

Pressure

Part 1



National Science Foundation
WHERE DISCOVERIES BEGIN

Fluids

Substances that flow are called *fluids*.

Common examples of fluids are gases, like air, and liquids, like water.

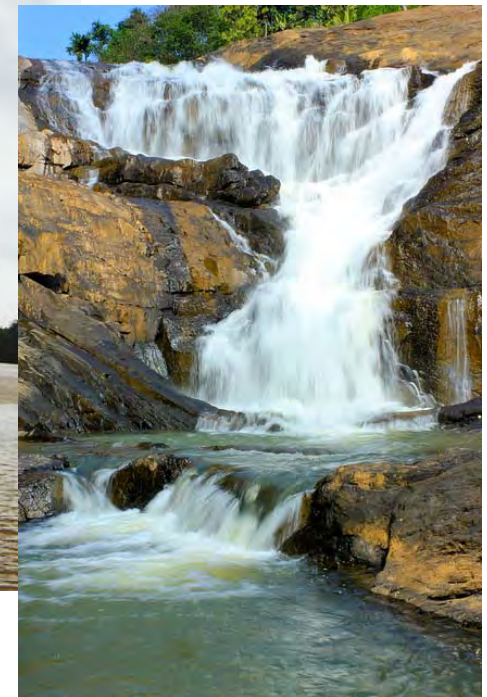
Grains, such as rice and flour, are also fluids.



<http://www.flickr.com/photos/bookminx/>



<http://www.flickr.com/photos/florg/>



<http://www.flickr.com/photos/cblue98/>

Pressure vs. Force

Sometimes it is more convenient to use pressure than force, especially for motion involving fluids.

<http://www.flickr.com/photos/neeravbhatt/>



Flag moving in the wind

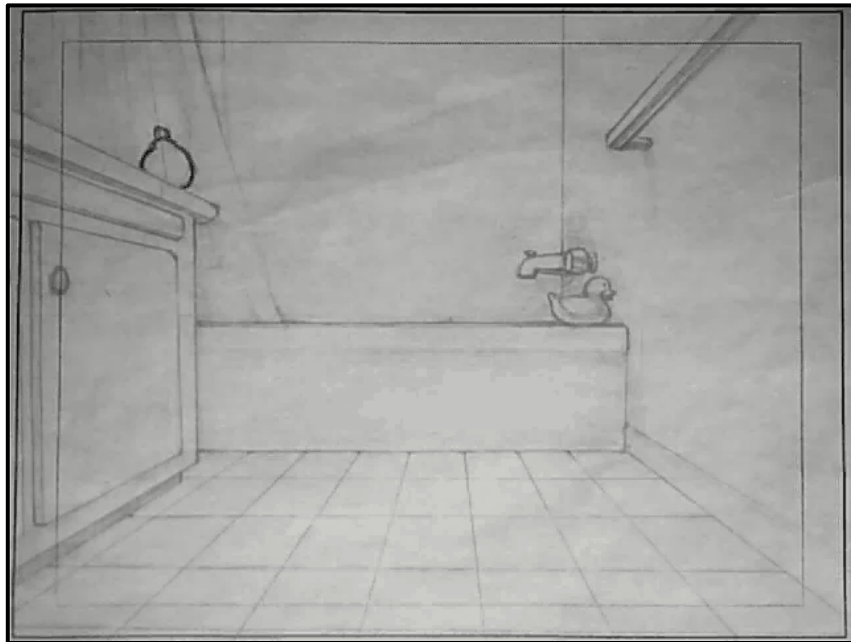


Boat floating in the water

<http://www.flickr.com/photos/32933171@N04/>

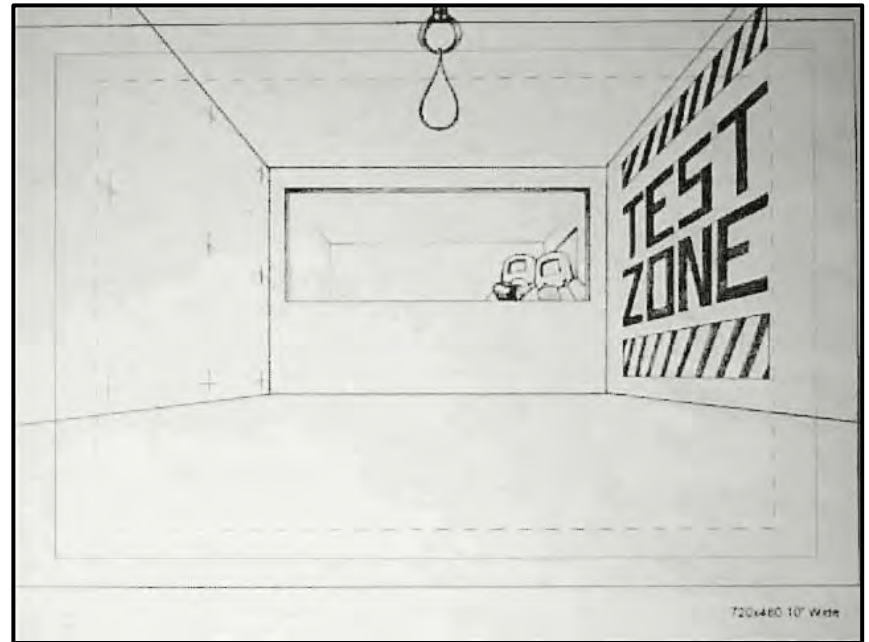
Water Balloon Drop

Water balloon drop is a common animation exercise for understanding squash & stretch.



By Mai Vu

<http://www.youtube.com/watch?v=ajC1oCZIkQI>



By Ken Calvert

<http://www.youtube.com/watch?v=0yWTJpaoJXI>

Water Balloon Reference

<http://www.youtube.com/watch?v=FI-Mq6BDtMQ>

Waterballoon Drop

Speed: 120 frames per second

Size: Water balloon - 3 inches

www.AnimationPhysics.com

<http://www.youtube.com/watch?v=XbGVBV3-F48>

Waterballoon Drop

Speed: 120 frames per second

Size: Water balloon - 3 inches

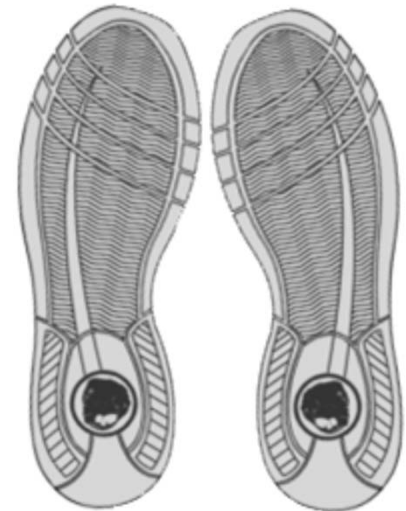
www.AnimationPhysics.com

Pressure and Force

Pressure is defined as

$$\text{Pressure} = \frac{(\text{ Force })}{(\text{ Surface Area })}$$

If you weigh 200 pounds and the surface area of the soles of your shoes is 100 square inches (10"x10") then your weight exerts a pressure of 2 pounds per square inch on the floor.



Sitting on a Bed of Nails

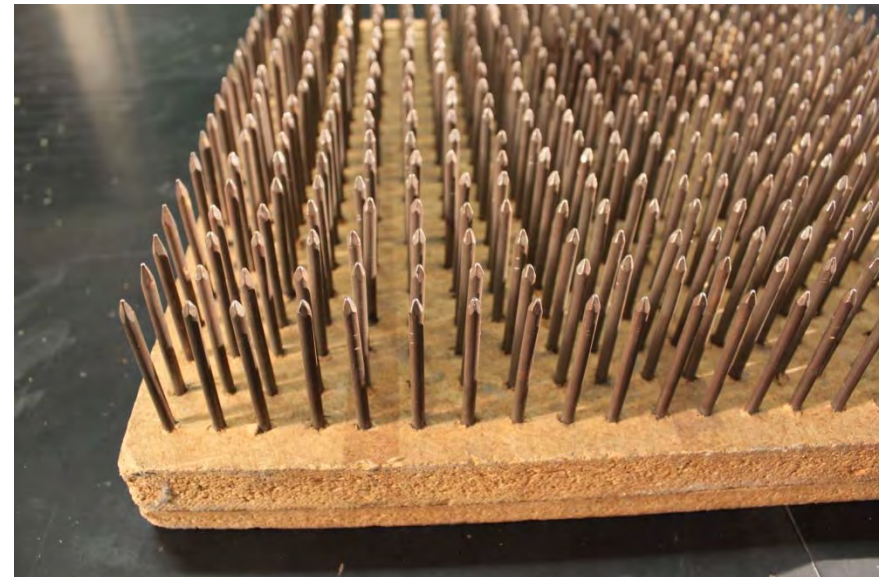
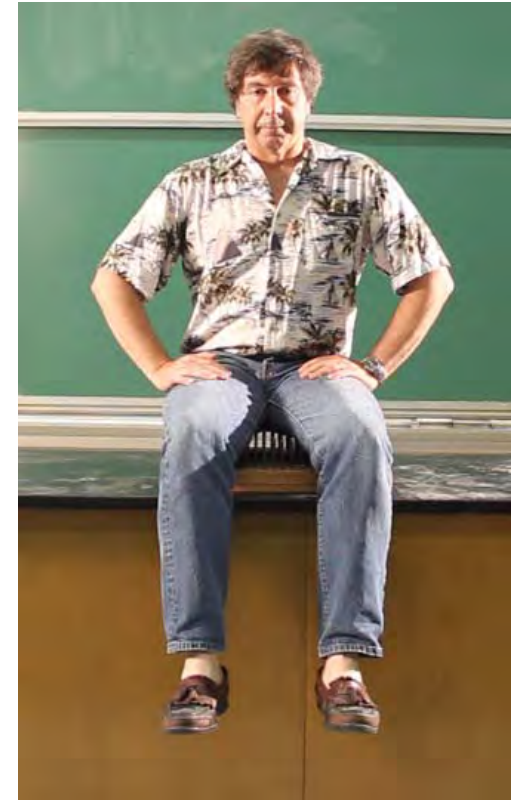


Bed of Nails, Analyzed

My weight is almost 200 pounds and the surface area of my butt is about 200 square inches.

Pressure on the bed is about 1 pound per square inch and there's about one nail per square inch.

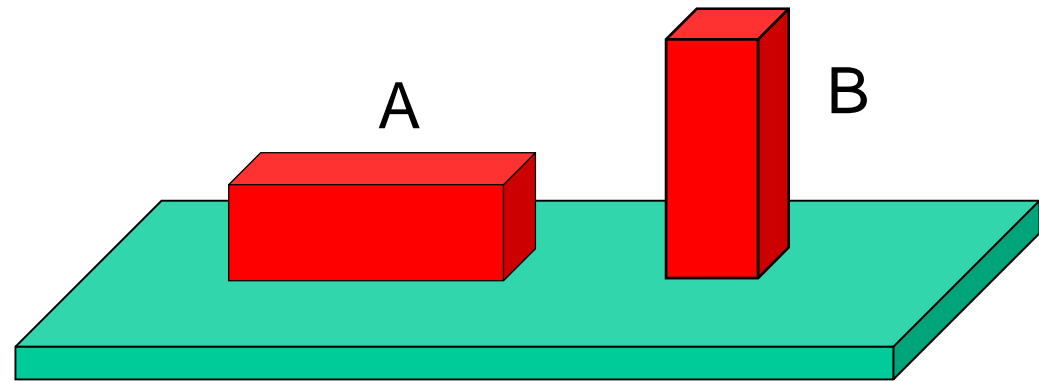
Need about 5 pounds per nail to pierce the skin.



Pressure Examples

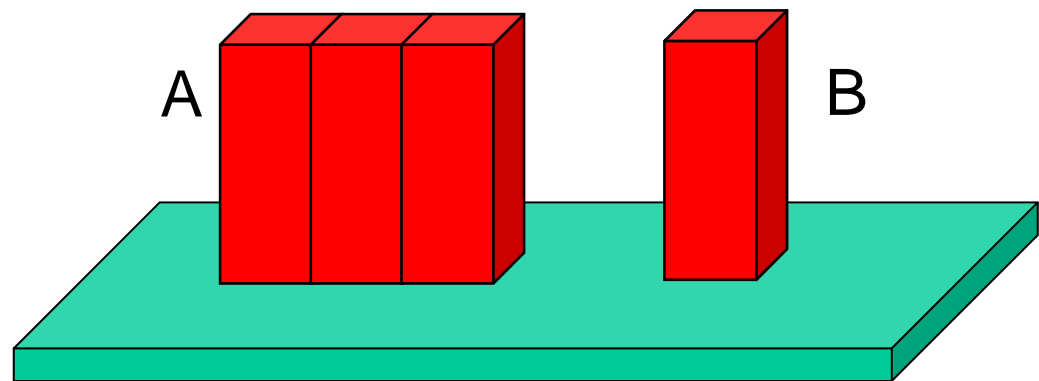
In which case is the pressure greatest?

Case B. Same force (same weight) but smaller area.



Same pressure in the two cases.

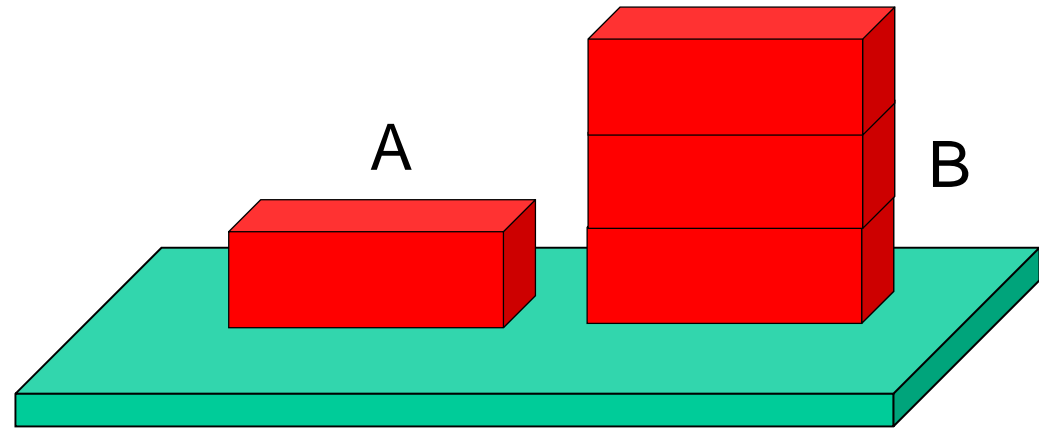
Case A has three times the weight but also 3x times area.



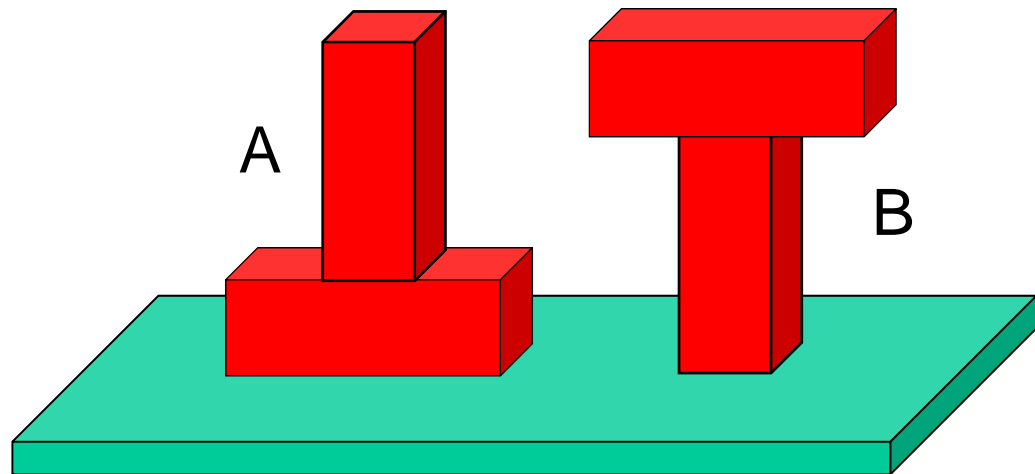
Pressure Examples

In which case is the pressure greatest?

Case B. Same area but 3x the force so 3x the pressure.

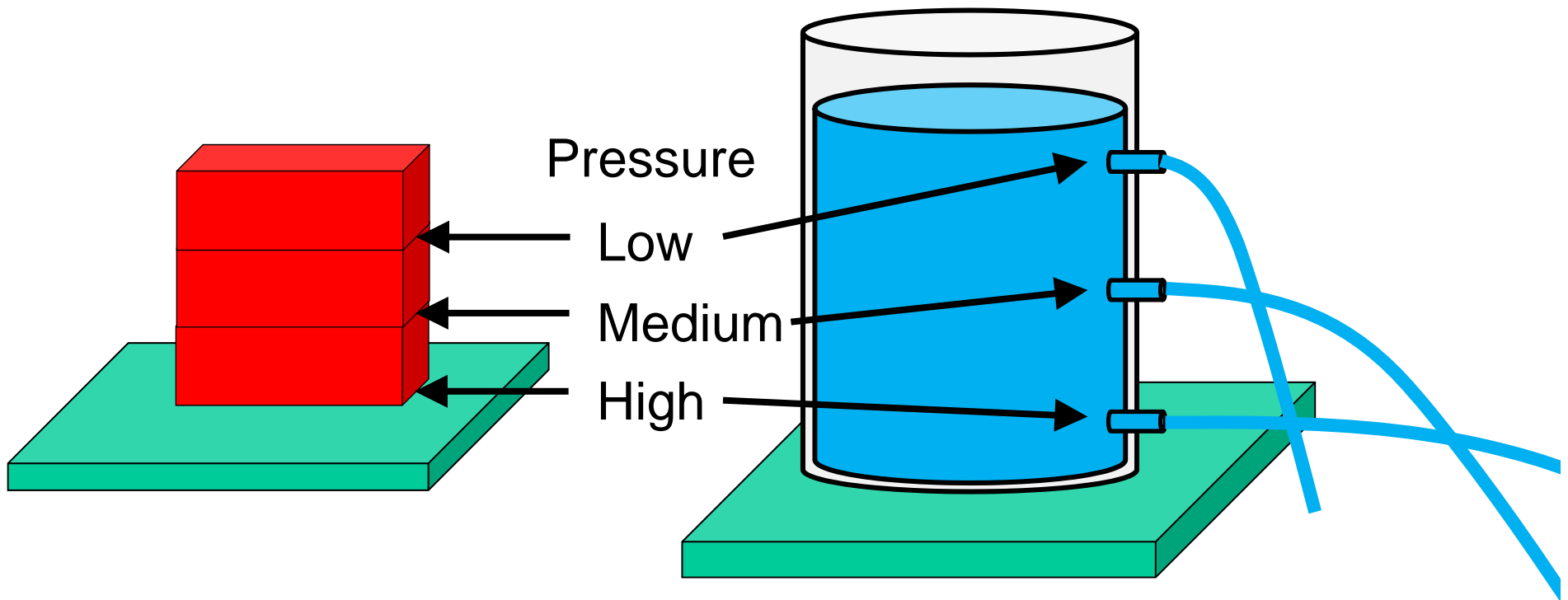


Case B. Same force but smaller area.



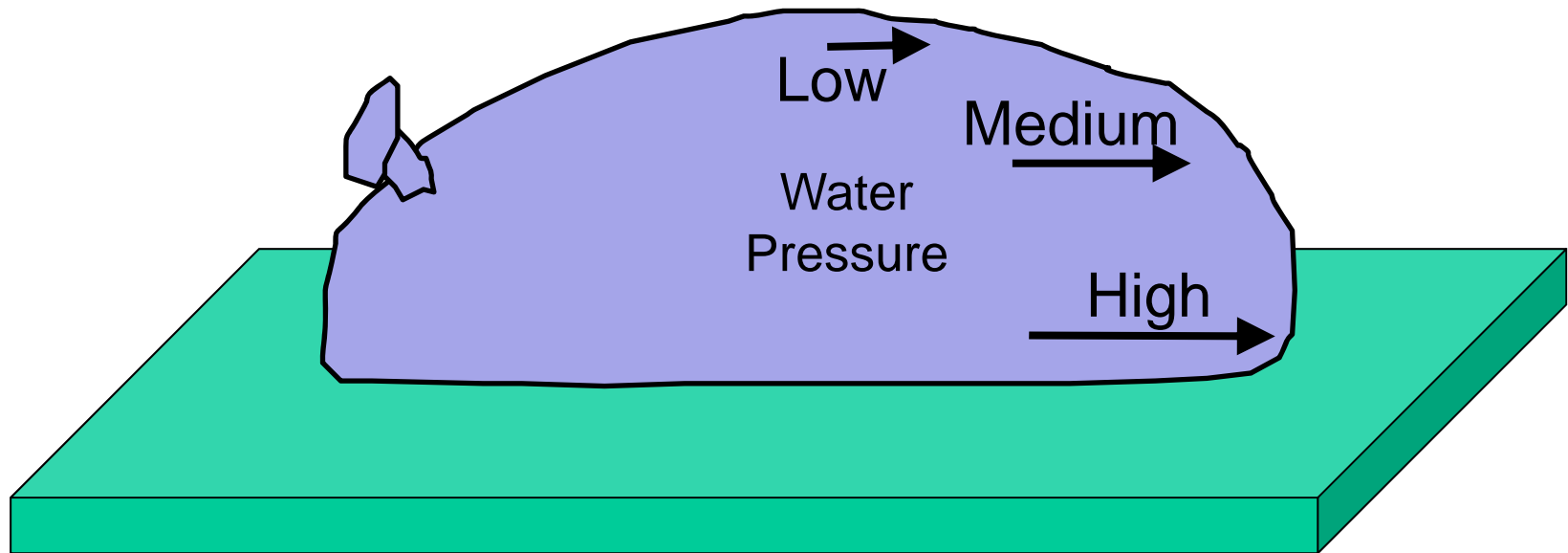
Pressure in Liquids

Pressure in a liquid depends on depth.
As with a stack of bricks, the weight of what's above determines pressure.



Water Balloon at Rest

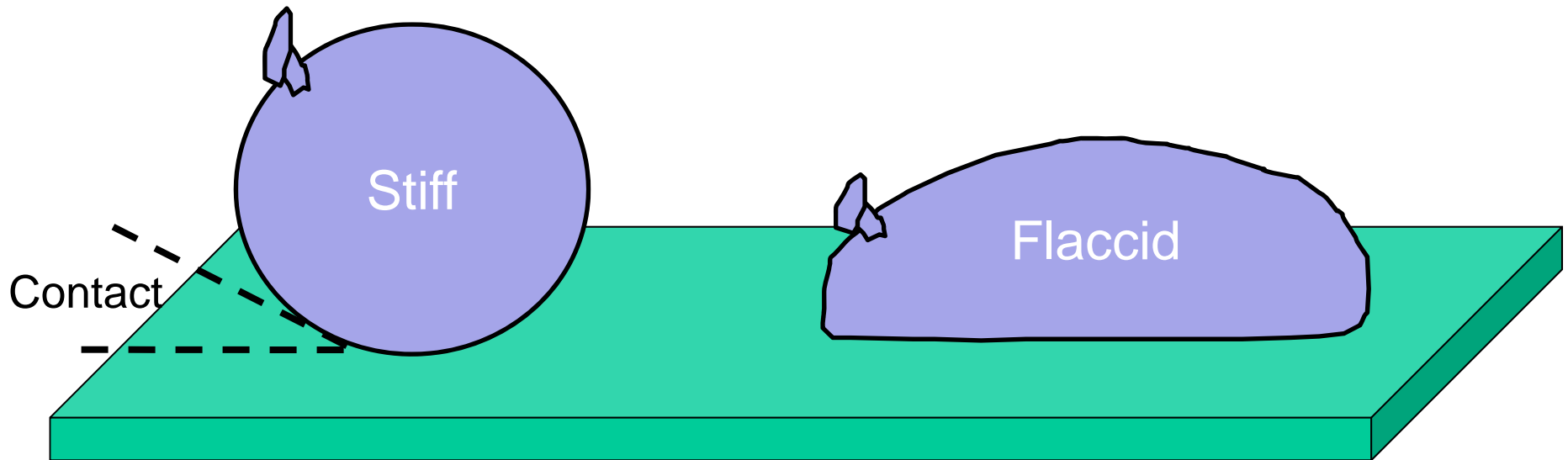
Water pressure pushes on the rubber, stretching it into a flattened shape.



Tension of the rubber also affects the shape.

Repose Angle and Contact Angle

Water balloon has a contact angle that depends on the water pressure and the rubber's stiffness.



Beads of liquid have similar shapes, depending on surface tension.



Pressure & Free Fall

Drop a can full of water with a hole in the side.

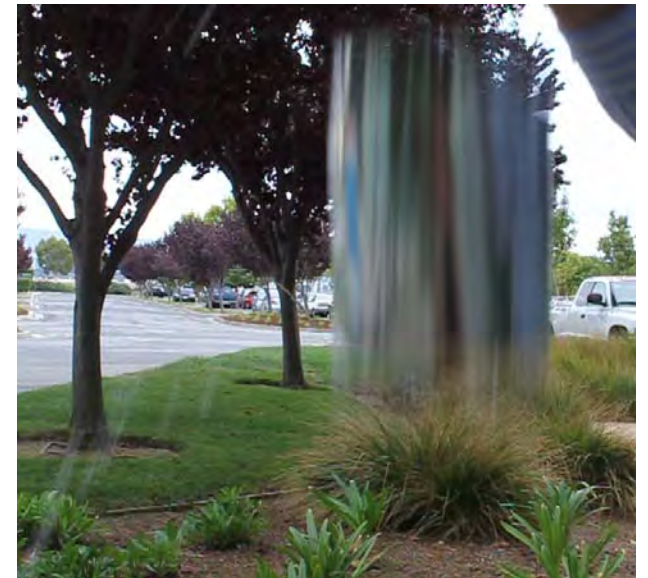
The falling can is weightless so the flow stops since the pressure is due to the water's weight.



Water is flowing

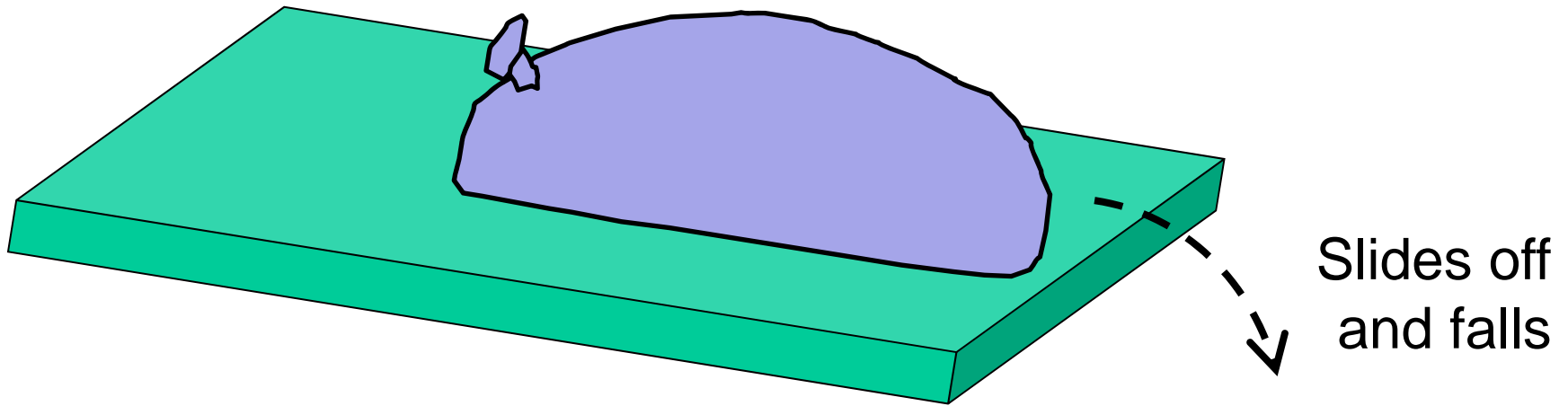


Release the can

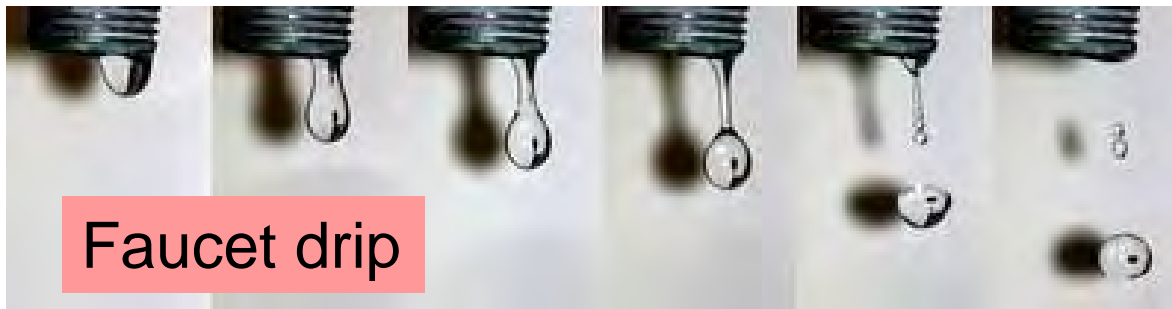


Water stops flowing

Falling Droplets and Balloons



Because freefall is a weightless state, droplets and water balloons are roughly spherical as they fall.



Summary

- Gases (like air) and liquids (like water) are called fluids because they flow.
- Pressure is related to force and it's useful for understanding motion involving fluids.
- Pressure is defined as the amount of force per area, such as pounds per square inch.
- The pressure in a fluid increases with depth due to the weight of the fluid.
- Pressure differences in a fluid disappear during weightless free fall.