Chapter 8-2

Pressure

Equation

Pressure = Force / Area

$P = F / A$

Area = pi r^2

SI unit – is the pascal (Pa)

1 Pa = $1N/m^2$

Atmosphere pressure at sea level=1.01×10^5

Potato Launcher

Tennis Ball Cannon

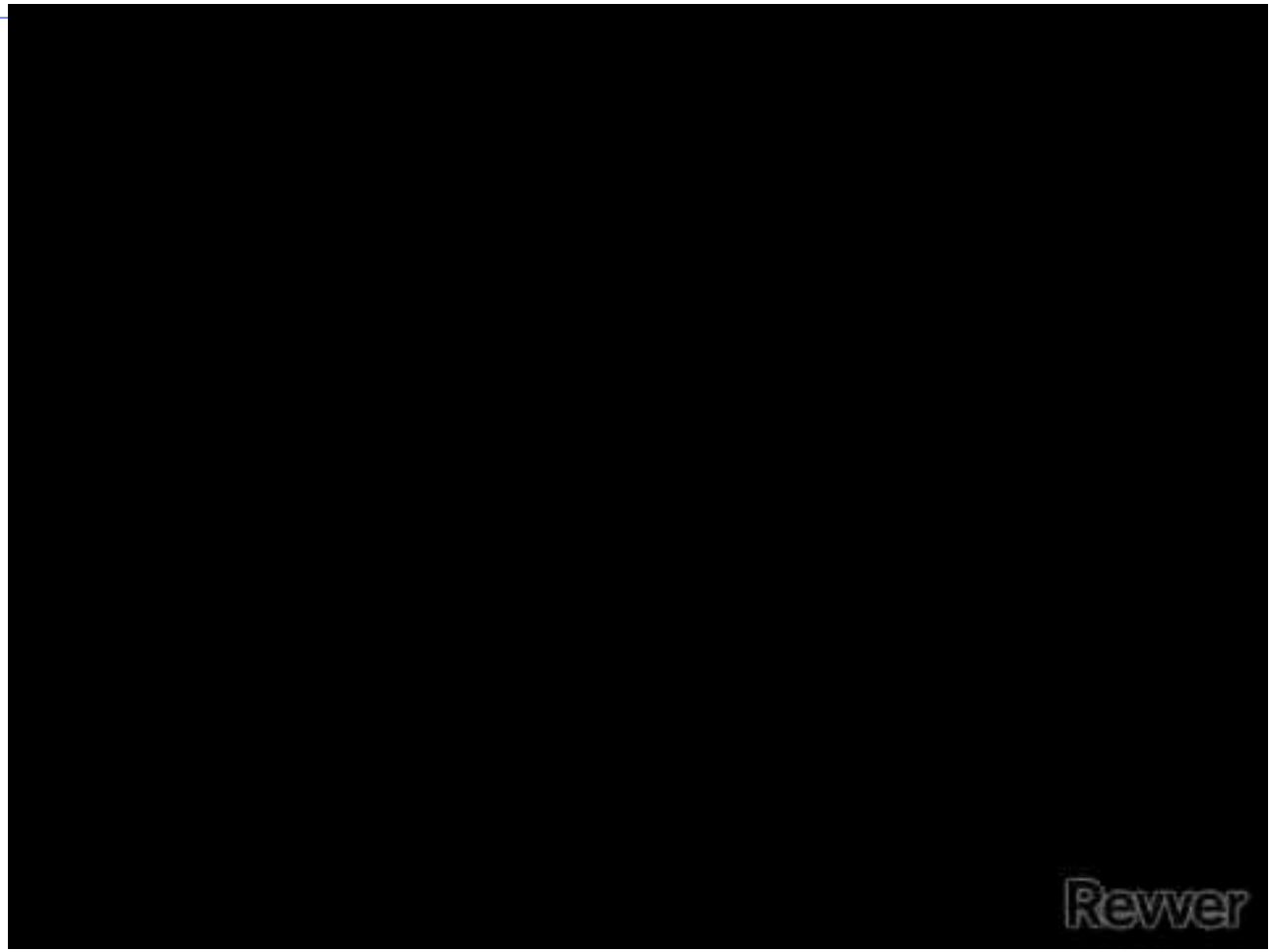
Bottomless Bottle Demo

Bed of Nails

3 Light Bulbs

Straw Popping

Mentos and Coke



Pascal's Principle

Pascal's Principle – Pressure applied to a fluid in a closed container is transmitted equally to every point of the fluid and to the walls of the container.

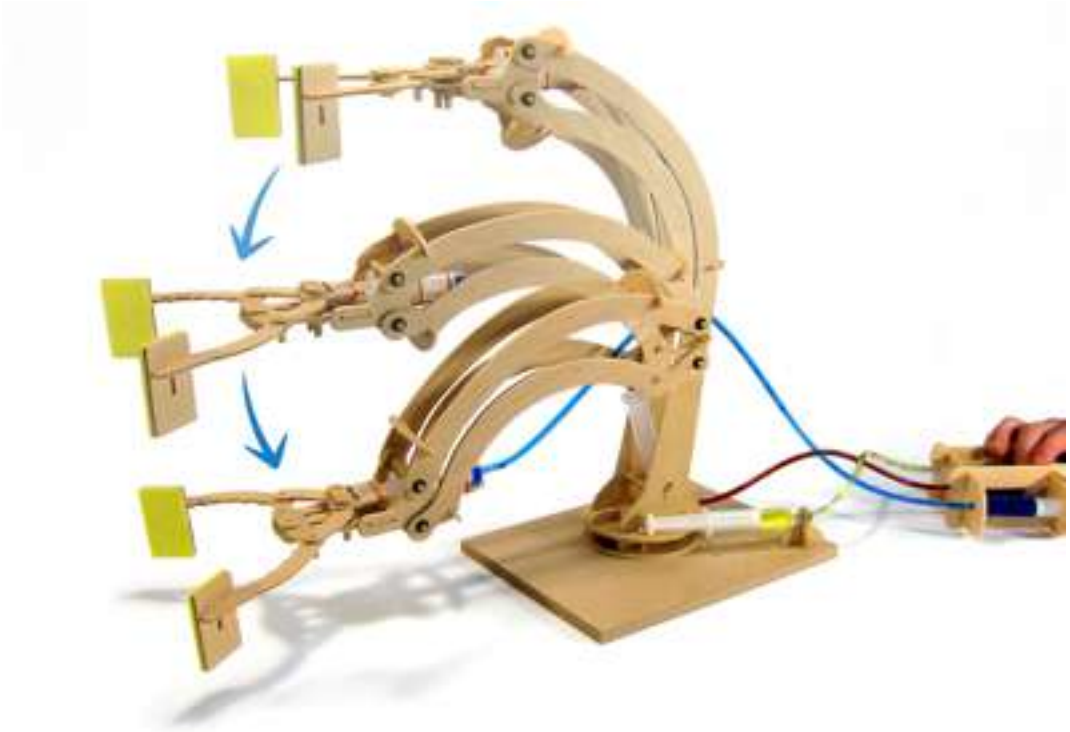
$P = F_1/A_1 = F_2/A_2$

Pascal's Demo

In a car lift, compressed air exerts a force on a piston with a radius of 10 cm. This pressure is transmitted to a second piston with a radius of 15 cm. How large a force must the compressed air exert to lift a 330 N car?

Hydraulics

Demos



Air Pressure Lifts a Car

Airbag to rescue truck

Atmospheric Pressure

Atmospheric Pressure is pressure from above. The weight of the air in the upper atmosphere exerts a pressure on the layers below.

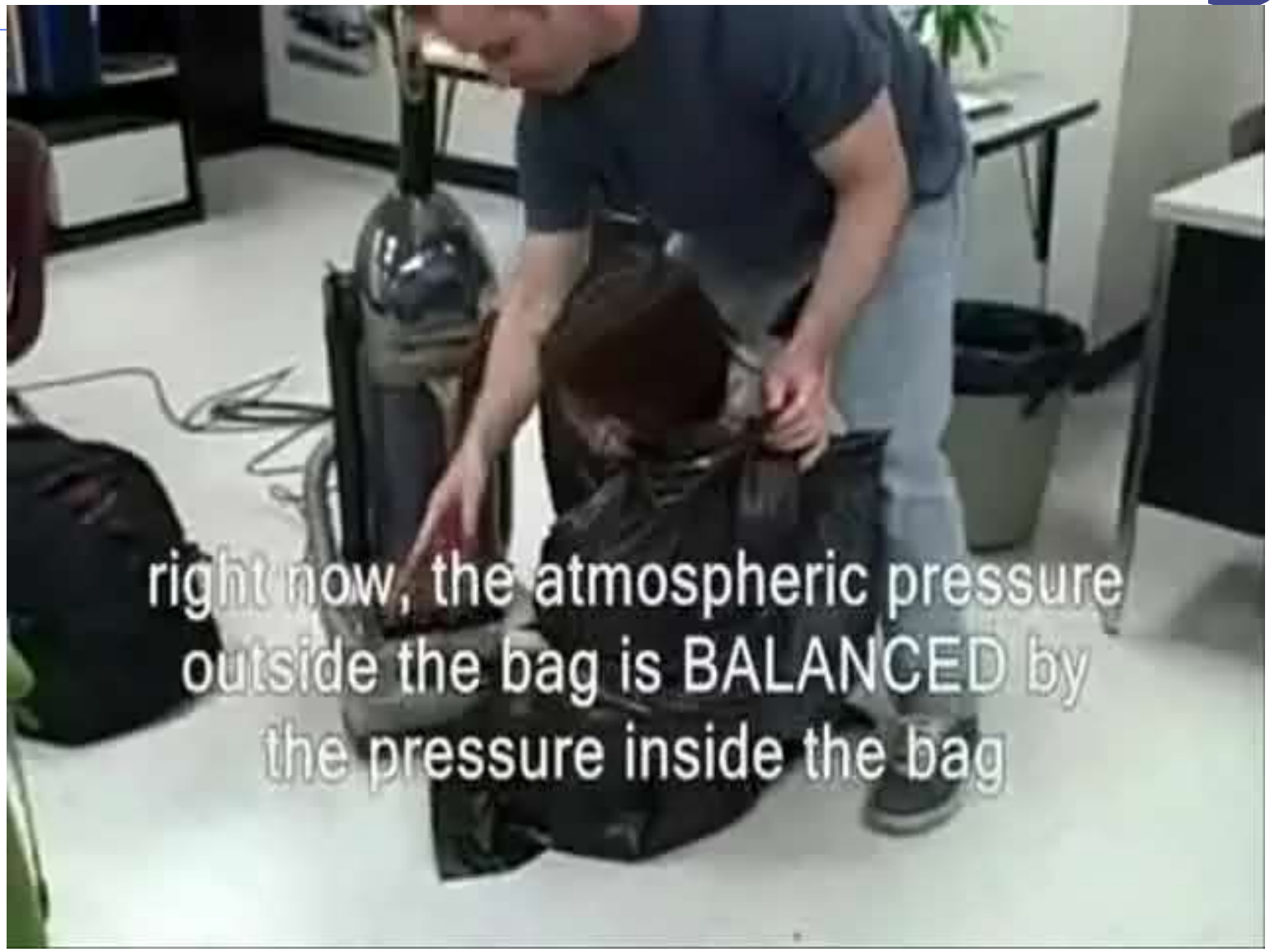
Pressure is a force


LiveLeak

Tornado

Vortex Rings

Vacuum Packing

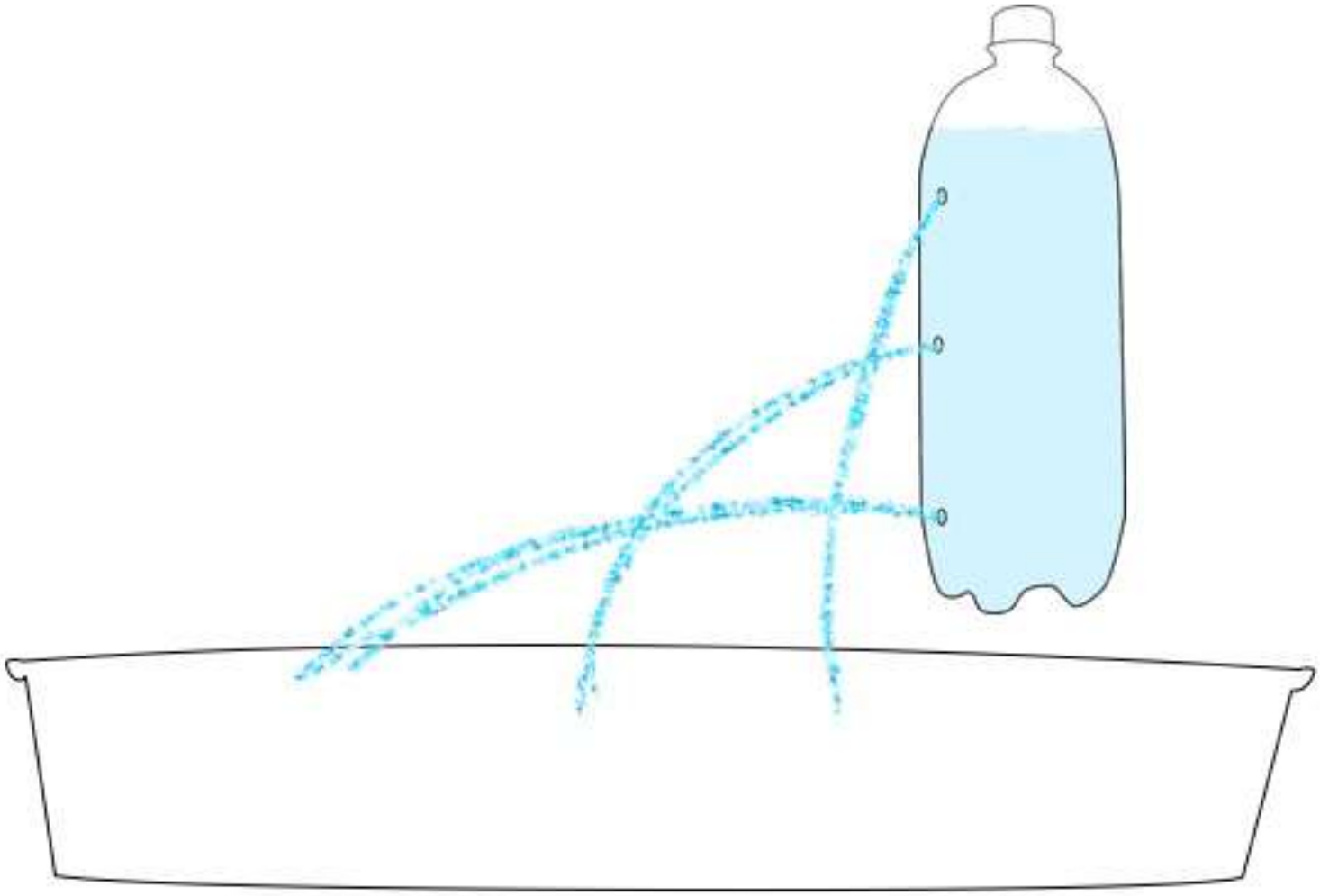


WALL CRAWLER CAR

Pressure and Depth

Absolute pressure = atmospheric pressure + (density x gravity x depth)

$P = P_{atm} + Dgh$



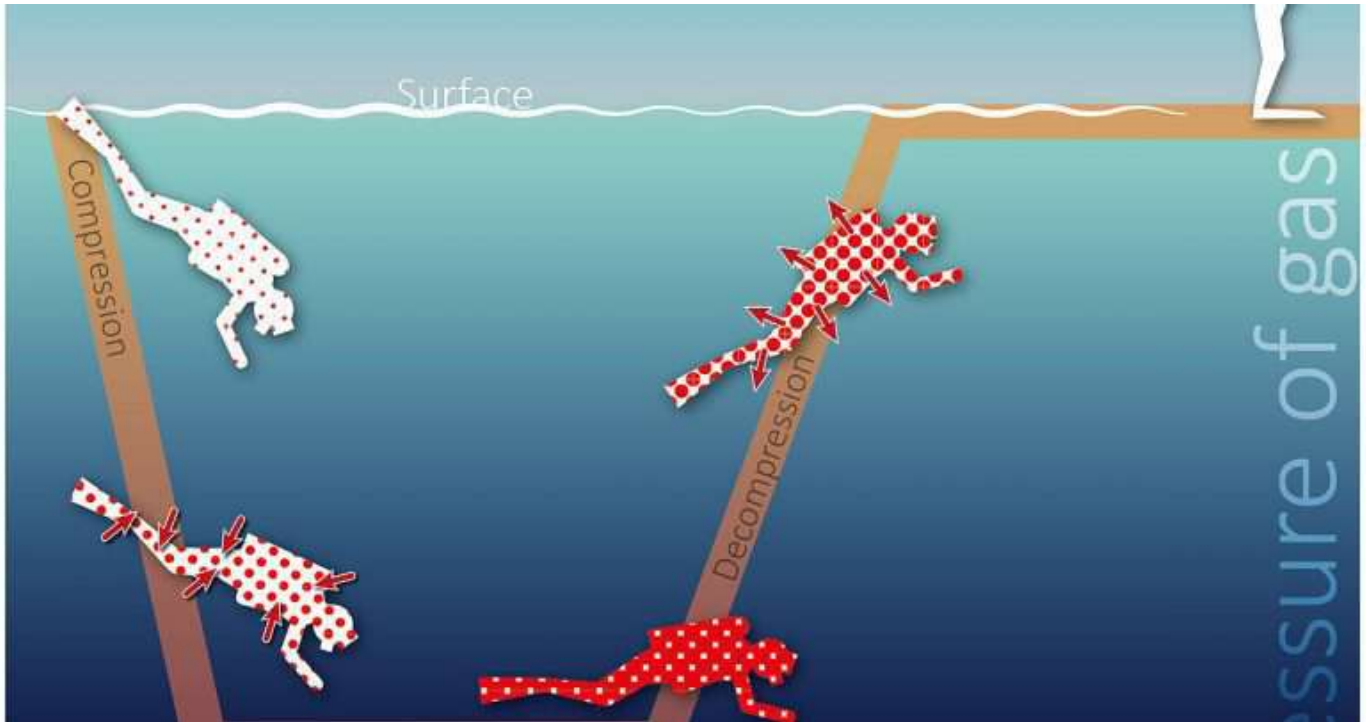
Barotrauma

Water has lots of pressure.

Remember the fish that is pulled up to quickly to the surface, his swim bladder expands very quickly to the point that the swim bladder is pushed out of his mouth.

Scuba Divers - Barotrauma

- Just like the fish, if a scuba diver comes up to quickly, the drastic pressure change can cause illness or death.
- Called decompression sickness or pulmonary barotrauma (bends).



Kinetic Theory

Kinetic Theory of gases describes the origin of gas pressure. Gas particles are like a collection of billiard balls that constantly collide with one another.

As they collide with the wall, they exert a force and this force per unit area is the gas pressure.

Temperature

- The higher the temperature, the faster the particles move.
- As the speed of the particles increase, the amount they hit the wall increases resulting in a higher force and therefore a higher pressure.
- Therefore, temperature and pressure are related.

Ivory Soap Demo

Chapter 8-3 and 8-4

Fluid Flow and Gas Laws

Laminar / Streamline

Laminar – if every particle that passes a particular point moves along the same smooth path. Also called **streamline**.

Different streamlines cannot cross each other.

At any point in a streamline flow, the direction and velocity of the fluid is the same throughout.

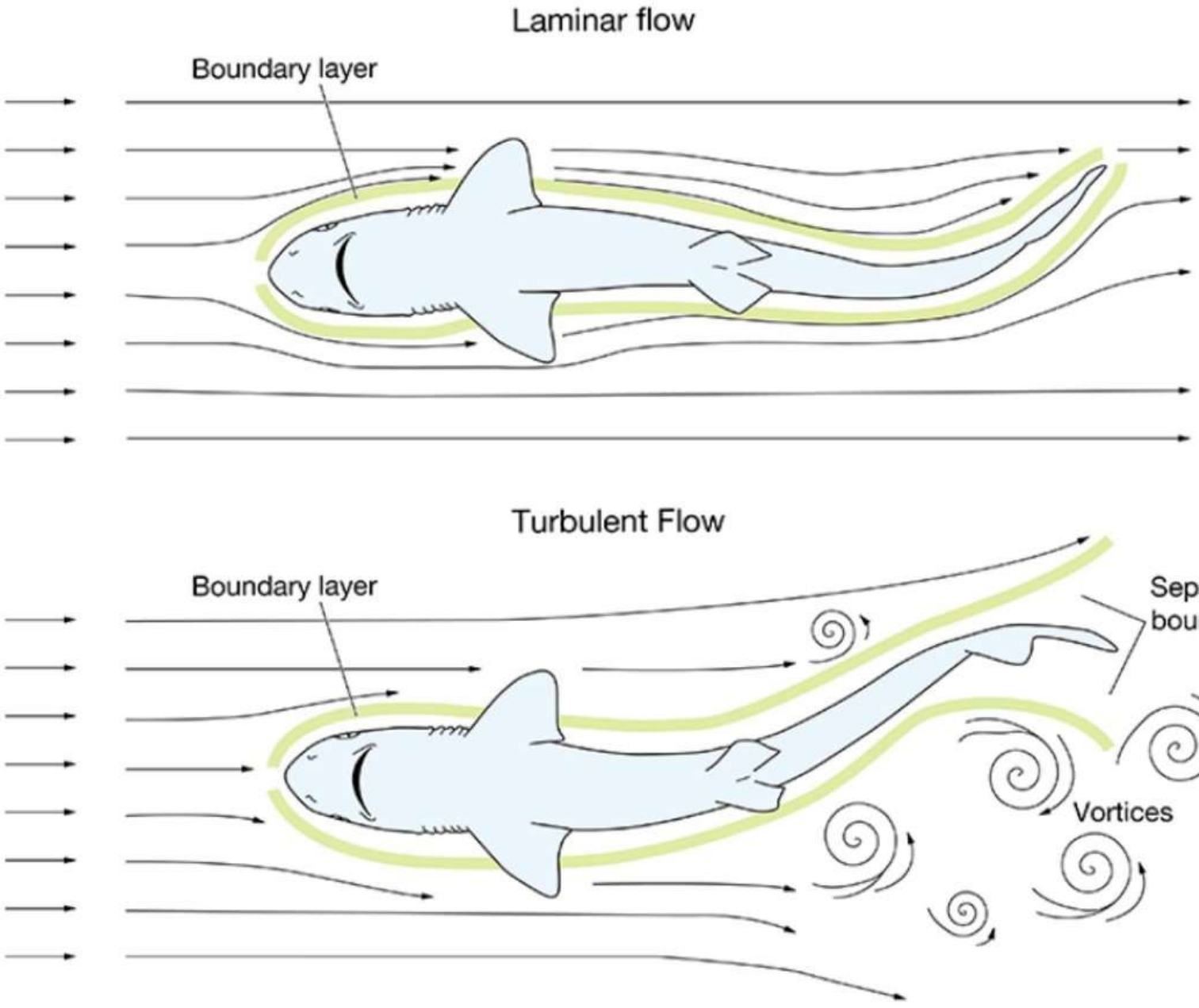

Physics Inn

Turbulent

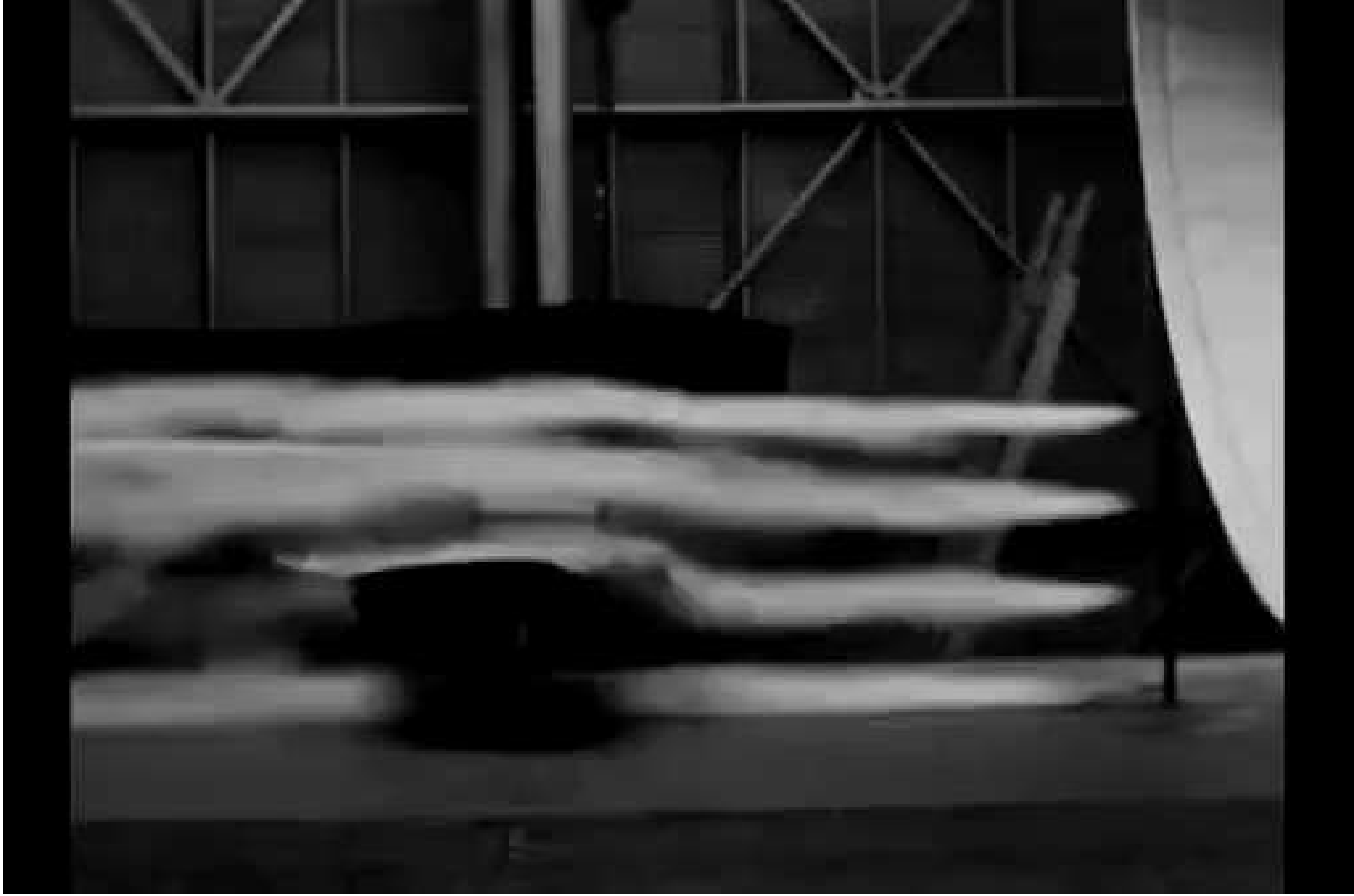
Turbulent – the flow of a fluid becomes **irregular** above a certain velocity or under conditions that can cause abrupt changes such as obstacles or sharp turns.

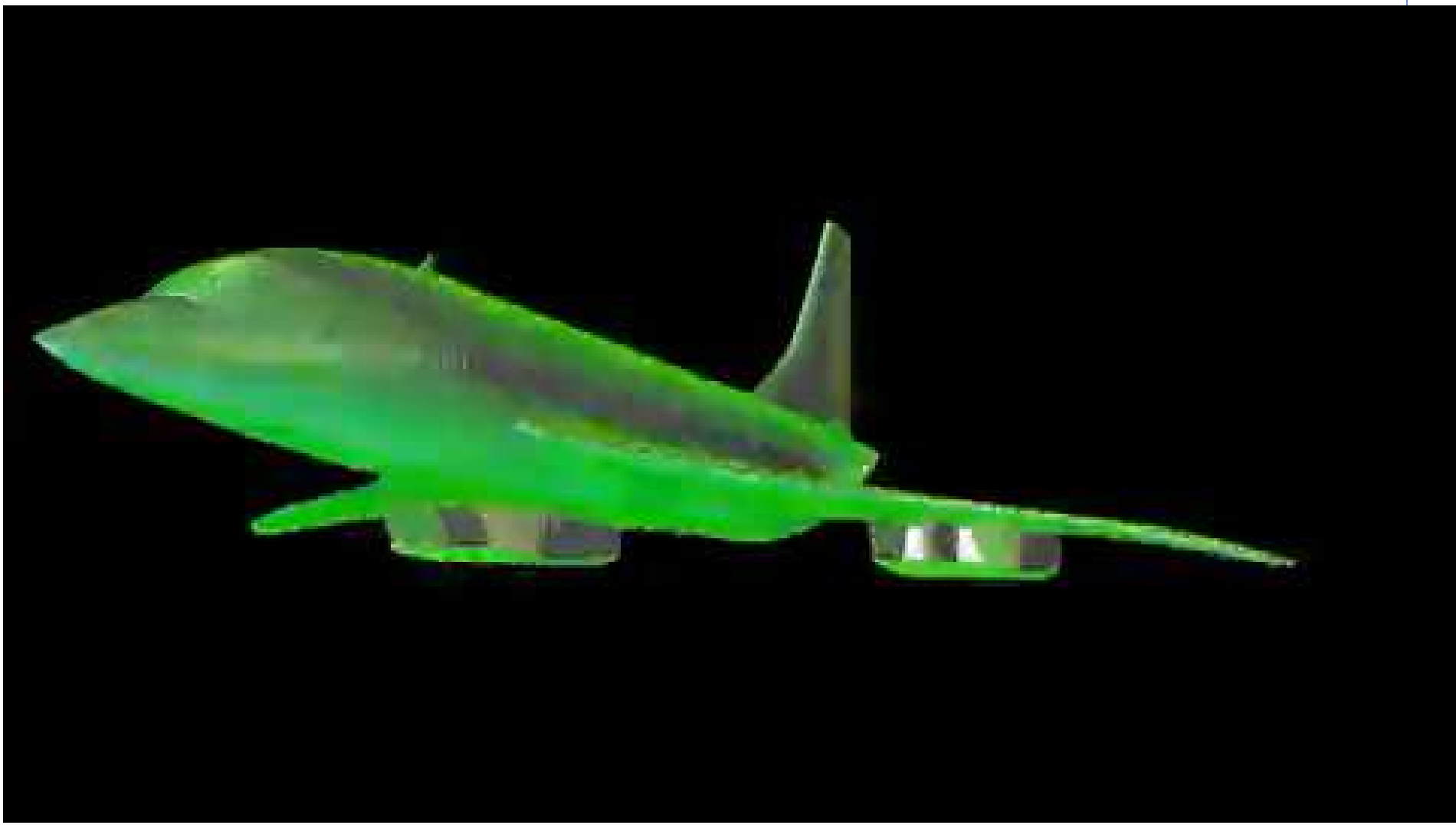
Irregular motions of the fluid, called **eddy currents**, are characteristic of turbulent flows.

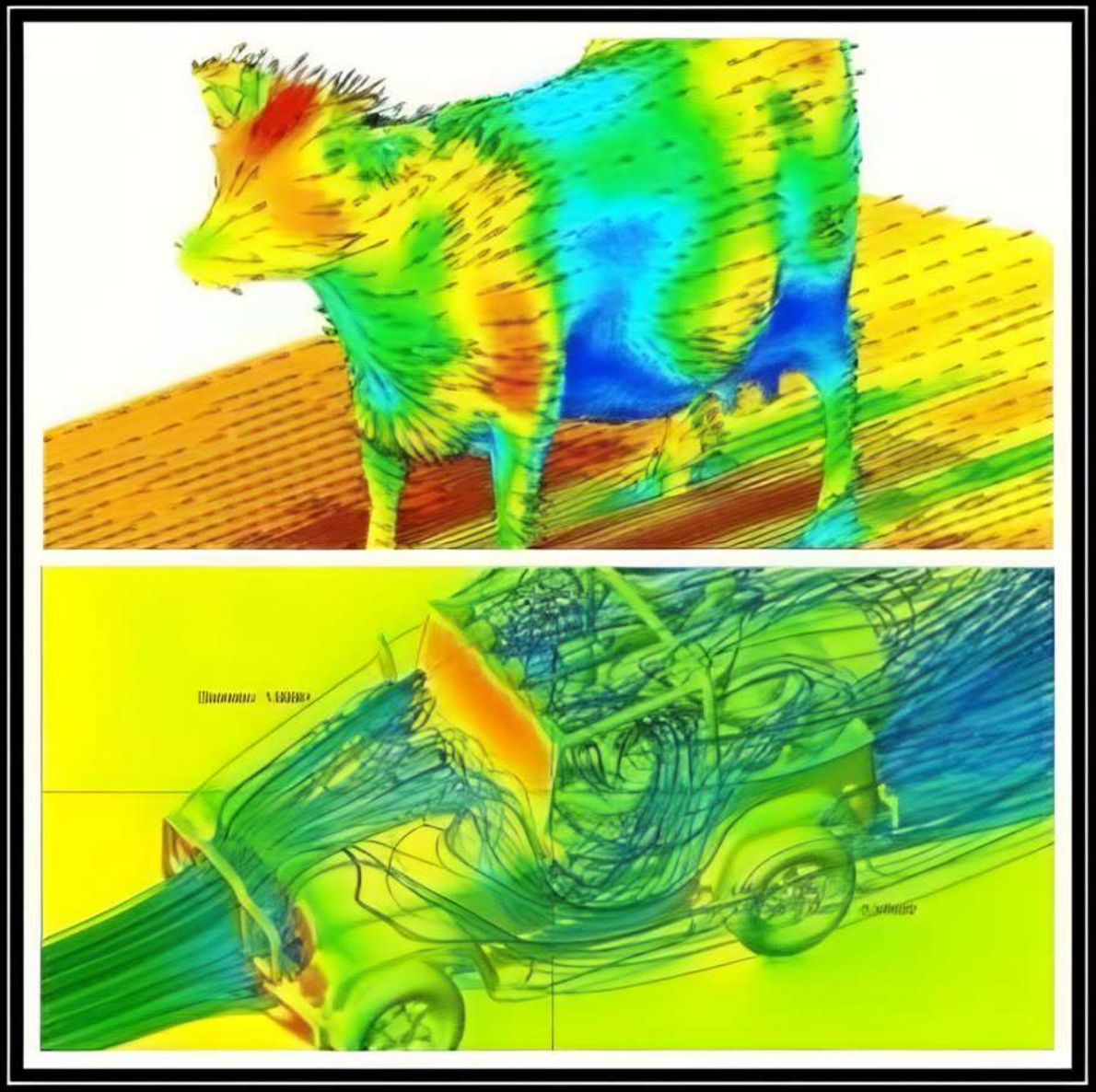
Image courtesy of Carrera


Laminar flow
Boundary layer
Turbulent Flow
Boundary layer
Separation of boundary layers
Vortices

Laminar versus Turbulent





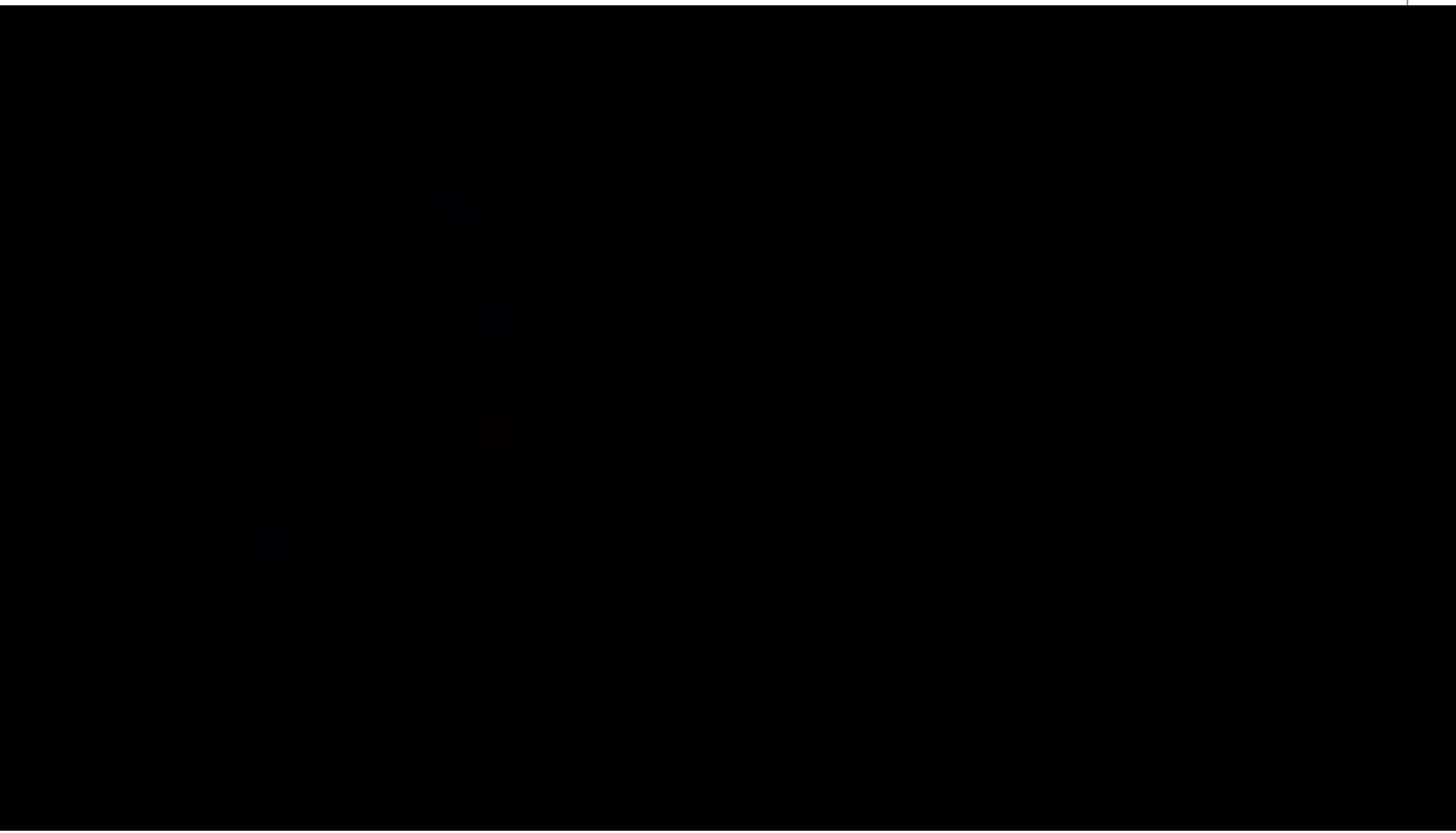


JEEP WRANGLER

Less aerodynamic than a cow

Fog and Laser

TURBULENT FLOW VS. LAMINAR FLOW



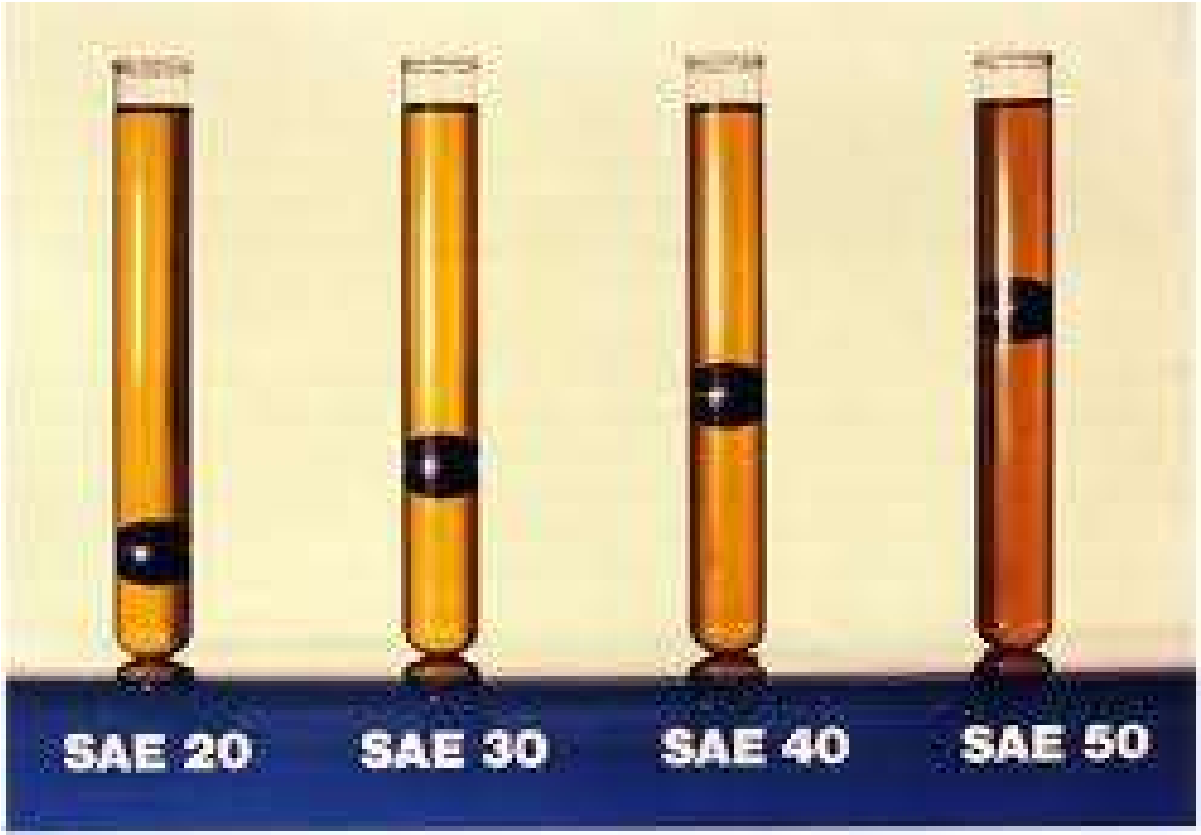
Viscosity

The term viscosity refers to the amount of **internal friction** within a fluid.

Internal friction occurs when layers of fluid slides past another layer.

A fluid with a high viscosity flows more slowly through a pipe than does a fluid with a low viscosity.

Viscosity Demo



Steel balls of equal weight dropped into test tubes filled with motor oils fall at different rates. Their rate of fall depends on the viscosity of the oil. The ball travelling through the light SAE 20 oil has travelled farthest, while the ball in the heavy SAE 50 has travelled least.

Ideal Fluid

Ideal fluids are considered nonviscous, so they don't lose kinetic energy due to friction as they flow.

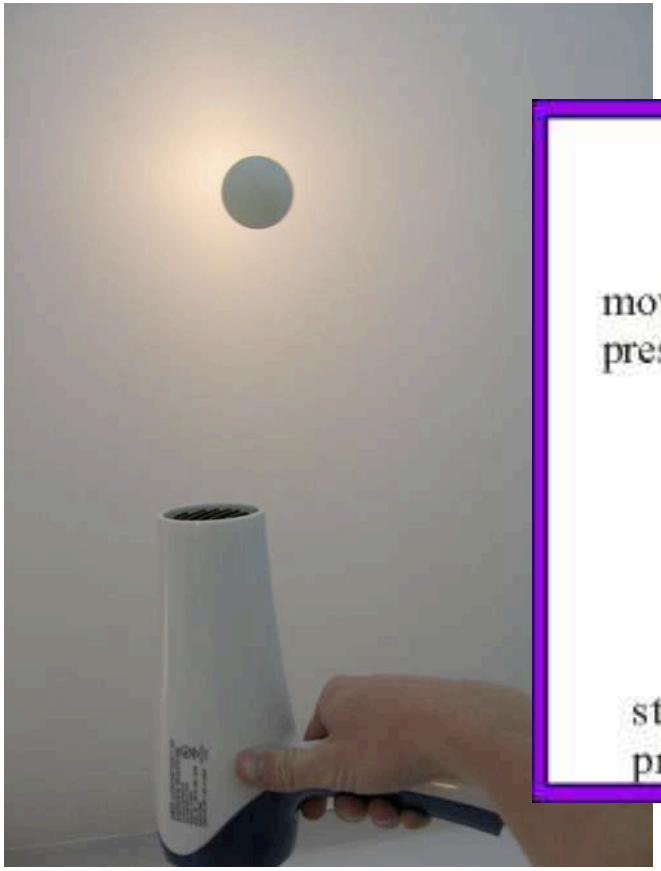
Ideal fluids are considered steady flow. The velocity, density, and pressure at each point are constant.

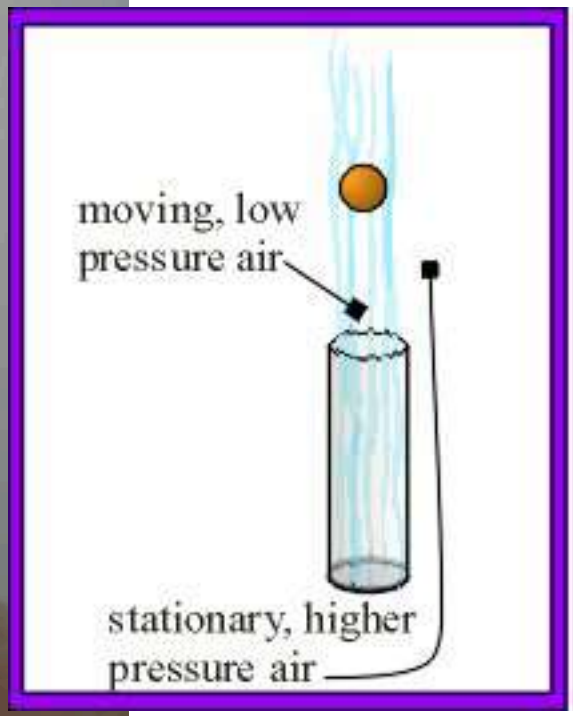
The flow is nonturbulent, which means no eddy currents.

Bernoulli's Principle

- The speed of fluid depends on cross sectional area.
- The pressure in a fluid is related to the speed of flow.
- Bernoulli's principle – The pressure in a fluid decreases as the fluid's velocity increases.

Bernoulli's Demos

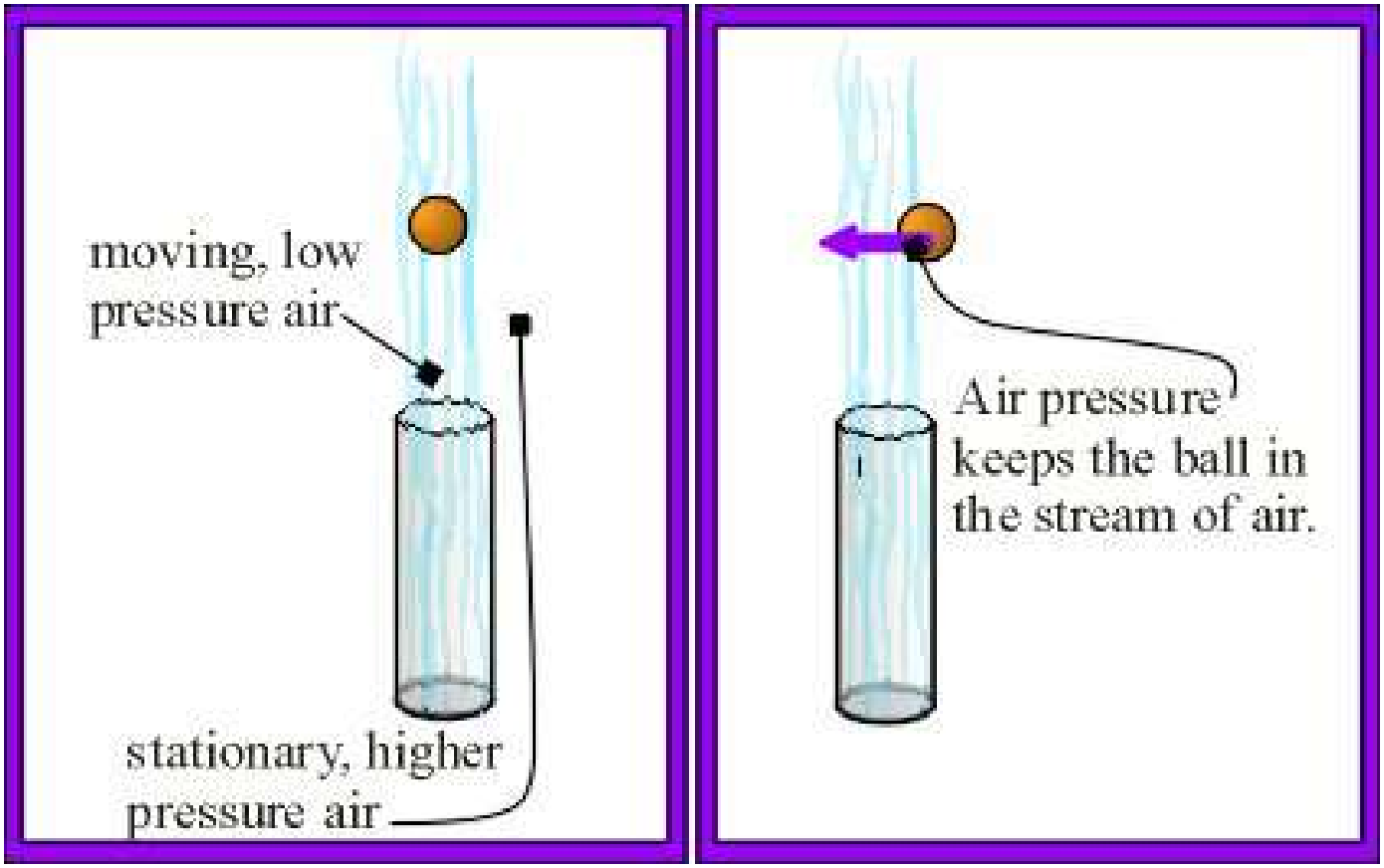




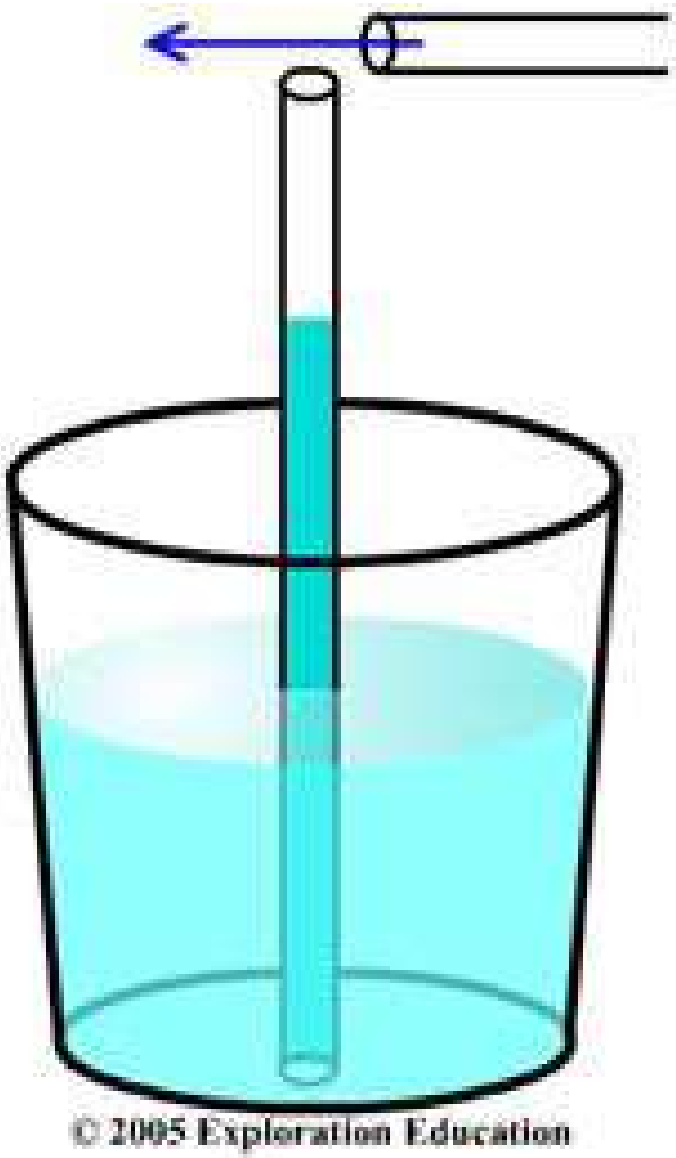
LEVITATION SHOOTING

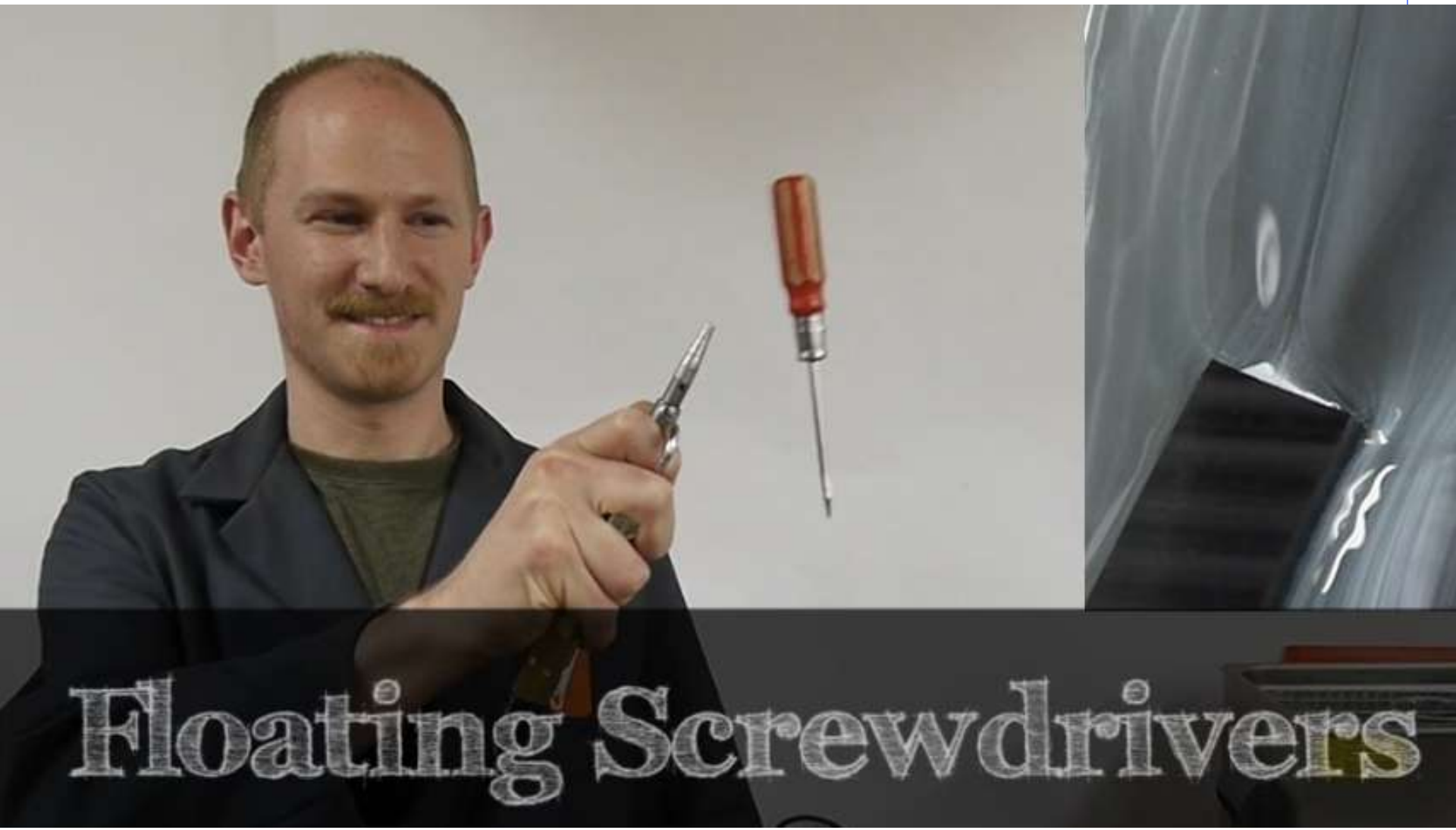
Different shooting methods with wind floating

Bucket of Ping Pong Balls Demo



Straw and water demo




Floating Screwdrivers

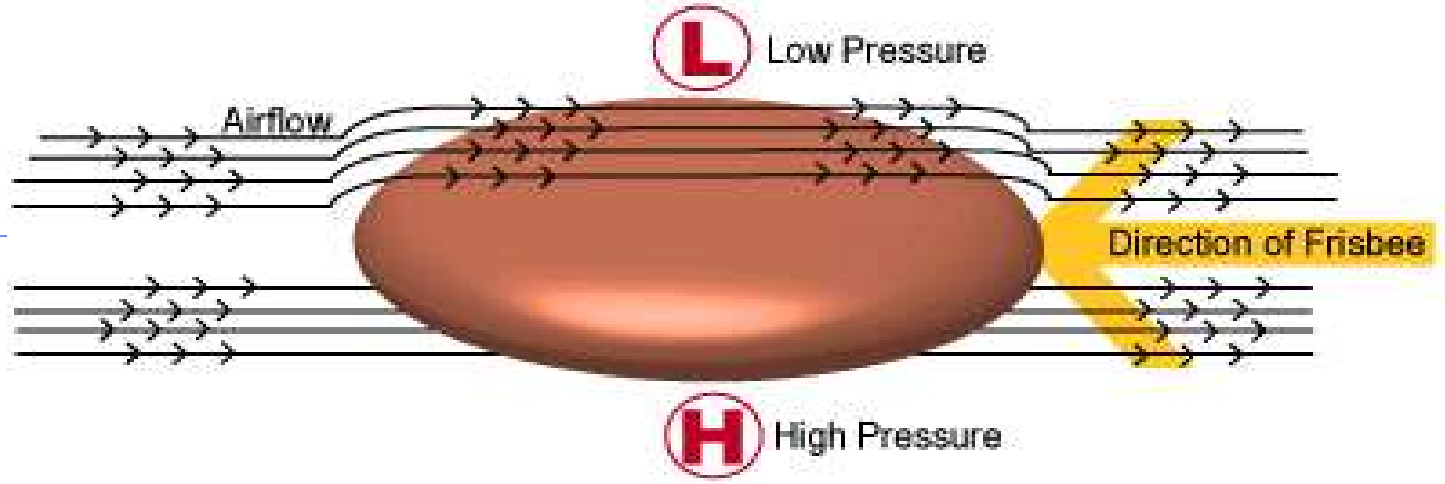
Vaping is bad! But cool video

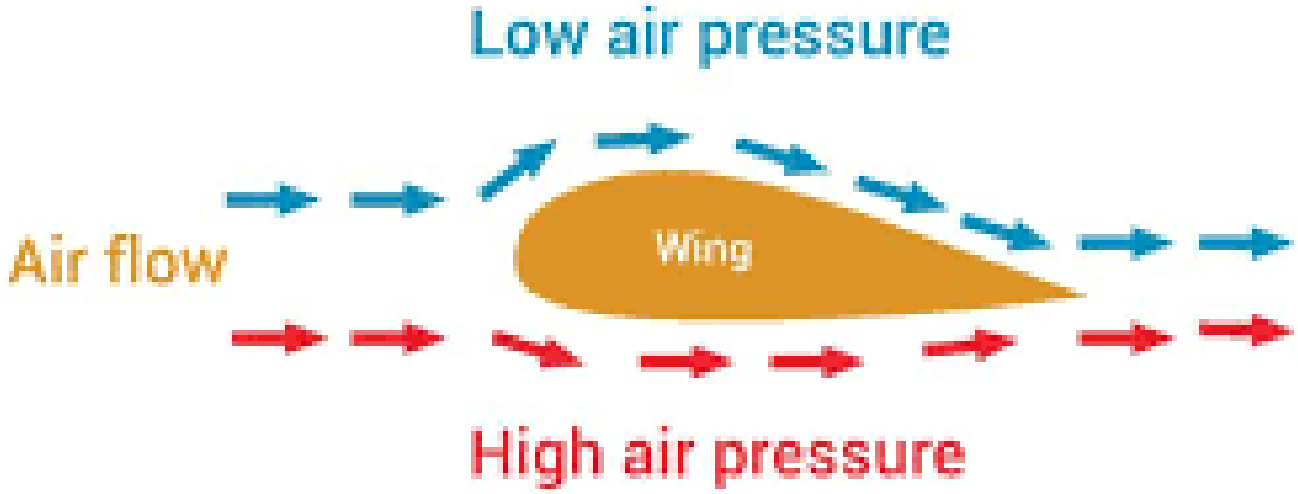
Lift on an Airplane

The lift on an airplane wing can be explained with Bernoulli's Principle.

Airplane wings are designed to direct the flow of air so that the air speed above the wing is greater than the air speed below the wing.

This makes the air pressure above the wing less than the pressure below which creates and upward force called lift.

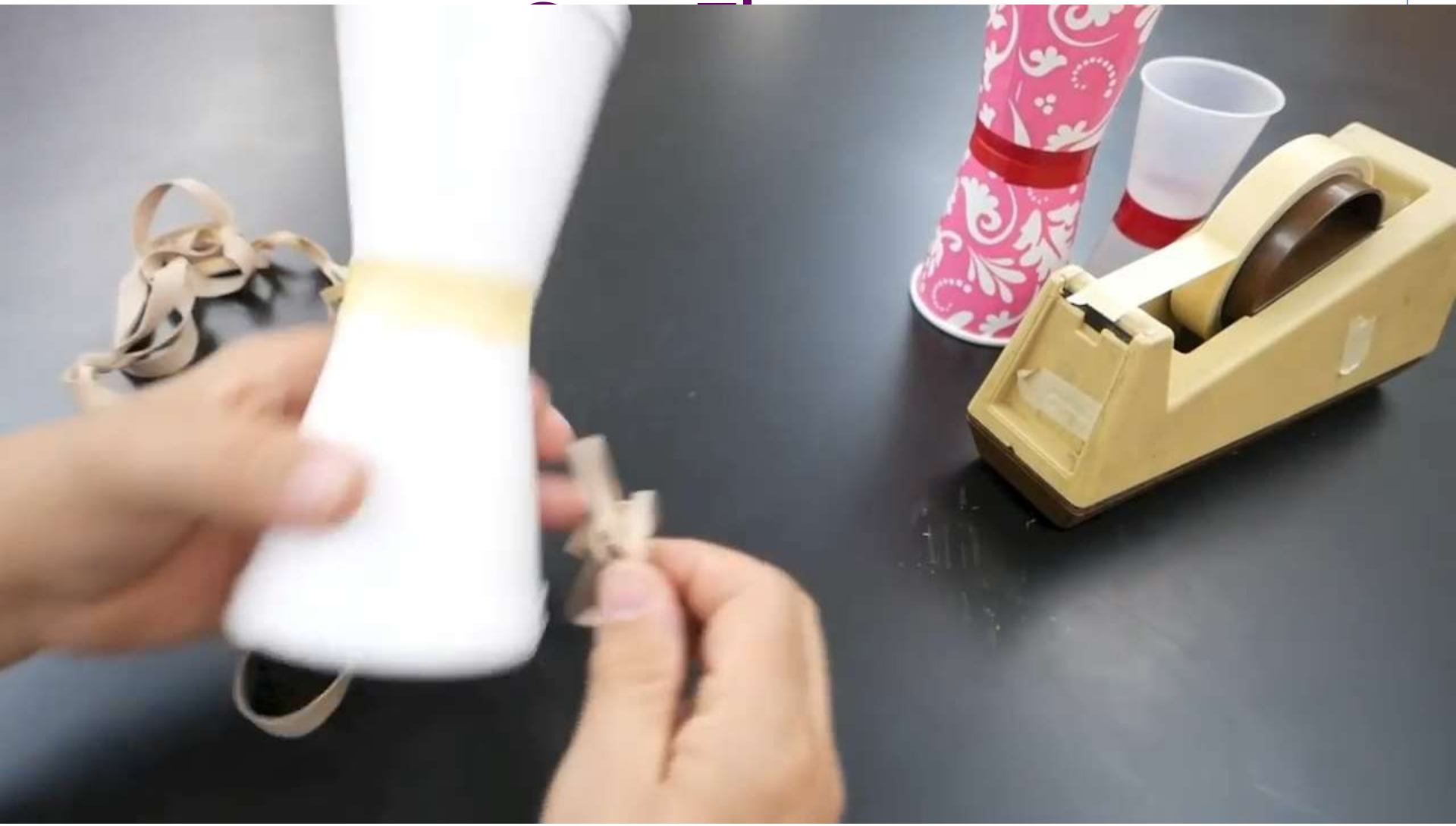

L
Low Pressure
Airflow
Direction of Frisbee
H
High Pressure


Low air pressure
Air flow
Wing
High air pressure

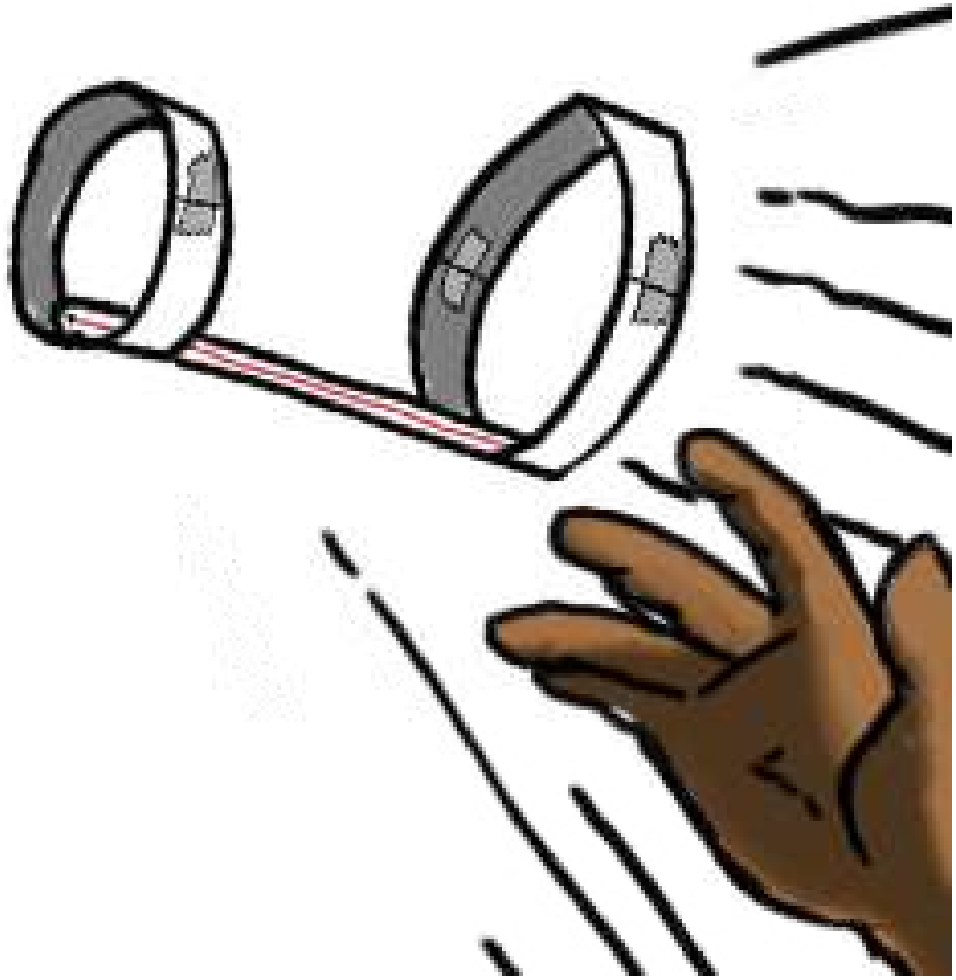
Bernoulli's Equation

$\text{Pressure}_1 + \frac{1}{2}\ \text{density} \times \text{velocity}_1^2 + \text{density} \times \text{gravity} \times \text{height}_1 = \text{Pressure}_2 + \frac{1}{2}\ \text{density} \times \text{velocity}_2^2 + \text{density} \times \text{gravity} \times \text{height}_2$

$P_1 + \frac{1}{2}\ Dv_1^2 + Dgh_1 = P_2 + \frac{1}{2}\ Dv_2^2 + Dgh_2$



Ring Gliders



Stunt Planes