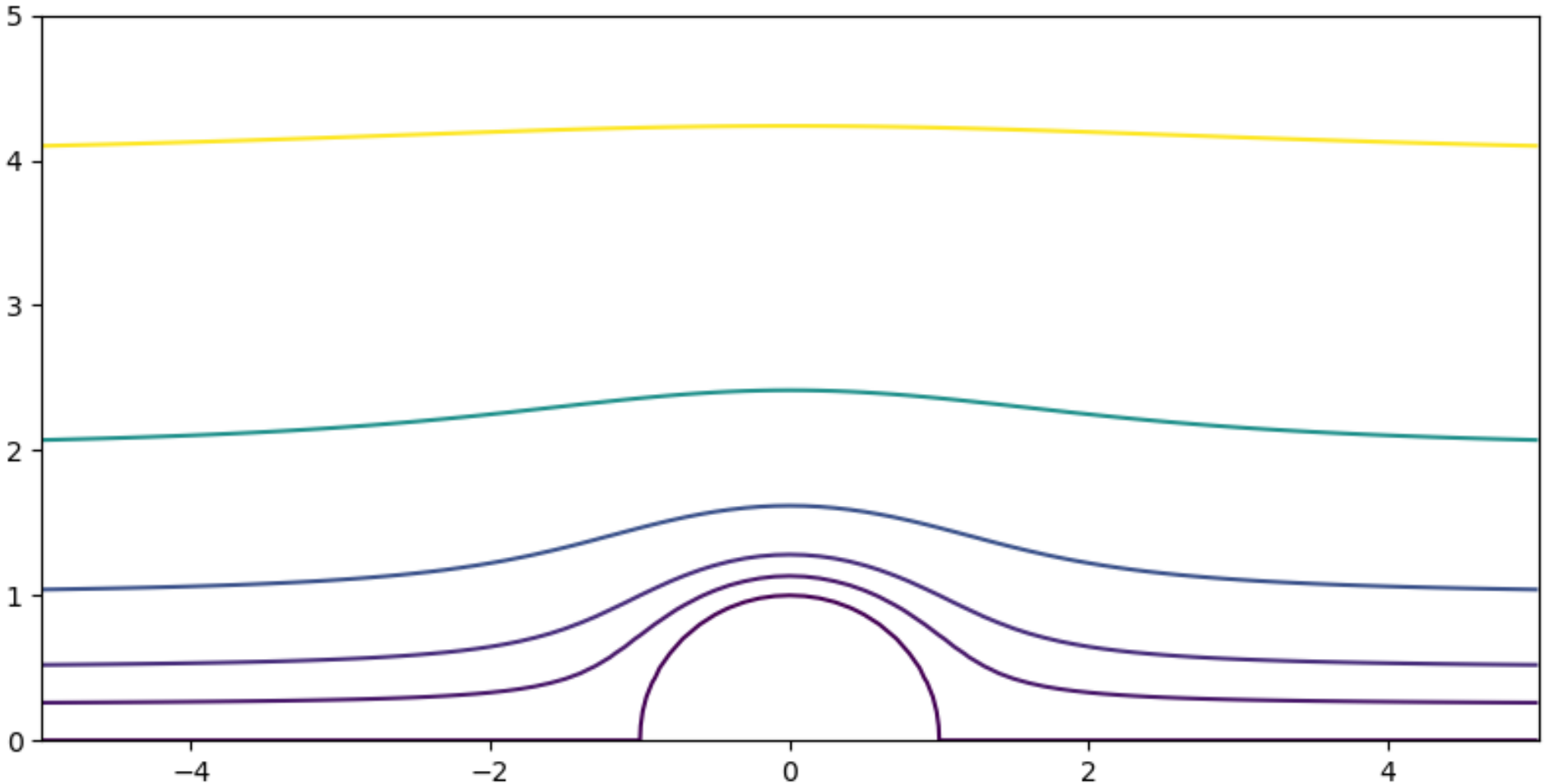


Fluid Particle Dynamics

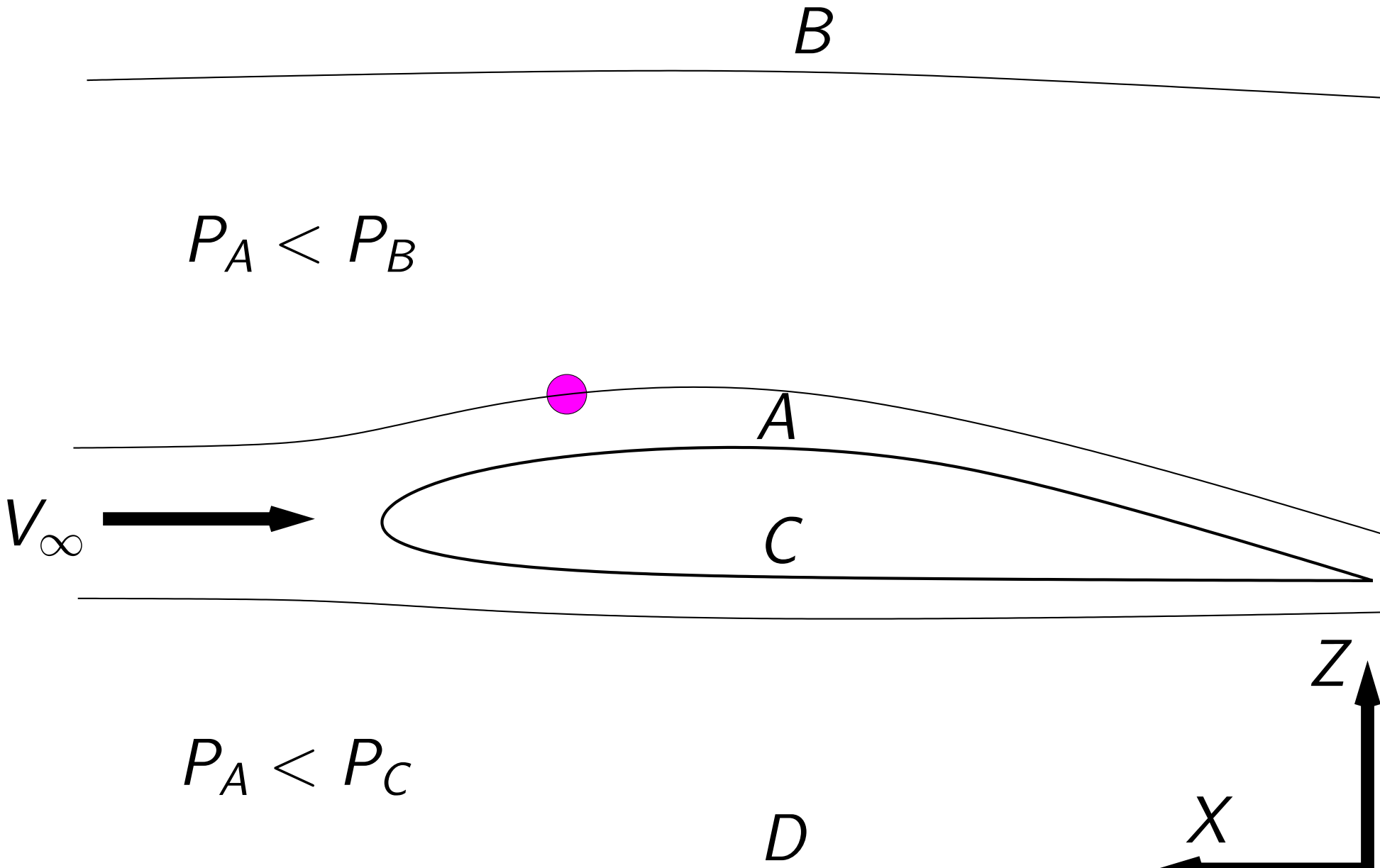


$$P_D > P_C$$

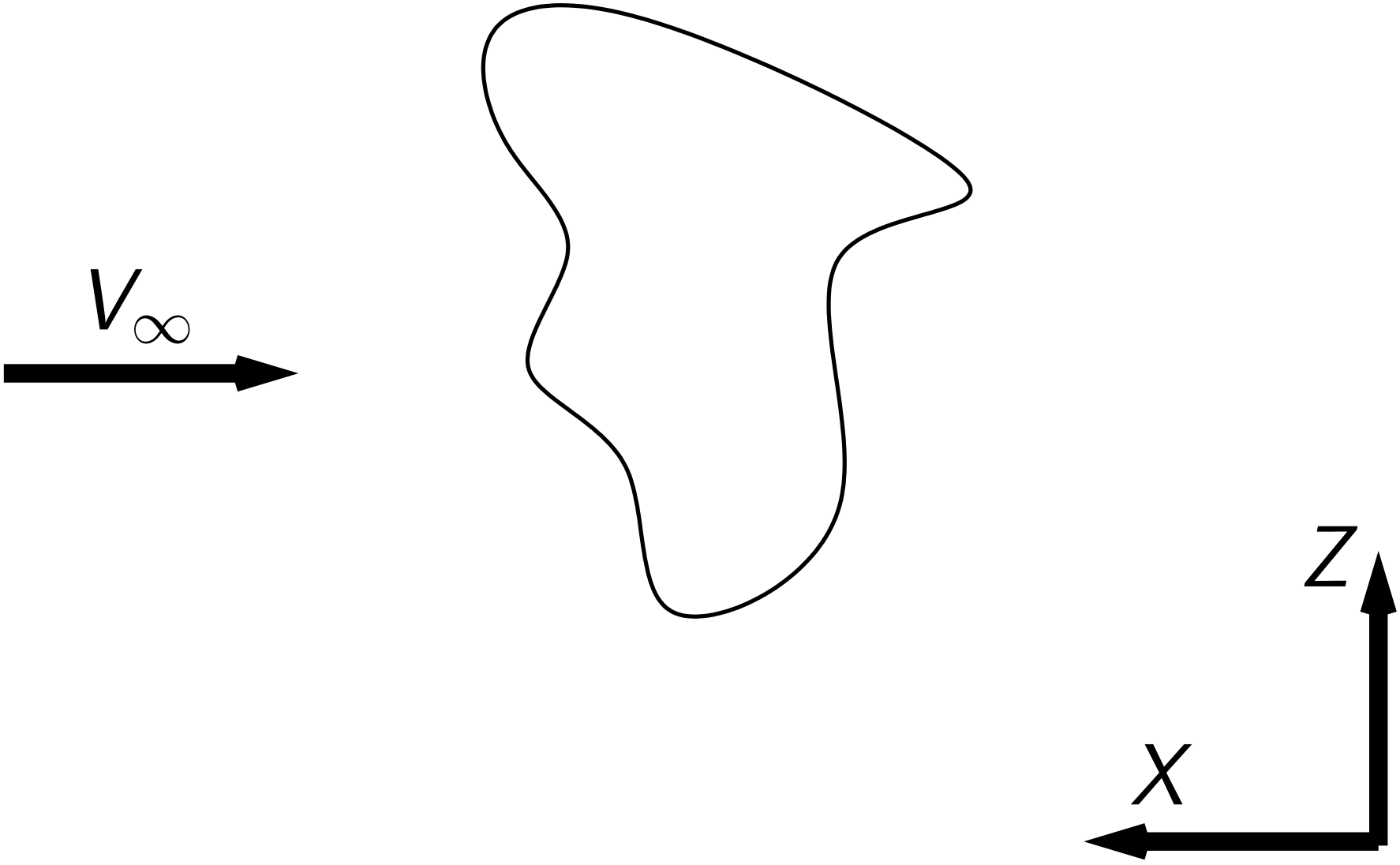
Steady, Inviscid Flow Past a Cylinder



2D Airfoil - lift?



2D Arbitrary Shape



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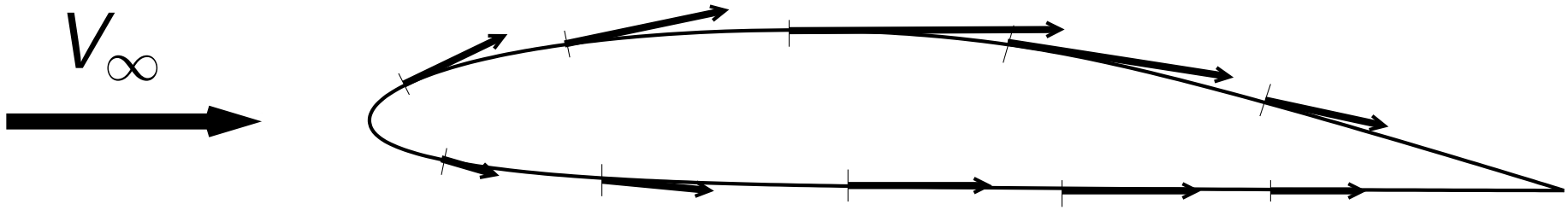
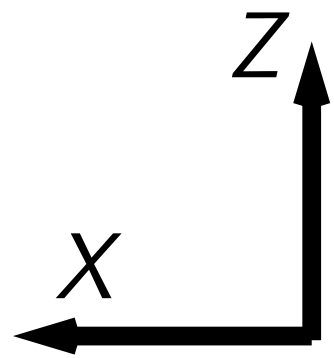
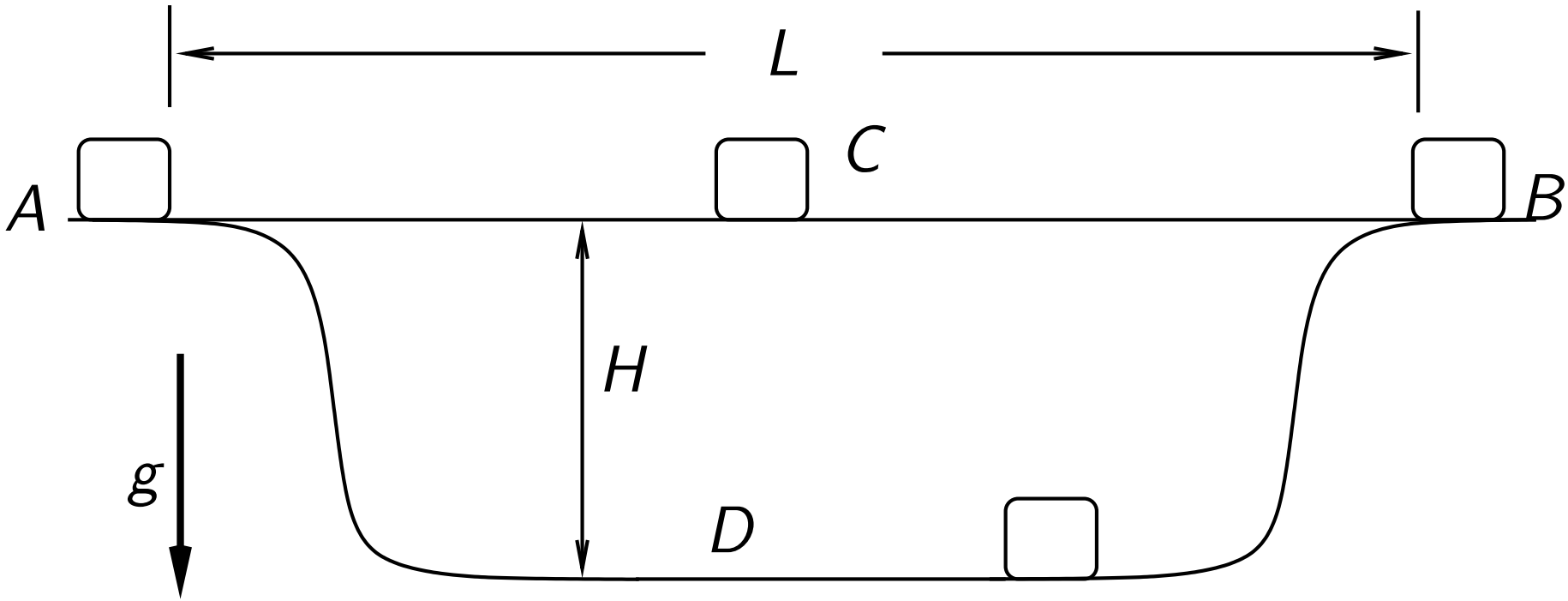


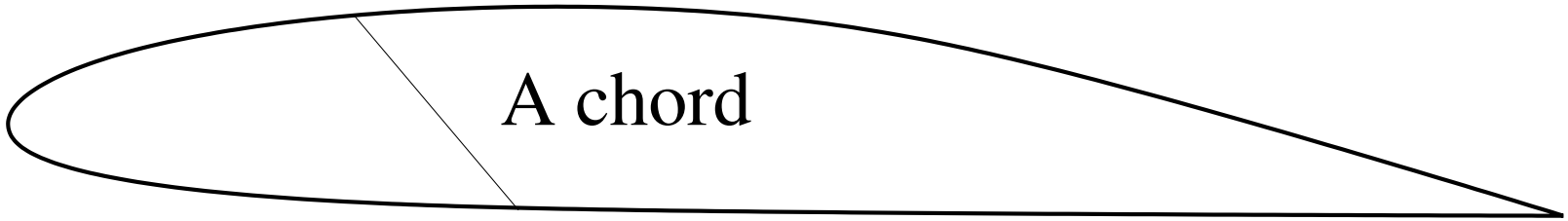


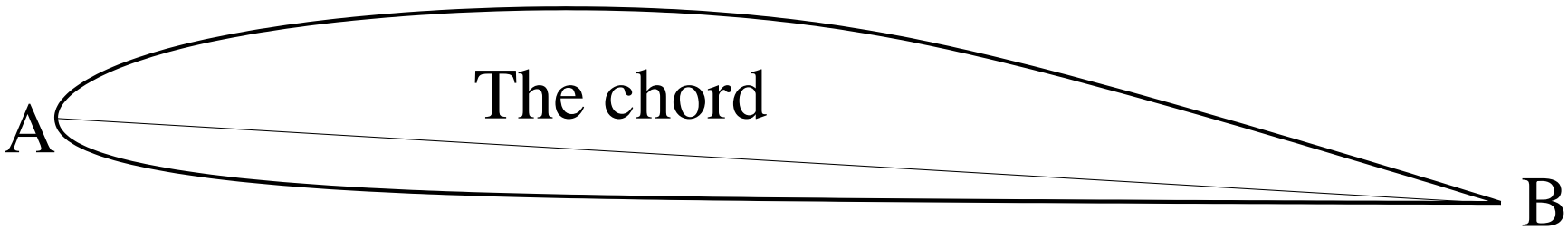
Bernoulli's Equation $p + \frac{1}{2}\rho V^2 = \text{Constant}$, So, $p \downarrow \implies V \uparrow$

No conservation of time - Blocks on a Frictionless Surface



Some Parts of an Airfoil

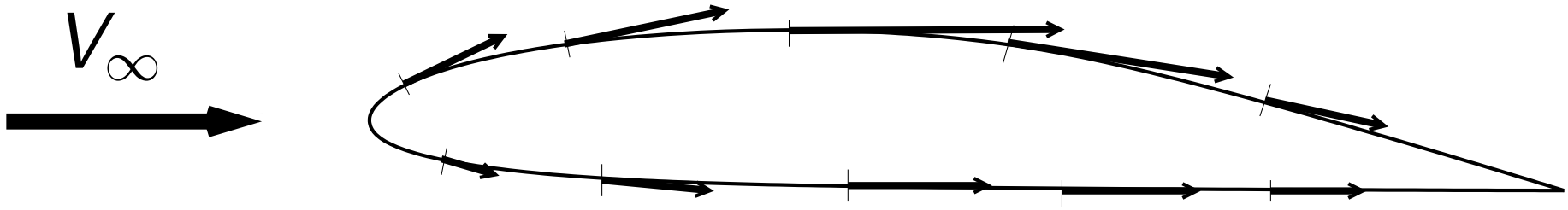


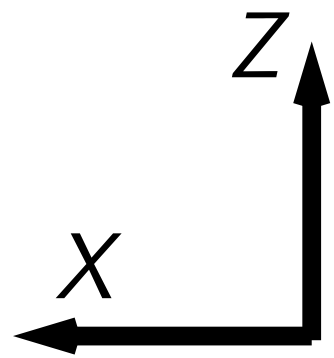


Chord length = c

Point A – leading edge, Point B is the trailing edge

2D Airfoil - lift?





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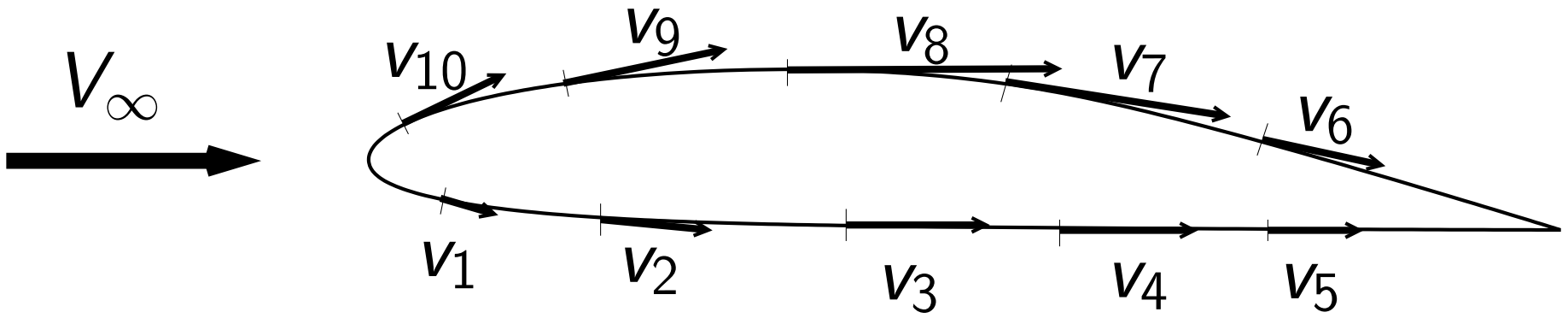
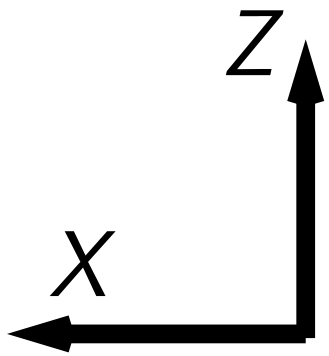


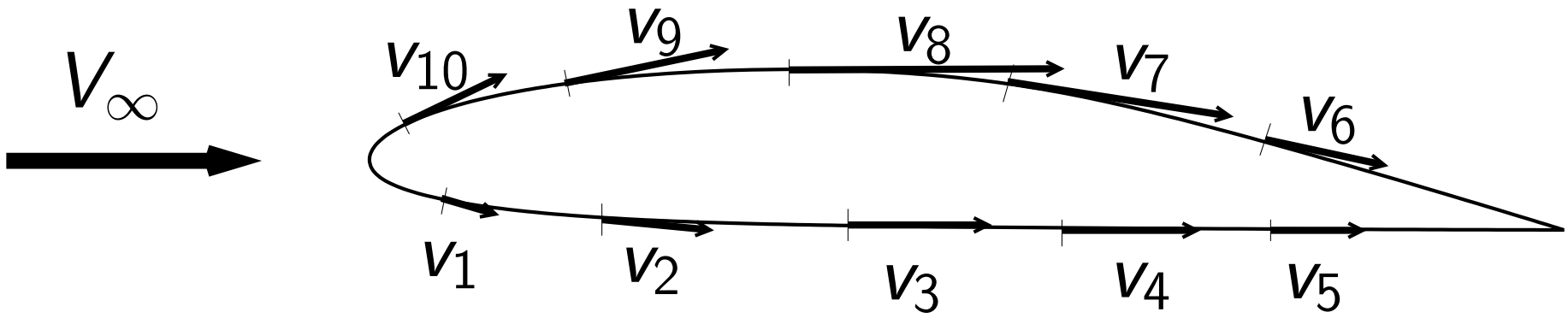
Δs_1 is the distance between point 1 and 2

Δs_5 is from pt 5 to the trailing edge

Δs_6 is from pt 6 to the trailing edge.

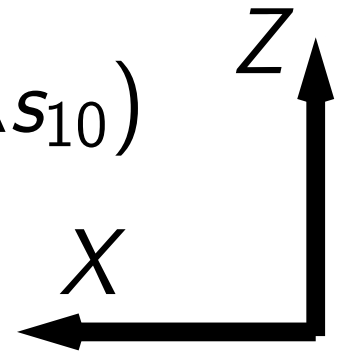


2D Airfoil - lift?

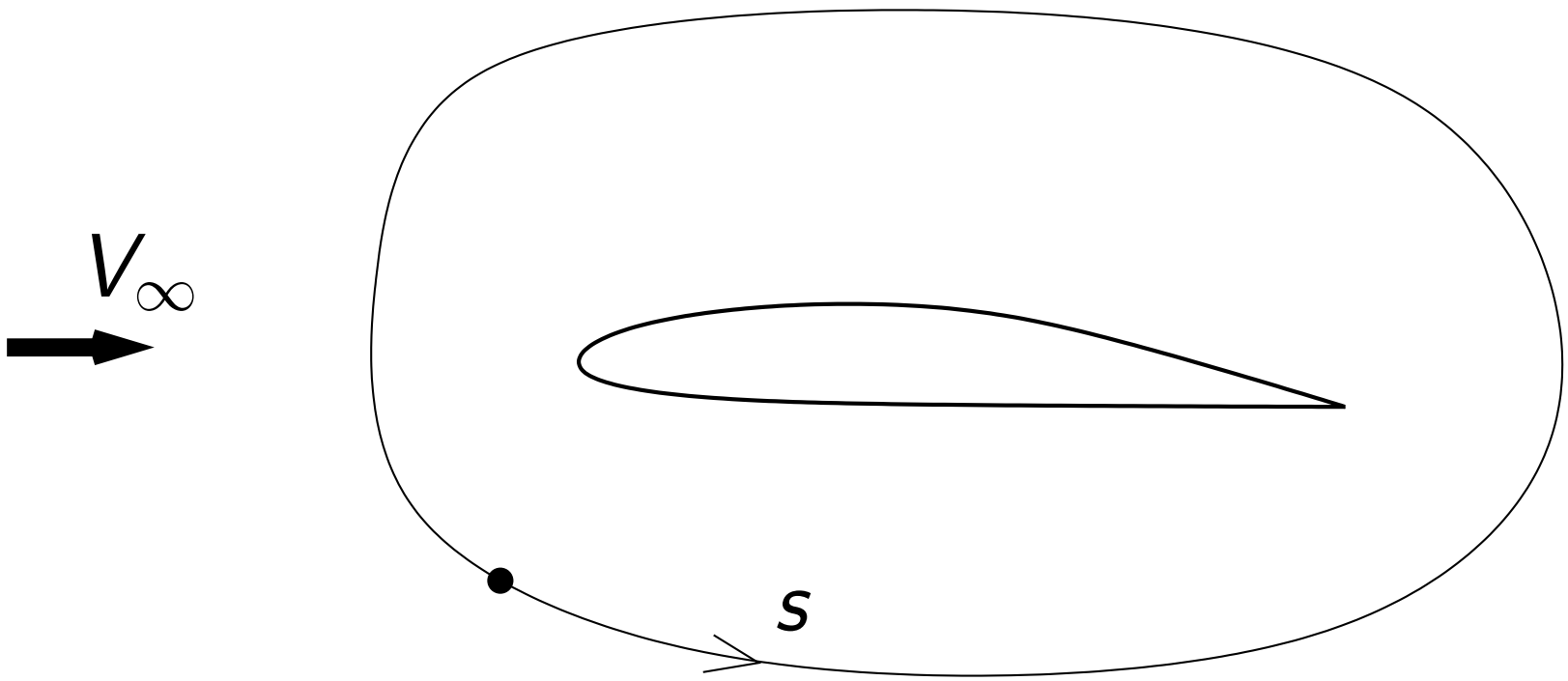


$$v_1\Delta s_1 + v_2\Delta s_2 + v_3\Delta s_3 + v_4\Delta s_4 + v_5\Delta s_5$$

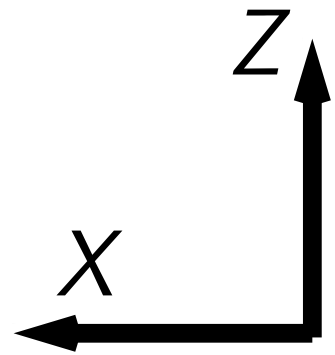
$$-\left(v_6\Delta s_6 + v_7\Delta s_7 + v_8\Delta s_8 + v_9\Delta s_9 + v_{10}\Delta s_{10}\right)$$



2D Airfoil - lift?



$$\Gamma = \oint \vec{V} \cdot \mathrm{d}\vec{s}$$



If we have circulation there is a possibility of lift

2D Airfoil - lift?

How do forces experienced generally depend on:

2D Airfoil - lift?

How do forces experienced generally depend on:

- Material of medium - for example water versus air

2D Airfoil - lift?

How do forces experienced generally depend on:

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- depends on density ρ

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How do forces experienced generally depend on:

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- Speed of movement - traveling faster versus slower

2D Airfoil - lift?

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2D Airfoil - lift?

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2D Airfoil - lift?

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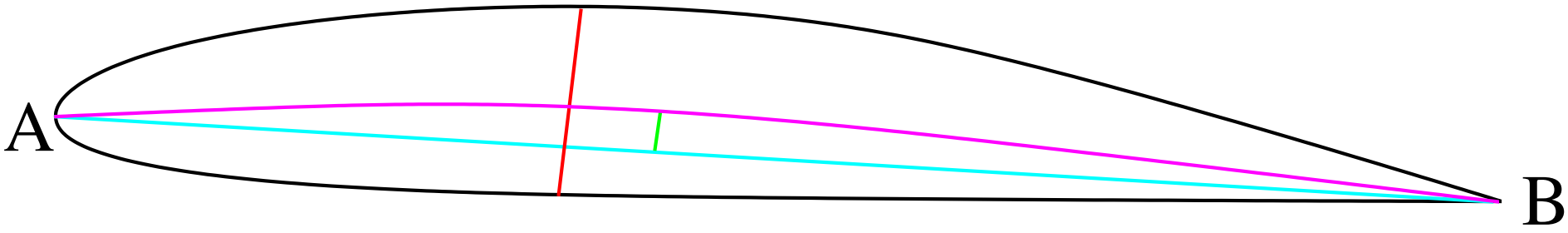
- depends on circulation Γ

2D Airfoil - lift?

Kutta - Joukowski Force

$$L = \rho V_\infty \Gamma$$

Parts of an Airfoil



Chord length = c

Point A – leading edge, Point B is the trailing edge

t is the thickness reported as t/c reported in %

Camber line

Camber reported as a percentage of c